RESEARCH RESONANCE

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Preface

Welcome to the Inaugural Issue of the **Research Resonance** - The Research Bulletin of GM University.

It is with great pleasure that we introduce the inaugural edition of the "Research Resonance". This publication marks a significant milestone in our ongoing efforts to foster a vibrant research culture at GM University. As a multidisciplinary journal, the GMU Research Bulletin aims to provide a comprehensive platform for the dissemination of high-quality research and scholarly work across a broad spectrum of academic disciplines.

Our university is home to a diverse and talented community of researchers, educators, and students who are dedicated to pushing the boundaries of knowledge and innovation. This bulletin seeks to capture and showcase their contributions, offering insights into the latest developments and cutting-edge research in fields such as Computer Science, Information Science, Artificial Intelligence, Internet of Things, Information Security, Civil Engineering, Mechanical Engineering, Biotechnology, Electronics and Communication Engineering, and Electrical and Electronics Engineering and many more.

The launch of the "Research Resonance" comes at a time when the exchange of ideas and collaborative research are more critical than ever. By bringing together a wide array of research topics and perspectives, we aim to inspire new ideas, encourage interdisciplinary collaborations, and contribute to the advancement of science and technology.

We are grateful to all the authors, reviewers, and editorial board members whose hard work and dedication have made this first issue possible. Their contributions are a testament to the academic rigor and excellence that GM University strives to uphold. We also extend our heartfelt thanks to our readers for their interest and support.

We hope that you find this inaugural edition both informative and inspiring, and we look forward to your continued engagement with the Research Resonance as we embark on this exciting journey together.

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Voice of the World – Multilingual Video Dubbing Through AI Localization

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ABSTRACT

Dubbing is the process of replacing original dialogue with translated versions. Currently there is time-consuming and costly nature of manual dubbing while enhancing accessibility and viewer experience. By breaking language barriers, it promotes global cultural exchange and redefines how we engage with video content across diverse audiences. The work begins with audio extraction from source videos and the separation of vocals from background audio. Utilizing advanced speech recognition through the Deepgram API, vocal content is transcribed into text, capturing speaker information and timing details. Microsoft's Edge Text-to-Speech Engine then transforms recognized text into lifelike audio, preserving emotional depth. Open-source Voice Cloning technology is employed to recreate original voices, enhancing authenticity. Dubbed audio is seamlessly merged with source video, ensuring synchronization. For multilingual output, the process customizes dubbing based on language preferences while maintaining original voices authenticity. The results demonstrate significant advancements in multilingual video dubbing. Through automation and advanced technology integration, the project achieves precise synchronization between dubbed audio and video content. Additionally, customization of voices for each character enhances authenticity. The user-friendly interface ensures seamless interaction for content creators, facilitating efficient dubbing processes. In conclusion, the project represents a pioneering effort in automating multilingual video dubbing. The user-friendly interface streamlines content creation, while rigorous testing ensures quality and reliability.

Keywords: Speech Recognition, Text-to-Speech Synthesis, Voice Cloning, Audio Extraction, Synchronization.

I. INTRODUCTION

In today's interconnected world, where digital content knows no boundaries, the demand for multilingual communication in multimedia has surged exponentially. As globalization continues to blur geographical borders and cultural barriers, the need to create content that resonates with diverse audiences in their native languages has become increasingly paramount. However, the process of multilingual content creation, particularly in the realm of video dubbing, presents formidable challenges that traditional methods struggle to address effectively. The current landscape is characterized by labour-intensive workflows, costly production processes, and often subpar results that fail to capture the nuances and authenticity of the original content. This has led to a growing demand for innovative solutions that can automate and enhance the video dubbing process while delivering high-quality results that preserve the emotional depth and cultural authenticity of the original voices.

The Voice of the World initiative emerges as a pioneering effort to tackle the complexities of multilingual video dubbing through the integration of

cutting-edge technologies and advanced methodologies. At its core, the initiative seeks to revolutionize the way multilingual content is created by leveraging artificial intelligence (AI) and machine learning (ML) techniques to streamline the dubbing process and ensure seamless synchronization between audio and video elements. By harnessing the power of speech recognition, text-to-speech conversion, and voice cloning technologies, the initiative aims to empower content creators with the tools and resources they need to produce compelling, culturally relevant content in multiple languages.

Central to the success of the Voice of the World initiative is its methodology, which is grounded in a deep understanding of the complexities inherent in multilingual content creation. The initiative adopts a systematic approach to dubbing, breaking down the process into discrete steps that can be optimized and automated using AI-driven algorithms and techniques. Through a combination of proprietary software tools and open- source frameworks, the initiative is able to extract, transcribe, synthesize, and synchronize audio and video elements with remarkable precision and efficiency. Key to the effectiveness of the Voice of the World initiative is its architecture, which is designed to facilitate seamless integration of various components and ensure efficient processing of multilingual dubbing tasks. The architecture comprises a modular framework that enables scalable, flexible, and maintainable dubbing workflows, allowing for easy customization and adaptation to different use cases and requirements. By establishing well- defined interfaces between modules and components, the architecture ensures smooth data flow and communication, minimizing latency and maximizing performance.

The literature survey encompasses a comprehensive exploration of voice cloning; a burgeoning field propelled by advancements in deep learning and AI technologies. Beginning with Gowda et al.'s study [1], the focus is on real-time voice cloning, highlighting a novel three-stage pipeline that reduces the data requirement to mere seconds of reference speech. This breakthrough not only promises cost-effectiveness but also emphasizes the potential for natural-sounding results, crucial for effective voice cloning. Moreover, the paper underscores the transformative impact of real-time voice cloning technology on human-computer interaction paradigms across various sectors, envisioning a future of seamless and engaging audio-based platforms. Similarly, González- Docasal and Álvarez [2] delve into methods for enhancing voice cloning quality, particularly addressing challenges posed by low-quality datasets. Their study emphasizes the importance of high-quality input data and proposes data curation techniques to optimize voice-cloning systems, showcasing significant improvements, especially for challenging datasets. Zeng [3] contributes to the literature by providing an overview of deep learning applications in automatic speech recognition (ASR). The paper outlines the evolution of ASR systems, highlighting the transition from traditional models to deep learning-based approaches, which have proven effective in processing large amounts of unlabeled speech data. Various deep learning models utilized in ASR, including CNNs, CTC, RNN-T, and LAS, are discussed, along with their advantages and limitations.

Moreover, Yang et al.'s work [4] on large-scale multilingual audio-visual dubbing offers valuable insights into addressing challenges inherent in multilingual content localization. The paper's emphasis on voice cloning techniques and audio-visual synchronization aligns closely with the objectives of AI-enhanced multilingual dubbing projects, demonstrating practical methodologies for achieving high-quality multilingual content. Additionally, previous works by Zeru [5], Wissmath et al. [6], Liao et al. [7], Cooke et al. [8], and Nagrani et al. [9] further contribute to the understanding of voice cloning, ASR, and related technologies, collectively enriching the literature and paving the way for future advancements in the field.

One of the primary motivations for research in this domain is the desire to overcome language barriers and facilitate communication and collaboration across different linguistic communities. Language is a fundamental aspect of human identity and culture, and yet, it can often serve as a barrier to understanding and engagement, particularly in online environments where content is predominantly available in a few dominant languages. By developing technologies that enable the seamless translation and localization of digital content, researchers aim to democratize access to information and promote inclusivity and diversity in the digital space.

Another key motivation for research in multilingual content creation is the economic and commercial potential associated with tapping into global markets. As businesses and organizations seek to expand their reach and attract audiences from diverse linguistic backgrounds, the ability to create and deliver content in multiple languages becomes a strategic imperative. Multilingual content not only enhances the accessibility of products and services but also fosters trust and engagement among international audiences, ultimately driving business growth and success in global markets.

Furthermore, the rapid advancement of artificial intelligence and machine learning technologies has opened up new possibilities for automating and optimizing the content creation process. By harnessing the power of machine translation, speech recognition, and natural language processing, researchers can develop innovative solutions for generating and localizing content at scale, reducing the time and resources required for manual translation and adaptation. Moreover, the increasing demand for personalized and immersive digital experiences has fueled interest in technologies such as voice cloning and synthesis. These technologies offer the potential to create highly engaging and interactive content experiences tailored to individual preferences and cultural sensitivities. Whether it's providing personalized virtual assistants, narrating audiobooks in multiple languages, or dubbing video content with authentic and expressive voices, voice cloning and synthesis technologies hold promise for revolutionizing the way we consume and interact with digital media.

Overall, the motivation behind research in multilingual content creation is driven by a combination of societal, economic, and technological factors. By addressing language barriers, fostering inclusivity, and leveraging advanced technologies, researchers aim to create a more connected, accessible, and culturally diverse digital landscape that benefits individuals, businesses, and communities around the world.

II. METHODS AND MATERIAL

Before delving into the step-by-step breakdown of the methodology for automating and enhancing the video dubbing process represented in Figure 1, it's essential to grasp the overarching concept and significance of each stage. Video dubbing, the process of replacing original audio tracks with translated or re-recorded dialogue, involves a series of meticulously orchestrated steps to ensure seamless integration of new audio while preserving the integrity and authenticity of the original content. Each stage of the methodology plays a critical role in this intricate process, from initial audio extraction and separation to advanced speech recognition, synthesis, and quality assurance testing. Additionally, user interface design considerations are paramount for facilitating smooth interaction and accessibility, ensuring that both content creators and viewers can engage with the dubbing system effortlessly. By understanding the purpose and intricacies of each step, we can appreciate the complexity of modern dubbing technology and its role in delivering immersive, multilingual content to diverse global audiences.

Audio Extraction

Audio extraction is the initial step in the video dubbing process, involving the separation of audio tracks from video files. This process is essential for isolating the audio content that will undergo further processing for dubbing purposes. Video processing techniques are utilized to extract the audio track from the input videos. In the preliminary stage of the video dubbing process, audio extraction serves as the cornerstone, facilitating the segregation of audio tracks from their accompanying video files.

This fundamental step is paramount, as it lays the groundwork for subsequent processing aimed at enhancing and refining the dubbed content. Leveraging advanced video processing techniques, including the integration of libraries such as MoviePy, enables the extraction of audio streams from diverse video formats with utmost precision and efficiency.

Through the utilization of sophisticated algorithms embedded within these libraries, the digital information encapsulated within video files undergoes meticulous analysis, allowing for the isolation and extraction of the audio component. Techniques such as demuxing and decoding are seamlessly integrated into the extraction process, ensuring the seamless separation of audio from video frames while preserving the integrity of both elements.

The incorporation of the MoviePy library, renowned for its robust capabilities in video manipulation and processing, further amplifies the efficiency and versatility of the extraction process. As a result, the dubbing workflow benefits from enhanced flexibility in handling a myriad of video formats, thus streamlining subsequent stages of audio processing and ultimately contributing to the seamless integration of dubbed content with visual media.

Vocal and Background Separation

In the vocal and background separation stage of the dubbing process, the utilization of advanced audio processing techniques, notably leveraging the capabilities of the Spleeter Python library, is pivotal. This phase is paramount as it aims to meticulously isolate the primary vocal elements, such as speech, from the ambient background audio, encompassing music or sound effects. By segmenting these distinct components, the dubbing process gains substantial refinement, enabling finer manipulation and enhancement of the vocal content. The application of Spleeter Python library augments the sophistication of the separation process, offering an array of specialized tools and algorithms tailored for audio source separation tasks. Through a combination of spectral analysis, frequency filtering, and the intricate mechanisms of machine learning algorithms deeply ingrained within Spleeter's framework, the system adeptly discerns and delineates the intricate nuances between vocal and background elements. Spectral analysis techniques delve into the frequency spectrum of the audio signal, scrutinizing the distinct spectral profiles characteristic of vocals and background noise. This granular analysis allows for precise identification and segregation of vocal components, ensuring a refined separation process. Additionally, frequency filtering mechanisms further augment this segregation, selectively attenuating frequencies associated with background noise while preserving the integrity of vocal frequencies.

Speech Diarization (Deepgram API)

In the process of speech diarization within our methodology, we rely on the Deepgram API's sophisticated capabilities to not only transcribe vocal audio into textual transcripts but also to perform speaker diarization. This advanced functionality allows for the identification of different speakers within the audio, along with the words they spoke and the respective timestamps. When the vocal audio is transmitted to the Deepgram API, it undergoes a comprehensive analysis that includes segmentation, transcription, and speaker diarization.

The JSON response generated by the Deepgram API encapsulates this rich information, detailing the words spoken, the timing of each utterance, and the corresponding speaker. This detailed transcription serves as the foundation for the subsequent dubbing steps, facilitating the seamless integration of voiceover and dubbing elements into our video content. Figure 2 illustrates a sample JSON response from the Deepgram API, showcasing the structured format of the transcription output. By leveraging the Deepgram API's speech diarization capabilities, we enhance the granularity and accuracy of our transcription process, laying the groundwork for precise and effective dubbing of our video content.

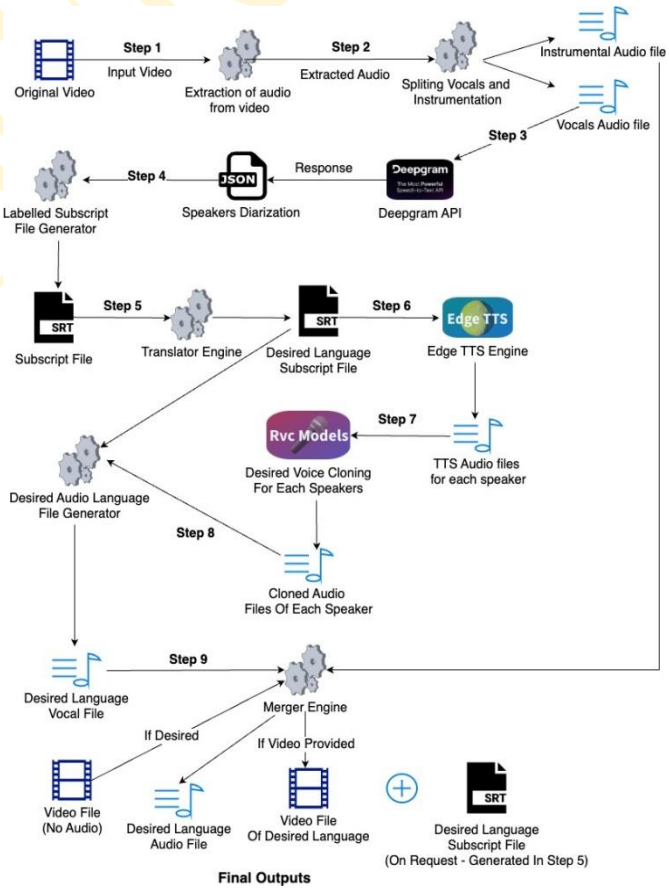

Figure 1: Proposed Methodology

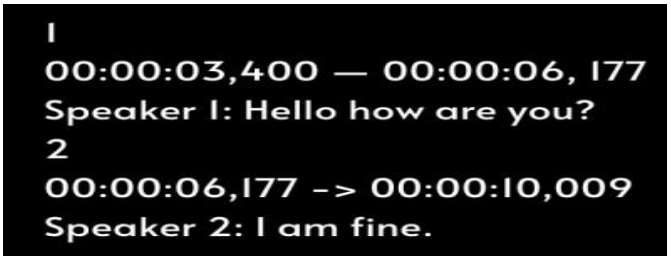

Figure 2: API Response

Speech Transcription and Translation

In the video dubbing process, speech transcription and translation are pivotal steps preceding Text-to-Speech (TTS) conversion, aiming to generate textual transcripts for each speaker's dialogue and translate them into the desired language. Figure 3 illustrates the SubRip (SRT) subtitle files, which provide timestamped captions for each line of dialogue, enhancing viewer accessibility. Moreover, as depicted in Figure 4, an information file is generated to store metadata about the dialogue, including speaker identities, timestamps, and original text. This file serves as a reference for subsequent translation steps, ensuring consistency and accuracy throughout the dubbing process. After separating vocal audio, the system employs speech analysis techniques to identify spoken words and segment them into sentences corresponding to each speaker. Utilizing speaker diarization techniques, multiple speakers in the audio are differentiated. The segmented sentences are then structured into SRT subtitle files, providing visual cues for dialogue comprehension. Concurrently, an information file is created to catalog metadata about the dialogue, laying the groundwork for subsequent translation.

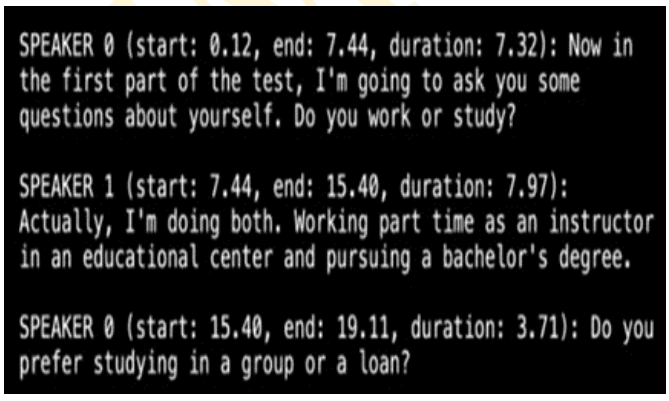

Figure 3: SubRip File after Parsing API Response

Figure 4: Information Data File after Parsing Api Response

Speech translation is initiated by processing the information file through Google Translate API, leveraging machine translation technology for efficient localization. Googletrans API facilitates this translation process, analyzing text syntax and semantics to produce accurate translations in the target language. The translated dialogue is integrated into the Text-to-Speech (TTS) step, replacing the original text input, enabling synthesis of speech in the desired language. Microsoft's Edge Text-to-Speech Engine, or a similar TTS system, is employed to process the translated text alongside speaker information from the information file. The TTS engine synthesizes the translated text into audio waveforms, aligning with speaker characteristics and maintaining coherence with the original dialogue. Subsequently, the translated dialogue is merged with voice cloning and synchronization steps to produce dubbed audio tracks reflecting accurate dialogue in the target language.

Quality assurance measures are paramount throughout the speech transcription and translation process to ensure accuracy and coherence of the translated dialogue. Automated algorithms scrutinize translated text for linguistic precision, grammatical correctness, and cultural relevance. Additionally, human reviewers conduct assessments on translation fluency, readability, and context fidelity.

Discrepancies or errors identified during quality assurance undergo iterative refinement and validation to uphold the highest standards of linguistic quality and

localization accuracy. Figure 5 illustrated the SubRip for target language Figure 6 illustrates the final output – translated information data, incorporating accurate translations of the dialogue into the dubbing process.
Through meticulous attention to detail and rigorous quality assurance, the system ensures seamless integration of translated dialogue, enhancing viewer accessibility and engagement with dubbed content.

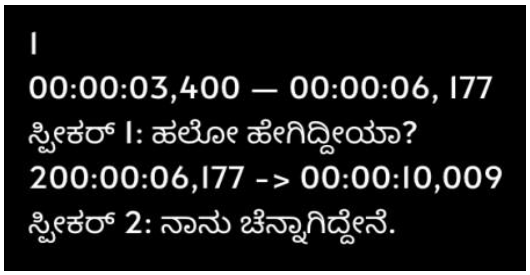

Figure 5: SubRip File after Translation

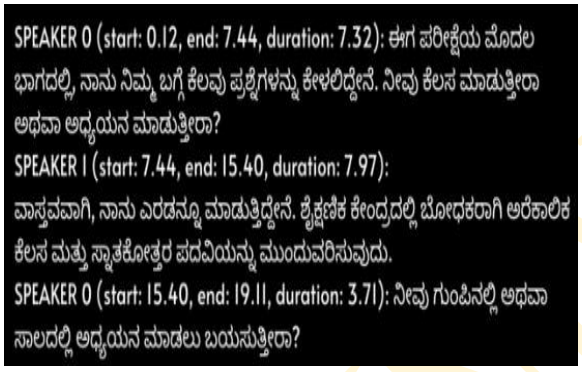

Figure 6: Information Data File after Translation

Text to Speech

The Text-to-Speech (TTS) conversion phase marks a pivotal stage in the video dubbing process, where the synthesized voices breathe life into textual transcripts derived from the preceding step. In this transformative process, the cutting-edge Microsoft's Edge Text-to-Speech Engine emerges as the vanguard, wielding its unparalleled prowess to orchestrate lifelike speech output that resonates with authenticity and clarity. As the textual transcripts, meticulously curated from the speech recognition Endeavor, are fed into the TTS engine, a symphony of algorithms and linguistic analyses ensues. The TTS engine meticulously dissects the textual fabric, unraveling the intricacies of syntax, semantics, and speaker nuances embedded within. Every cadence, intonation, and phonetic nuance is scrutinized with meticulous precision to encapsulate the essence of the original speakers' voices. Yet, the true marvel lies not merely in the synthesis of speech, but in the profound customization afforded by the TTS engine. Here, within the digital realm, the ethereal essence of human voice finds resonance, sculpted by the deft hands of customization. Speaker characteristics, ranging from subtle inflections to pronounced accents, serve as the cornerstone upon which the TTS engine operates. By harnessing a repertoire of parameters such as pitch, tone, and pacing, the TTS engine refines its output to mirror the idiosyncrasies of each speaker with unparalleled fidelity. This meticulous calibration transcends mere mimicry, heralding a new frontier in the realm of dubbing where synthesized voices seamlessly intertwine with the fabric of narrative, breathing life into characters with unparalleled authenticity. As the synthesized audio waveforms take shape, they emerge not as mere echoes of the original, but as vibrant echoes imbued with the essence of their predecessors. The convergence of cutting-edge technology and human expression manifests in the synthesized voices, bridging the chasm between artificiality and authenticity with resounding clarity. Thus, within the crucible of the Text- to-Speech conversion, a transformative alchemy unfolds, where the essence of language finds expression in the symphony of synthesized voices, ushering forth a new dawn in the realm of video dubbing.

Voice Cloning

Voice cloning, a pivotal facet of the dubbing process, encapsulates the intricate Endeavor of crafting personalized voice models for every character portrayed in the video narrative. Its execution relies on the utilization of an open-source Voice Cloning (RVC) tool, meticulously tailored to harness original audio samples as foundational data for model training, thereby facilitating the faithful replication of the nuances inherent in the original speakers' vocalizations. The initiation of this multifaceted process entails the meticulous curation of an ample repository of audio snippets representative of each character's vocal repertoire, serving as the raw material indispensable for model training. These audio excerpts, meticulously curated to encapsulate the breadth and depth of vocal expression, encompass a gamut of emotions, tones, and inflections characteristic of each character's persona, thereby laying the groundwork for an authentic emulation of their speech patterns.

As the training regimen progresses, the voice models evolve, imbibing a rich tapestry of vocal characteristics that mirror the idiosyncrasies of the original speakers with remarkable fidelity. Leveraging the insights gleaned from the amalgamated audio samples, the models assimilate an intricate understanding of the subtle nuances embedded within each utterance, thus culminating in the synthesis of synthetic speech that bears an uncanny resemblance to its human counterpart. The culmination of this arduous process yields voice models that stand as paragons of verisimilitude, poised to infuse the dubbed content with a sense of authenticity and immersion hitherto unparalleled in conventional dubbing endeavours.

Indeed, the advent of voice cloning technology heralds a paradigm shift in the realm of audio-visual production, empowering dubbing aficionados to embark upon a transformative journey wherein the boundaries of realism and immersion are transcended with unparalleled finesse. Through the judicious application of machine learning algorithms and the astute curation of audio data, the dubbing process emerges as an art form in its own right, wherein the nuances of vocal expression are not merely replicated, but rather elevated to the realm of artistic veracity. As the synthesized voices reverberate across the cinematic landscape, they serve as testaments to the boundless potential inherent in the convergence of technology and artistic expression, embodying a synthesis of innovation and tradition that resonates with audiences on a profound and visceral level. The original video frames seamlessly. FFmpeg offers functionalities for muxing (combining) audio and video streams while preserving synchronization. By specifying the input audio and video files along with their respective timestamps, FFmpeg ensures that the dubbed audio aligns precisely with the lip movements and gestures of the characters.

In addition to FFmpeg, the rubber band tool is utilized for maintaining synchronization when merging translated or dubbed audio chunks. The rubber band tool is a time-stretching and pitch-shifting library that provides high-quality audio processing capabilities. When merging dubbed audio chunks with the original video, maintaining the time duration is crucial to ensure proper synchronization between audio and visual elements. The rubber band tool offers features for adjusting the tempo and pitch of audio segments while preserving their duration. By applying appropriate time-stretching algorithms, the tool ensures that the dubbed audio aligns accurately with the timing of the original dialogue, maintaining coherence and realism in the dubbed content.

Overall, the combination of FFmpeg for video processing and the rubber and tool for audio manipulation enables efficient and accurate merging of dubbed audio tracks with video content. Through precise synchronization techniques and advanced processing capabilities, these tools contribute to the seamless integration of translated or dubbed content into multimedia presentations, enhancing the viewing experience for audiences worldwide.

III. RESULTS AND DISCUSSION

In this section, the multilingual output aspect of the dubbing system is explored in-depth, emphasizing its importance in catering to diverse language preferences among viewers. This customization process involves meticulous adjustments of both text-to-speech settings and voice models to ensure that the dubbed content seamlessly aligns with the linguistic characteristics of the target languages while preserving the authenticity of the original voices.

In the context of merging dubbed audio tracks with video content, Fmpeg plays a crucial role in synchronizing audio and video streams. After generating the dubbed audio tracks through text-to-speech synthesis and voice cloning, the next step is to combine them within this framework; the dubbing system prioritizes flexibility, allowing users to choose from a wide array of target languages for the synthesized audio. This adaptability enhances accessibility and inclusivity, enabling viewers from different linguistic backgrounds to effectively engage with the content.

Text-to-speech settings play a crucial role in this process, determining the linguistic nuances and pronunciation rules employed in generating speech output. By tailoring these settings to each target language, the system produces accurate and natural-sounding speech, enriching the overall viewing experience for global audiences.

Furthermore, the integration of voice cloning models enhances the multilingual capabilities of the dubbing system. These models undergo rigorous training or adaptation processes to capture the unique vocal characteristics of each speaker in the target language. Leveraging advanced voice cloning technology ensures that the dubbed voices closely resemble those of the original speakers, maintaining consistency and authenticity across different language versions of the content.

The implementation of a dash media player in the frontend serves as a pivotal enhancement to the multilingual capabilities of the dubbing system. This dynamic player allows users to seamlessly switch between subtitle and audio tracks, providing unparalleled flexibility in navigating multilingual content. Additionally, compatibility with popular video players such as VLC ensures a seamless playback experience across various platforms, further enhancing accessibility and user experience.

Moving on to the results section, a detailed overview of various screens and interfaces integral to the functionality and management of the Voice of the World project is provided. Each of these screens offers valuable insights into different stages of the project workflow, providing users with essential tools for content creation, management, and playback. In conclusion, our project has effectively achieved its objectives in advancing digital forensics and content authentication. We introduced a novel CNN architecture for image forgery detection and proposed the FIDAC dataset, demonstrating enhanced accuracy through dataset combination. Our CNN architecture showed competitive performance against established classifiers, underscoring its efficiency. By meeting objectives of detecting forged images and videos and establishing a user-friendly content analysis portal, our project significantly contributes to digital forensics. Through further refinement, we aim to ensure integrity and authenticity across various applications, thus making a meaningful scientific contribution.

Figure 7: Video Upload

The Creator/Admin Side Video Upload Screen (Figure 7) serves as the primary entry point for creators and administrators to upload video files. This screen facilitates seamless addition of new content to the platform, allowing users to select and upload video files directly.

Next, the Processing Video Screen visually represents the processing stage, where the system extracts audio from uploaded videos and obtains transcripts. This screen offers a comprehensive overview of backend processes involved in preparing video content for further processing and dubbing.

Moving on to the Speaker Information Screen (Figure 8), administrators gain access to crucial details about speakers present in the uploaded video. This screen displays information such as the number of speakers detected, their names, genders, and the list of languages to be dubbed, facilitating effective organization and customization of the dubbing process.

Figure 8: Speakers Information

Figure 9: Edge TTS Voice Model Selection

The Edge TTS Voice Model Selection Screen (Figure 9) allows administrators to select suitable Edge TTS voice models for each speaker based on their gender. This screen ensures that the dubbed audio aligns with the gender characteristics of the original speakers, enhancing the authenticity of the dubbing process.

Similarly, the RVC Voice Model Selection Screen enables administrators to choose RVC voice models for each speaker based on their gender. This screen provides additional customization options for achieving desired voice characteristics in the dubbed content, further enriching the multilingual capabilities of the dubbing system. Moving on to the Dubbing Processing Screen, users gain insight into the dubbing processing stage, where the system generates multilingual dubbed audio tracks based on selected voice models and transcripts. This screen visually represents the transformation of original audio content into multilingual versions tailored to specific languages and speakers.

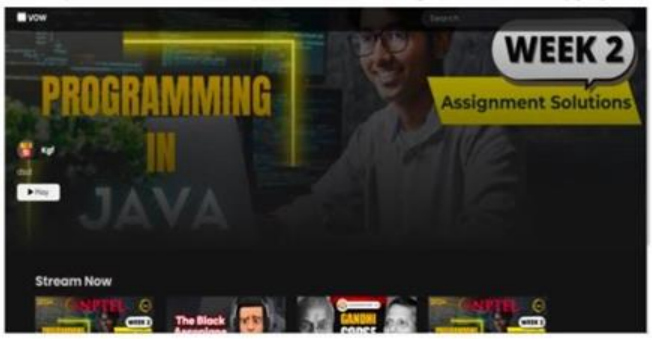

Figure 10: Dashboard Screen

The Streaming Dashboard Screen (Figure 10) serves as a centralized hub for managing and accessing video content within the system. This screen provides users with an overview of all uploaded videos, allowing them to browse, select, and stream videos for playback or dubbing purposes.

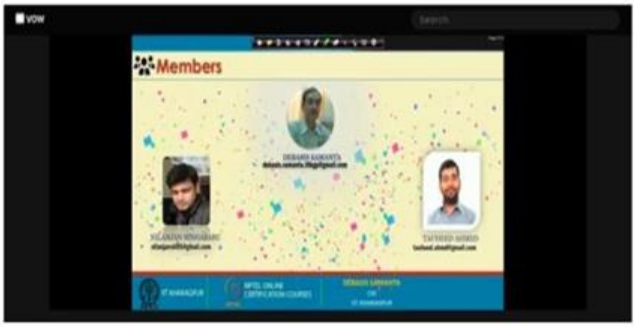

Figure 11: Streaming Screen

Next, the Streaming Screen (Figure 11) offers users a dedicated viewing interface where they can watch selected videos along with any associated dubbing or subtitles. This screen provides controls for playback, volume, and other viewing options, ensuring a seamless viewing experience.

Figure 12: Player Settings – Subtitles

Moving on to the Player Settings - Subtitles (Figure 12), users gain the ability to adjust subtitle settings during video playback. This screen allows users to toggle subtitles on or off, change subtitle languages, or customize subtitle appearance to suit their preferences.

Figure 13: Player Settings – Dubbed Audio selection

Similarly, the Player Settings - Dubbed Audio Selection (Figure 13) allows users to modify audio settings related to dubbed content during video playback. This screen empowers users to switch between different dubbed audio tracks, adjust volume levels, or enable/disable specific audio channels as per their preferences, further enhancing the flexibility of the viewing experience.

Figure 14: Django Admin Interface

Lastly, the Django Administration Interface (Figure 14) serves as a backend management tool, providing super admin access to view and manage database contents. This interface offers functionalities for data administration, user management, content moderation, and system configuration, ensuring efficient backend operations and system maintenance.

IV. CONCLUSION

In conclusion, the research has unveiled the intricacies and advancements in the Voice of the World project, which aims to revolutionize the video dubbing process by integrating cutting-edge technologies and methodologies. The emphasis on multilingual output underscores the project's commitment to catering to diverse language preferences among viewers, thereby enhancing accessibility and inclusivity on a global scale. Through meticulous adjustments of text-to-speech settings and voice models, the dubbing system ensures that the synthesized audio aligns seamlessly with the linguistic characteristics of target languages while preserving the authenticity of original voices. The integration of voice cloning models further enriches the multilingual capabilities of the system, enabling the accurate replication of speakers' voices across different linguistic backgrounds. Leveraging advanced voice cloning technology ensures consistency and authenticity in dubbed content, reinforcing the viewer's connection with the original speakers.

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Development and Performance Analysis of Silk Fiber Reinforced Composite for Lower Limb Prosthesis

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ABSTRACT

Composite silk fiber for limb prosthetics the leading edge of the prosthetic limb technology is one of the best demonstrates the silk unique strength, stiffness and their biocompatibility basis, and they mimic the mechanical property of the natural tissues and it leads to the considerable improvement of mobility and functionality of amputees. The creation of silicon-reinforced low limb prostheses as an example of new achievements, efficient testing in tension, bending, and moisture characteristics are only small part of the big picture – the whole innovative process. In addition to mechanical benefits, silk's ability to be broken down and carry no toxins limit to some degree on long term health risks and environmental effects. The sequential process that forms a mold and tests the product material is an important step towards determining sturdiness and functionality of these prosthetic parts. As research moves forward, silk fiber composites create prospect for these kind of individualized prostheses as well as participation in more effective rehabilitation procedures, bringing significant improvement of patient results and quality of life.

Keywords: Natural Fiber composite, Prosthetic lower limb, Mechanical Properties, Orthopedic application.

I. INTRODUCTION

The apprehension of composite materials is aimed at blending different materials to achieve enhanced performance unattainable by individual constituents, typically consisting of a reinforcing medium and a matrix medium. These materials are classified by reinforcement type, such as polymer, cement, and metal matrix composites, with the matrix playing a crucial role in performance. Examples include straw-reinforced mud, carbon black in rubber, and steel rods in concrete, while natural composites like cellulose fibers in wood and collagen fibers in bone also exist [1].

Due to increased exploitation of natural resources, the use of natural fibers for reinforcement in composites has risen, with fibers like flax, jute, hemp, and silk offering advantages over synthetic fibers. Natural fibers are categorized into mineral-based, plant-based, and animal-based, providing eco-friendly, renewable, and biodegradable options. Composite classifications extend to particulate, fibrous, and laminated types, with specific categories like Metal Matrix Composites (MMC), Ceramic Matrix Composites (CMC), and Polymer Matrix Composites (PMC). The mechanical properties of these composites are influenced by fiber characteristics and the fiber-matrix interface, with silk fiber composites being notable for their high strength-to-weight ratios and suitability for various applications due to their exceptional tensile strength, durability, and biodegradability [2].

The apprehension of composite materials is cantered on the idea of combining different materials to achieve enhanced performance characteristics that are unattainable by the individual constituents alone. Typically, a composite material consists of two primary components: a reinforcing medium and a matrix

medium. The reinforcing medium, often fibrous, provides strength and rigidity, while the matrix medium, usually more ductile, helps to hold the reinforcement together and distribute loads evenly across the structure [3].

Composite materials are classified based on the type of reinforcement used. Common categories include polymer matrix composites (PMCs), cement matrix composites, and metal matrix composites (MMCs).

Each type of matrix plays a crucial role in defining the overall performance of the composite. For instance, PMCs often incorporate materials like carbon fiber or glass fiber to achieve a high strength-to-weight ratio, making them ideal for aerospace and automotive applications [4]. Examples of composite materials are abundant and varied. Historical examples include straw-reinforced mud bricks used in ancient construction, which exhibited increased tensile strength and durability.

In the modern era, carbon black is added to rubber to improve its wear resistance and tensile strength, commonly used in tires. Steel rods, or rebar, are embedded in concrete to enhance its tensile strength and ductility, creating reinforced concrete that is a staple in contemporary construction [5].

Natural composites also exist, such as cellulose fibers in wood, which provide structural integrity and flexibility, and collagen fibers in bone, which impart strength and toughness.

The study and application of composite materials are essential in numerous fields, as they offer tailored properties that meet specific engineering requirements. By understanding and leveraging the synergistic effects of different materials, engineers can design and fabricate structures and components that are lighter, stronger, and more durable than those made from conventional materials alone.

II. METHODS AND MATERIAL

The materials which are selected for this present work for preparation of composites and mold are mentioned below:

- ❖ Reinforcing material as SILK fiber.
- ❖ Matrix material as epoxy resin (L-12 and K-6).
- ❖ Plastic, Aluminum foil and synthetic socks for preparation of mold.

Table 1: Percentage composition of materials in composites

Reinforcement	Matrix	Composition
60%	40%	100%
Silk fiber	Epoxy Resin	composite

Epoxy resin:

Epoxy resin Lapox-12 (L-12) is used as matrix material and for this a suitable hardener K-6 is used, Epoxy is a non-crystalline material under room temperature condition and it delivers a good resistance to alkali and adhesive properties. Hardener IS used as curing agent; it is mixed with epoxy with the ratio of 10:l. Epoxy resin usually made by retaliate epichlorohydrin with bi-phenol, which are linear polymers that developing thermosetting resins mainly by the reaction with the hardeners [l].

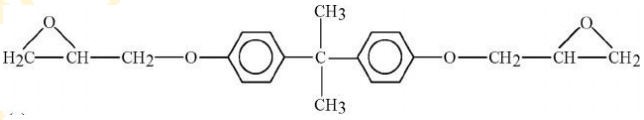

Figure 1: Chemical structure of Epoxy resin

Preparation of mold:

We have devised a form from plastic pipes of different sizes. One of the two pipes was fitted inside the other and then cut and bent so that the top part was wider than the bottom part creating a shape like that of a lower leg. After that we made an addition to this construction by placing an artificial sock filled with waste at its base and fixing it there. This gave the design a more complete look like that of a leg from the knee downwards. To make the shape of the leg even more lifelike, we wrapped the mould in aluminium foil and stuck it down with cello tape. So doing enabled us to get a natural-looking limb while using only simple materials and methods.

Hand Lay-up method:

Making a silk fiber composite involves applying a thin layer of mould release agent on the surface of the mould for the initial stage. This agent is the reason that the composite does not stick to the mould, so that it can be removed after the curing process. After that, place the silk fibers gently onto the mold carefully until they are evenly spread and distributed properly. Several layers of fibers are added to bulk and reinforce a composite. The fibers are then soaked in a resin mixture using a brush or a roller to ensure that all the fibers are completely saturated. It is the one which acts as the matrix for the fibers to be held together and provide the structural strength. Press lightly upon the fiber and resin layers to get rid of the air bubbles that can be seen among the fibers and resins, thus giving the composite structure uniform and solid shape. The method of layering fibers and resin is repeated until the desired thickness of the composite is reached. It's very important to achieve full resin immersion in each of its layers to create a joint stronger by molecular level. After the lay-up process is finished, clean the remaining resin from the surface with a sponge or roller brush to avoiding dripping and uneven surfaces. This precise layering and impregnation process give rise to a strong, durable and also uniform silk fiber composite.

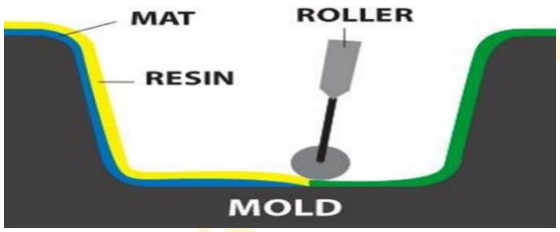

Figure 2: Hand Lay-Up method

Mechanical Tests:

Bending test:

Bending test is an integral part of the material characterization process which is especially useful to study the materials' response to the bending forces and estimate their flexibility, strength, and resistance to deformation. These tests are very widely used in industries like manufacturing, quality checks, and product design. This refined process entails exposing materials to controlled motions as well as parameters such as load, deflection, stress and strain in order to find out their mechanical properties like flexural strength, flexural modulus and toughness. This information contributes to material procurement, product design, and quality confirmation processes in such a way that bend tests are considered important in endurance testing of many product lines. ASTM D790 is a test procedure that has been adopted as a standard for the evaluation of the various flexural properties of the reinforced and unreinforced plastics.

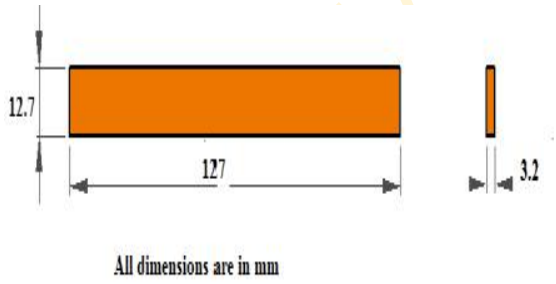

Figure 3: Bending test specimen dimensions

Tensile test:

Tensile tests are the basis of materials science and engineering because the way materials react under tensile (pulling) stress belongs to the universal laws of physics. The main purpose of these tests is to determine the extent of the material's resistance to elongation, bending, and the development of cracks when exposed to stress or loads, which help to evaluate the mechanical properties of a material. Tensile tests, especially, are in great demand, by many industrial sectors including manufacturing, product development, and quality control. Through the utilization of controlled loads to a sample with a later measurable response, mechanical properties like ultimate tensile strength, yield strength, modulus of elasticity, and elongation at fracture can be determined by engineers and researchers. ASTM D638 is one important test method used in evaluating the plastic characteristics with detailed instructions on how to evaluate the strength, elongation and modulus of elasticity of tension force.

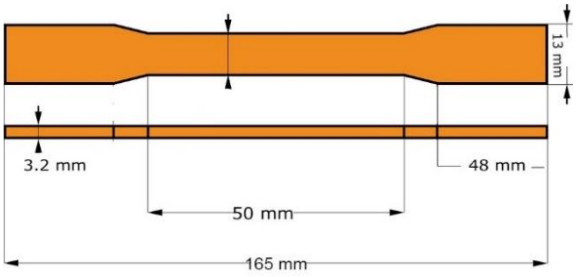

Figure 4: Tensile test specimen dimensions

Moisture absorption test:

Moisture test is extremely useful in fields like material science and manufacturing where the primary aim is to identify how much water or moisture a material possesses. The central role of this testing lies in the determination of moisture content of materials by controlling the drying conditions and weighing simultaneously which shows the moisture change in the sample. This test matters a lot when it comes to assessing the property, quality or applicability in different situations. ASTM D5229 serves as the test method for water absorption measurement in fiber-reinforced polymer matrix composites.

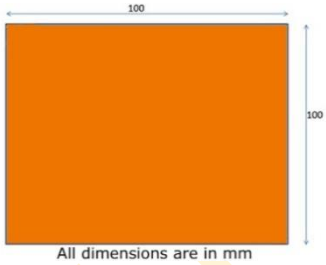

Figure 5: Moisture absorption test specimen dimensions

III. RESULTS AND DISCUSSION

Bending test:

The bending test results, taken from our silk fiber composite samples that were prepared according to ASTM D 790, give us the important information about the mechanical behaviour of the material. Out of the samples that were tested, SE-1 had the highest bending load of 243. 18 N, which means it has a better stiffness and strength than SE-2 and SE-3. SE-2 was the second one with a bending load of 227. 31 N, which means it has the same but slightly lower stiffness or strength. SE-3 demonstrated a slightly lower bending load of 221. 49 N, meaning it possibly has a slightly lower stiffness or strength than the other samples. In the aspect of maximum displacement before fracture, SE-1 and SE-2 showed the same flexibility, with maximum displacements of approximately 31. 5 mm, SE-3, on the other hand, had a slightly lower maximum displacement of 29. 21 mm. These results collectively show that although SE-1 and SE-2 have higher strength and the same flexibility, SE-4 is a bit weaker than the other two but still has acceptable mechanical properties. In general, this analysis helps in material selection, design optimization, and quality control, thus, it is possible to develop high-performance composite materials which are suitable for various applications.

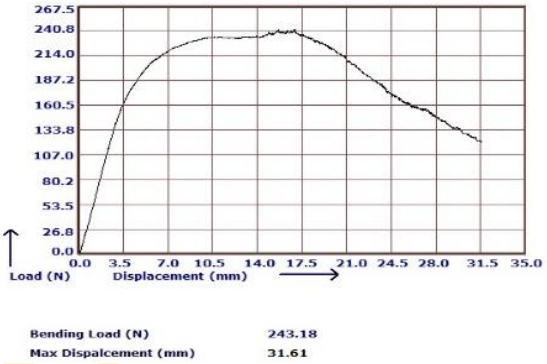

Figure 6: Load vs displacement graph for bending test sample

Tensile test result:

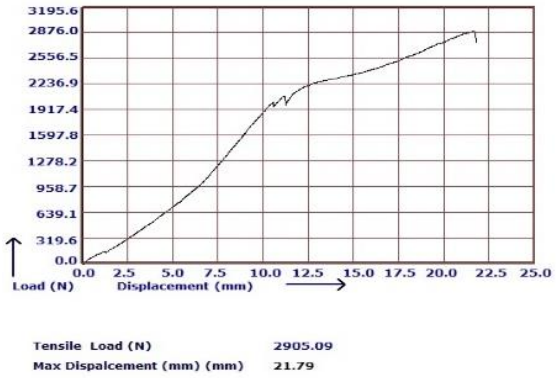

Figure 7: Load vs displacement graph for tensile test sample

In the tensile test results for our samples TSE-1, TSE-2, and TSE-3, we have found out that there were significant differences in both the tensile load and the maximum displacement. TSE-2 showed the greatest tensile load of 3094. 63 N, TSE-1 with 2905 in the next step. 09 N is the most possible number, plus TSE-3 with 2782. 68N. This is the evidence of the fact that TSE-2

needed the biggest force to make the material to break, hence, it has the greatest strength among the samples that have been tested. TSE-1 and TSE-3 resulted in slightly lower tensile loads, which prove that they were slightly weaker than TSE-2 but still had good mechanical properties.

When it comes to maximum displacement, TSE-2 was the one which showed the maximum value of 26. 62 mm, meaning it was the one most deformed before breaking. TSE-1 and TSE-3 had the largest displacements of 21. 79 mm and 21.1 mm, respectively. This shows that TSE-2 has not only the higher strength but also the higher ductility or elongation before the fracture compared to TSE-1 and TSE-3.

Moisture absorption test:

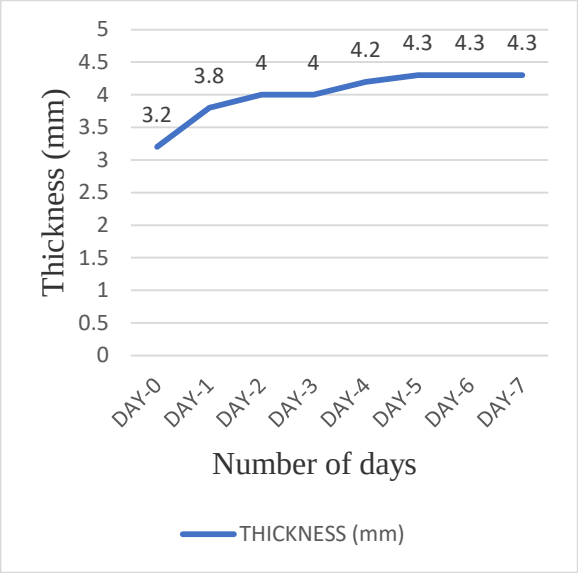

Figure 8: Thickness VS Number of days graph for moisture absorption sample

The moisture test results, which were performed on our silk fiber composite samples in accordance with ASTM D5229, show the changes in the moisture content of the samples, which occurred during five days. In the experiment, the samples M-1, M-2, and M-3 were kept under observation for both thickness and weight over consecutive days. In all the samples, the initial thickness was four mm on day 1 and the initial weights were different. Throughout the experiment, the thickness of all samples remained almost the same, with the only changes being very minor. Samples M-1, M-2, and M-3 had the same thickness of 4 mm on days 1 to 4, which was succeeded by a slight increase to 4. 5 mm on day 5. This increase in thickness on the final day could be seen as a small absorption of moisture, which could cause the swelling in the samples.

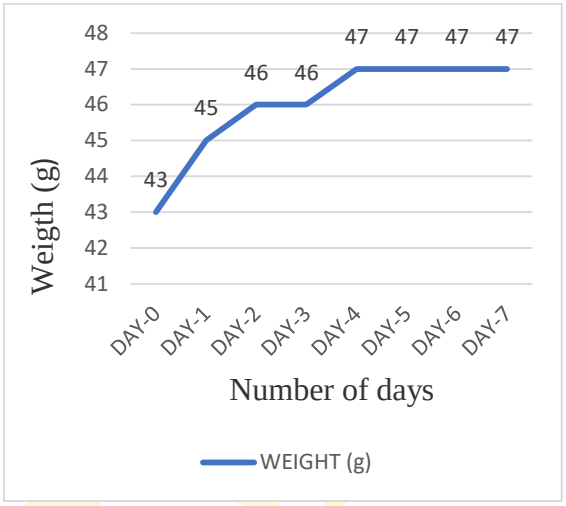

Figure 9: Thickness VS Number of days graph for moisture absorption sample

Regarding the weight, slight differences were noticed. For the Sample M-1, the weight was 46 g on the first day, and it was 47 g from the second day on. Same with both samples M-2 and M-3, they both started with the weights of 45 g and 44 g respectively on day 1, and after that, they gradually increased to 47 g from day 2. The regular rise in weight across all the samples indicates small moisture absorption during the whole test.

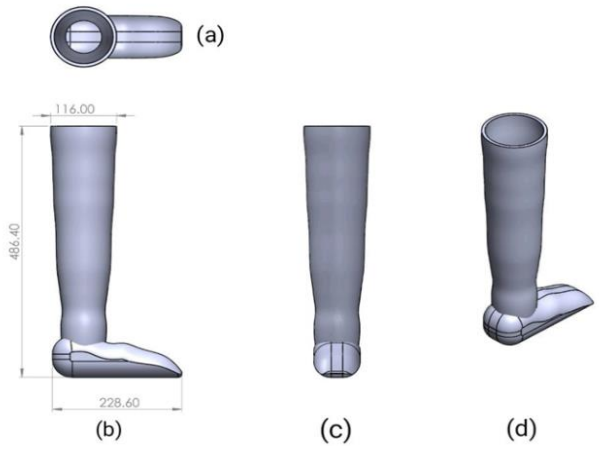

Figure 10: Different views of CAD Model

IV. CONCLUSION

The experimental investigation on silk fibre reinforced composites for lower limb prostheses reveals crucial insights into their mechanical properties and durability.

Bending tests indicate a Young's modulus ranging from 1097.6 MPa to 1156.2 MPa, adequate bending load (221.49 N to 243.18 N), and a consistent stress distribution (123.92 MPa to 142.49 MPa), ensuring good stiffness and load-bearing capacity. The modulus of resilience (20.38 J/m³ to 26.93 J/m³) highlights the material's energy absorption capabilities. Tensile tests show tensile strength between 66.89 N/mm² and 74.39 N/mm², with 30.14% to 38.03% elongation, demonstrating good resistance to pulling forces and ductility. Moisture tests reveal minimal moisture absorption, indicating robust structural integrity over time. These composites exhibit strong interfacial bonding between silk fibers and the matrix, contributing to their mechanical strength and durability. Silk fiber composites, leveraging silk's exceptional tensile strength, stiffness, and biocompatibility, are promising for orthopedic applications, including lightweight, aesthetically pleasing prosthetic covers and durable joint components like ankle joints. Future research should explore environmental effects, composition variations, advanced mechanical analyses, and long-term biocompatibility to optimize these composites for diverse real-world scenarios, enhancing patient outcomes and prosthetic lifespan.

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Battery Thermal Management System for Electric Vehicles using MATLAB Simulink

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ABSTRACT

The Battery Thermal Management System (BTMS) project aims to develop an innovative solution to optimize the thermal performance and enhance the safety and longevity of lithium-ion batteries used in electric vehicles (EVs). Effective thermal management is critical to maintaining battery efficiency, preventing overheating, and ensuring consistent performance under various operating conditions. This project involves the design, simulation, and testing of advanced BTMS technologies, including active and passive cooling methods, phase change materials, and integrated thermal management strategies. The research focuses on optimizing heat dissipation, reducing thermal gradients, and improving overall energy efficiency. By addressing the thermal challenges associated with high-energy-density batteries, the project seeks to extend battery life, enhance vehicle safety, and support the broader adoption of EVs. The outcomes of this project are expected to contribute significantly to the advancement of battery technology and the development of sustainable transportation solutions.

Keywords: Electric Vehicle, Battery Thermal Management System, Peltier Device, SoC, SoH, Cell Balancing.

I. INTRODUCTION

Electric vehicles (EVs) are at the forefront of a transformative shift in the automotive industry, offering a sustainable and environmentally friendly alternative to traditional internal combustion engine vehicles. These vehicles are powered by electricity stored in rechargeable batteries, driving one or more electric motors for propulsion. With components like the battery pack, electric motor, power electronics, and charging port, EVs provide a cleaner and more efficient mode of transportation. There are various types of EVs, including battery electric vehicles (BEVs), plug-in hybrid electric vehicles (PHEVs), and hybrid electric vehicles (HEVs), each catering to different needs and preferences. The benefits of EVs are manifold [1]: they produce zero tailpipe emissions, thus significantly reducing air pollution and greenhouse gases; they are more energy-efficient than conventional vehicles; and they have lower operational costs due to fewer moving parts and reduced maintenance. Additionally, EVs contribute to noise reduction in urban environments. However, challenges such as range anxiety, battery life and disposal issues, and higher initial costs remain. Despite these hurdles, the future of electric vehicles looks promising, with ongoing advancements in battery technology, expanding charging infrastructure, and supportive government policies driving their adoption [2]. As technology evolves, EVs are expected to become more affordable and efficient, playing a crucial role in the global shift towards sustainable transportation.

Challenges of Electric Vehicles:

Electric vehicles (EVs) face several challenges that hinder their widespread adoption. Range anxiety, or the fear of running out of battery power before reaching a charging station, remains a significant concern, despite modern EVs offering improved ranges [3]. The availability and speed of charging infrastructure are also

critical issues, as gaps in coverage and longer charging times compared to refuelling gasoline cars pose obstacles. The longevity and cost of EV batteries present further challenges, with high initial costs and potential degradation over time. Additionally, the environmental impact of battery production and disposal, including mining for materials and recycling used batteries, raises sustainability concerns [4]. Limited model availability and market penetration, especially for specific vehicle types, along with uneven global adoption rates, further complicate the scenario. Technological adaptation and consumer acceptance require overcoming a learning curve related to new features and energy management. Economic factors and government policies significantly influence EV adoption, with supportive policies and incentives varying widely across regions. Addressing these challenges involves coordinated efforts to enhance infrastructure, advance battery technology, promote sustainable practices, and create favourable economic and policy environments, ultimately accelerating the transition to electric vehicles.

Overview of Electric Vehicles:

Range Anxiety: The fear of running out of battery power before reaching a charging station. Although modern EVs offer improved ranges, this remains a significant concern for potential buyers [5].

Charging Infrastructure: The availability and accessibility of charging stations are critical for the widespread adoption of EVs. While urban areas are increasingly equipped with public chargers, rural areas may still lack adequate infrastructure.

Battery Life and Cost: The high initial cost of EV batteries and concerns about their lifespan and degradation over time are major challenges. However, advancements in battery technology are gradually addressing these issues.

Electric vehicles (EVs) offer environmental benefits with zero emissions, reducing greenhouse gases and promoting cleaner air. Economically, they feature lower operating costs and simplified maintenance, driven by cheaper electricity and fewer moving parts [6]. Advances in battery technology enhance range and reduce charging times, increasing practicality. Renewable energy sources reduce reliance on fossil fuels, aiding energy independence. Government incentives like tax credits encourage EV adoption, addressing financial barriers. Regulatory pressures and consumer demand propel the automotive industry towards EVs, while integration with autonomous driving technology promises safer transportation [7]. EVs contribute to public health by reducing air pollution and offer sustainability throughout their lifecycle with battery material sourcing and recycling efforts.

II. METHODS AND MATERIAL

Designing a Battery Management System (BMS) in MATLAB Simulink involves defining requirements, such as battery type (e.g., Li-ion) and key functions like SoC and SoH estimation, thermal management, cell balancing, and protection mechanisms as shown in figure 1. Accurate parameterization of pre-built models ensures realistic simulations. SoC estimation uses Kalman filtering, and SoH tracks capacity fade. Thermal management simulates temperature dynamics, while cell balancing uses passive or active methods. Protection mechanisms address overcharge, over discharge, overcurrent, and temperature issues. The supervisory control algorithm coordinates these functions, tested via simulations. The model is validated with real-world data, and Embedded Coder generates deployment-ready code, with HIL testing ensuring reliability [8].

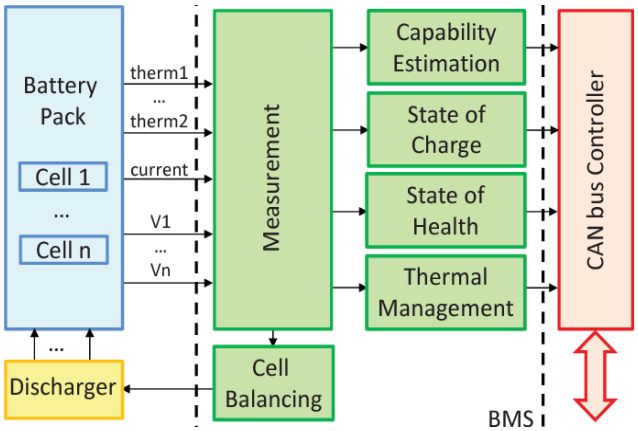

Figure 1: Block diagram of BMS

Optimal Temperature Control Using Peltier Element:

A Peltier element, or Thermoelectric Cooler (TEC), functions via the Peltier effect, transferring heat between two materials when an electric current passes through

them. Comprising p-type and n-type semiconductor pairs like bismuth telluride, these elements are sandwiched between ceramic plates. Current flow causes one side to cool while the other heats up. Cooling efficiency requires proper heat dissipation from the hot side, often with a heat sink or fan. Despite lower efficiency compared to traditional methods, Peltier elements excel in precise temperature control for electronic devices, portable coolers, and scientific instruments. Their solid-state, maintenance-free design offers reliability, but their energy consumption and heat dissipation requirements remain challenges [9].

Peltier Device Operation:

A Peltier device, also known as a thermoelectric cooler (TEC), operates on the principle of the Peltier effect, discovered by Jean Charles Athanase Peltier in 1834. This effect describes the heating or cooling that occurs when an electric current passes through the junction of two different conductors or semiconductors. Here's an overview of how a Peltier device operates.

Design and Simulation:

Designing a Battery Thermal Management System (BTMS) with Simulink involves a systematic approach. Engineers begin by thermally modelling the battery pack, considering cell configuration, material properties, and heat generation during charge/discharge. This model simulates internal heat transfer processes. Cooling components like fans, heat sinks, or Peltier devices are then integrated into the Simulink environment. A control algorithm, developed based on battery temperature measurements, manages the cooling system using feedback loops and logical control. The BTMS is simulated under various conditions to optimize performance, efficiency, and reliability, ensuring model accuracy through validation against experimental data. The process culminates in a comprehensive report detailing methodology, results, simulation setup, and recommendations. This iterative method enables engineers to design effective BTMS systems, ensuring the safe and efficient operation of battery packs in diverse applications.

Simulation of Battery Thermal Management System:

A thermal battery management system (BMS) simulation in Simulink integrates various components to monitor and control battery performance. This includes control logic, state estimation techniques, and models for the battery pack and thermal management system. The batteries pack model accounts for thermal behaviour (heat generation and dissipation) and electrical properties (voltage, current, internal resistance). State estimation techniques, like adaptive Kalman filters, assess the battery's State of Health (SOH) and State of Charge (SOC). Cell balancing modules ensure consistent SOC and voltage across cells, enhancing longevity. Peltier devices in the thermal management system maintain optimal battery temperatures. By simulating SOC, SOH, temperature control, and cell balancing effectiveness, engineers can optimize battery management strategies. This integrated approach as shown in figure 2 in Simulink allows for comprehensive assessment and improvement of thermal BMS, ensuring optimal performance and longevity for battery packs in energy storage systems and electric vehicles.

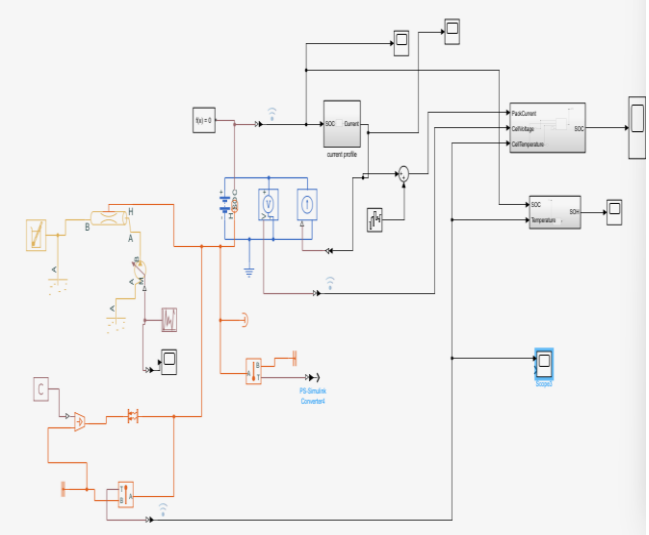

Figure 2: Simulation of BTMS in MATLAB

A thermal battery management system (BMS) simulation in Simulink integrates various components to monitor and control battery performance. This includes control logic, state estimation techniques, and models for the battery pack and thermal management system. The battery packs model accounts for thermal behaviour (heat generation and dissipation) and electrical properties (voltage, current, internal resistance). State

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III. RESULTS AND DISCUSSION

The Battery Thermal Management System (BTMS) for Electric Vehicles (EVs) using MATLAB Simulink produced promising results. The TBMS effectively controlled State of Charge (SoC) within specified limits, optimizing energy storage. It preserved State of Health (SoH) by preventing overcharging and excessive discharging, extending battery life. Cell balancing ensured uniform charge distribution, enhancing performance. Managed by a relay, the temperature control system precisely maintained battery temperature and optimizing efficiency. These outcomes underscore the Peltier device's efficiency in the BTMS, offering comprehensive control over temperature regulation, cell balancing, SoC, and SoH, thus bolstering EV battery performance and reliability.

SoC Result:

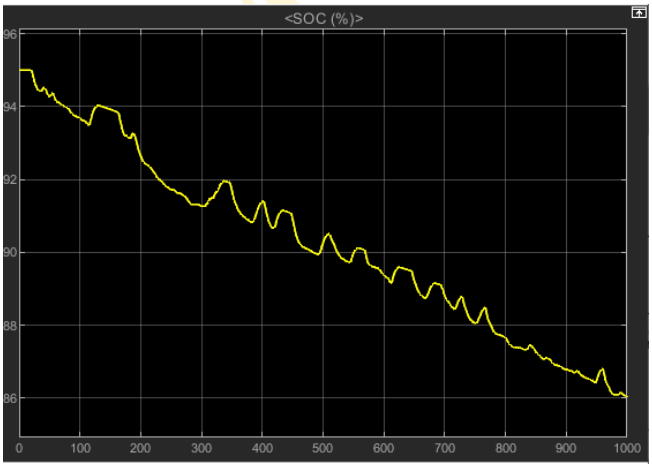

Figure 3: SoC output result from MATLAB

Using MATLAB Simulink, we developed a Battery Thermal Management System (BTMS) for Electric Vehicles (EVs) with promising outcomes, especially in State of Charge (SOC) estimation. The BTMS accurately forecasted SOC levels through rigorous simulations and real-world data integration as shown in figure 3. The adaptive Kalman filter dynamically adjusted model parameters based on environmental conditions and battery health, ensuring precise SOC estimation even under challenging conditions. This advancement enhances EV battery management, improving longevity, durability, and efficiency for electric vehicle applications. These results mark significant progress in EV battery technology.

Temperature Result:

Our focus on temperature management produced notable outcomes in our engineering project, which involved integrating a Peltier device into a Battery Thermal Management System (BTMS) for Electric Vehicles (EVs) utilizing MATLAB Simulink. Our BTMS successfully used a Peltier device controlled by a relay to control the battery pack's temperature within the specified range thorough simulations.

This accurate temperature management improves the longevity and safety of the battery while also ensuring optimal performance. Our system demonstrated good thermal management capabilities by dynamically modifying the Peltier device's operation based on temperature feedback, reducing the dangers related to overcooling or overcooling. These results represent a noteworthy advancement in EV battery technology, promising improved reliability, efficiency, and durability for electric vehicle applications, thereby contributing to the sustainable evolution of transportation solutions.

IV. CONCLUSION

The successful deployment of a robust BTMS directly translates to extended battery life, improved vehicle safety, and enhanced overall performance, thereby addressing some of the key challenges facing the adoption of electric vehicles. As the demand for EVs continues to grow, advancements in BTMS technology will play a pivotal role in supporting the broader transition to sustainable transportation solutions. Ongoing research and innovation in this field will not

only contribute to the development of more efficient and durable batteries but also reinforce the environmental and economic benefits of electric mobility.

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Development of Analytical Method for Rotigotine Using UV-Visible Spectrophotometry

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ABSTRACT

A simple and effective spectrophotometric method was developed for the quantitative determination of Rotigotine, a medication used in the treatment of Parkinson's disease. This method is based on measuring the absorbance of Rotigotine at a wavelength of 273 nm, its optimum absorbance peak. The method follows Beer's law within the concentration range of 40-200 µg/ml, demonstrating a direct proportionality between absorbance and concentration. The regression equation obtained from the calibration curve is Y = 0.0025x, where Y represents the absorbance and x denotes the concentration of Rotigotine in µg/ml. The correlation coefficient (R^2) is 0.999, indicating an excellent linear relationship and high precision of the method. The high correlation coefficient suggests that the method is both accurate and reliable for the intended concentration range. This linearity ensures that even small changes in Rotigotine concentration can be detected with a high degree of accuracy, making the method suitable for routine analysis in quality control laboratories. Moreover, the simplicity of the spectrophotometric approach allows for rapid and cost-effective analysis without the need for complex instrumentation or extensive sample preparation. Overall, the proposed spectrophotometric method is advantageous for its simplicity, accuracy, and linearity, making it a practical choice for the determination of Rotigotine in various pharmaceutical formulations. Its ability to provide reliable results in the specified concentration range ensures its applicability for quality control and routine analysis, thereby supporting the consistent production of effective Rotigotine-containing medications.

Keywords: Rotigotine, UV-visible Spectrophotometry, Beer-Lambert's law, linearity, calibration.

I. INTRODUCTION

Rotigotine {(6S)-6-(propyl[2-(2-thienyl) ethyl] amino)-5,6,7,8-tetrahydro-1-naphthalenol} is a hydrophilic drug; it is primarily used as dopamine receptor agonist in the treatment of early and advance stage idiopathic Parkinson's disease and moderate to severe restless leg syndrome. It is available in various forms, including patches for transdermal delivery and approved for use in the USA, Europe and other countries. Some researchers explore its potential to treat psychosis associated with Parkinsonism. Rotigotine is a dopamine agonist that binds to D1 to D5 receptors; it is best described as a D3/D2/D1 receptor agonist and exhibits antagonist activity by inhibiting dopamine uptake at specific doses.

The accurate quantification of rotigotine in pharmaceutical formulations is essential for ensuring proper dose, therapeutic efficacy, and patient safety [1,2]. To achieve this, developing an analytical method is essential. The analytical method is a systematic tool used in pharmaceutical research and development to assess quantitatively or qualitatively the presence and the concentration of Rotigotine in the sample [3].

Developing an analytical method begins with selecting a suitable technique, which includes mass spectroscopy, chromatography (HPLC with UV detection), and UV spectrophotometry, which are commonly employed. The individual technique offers unique advantages in terms

of sensitivity, specificity and applicability to various drug substances [4].

UV-visible spectrophotometry is one of the best techniques for analysis of pharmaceutical substances. This method measures the absorption of electromagnetic radiation by molecules. Rotigotine absorbs ultraviolet (UV) or visible light at a specific wavelength by a substance in solution. According to Beer-Lambert's law, absorbance (A) is directly proportional to the concentration (C) of the absorbing species and the path length (l) of the sample cell.

Mathematically, this relationship is expressed as $A = \varepsilon cl$, where ε is the molar absorptivity (extinction coefficient) of the analyte at a given wavelength. This technique is ideal for the initial screening of substances due to its high sensitivity, specificity, and cost-effectiveness, as well as its ability to provide rapid results in routine analysis.

The fundamental characteristic of an analytical method is linearity, which assesses the relationship between the concentration of the Rotigotine to the absorbance or peak area. It is crucial for ensuring accuracy in various fields like pharmaceutical analysis, environmental monitoring and clinical diagnostics.

The linearity of the method is assessed by examining the regression coefficient (R^2) of the standard curve. The R^2 value close to 1 indicates a strong linear correlation, showing that the method can accurately quantify the substance across the tested concentration range. This study aims to develop a simple spectrophotometric method of determination of Rotigotine [5].

The inaccurate quantification and non-linearity can be reduced by correlating the absorbance with the concentration of Rotigotine using the calibration curve. This ensures reproducibility in results thus essential for quality control of Rotigotine. This method provides the validated documents for linearity that ensure compliance with regulatory requirements for pharmaceutical analysis. Also reduces time consumption and cost-effectiveness.

- To develop the reproducible UV-visible spectrophotometer method for quantitative determination of Rotigotine.
- To develop a calibration curve by preparing a standard solution of Rotigotine in selected solvents and obtaining the absorbance.
- To assess the linearity of the method by evaluating the correlation coefficient (R^2) of the calibration curve over a specified concentration range.
- To determine the presence of impurities or substandard of the Rotigotine, helps in qualitative analysis.

A suitable UV-visible spectrophotometer was used to develop an analytical method for Rotigotine. As Rotigotine is a BCS class 1 drug, it is dissolved in suitable solvents, providing maximum solubility like methanol, ethanol, chloroform, and pH 7.4 phosphate buffer. Under the specified concentration range (Beer's range: 40-200µg/ml), a standard solution is prepared. They are determining the optimal absorbance of Rotigotine at a specific wavelength (λ_{max}). The solutions are prepared from standard solutions, and their absorbance is obtained at a specified wavelength of 273nm. Plot the absorbance against the concentration of standards to generate a calibration curve which undergoes validation studies. It includes the determination of linearity by calculating the correlation coefficient (R^2). The calibration curve shows a linear relationship between the absorbance and concentration with a high correlation coefficient (R^2>0.999). Thus, the proposed method provides a structured approach to developing an analytical technique for rotigotine, ensuring its quality and efficacy.

II. METHODS AND MATERIAL

Instruments and Apparatus required: UV-Vis spectrophotometer, weighing balance, funnel, pipette, measuring cylinder, volumetric flask, glass test tubes.

Chemical & reagents required: Rotigotine, 0.2M 7.4 pH Phosphate buffer, 0.2M NaOH solution, methanol.
Preparation of Buffer solution: 100 ml of 0.2M KH_2PO_4 was mixed with 78.2 ml of 0.2M NaOH solution in a glass beaker and then diluted with distilled water up to 400 ml.

Preparation of stock solution: Standardized rotigotine solution of 100µg/ml was prepared by weighing 10mg of rotigotine using an analytical weighing balance and transferred into 100ml of volumetric flask then the

equimolar concentration of methanol and 7.4 pH phosphate buffer was added slowly until complete dissolved.

Determination of maximum absorption: Absorbance was measured at a wavelength of 273 nm. 7 series of concentration was prepared like 40µg/ml, 50µg/ml, 60µg/ml, 70µg/ml, 80µg/ml, 90µg/ml, 100µg/ml . The prepared stock solution was pipetted such as 4ml, 5ml, 6ml, 7ml, 8ml, 9ml, and 10ml into a 10 ml test tube and diluted with a 7.4 phosphate buffer and makeup to the mark. Absorbance was measured using a UV-visible spectrophotometer at a wavelength of 273 nm. The standard graph was plotted by taking absorbance on the Y-axis and concentration on the X-axis.

Determination of linearity and calibration curve: To determine the linearity of the Rotigotine, using a UV-visible spectrophotometer, 5 points of calibration curve were generated. Linearity was evaluated by correlation coefficient (R^2).

III. RESULTS AND DISCUSSION

The maximum absorbance of Rotigotine was found at the wavelength (λ max) of 273 nm, as shown in Figure 1. This peak wavelength was determined by scanning Rotigotine solutions over a range of wavelengths and identifying the point of highest absorbance. Once the optimal wavelength was established, a series of stock solutions with varying concentrations of Rotigotine were prepared to create a calibration curve. The absorbance of each stock solution was measured at 273 nm using a spectrophotometer. The results, including the absorbance values for each concentration, are detailed in Table No. 4.1. This table provides a comprehensive view of how the absorbance values change with concentration, demonstrating the linear relationship between the two variables. By plotting these absorbance values against their corresponding concentrations, a calibration curve was constructed. This curve was used to derive the regression equation Y = 0.0025x, where Y represents the absorbance and x denotes the concentration of Rotigotine in µg/ml. The data exhibited a correlation coefficient (R^2) of 0.999, indicating an excellent linear relationship and validating the precision and reliability of the method. This high degree of linearity confirms that even minor variations in Rotigotine concentration can be accurately detected, making this spectrophotometric method highly suitable for routine quality control analysis in pharmaceutical laboratories. The simplicity and cost-effectiveness of this approach further enhance its practicality for regular use, ensuring consistent production quality of Rotigotine-containing medications.

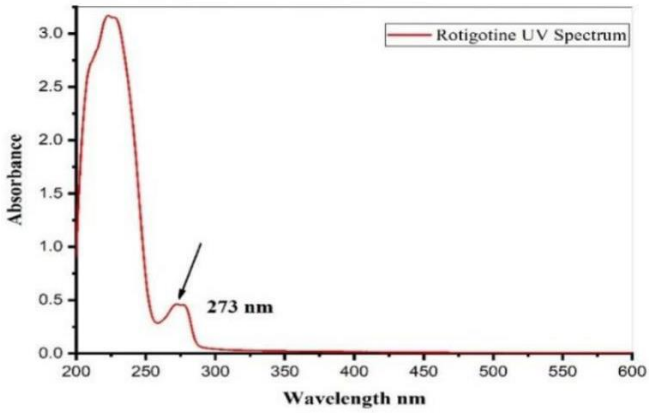

Figure 1: UV Spectrum of Rotigotine

Table 1: Stock solutions absorbance

Conc. (µg/ml)	Absorbance	S.D
0	0	0.0000
40	0.126	0.0106
50	0.162	0.0106
60	0.192	0.0120
70	0.23	0.0141
80	0.265	0.0180
90	0.299	0.0141
100	0.324	0.0071

IV. CONCLUSION

In conclusion, our project has effectively achieved its objectives in advancing digital forensics and content authentication. We introduced a novel CNN architecture for image forgery detection and proposed the FIDAC dataset, demonstrating enhanced accuracy through dataset combination. Our CNN architecture showed competitive performance against established classifiers, underscoring its efficiency. While acknowledging room for improvement, such as dataset enlargement and optimization exploration, our ongoing research, including ViFoDAC for video forgery detection,

underscores our commitment to continuous advancement. By meeting objectives of detecting forged images and videos and establishing a user-friendly content analysis portal, our project significantly contributes to digital forensics. Through further refinement, we aim to ensure integrity and authenticity across various applications, thus making a meaningful scientific contribution.

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Design and Verification of RISC Processor using Cadence

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ABSTRACT

The growing demand for specialized processors tailored to embedded systems and low-power applications has spurred interest in developing efficient microprocessors. This project focuses on the creation of a 16-bit Reduced Instruction Set Computing (RISC) processor using Cadence tools, aiming to achieve a balance between performance, power efficiency, and area utilization. The design process begins with defining the Register Transfer Level (RTL) architecture, followed by rigorous verification and validation procedures to ensure the design's correctness and reliability under diverse scenarios. During the logic synthesis phase, the primary objective is to optimize the processor's design, meticulously balancing the trade-offs between performance, power consumption, and chip area. Challenges in the physical design stage include adhering to stringent timing constraints, minimizing power consumption, and ensuring manufacturability. Addressing these issues is crucial to achieving a robust and efficient processor design. The final step involves a comprehensive evaluation and testing of the fabricated processor. This stage assesses the processor's performance, power consumption, and reliability, ensuring that it meets the intended design specifications and operates efficiently in real-world applications. The insights gained from this project will contribute to advancing the design methodologies for 16-bit RISC processors, particularly for embedded systems and low-power environments. In summary, this project navigates the complexities of microprocessor design, from RTL development through to physical implementation and testing, providing valuable lessons and strategies for creating optimized, efficient, and reliable processors suitable for the demands of modern embedded systems.

Keywords: Reduced Instruction Set Computing, Register Transfer Logic, Verilog, Cadence

I. INTRODUCTION

A microprocessor is the central processing unit (CPU) of a computer system, responsible for executing instructions and performing calculations. It serves as the brain of the computer, managing data and controlling various operations to enable the functioning of software applications. This introduction will provide a concise overview of microprocessors, exploring their architecture, functions and historical development.

Microprocessors are built upon a complex architecture comprising various components that work together seamlessly to execute instructions. The fundamental building blocks include the Arithmetic Logic Unit (ALU), Control Unit, Register File and Memory Interface. The ALU performs arithmetic and logical operations, the Control Unit manages the execution of instructions, the Register File stores temporary data and the Memory Interface facilitates communication with the system's memory. Modern microprocessors are based on the von- Neumann architecture, which integrates the CPU and memory, allowing for the execution of stored instructions. They typically include multiple cores, enabling parallel processing and improved performance. The instruction set architecture (ISA) defines the set of instructions a microprocessor can execute and it plays a

crucial role in determining the compatibility of software with a specific processor [1].

The primary function of a microprocessor is to fetch, decode and execute instructions stored in memory. This process is known as the instruction cycle. The fetch phase involves retrieving the next instruction from memory, the decode phase interprets the instruction and the execute phase performs the required operation.

This cycle repeats continuously, allowing the microprocessor to execute a sequence of instructions to accomplish various tasks. Microprocessors operate based on the binary system, where data and instructions are represented using combinations of 0s and 1s. Machine language, composed of binary code, is the lowest-level programming language that a microprocessor understands [2]. Higher- level programming languages are translated into machine code through a process known as compilation, enabling developers to write software that can run on diverse microprocessor architectures.

The evolution of microprocessors has been marked by continuous advancements in processing power, efficiency and integration. The Intel 4004, introduced in1971, is considered the first commercially available microprocessor. Since then, there has been a rapid progression in microprocessor technology, align with Moore's Law driving a consistent increase in the number of transistors on a chip.

Intel, AMD and other semiconductor manufacturers have played pivotal roles in shaping the microprocessor landscape. The development of Reduced Instruction Set Computing (RISC) and Complex Instruction Set Computing (CISC) architectures has contributed to the diversity of microprocessor designs, each with its own strengths and applications. The ALU performs mathematical and logical operations, such as addition, subtraction and, OR and NOT. It is responsible for executing the core computational tasks. The Control Unit manages the flow of data within the microprocessor. It interprets and decodes instructions, directing the operations of other components. It also oversees the fetching of instructions from memory [4].

Digital media, particularly images and videos, pervade various aspects of modern communication and documentation, ranging from social media platforms to critical domains like law enforcement, healthcare, and finance. However, the widespread availability of powerful editing tools poses a significant challenge to the authenticity and integrity of such content. Ensuring the trustworthiness of digital media has become imperative, given the potential consequences of misinformation and manipulation.

Recent advancements in deep learning, particularly with techniques such as Recurrent Neural Networks (RNN), Deep Convolutional Neural Networks (DCNN), and Adaptive Neural Networks (ANN), have offered promising avenues for addressing digital forgery detection. These techniques enable the analysis of visual and audio cues to distinguish between authentic and manipulated content [3]. Additionally, efforts have been made to tackle the challenges posed by anti-forensics, compression methods, and the availability of suitable datasets for training and testing.

One major focus of multimedia forensics is the detection of copy-move forgery in images and videos, where portions of content are duplicated or altered to mislead viewers. While existing approaches have shown effectiveness, they often face challenges in balancing detection efficiency, robustness, and applicability across various scenarios. In response, our project proposes a novel approach that leverages optical flow and stable parameters to detect frame-level copy-move forgery, enhancing both accuracy and reliability.

This paper aims to present a comprehensive framework for advanced video and image forgery detection, emphasizing multi-modal deep learning techniques. By integrating diverse data sources and leveraging deep learning architectures, we seek to develop methods capable of accurately and reliably identifying manipulated multimedia content. Specifically, our objectives include:

- Developing algorithms for detecting forged images by analyzing visual cues, ensuring integrity across diverse applications.
- Implementing deep learning techniques to detect alterations in video content, enhancing the accuracy of identifying manipulated sequences.

➢ Introducing a metric to quantify the extent of tampering within video content, providing a measure of manipulation severity.

➢ Establishing a web portal for real-time analysis and verification of multimedia content, offering a user-friendly interface for authenticity assessment.

Through these objectives, we aim to contribute to the advancement of digital forensics by providing robust solutions for detecting image and video forgeries in various contexts.

In this rapid growing technology, there is a need of high-performance processors which work on low power. In response, design a 16-bit RISC processor and verify the ALU operations such as addition, subtraction, and other logical functions while considering power consumption, area consumption, and delay [5].

❖ To develop a RISC processor architecture that optimizes instruction execution, selecting an appropriate pipeline structure while minimizing hardware complexity.

❖ To evaluate the processor's performance in terms of execution speed and efficiency, providing insights into its capabilities.

❖ To assess the power consumption of the processor to determine its energy efficiency and sustainability.

In the Cadence environment, the RISC CPU architecture is painstakingly constructed using advanced test benches and design. These benches cover a wide range of conditions, such as different instruction sets and different memory access patterns, to provide thorough validation. Functional correctness and time analysis are carefully examined using rigorous simulation. After the simulation runs well, the design moves to synthesis using the Cadence Genus Synthesis Solution, where it is critical to optimize for power, speed and space limitations. Further post-synthesis simulations carefully verify the physical soundness and functional behaviour of the synthesized RISC processor, ensuring that the original specifications are followed and that it operates reliably in actual hardware scenarios [8]. This comprehensive approach, which makes use of cutting-edge tools and techniques, strengthens the design and verification process of RISC processors, guaranteeing their effectiveness and dependability.

II. METHODS AND MATERIAL

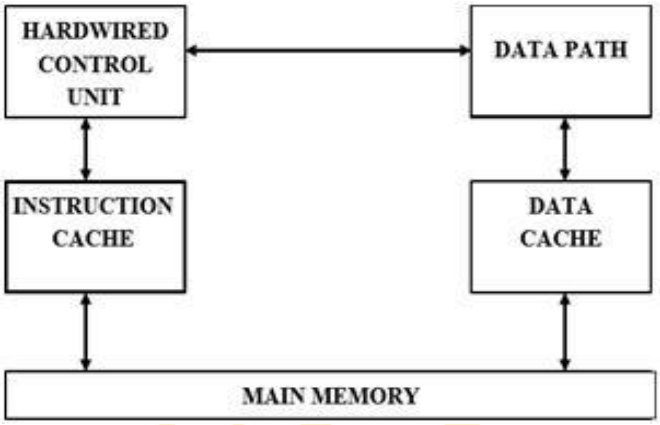

Figure 1: The Block diagram of RISC Processor

A hard wired control unit is a digital circuit responsible for generating control signals within a computer's central processing unit (CPU) [6]. Unlike micro programmed control units, hardwired control units use a fixed set of logic gates and connections to execute instructions directly. These results in faster operation but makes modification or updates more challenging compared to micro programmed control units.

In a hardwired control unit, the control signals needed to execute instructions are generated using a fixed arrangement of combinational logic circuits, such as AND gates, OR gates and decoders. These circuits are designed to produce specific control signals based on the opcode (operation code) of the instruction being executed. However, the downside is that any modifications or updates to the instruction set architecture usually require redesigning the hardware [7].

This lack of flexibility is one reason why micro programmed control units, which use a set of stored instructions to generate control signals, offer more adaptability at the expense of some speed. Hardwired control units are often found in simple and dedicated systems where the instruction set is unlikely to change frequently.

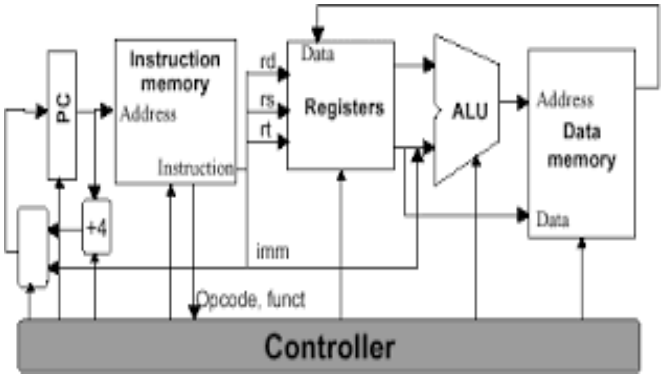

Figure 2: Block Diagram of Instruction memory

Instruction caches are typically part of the CPU architecture and come in various sizes. They work in conjunction with other levels of cache (L1, L2, etc.) and the main memory hierarchy. The cache management algorithm decides which instructions to keep in the cache and when the cache is full, it may replace less frequently used instructions. Efficient use of instruction caches is crucial for improving overall system performance, especially in scenarios where programs exhibit predictable patterns of instruction execution [9].

A data cache is a type of cache memory that stores frequently accessed or recently used data to expedite the retrieval of information by the central processing unit (CPU). When the CPU needs to read or write data to memory, it first checks the data cache. If the required data is found in the cache (a cache hit), the CPU can quickly access it, avoiding the longer latency associated with accessing the main memory directly.

Although there is much space for memory in the CPU, there is a requirement for data cache in processor, a process can't be put to wait until the CPU fetches the data from primary memory; some required data is stored in cache. Data caches operate based on the principle of spatial and temporal locality. Spatial locality refers to the tendency of a program to access memory locations that are near each other, while temporal locality suggests that recently accessed data is likely to be accessed again in the near future. Similar to instruction caches, data caches are part of the CPU architecture and exist at different levels (L1, L2, etc.) within the memory hierarchy.

Instruction Fetch: The hard wired control unit fetches instructions from main memory. The instruction cache is checked for frequently used instructions, reducing the time needed for instruction retrieval.

Instruction Decode: The control unit interprets the fetched instruction and generates control signals. The data path is configured based on the decoded instruction, setting up the necessary pathways for data manipulation.

Operand Fetch: If the instruction involves data manipulation, the operands (data) are fetched from registers or, if needed, from main memory.

Execution: The data path, including the Arithmetic Logic Unit (ALU), performs the actual computation or logic operation on the fetched operands. Instructions are executed in a single clock cycle due to the simplified nature of the instruction set.

Result Write Back: The result of the operation is written back to the registers or main memory, depending on the instruction.

Data Cache Utilization: Frequently accessed data is stored and retrieved from the data cache, reducing the need to access the slower main memory for data operations.

Control Flow and Branch Prediction: The control unit handles control flow instructions and branch prediction techniques may be used to mitigate pipeline stalls caused by conditional branches.

Pipelining: Pipelining is employed to increase instruction throughput. Multiple instructions are in different stages of execution simultaneously, enhancing overall processing speed.

Cadence is a mutual, consumer friendly electronic design automation (EDA) environment. It yields best integrated chip design improved in every stage by the components needed to increase the tool features. Each single design carried out by design verification. These tools are completely universal, bearing several design fabrications of semiconductor technologies.

Specifications:

CADENCE Licensed Version boasts several specifications that make it a preferred choice for integrated circuit(IC) designers. It offers a rich set of design entry options, allowing designers to choose

between schematic- based or layout-based design methodologies.

- ❖ Compilers: ncvhdl, ncvlog, ncsdfc
- ❖ Elaborators: ncelab,ncupdate
- ❖ Simulator: ncsim

III. RESULTS AND DISCUSSION

Figure 3: Output waveform of 16 bit RISC Processor

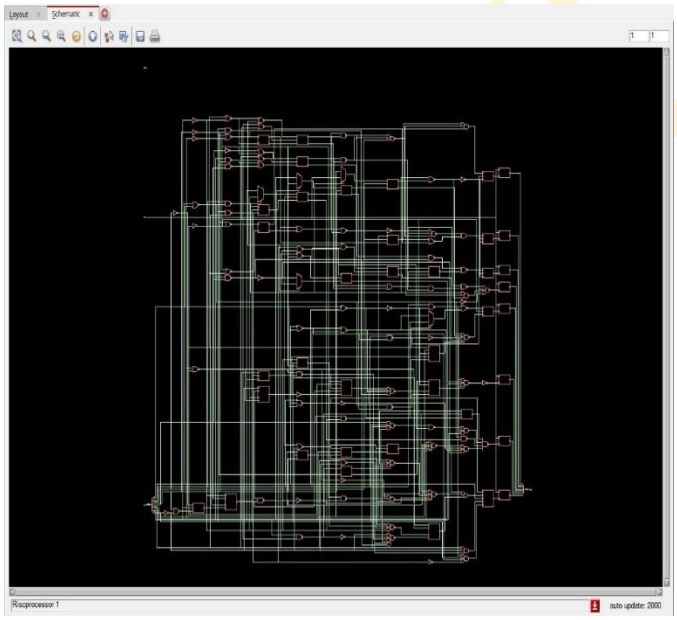

Figure 4: Synthesis version of output waveforms of a 16–bit RISC Processor

```
=============================================================
  Generated by:           Genus(TM) Synthesis Solution 17.22-s017_1
  Generated on:           May 02 2024  05:20:50 pm
  Module:                 Riscprocessor
  Technology libraries:   slow
                          physical_cells
  Operating conditions:   slow
  Interconnect mode:      global
  Area mode:              physical library
=============================================================

                    Leakage    Dynamic     Total
   Instance   Cells Power(nW)  Power(nW)  Power(nW)
-------------------------------------------------------
Riscprocessor   135  3479.284 100894.568 104373.852
```

Figure 5: Power analysis of a16–bit RISC Processor

Gate	Instances	Area	Library
ADDFX1	7	137.756	slow
ADDHXL	3	36.331	slow
AND2X1	1	4.541	slow
AO21X1	1	6.812	slow
AOI21XL	6	27.248	slow
AOI221XL	5	37.845	slow
AOI222XL	1	8.326	slow
AOI22XL	6	36.331	slow
CLKXOR2X1	3	24.978	slow
DFFQX1	8	127.159	slow
INVXL	20	45.414	slow
MX2X1	1	6.812	slow
MXI2XL	4	24.221	slow
NAND2XL	16	48.442	slow
NAND3BXL	1	6.055	slow
NAND4XL	1	5.298	slow
NOR2BXL	8	36.331	slow
NOR2XL	18	54.497	slow
OA21X1	1	6.812	slow
OAI211XL	4	21.193	slow
OAI21XL	10	45.414	slow
OAI221XL	1	7.569	slow
OAI22XL	1	6.055	slow
OAI2BB1XL	3	15.895	slow
OAI32XL	2	13.624	slow
OR2X1	1	4.541	slow
XNOR2X1	2	16.652	slow
total	135	812.154	

Type	Instances	Area	Area %
sequential	8	127.159	15.7
inverter	20	45.414	5.6
logic	107	639.581	78.8
physical_cells	0	0.000	0.0
total	135	812.154	100.0

Figure 6: Gate analysis of a 16 –bit RISC Processor

IV. CONCLUSION

In the project, it is successfully built and checked a 16-bit RISC processor using Cadence tools. By following the design plan and testing we created a processor that works well for some specific test cases of ALU. This project shows how important it is to use the right tools when making digital systems and finally we observed the synthesis report where we understand the physical implementation requirements.

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Free Vibration Studies on Biodegradable Composite Plate with Cut Outs

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ABSTRACT

This study investigates the fundamental natural frequencies of isotropic and laminated composite plates with cutouts made from woven areca sheath fiber using both Finite Element Method (FEM) and experimental approaches. Understanding the vibration characteristics of plates with cutouts is crucial in structural mechanics for designing efficient structures. The experimental assessment involved determining the first five natural frequencies of Clamped-Free-Clamped-Free (CFCF) and Clamped-Free-Free-Free (CFFF) laminated plates with cutouts. This was achieved using the Fast Fourier Transform (FFT) technique, which provided a clear and precise measurement of the natural frequencies. These frequencies are key indicators of the dynamic behavior and structural integrity of the plates, especially when subjected to various operational conditions. In parallel, FEM analysis was conducted to simulate the vibration characteristics of these plates. Among the various elements used in FEM, the CQUAD8 element demonstrated superior accuracy and reliability in predicting the natural frequencies compared to others. This highlights the importance of selecting appropriate finite elements in the simulation of composite structures. Further, parametric studies were conducted to examine the effects of varying cutout types, sizes, and fiber orientations on the vibration characteristics of the plates. These studies revealed significant insights into how these factors influence the dynamic response of the plates. For instance, different cutout shapes and sizes can alter the stiffness and mass distribution of the plates, thereby affecting their natural frequencies. Similarly, the orientation of the woven areca sheath fibers plays a critical role in defining the anisotropic properties of the laminated plates, which in turn affects their vibrational behavior. Overall, this comprehensive study provides valuable information for the design and optimization of composite structures with cutouts, contributing to the development of more efficient and resilient engineering applications.

Keywords: Natural Frequencies, Composite Plates, FEM, Experimental Analysis, Vibration Behavior.

I. INTRODUCTION

In this study, we investigate the free vibration behaviour of a biodegradable composite plate with cut-outs using experimental and numerical approaches. By analysing the results, we aim to gain insights into the dynamic characteristics and structural integrity of the composite plate for various applications. The vibrational characteristics of composite plates with cutouts play a crucial role in the design and optimization of aerospace, automotive, marine, and structural components [1, 2]. Understanding how cutouts influence the natural frequencies, mode shapes, and damping characteristics of composite plates is essential for ensuring the structural integrity and performance of these advanced materials in practical applications.

Composite materials, which combine different materials to achieve enhanced mechanical properties, offer a wide range of applications across various industries such as aerospace, automotive, and civil engineering [3]. Understanding their vibrational behaviour is crucial for

optimizing their design and performance. Isotropic composites are traditionally used due to their isotropic (uniform) material properties.

The experimental and numerical study involves conducting vibration tests on isotropic and biodegradable composite laminated plates with predefined cutout geometries [4]. Modal analysis techniques will be employed to identify the natural frequencies and mode shapes of the laminates under free vibration conditions. Through meticulous experimentation, valuable insights will be gained into the vibrational behaviour of these composite structures, facilitating a deeper understanding of their dynamic response mechanisms [5].

The outcomes of this study will provide valuable insights into the vibration behaviour in isotropic and biodegradable composite laminates [6]. Furthermore, the comparison between experimental and numerical results will validate the effectiveness of computational modeling in predicting the dynamic characteristics with implications for optimizing the design and utilization of composite materials in various engineering applications.

In recent years, the exploration of biodegradable composite materials has gained considerable traction in the field of mechanical engineering, owing to their potential to address sustainability concerns and reduce environmental impact. This project focuses on the experimental and numerical investigation of the free vibration behaviour exhibited by biodegradable composite plates with cut outs [7].

Through a comprehensive analysis, the project aims to enhance understanding of the dynamic characteristics of these innovative materials and contribute to their application in various engineering sectors.

Traditionally, composites have been fabricated using synthetic fibres such as carbon or glass embedded in a polymer matrix. However, the increasing emphasis on sustainability and environmental stewardship has led to the development of biodegradable composites, which utilize natural fibres and biopolymers derived from renewable sources. The structures are exposed to the dynamic type of loading during their service, which may lead to severe vibrations. Laminated plates with cut-outs are extensively used in automobiles, aircraft, and space vehicles. Holes of different shapes—circular, square, rectangular, are used in plates [4, 8]. They serve the purpose of weight reduction, altering resonant frequency, inspection, maintenance, venting, and attachment to other units, for the cables to pass through and so on.

It is needed at the bottom plate for passage of liquid in liquid-retaining structures. These structures are subjected to undesirable vibration, deflection, and rotation during their service life.

The motivation behind this study lies in the pressing need to explore eco-friendly alternatives to conventional composite materials. Biodegradable composites offer several advantages, including reduced reliance on non-renewable resources, lower carbon footprint, and end-of-life recyclability.

By investigating the vibrational behaviour of biodegradable composite plates with cut outs, this project aims to assess their mechanical performance and suitability for engineering applications, thereby contributing to sustainable development initiatives.

The present study deals with the free vibration of isotropic and laminated composite plates with a central cut-out. The exact solutions to free vibration problems of plates are mathematically involved and in many complicated cases not available. A great need exists for an elaborate study on the free vibration of laminated plates with central cut-outs and the present work is one attempt in this direction.

Scope: The scope of this study encompasses experimental and numerical investigations of the free vibration behaviour of biodegradable composite plates with various types of cutouts. The materials considered for the study include biodegradable polymers reinforced with natural fibres such as jute, flax, or hemp. The cutouts may vary in shape (e.g., circular, square rectangular), size, and orientation to evaluate their impact on the vibrational characteristics of the composite plates.

Limitations:

Experimental Testing Conditions: The experimental investigations will be conducted within controlled

laboratory settings. Consequently, the findings may not perfectly reflect the performance of these materials in real-world operational environments.

Assumptions in Numerical Simulations: The numerical simulations will be based on finite element analysis, which inherently involves assumptions and simplifications. These simplifications could lead to disparities between simulated results and actual physical behaviour.

Focus on Free Vibration Analysis: The study primarily focuses on free vibration analysis and does not address other dynamic loading scenarios such as forced vibrations or impact loading.

While the project aims to provide valuable insights into the dynamic behaviour of biodegradable composite plates with cutouts, certain limitations are acknowledged.

When considering composite materials as a whole, there are several resin, fibre and core material possibilities to select from, each with a separate set of special qualities including strength, stiffness toughness, heat resistance, cost, manufacturing of special qualities including rate, etc.

However, the final characteristics of a composite component made from these various materials depend on the more than just the unique characteristics of the resin matrix and fibre, they also depend on how the materials were used to create the part and how they were treated.

Hand Layup Method

By hand, matrix/resin impregnations are made into fibres that are woven, knit, stitched, or bonded into textiles. In addition to the increasingly popular nip-roller type impregnators, which employ revolving rollers and a resin bath to force resin into the textiles, this is often done with brushes or rollers. Laminates are left to curve under standard atmospheric conditions.

Specimen dimensions:

- The specimen is made according to the ASTM standards with a length of 200mm and the width of 35mm of areca sheets.
- The thickness of the specimen is varied by the addition of the multiple layers of areca sheets.

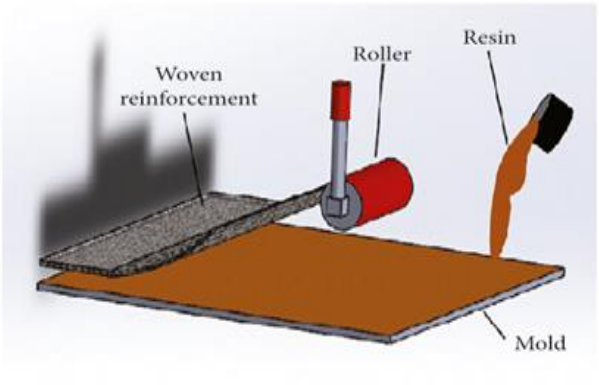

Figure 1: Hand Layup Method

Preparation of Specimen

- Select the sufficient area for preparing specimen.
- Take a plastic sheet and make a thin wax layer of it.
- Place the Areca sheet on the wax coted plastic sheet.
- Now add a thin layer of the epoxy-resin mixture on to the Areca sheet.
- After applying resin, add a layer of areca-fibre sheet.
- Again, apply the resin and add required layer of areca sheet.
- Carefully remove the specimen from the wax sheets
- Mark on the specimens by using marker and ruler according to the dimensions.
- After marking carefully cut the specimen according to dimensions using hand cutting machine.

II. METHODS AND MATERIAL

Numerical Method

The numerical method is the simple software package and takes less time to analyze any component. In the present work the numerical analysis was carried out using Hyper-Mesh as pre and post-processor and MSC/NASTRAN as solver. The finite element method is numerical technique, well suited to digital computer,

which can be applied to solve problems in solid mechanics, fluid mechanics, heat transfer vibrations.

The procedures to solve problems in each of these fields are similar in all finite element models of the domain (the solid in solid mechanics problems) is divided ate a finite number of elements.

Experimental Method

To understand the effect of length/breadth ratio, cut shape and size on the vibration characteristics of Areca Woven Sheath laminated composite plate were performed. The specimen was clamped at two opposite sides and kept free at other two sides. The free vibration behaviour of the plates is studied with the use of Fast Fourier Transform [FFT]. The experimental approach starts from the measurement of dynamic input forces and output response of the structure of interest. For composite plate and obtained results are compared with the numerical value of finite element analysis approach.

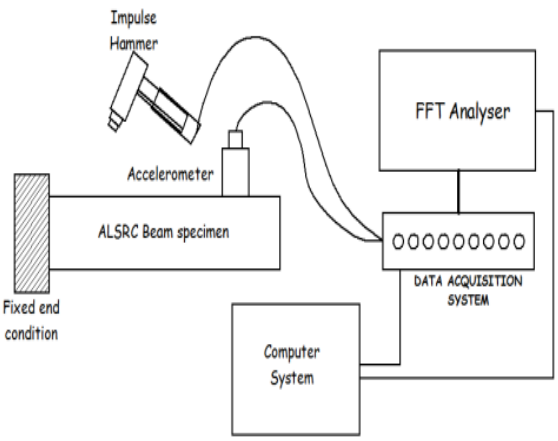

Figure 2: Schematic Experimental Setup for Vibration Studies

III. RESULTS AND DISCUSSIONS

The primary focus of this study is to present the fundamental natural frequencies of isotropic and laminated composite plates with cutouts, which were determined through Finite Element Method (FEM) and experimental techniques. The accuracy of the finite element method was validated by comparing the results with established closed-form solutions found in existing literature.

By conducting experimental tests and numerical simulations, we aim to provide valuable insights into the composite materials engineering. This research specifically delves into the vibration characteristics of isotropic and biodegradable composite laminated plates, examining parameters such as cut-out type, cut-out size, fibre orientation cross ply.

The results that are obtained from Experimental and FEM Methods are Tabulated for Isotropic and Biodegradable Composite Laminated Plates.

Clamped-Free-Clamped-Free

Table 1: Dimensional Frequency for $[0/90]^0$ Biodegradable Composite Laminated Plate without Cut Outs

Shape	AR	Mode No.	Frequency (Hz)	
			Experimental	FEM
Without Cutout	0.5	1	27.50	28.33
		2	39.50	41.48
		3	89.50	92.63
		4	105.00	108.15
		5	147.00	154.35

It has been observed that the present finite element model with eight quadrilateral I element perform excellently. Natural frequency of the plate will decrease as the cut out changes its shape from circular to square to Rectangular for the materials. For circular cut out the fundamental frequency will be greater than square and rectangular cut out. As the cutout shape changes the plate the fundamental frequency of the plate will increase.

Table 2: Dimensional Frequency for [0/90]0 Biodegradable Composite Laminated Plate with Central Cut Outs

Shape	Cut out size	Mode No	Frequency in Hz	
			Experimental	FEM
Circular Cut Out	D=10mm	1	29.50	30.39
		2	48.50	50.93
		3	104.24	107.64
		4	133.33	136.99
		5	176.65	184.80
Square Cut Out	D=B=10mm	1	28.50	29.50
		2	42.65	43.26
		3	86.50	90.83
		4	100.34	103.50
		5	123.22	126.69
Rectangular Cut Out	D=10mm B=15mm	1	27.50	28.88
		2	34.54	35.19
		3	45.50	46.87
		4	57.50	60.38
		5	78.50	81.25

Clamped-Free-Free-Free

Table 3: Dimensional Frequency for [0/90]0 Biodegradable Composite Laminated Plate without Cut Outs

Shape	AR	Mode No	Frequency in Hz	
			Experimental	FEM
With Out Cut Out	0.5	1	11.05	11.38
		2	29.50	30.98
		3	44.50	45.54
		4	47.50	48.93
		5	104.00	109.20

Table 4: Dimensional Frequency for [0/90]0 Biodegradable Composite Laminated Plate without Cut Outs

Shape	Cut out size	Mode No	Frequency in Hz	
			Experimental	FEM
Circular Cut Out	D=10mm	1	17.50	17.51
		2	20.50	21.53
		3	29.50	30.02
		4	32.50	33.48
		5	124.00	130.20
Square Cut Out	D=B=10mm	1	13.50	13.97
		2	19.50	20.09
		3	20.50	21.53
		4	30.39	31.45
		5	91.00	93.73
Rectangular Cut Out	D=10mm B=15mm	1	11.50	12.08
		2	15.50	16.04
		3	19.50	20.09
		4	29.50	30.98
		5	78.50	81.25

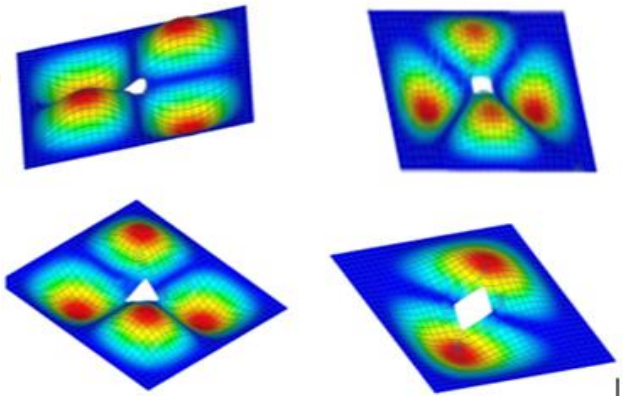

Figure 3: Mode Shapes Obtained for Areca Plate with Cutouts

IV. CONCLUSION

Using both experimental and numerical methods, the goals of this study were to thoroughly examine the free vibration properties of biodegradable composite plates with cuts. We aimed to compare vibrational responses between biodegradable and conventional synthetic composites, analyse the impact of cutout parameters,

validate numerical simulations against empirical data, and provide design insights and optimization strategies for such composite structures through a rigorous set of experiments and finite element analysis (FEA).

The study examined a range of factors under distinct boundary conditions, such as cutout type, size, and fibre orientation angle. Surprisingly, the eight-quadrilateral element finite element model performed admirably throughout the analysis.

First, it was noted that for the materials under consideration, the natural frequency of the plate falls as the cutting shapes from circular to square to rectangular. In conclusion, the numerical studies presented in this work highlight the intricate relationship between cut out size, cut out shape, and natural frequencies of isotropic plates under different boundary conditions. These findings contribute to the broader body of knowledge on structural vibration behaviour and offer valuable insights for engineering design and optimization.

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MilaDen: Missing Person Detection System

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ABSTRACT

The "MilaDen" research marks a significant milestone in utilizing technology to confront the urgent issue of missing individuals in society. Through the amalgamation of machine learning algorithms and facial recognition techniques, the study revolutionizes the search process by enabling users to submit images of missing persons for comparison against a centralized database. Upon identifying a match, the system promptly notifies relevant authorities and stakeholders, facilitating rapid response and coordination in search and rescue endeavors. The research's modular architecture, constructed using Python, TensorFlow, OpenCV, and Django, ensures scalability and adaptability for future innovations. Moreover, the envisioned integration of real-time video analysis and the development of a mobile application version hold promise for expanding the research's scope and efficacy. In sum, the "Missing Person Detection System" underscores the transformative potential of technology in addressing societal challenges and underscores the imperative of innovation in humanitarian research.

Keywords: Machine learning algorithms, Facial recognition, TensorFlow, OpenCV, Django.

I. INTRODUCTION

Every day, numerous individuals such as children, youth, young women, the mentally handicapped, and the elderly with dementia go missing in our society. Despite the efforts of law enforcement agencies, locating these missing persons remains a challenging and time-consuming task. The current protocol requires reporting the missing person to the nearest police station, which then initiates an investigation based on the gathered information. This conventional process is labour-intensive and often fraught with delays, contributing to emotional distress and uncertainty for the families involved.

To address these challenges, we have developed a project called "Mila Den." This application leverages advanced technologies, including facial recognition algorithms, to enhance the efficiency and effectiveness of locating missing individuals [1]. When a disappearance is captured on CCTV, Mila Den can utilize facial recognition to identify matches. Once a match is detected, the system generates custom alerts and location updates, which are immediately sent to family members and relevant authorities.

Mila Den comprises several key modules that facilitate its functionality. The "Image Upload" module allows users, including family members and law enforcement, to submit images of missing persons along with pertinent information. The "Face Recognition" module employs machine learning algorithms to extract and compare facial features against a comprehensive image repository [2]. The "Database Management" module ensures efficient organization and retrieval of this information, supporting the overall system's performance. The project's primary objective is to develop a user-friendly digital platform that integrates seamlessly with existing investigative processes. Built using Django, HTML, CSS, JavaScript, OpenCV, and facial recognition technologies, Mila Den is designed to streamline the identification and reunion of missing persons with their families. Users can register complaints through the platform, triggering facial

recognition surveillance and generating email alerts upon detection of a match. The system securely stores the last known locations and relevant details of missing individuals, enabling efficient database management and quick retrieval of information [3].

The "Missing Person Detection System" offered by Mila Den represents a transformative approach to addressing the inefficiencies of traditional investigative processes. By integrating machine learning and facial recognition technologies, the system streamlines search efforts, generates prompt alerts, and facilitates quick responses. Future enhancements, such as real-time video analysis and a mobile application version, aim to further extend the system's accessibility and effectiveness. Utilizing a technology stack that includes Python, TensorFlow, OpenCV, and Django, this project lays the foundation for seamless integration with law enforcement databases and processes, ultimately bridging the gap between technology and empathy in the search for missing persons [4].

The modular design of Mila Den facilitates ease of use and scalability, with distinct modules dedicated to image uploads facial recognition, and database management. Future enhancements, such as real-time video analysis and a mobile application version, aim to further broaden the system's accessibility and effectiveness. The project utilizes a robust technology stack, including Python, TensorFlow, OpenCV, and Django, laying the groundwork for future collaboration with law enforcement agencies [5].

This collaboration will enable seamless integration with existing investigative processes and databases, ultimately bridging the gap between technology and empathy in the search for missing persons. Mila Den's innovative approach to missing person detection not only improves the efficiency of search efforts but also provides vital support to families in distress. By leveraging cutting-edge technologies and a user-centric design, Mila Den aims to expedite the reunion of missing individuals with their families, thereby reducing the emotional and psychological impact of such traumatic events. Through ongoing development and enhancements, Mila Den aspires to become an indispensable tool in the global effort to locate and reunite missing persons with their loved ones.

II. METHODS AND MATERIAL

The system is built using Python for its versatility and extensive support in various domains. Django, a high-level Python web framework, forms the well-structured foundation for backend development, seamlessly integrating with OpenCV and the Face-Recognition library to enable machine learning capabilities.

Django:

Django's Model-View-Controller (MVC) architectural pattern enables efficient database integration and management, simplifying interactions through its ORM (Object-Relational Mapping).The built-in authentication system and security features support user authentication and access control, crucial for protecting sensitive information and functionalities such as facial recognition.

Integration with OpenCV allows for real-time image processing and facial recognition managed by Django's views and connected to the frontend. Django handles email functionalities using the built-in Email Message class, allowing for notifications and alerts to enhance user experience.

OpenCV:

OpenCV, an open-source computer vision and machine learning library, provides essential tools and algorithms for image and video analysis. It plays a crucial role in facial recognition by leveraging pre-trained deep learning models to detect and recognize faces in images and video streams, integrated into the Django backend for secure identification.

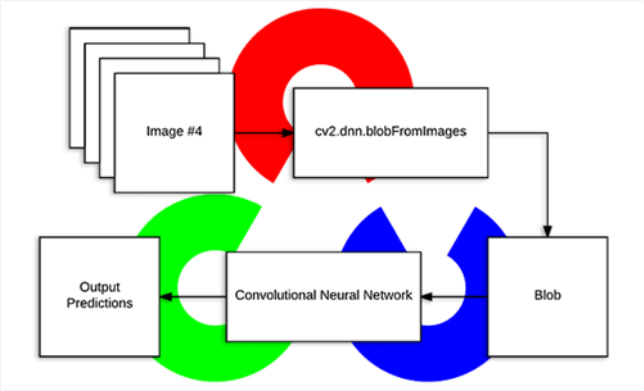

Figure 1: Working of OpenCV

The Figure 1 illustrates the workflow of OpenCV within the system architecture. It demonstrates how images and video streams are processed in real-time using OpenCV's pre-trained deep learning models for facial recognition. The steps include capturing input from CCTV or uploaded images, preprocessing the images to optimize conditions for recognition, applying facial recognition algorithms to detect and identify individuals, and integrating these results with the Django backend for further action and notification. The figure highlights the seamless interaction between OpenCV's computer vision capabilities and the Django framework, showcasing the system's efficiency in identifying and processing visual data.

Face-recognition library:

Face recognition is a critical component of many computer vision applications, and several libraries provide robust solutions for implementing this functionality. While there are various face recognition libraries available, one popular choice is the "face recognition" library in Python. Here's an overview of its uses and how it might have assisted us in our research.

Facial Detection: The face recognition library uses pre-trained deep learning models to detect faces in images or video frames. It identifies the location of faces within the given input and provides bounding box coordinates.

Facial Landmark Detection: Beyond face detection, the library can also detect facial landmarks, such as eyes, nose, and mouth. Knowing these landmarks allows for more detailed analysis and manipulation of facial features.

Face Encoding: The library computes facial encodings, which are numerical representations of facial features. These encodings serve as unique identifiers for different faces and are used for face matching and recognition.

Face Recognition: The primary purpose of the library is, as the name suggests, face recognition. It compares the facial encodings of known faces with those in the input data to identify individuals. It can recognize faces in images, video streams, or even in real-time scenarios.

Accuracy and Performance: The face recognition library is known for its accuracy in identifying faces, even in challenging conditions. It leverages the dlib library for its deep learning models, which are optimized for both accuracy and performance.

Integration with Databases: Face recognition is often used in conjunction with databases to associate recognized faces with relevant information. In this research, integrating face recognition with Django's database capabilities would have allowed for seamless storage and retrieval of information associated with recognized individuals.

Security and Access Control: Face recognition is widely used for security applications and access control systems. In this research, this feature has been leveraged for secure authentication and authorization.

Customization and Scalability: The face recognition library is flexible and allows for the training of custom models for specific faces or features. This customization feature can be particularly useful in projects where unique facial attributes or expressions need to be recognized.

Handling Large Datasets: For projects dealing with extensive datasets of faces, the face recognition library efficiently handles large-scale recognition tasks. This scalability is advantageous when working with applications that involve a diverse range of individuals and require the recognition of numerous faces in real-time or batch processing.

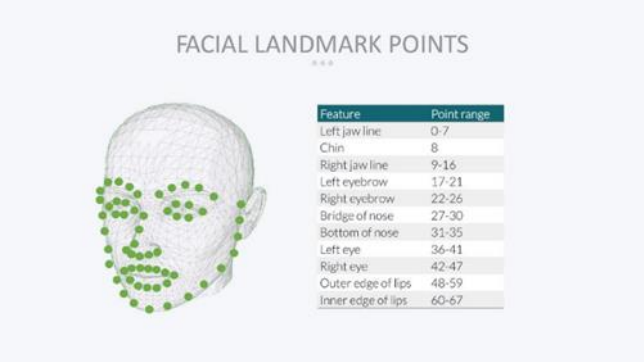

Figure 2: Facial Landmark Points

The Figure 2 depicts the facial landmark points detected by the face recognition library. It highlights key features such as the eyes, nose, and mouth, which are crucial for detailed facial analysis and manipulation. These

landmarks serve as reference points for various facial recognition tasks, ensuring accurate identification and providing a foundation for further processing and feature extraction. The figure demonstrates the capability of the face recognition library to precisely locate and map these critical points on a face within an image.

This research focuses on developing an efficient system for the identification and notification process for missing persons using advanced facial recognition technology. The methodology involves several key steps to ensure accurate and timely processing of information.

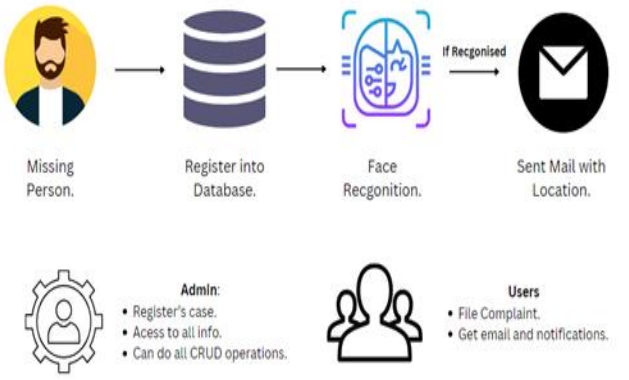

Figure 3: Project Model

Input Image / Case Registration:

The research begins with the user providing an input image or registering a case through the user interface or an API endpoint. This initial step captures essential details for subsequent analysis and sets the foundation for the system's processing.

Data Registration: Once the input is received, the system processes the registration by storing relevant details in a database. This includes user information, case specifics, and a reference to the provided image. The database acts as a central repository for all case-related data, facilitating organized and accessible information management.

Facial Detection and Recognition: The core of the system's functionality involves utilizing OpenCV for facial recognition. The system preprocesses the input image to enhance detection accuracy, extracts facial features, and employs the face recognition library to identify faces. This step is critical in determining the presence of a face in the registered image, which is necessary for subsequent notification actions.

Notification and Alert System: Upon successful face detection, the system initiates a series of notification actions. Email notifications and alerts are sent to relevant parties, including case investigators, administrators, or other designated individuals. This immediate communication ensures that appropriate actions can be taken swiftly, enhancing the system's responsiveness and effectiveness.

Iterative Search Process: In cases where no face is detected, the system prompts the user to conduct another search. This iterative process continues until a valid face is detected or the user decides to terminate the search. This step ensures comprehensive efforts in face detection, maximizing the likelihood of successful identification. Functionality involves utilizing OpenCV for facial recognition. The system preprocesses the input image to enhance detection accuracy, extracts facial features, and employs the face recognition library to identify faces. This step is critical in determining the presence of a face in the registered image, which is necessary for subsequent notification actions.

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III. RESULTS AND DISCUSSION

The MilaDen project represents a significant advancement in the field of missing person detection and search operations. Through the integration of Python programming, machine learning algorithms, and web development methodologies, the system has demonstrated remarkable capabilities in enhancing search and rescue efforts for missing individuals.

Enhanced Search Efficiency: The implementation of advanced facial recognition technology has significantly improved the efficiency of search operations. By accurately detecting and identifying missing persons

from input images, MilaDen streamlines the search process and minimizes the time required for identification.

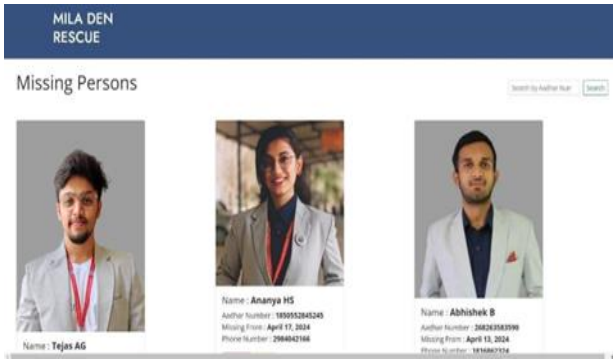

Figure 4: Missing persons

Figure 5: Message notified to family

Timely Notification Mechanism: The system's prompt notification mechanism ensures that relevant parties are informed swiftly upon the detection of a missing person. Through email notifications and alerts, MilaDen notifies case investigators, administrators, and other designated individuals, enabling timely interventions and actions.

Iterative Search Process: In cases where a face is not initially detected, MilaDen prompts users to initiate another search. This iterative process continues until a valid face is detected or the user terminates the search. This iterative approach maximizes the chances of successful identification and contributes to comprehensive search efforts.

Administrative Capabilities: MilaDen provides administrative users with robust capabilities for accessing, editing, modifying, and deleting information stored in the system. Through a secure admin interface, administrators can efficiently manage database records, ensuring data integrity and accuracy.

Future Scopes for Improvement: The project outlines several future scopes for enhancement, including advanced facial recognition techniques, real-time video analysis, mobile app development, and collaboration with law enforcement agencies. These planned enhancements aim to further strengthen the system's impact and effectiveness in locating missing persons.

IV. CONCLUSION

In the culmination of MilaDen lies a testament to the harmonious marriage of technology and social consciousness, presenting an unprecedented solution to a critical societal dilemma. The synthesis of Python programming, machine learning algorithms, and web development methodologies has birthed a transformative tool set to revolutionize search and rescue operations for missing persons.

This project epitomizes the fusion of technology and social responsibility, offering a groundbreaking solution to a pressing societal issue. The integration of Python programming, machine learning, and web development has yielded a powerful tool poised to significantly impact search and rescue efforts for missing individuals. Looking forward, the system holds vast potential for growth and enhancement, with planned future scopes including advanced facial recognition, real-time video analysis, mobile app development, and collaboration with law enforcement agencies.

As we reflect on this journey, we take pride in MilaDen as a beacon of technological innovation serving the greater good. It not only demonstrates the capabilities of modern technology but also underscores the significance of collaboration, mentorship, and a shared vision in addressing real-world challenges.

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Multi-Model Advanced Video and Image Forgery Detection

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ABSTRACT

This research work focuses on developing a sophisticated forgery detection system for images and videos, leveraging Convolutional Neural Networks (CNNs) and the ResNet50 architecture. With the rise of image and video manipulation tools, detecting forged media has become increasingly challenging. Our approach addresses this by using CNNs and ResNet50 trained on the FIDAC dataset, covering various types of forgeries. By harnessing deep learning, we aim to enhance detection accuracy and robustness. We chose CNNs and ResNet50 for their ability to capture intricate features and patterns, enabling the detection of subtle alterations. We trained multiple models on the FIDAC dataset, each specializing in detecting specific forgery types. Fine-tuning the pre-trained ResNet50 improved the system's ability to recognize complex manipulations. The outcome is a highly accurate forgery detection system for both images and videos. Extensive testing demonstrates its effectiveness across various resolutions and manipulation techniques. In conclusion, this project advances digital forensics by providing a robust solution for detecting image and video forgeries using CNNs and ResNet50 trained on the FIDAC dataset.

Keywords: Forgery detection, Convolutional Neural Networks (CNNs), ResNet50 architecture.

I. INTRODUCTION

Digital media, particularly images and videos, pervade various aspects of modern communication and documentation, ranging from social media platforms to critical domains like law enforcement, healthcare, and finance. However, the widespread availability of powerful editing tools poses a significant challenge to the authenticity and integrity of such content. Ensuring the trustworthiness of digital media has become imperative, given the potential consequences of misinformation and manipulation.

Recent advancements in deep learning, particularly with techniques such as Recurrent Neural Networks (RNN), Deep Convolutional Neural Networks (DCNN), and Adaptive Neural Networks (ANN), have offered promising avenues for addressing digital forgery detection. These techniques enable the analysis of visual and audio cues to distinguish between authentic and manipulated content. Additionally, efforts have been made to tackle the challenges posed by anti-forensics, compression methods, and the availability of suitable datasets for training and testing.

One major focus of multimedia forensics is the detection of copy-move forgery in images and videos, where portions of content are duplicated or altered to mislead viewers. While existing approaches have shown effectiveness, they often face challenges in balancing detection efficiency, robustness, and applicability across various scenarios. In response, our project proposes a novel approach that leverages optical flow and stable parameters to detect frame-level copy-move forgery, enhancing both accuracy and reliability [1].

This paper aims to present a comprehensive framework for advanced video and image forgery detection, emphasizing multi-modal deep learning techniques. By integrating diverse data sources and leveraging deep learning architectures, we seek to develop methods

capable of accurately and reliably identifying manipulated multimedia content. Specifically, our objectives include:

1. Developing algorithms for detecting forged images by analyzing visual cues, ensuring integrity across diverse applications.
2. Implementing deep learning techniques to detect alterations in video content, enhancing the accuracy of identifying manipulated sequences.
3. Introducing a metric to quantify the extent of tampering within video content, providing a measure of manipulation severity.
4. Establishing a web portal for real-time analysis and verification of multimedia content, offering a user-friendly interface for authenticity assessment.

Through these objectives, we aim to contribute to the advancement of digital forensics by providing robust solutions for detecting image and video forgeries in various contexts.

II. METHODS AND MATERIAL

The proposed system design integrates two distinct CNN architectures tailored for image and video forgery detection, namely the CNN Architecture and ResNet50. Each architecture is optimized for discerning between authentic and tampered content, employing advanced convolutional neural network techniques to achieve accurate detection.

CNN Architecture

For image forgery detection, the proposed CNN Architecture was employed, which featured multiple convolutional layers with ReLU activation functions for feature extraction. Additionally, max-pooling layers were utilized to reduce spatial dimensions, while fully connected layers with dropout facilitated classification into authentic or tampered categories. Notably, the CNN Architecture was designed to process ELA- pre-processed images with an input size of 128x128x3, optimizing efficiency in discerning between authentic and manipulated images [2].

Regarding video forgery detection, individual frames of video sequences were processed using the CNN Architecture, thereby adapting it for this purpose. This adaptation included incorporating residual blocks with skip connections to address vanishing gradient issues inherent in deep networks, while the architecture's bottleneck structure reduced computational complexity through the utilization of 1x1 and 3x3 convolutional layers. Figure 1 shows that it is the CNN Architecture which is used for image forgery detection [4].

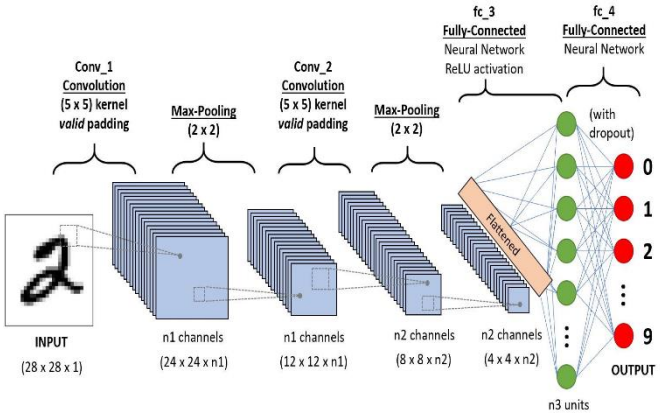

Figure 1: CNN Architecture

ResNet 50

The ResNet50 architecture, initially proposed for image classification tasks, was repurposed for video forgery detection. This architecture leveraged its deep architecture and skip connections to effectively learn features from video frames, thereby enabling accurate detection of forged segments within video sequences. Pooling layers were utilized to down sample feature maps, and fully connected layers were employed to aggregate features for classification, with the output layer typically utilizing softmax activation to classify videos as authentic or tampered [3].

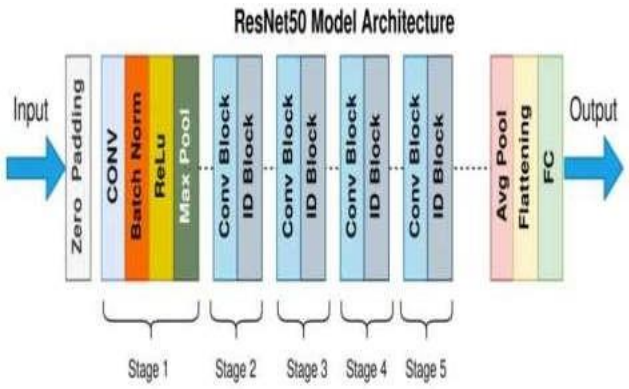

Figure 2: ResNet50 Architecture

Figure 2 shows that, it is the ResNet50architecture where it is a convolutional neural network (CNN) architecture that is part of the ResNet (Residual Network) family, originally proposed for image classification tasks.

III. RESULTS AND DISCUSSION

The study's findings affirm the effectiveness of the proposed CNN architecture in detecting image and video forgeries. Utilizing Error Level Analysis (ELA) preprocessing, images were transformed into ELA representation, facilitating the calculation of absolute differences between original and recompressed images. This preprocessing step provided valuable insights into the extent of tampering present in the images. The CNN architecture, consisting of 15 layers including convolutional, pooling, fully connected, and dropout layers, exhibited robust performance. With input dimensions set at 128x128x3 (RGB), the architecture's summary, detailing layer types, output shapes, and parameters, ensured transparency and reproducibility.

Experimental setup on a system with 16 GB RAM, an Intel i5 processor, and a 2GB graphics card, provided a reliable environment for conducting experiments. Utilizing CASIA and FIDAC datasets for training and testing, and employing pre-defined CNN architectures for comparison, our model showcased promising results across various datasets and epochs.

Figure 3: Authentic Image Detection

Figure 3 shows the authentic image which has been detected by the website.

Figure 4: Forged Image Detection

Figure 4 shows the forged image which has been detected by the website.

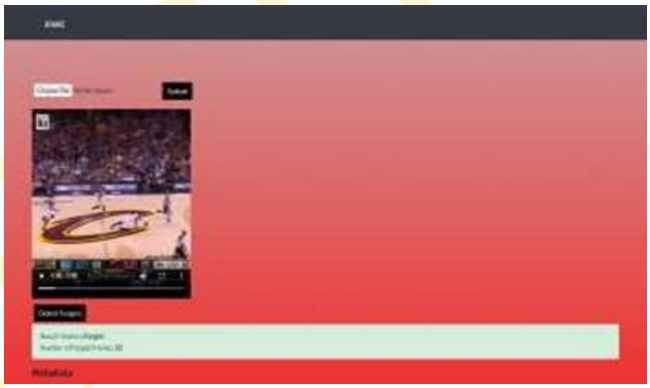

Figure 5: Forged Video Detection

Figure 5 shows that, it is the Forged video which has been detected by the website.

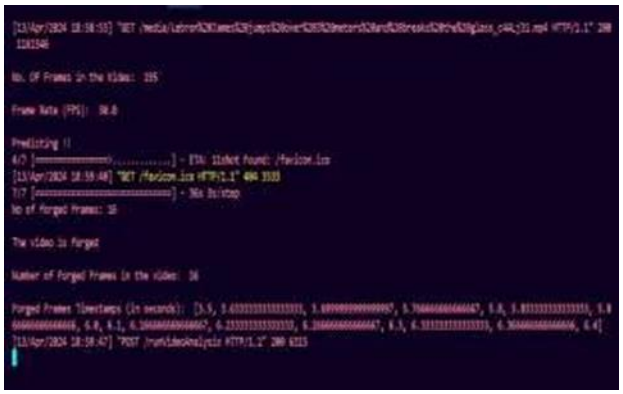

Figure 6: Time-Frames in forged video

Figure 6 show that, it is the time frame in which part the video has been forged so that the detection of where it has been forged would be easy to find out.

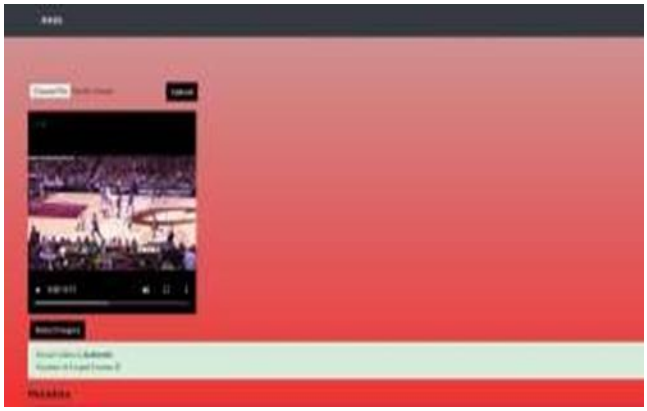

Figure 7: Authentic Video Detection

Figure 7 show that it is the authentic video which has been detected by the website.

This section presents the results of experiments conducted for 15 and 50 epochs, comparing training, validation, and testing accuracies across CASIA, FIDAC, and CASIA-FIDAC datasets. It includes confusion matrix analysis detailing true positives, false negatives, false positives, and true negatives. Performance measures such as sensitivity, specificity, precision, negative predictive value, false positive rate, false discovery rate, false negative rate, accuracy, and F1 score are provided for the proposed architecture trained on the CASIA- FIDAC dataset for 50 epochs.

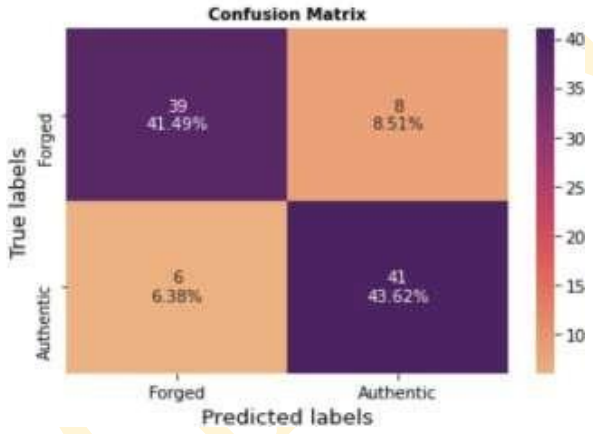

Figure 8: Confusion Matrix

Figure 8 shows that it is a confusion matrix is a table that is used to describe the performance of a classification model on a set of test data for which the true values are known.

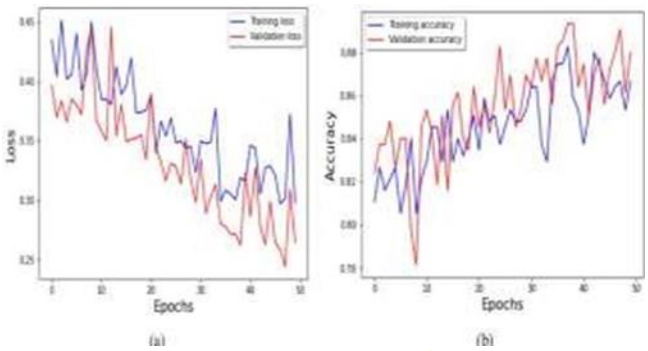

Figure 9: a) The evolution of training loss (top) b) accuracy (bottom) versus number of epoch

The results obtained from the experiments indicate the promising potential of the proposed CNN architecture in the field of digital forensics and multimedia authentication. The robust performance demonstrated across different datasets and epochs underscores the architecture's ability to effectively discern between authentic and tampered content. The clear distinction between true positive (TP), false negative (FN), false positive (FP), and true negative (TN) outcomes, as revealed by the confusion matrix analysis, highlights the model's classification accuracy. In summary, the results and subsequent discussion affirm the proposed CNN architecture's capability to advance the field of digital forensics by providing a reliable and accurate method for detecting image and video forgeries.

IV. CONCLUSION

In conclusion, our project has effectively achieved its objectives in advancing digital forensics and content authentication. We introduced a novel CNN architecture for image forgery detection and proposed the FIDAC dataset, demonstrating enhanced accuracy through dataset combination. Our CNN architecture showed competitive performance against established classifiers, underscoring its efficiency. While acknowledging room for improvement, such as dataset enlargement and optimization exploration, our ongoing research, including ViFoDAC for video forgery detection, underscores our commitment to continuous advancement. By meeting objectives of detecting forged images and videos and establishing a user-friendly content analysis portal, our project significantly contributes to digital forensics. Through further refinement, we aim to ensure integrity and authenticity across various applications, thus making a meaningful scientific contribution.

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Underground Pipeline Water Detection and Monitoring for Leakage

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ABSTRACT

The project focuses on developing an advanced water leak detection and monitoring system for underground pipelines, utilizing NodeMCU integrated with water flow sensors. By leveraging blynk as a cloud server, the system enables real-time data analysis and visualization, enhancing proactive decision-making capabilities. The primary objectives include early leakage detection, finding pin leak location, water conservation, operational efficiency, and cost savings in micro irrigation systems. The ESP32 microcontroller plays a crucial role by providing essential connectivity features like Wi-Fi and Bluetooth for IoT applications, facilitating improved maintenance practices, reduced environmental impact, and remote monitoring functionalities. Addressing pipeline leakage issues, including high non-revenue water percentages due to leaks, corrosion, and aging infrastructure, is a key focus of the project. Through the integration of innovative leak detection methods and enhanced monitoring systems, the project aims to revolutionize the monitoring and maintenance of underground pipelines. By combining cutting-edge technology with sensor networks and cloud platforms, the project seeks to enhance efficiency, reduce water losses, and improve overall system reliability. Ultimately, the project aims to contribute to water conservation efforts, operational optimization, and sustainable water management practices in micro irrigation systems.

Keywords: Flow sensor, IoT, Fluid Mechanics, Node MCU.

I. INTRODUCTION

Farming has always been super important in India. It's shaped how people think and live. India's got all kinds of climates, so we can grow lots of different crops. This helps the country grow and get better. Right now, farming makes up a big part of India's money-making, like 25% of all the stuff we make, and 15% of the stuff we sell to other countries. It also gives jobs to more than half of the people who work here, making sure over 650 million folks have enough to eat and make a living [1, 2].

In the future, India will need a lot of water for different things, like farming, industry, and homes. Right now, most of the water we use is for farming, but that's going to change. By 2050, we'll need less water for farming, but more for other stuff like factories and homes. This could be tough for farming because we might not have enough water to grow our crops. Also, each person will have less water available for them every year. So, we need to change how we use and manage water to make sure everyone has enough in the future. Micro irrigation is a smart way to water plants directly at their roots. Some countries already use it to improve farming. India has started using it too, especially for growing fruits and vegetables. But not enough farms are using it yet, even though it's really good [3].

Most farms in India still use old ways to water crops, which isn't great. With less water available, we need better ways to use it. Micro irrigation helps by saving water, fertilizers, and electricity. It's not just about watering plants; it's about using resources wisely. Plus,

it makes sure different parts of the farm get the right amount of water, which is super important. So, micro irrigation could make farming much better by being more efficient and diverse.

Water productivity is a way to measure how well we use water for farming. It compares the amount of crops we get with the amount of water we use. In micro-irrigation, we can grow more crops using less water compared to old ways. So, water productivity goes up because we get more crops with less water. This is really helpful, especially in places where water is scarce, like dry areas. That's why micro-irrigation is seen as a cool way to help farming grow sustainably.

Urban and industrial areas are using more and more water, which is bad news for farming. Soon, only 50% of water will be available for farming, down from 70%. But India needs to increase its farming area to meet the needs of its growing population. However, there's not enough water for this. So, we need to use water-saving technologies, like collecting rainwater and using it wisely. Micro-irrigation is one way to help. It uses less water and can work well even in areas with poor soil. It's like a system of pipes that deliver water right to the plants' roots. With micro-irrigation, we can use up to 90% of the water, which is much better than other methods. So, it's really important for the future of farming. Problem faced in micro-irrigation system in agriculture: Farming is changing worldwide, and a big part of this change is precision farming. One key aspect of precision farming is micro irrigation, which helps farmers use water more efficiently. Water is crucial for growing crops well. When we water crops, they grow better, allowing farmers to grow different types of crops. In India, irrigation has greatly improved farming by helping us produce more food. However, using too much water can lead to problems like water logging and soil salinity. Additionally, a lot of water is lost to evaporation.

India doesn't have a lot of water compared to its population, and most of it is used for farming. However, a significant amount of water is lost to evaporation. So, we need to find ways to use water more wisely. Micro irrigation is one solution. It delivers water directly to the roots of plants, reducing water waste. Although the government encourages its use, many farmers haven't tried it yet. In places like Ranga Reddy in Telangana, farmers face their own challenges. They rely heavily on groundwater for irrigation, which is increasing over time. While groundwater helps crops grow better, it's important to use it wisely to avoid running out of water.

Overall, adopting micro irrigation can help farmers save water and grow more crops. Projects in places like Telangana aim to increase its use, which could lead to higher food production with less water. Leakage problems in water pipes are a big deal because they lead to the loss of clean water, which is super important in our daily lives. Not only does it cause financial losses for farmers, affecting their crops, but it also affects water quality and quantity. Detecting leaks in water pipes, especially underground ones, is a challenge because it's usually done manually, which takes a lot of time and effort. Leaks in pipes can be caused by various factors like the age of the pipe, rust, and natural factors, which can also affect water quality.

To solve this problem, we need a system to monitor and detect leaks in water pipes. This system should be able to identify leaks even in underground pipes, saving time and effort. It should also have an easy-to-use interface for users. One important aspect of this system is data communication, which can be achieved using telemetry, a technology that collects and transmits data from remote locations. Different methods, such as acoustic sound detection, vibration sensors, and water level sensors, have been tried, but each has its drawbacks.
One main problem to solve is detecting leaks and measuring their severity. Another challenge is pinpointing the exact location of the leak. To address these challenges, water flow sensors can be used to measure the flow in the pipe, indicating if there's a leak. Adding multiple sensors along the water line can help identify the leak's location by comparing water flow values at different points. Additionally, the communication model used in the system is crucial, and applying the Internet of Things (IoT) concept can be a solution. IoT technology allows objects to send and receive data over the internet, providing real-time monitoring of water pipe leaks through smartphones or other devices. Moreover, the effectiveness of micro-irrigation systems depends on factors like soil type, crop type, and climate conditions. In regions where groundwater is the primary source of irrigation, over-extraction can lead to depletion and deterioration of aquifers, exacerbating water scarcity issues. Therefore,

alongside promoting micro-irrigation, there's a need for holistic water management strategies that integrate conservation measures, water recycling, and sustainable groundwater usage practices.

Micro irrigation systems play a pivotal role in modern agriculture, delivering precise amounts of water directly to crops. However, these systems face significant challenges, including undetected pipeline leakages, which can compromise the efficiency of water distribution. Current detection methods are often labor intensive and lack real-time capabilities. To address these issues, there is a need for an innovative solution that leverages sensor-based technology for the pre-detection of micro irrigation pipeline leakage and the finding the pin location of the leak from the sensors.

The main objectives of this research work are;

- Early Leakage Detection: To Design and implement a robust sensor network capable of detecting micro irrigation pipeline leakages in real time. Develop an intelligent algorithm for analyzing sensor data and promptly identifying potential leakage points.
- Distance finding of the leak: Implementation of the algorithm to find the approximate distance from the sensors to reduce the time of workers to find and repair the pipeline network
- Real-time Monitoring and Reporting: Establish a centralized monitoring system to continuously assess the condition of micro irrigation pipelines. Implement a reporting mechanism for instant alerts and notifications to facilitate prompt response to emerging issues.

II. METHODS AND MATERIAL

As the Figure 1 shows that the NodeMCU is a low-cost in-built Wi-Fi microcontroller. It has 8 digital pins and one analog read pin. Except D0, all other pins are support with interrupts. YF-S201 water flow sensors are connected to digital I/O pins D8 and D7 of NodeMCU. This water flow sensor consists of a rotor in it and also this sensor sits in line with your water line and contains a pin wheel sensor to measure how much liquid has moved through it. There's an integrated magnetic hall effect sensor that outputs an electrical pulse with every revolution. The hall effect sensor is sealed from the water pipe and allows the sensor to stay safe and dry. Unlike motor, hall effect sensor produces pulse as an output when rotor rotates.

Distributed at key locations within the pipeline network, NodeMCU serves as the intelligent nodes responsible for collecting data from the water flow sensors. Equipped with Wi-Fi connectivity, these microcontrollers transmit the collected data to the cloud server for analysis. They also manage power and communication between sensors and the cloud.

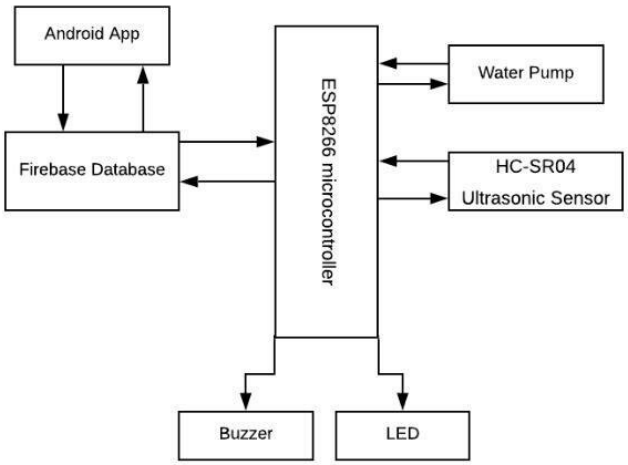

Figure 1: Water leakage detection system block diagram

So, when water flows through the flow sensor, with speed of rotation, pulses will be produced at the output. In microcontroller, this pulse signal is read as an interrupt signal. By counting the pulses from the output of the sensor, the water flow can be calculated. Each pulse is approximately 2.25 milliliters. Detecting water pipeline leakage is crucial for preventing water wastage and ensuring efficient water management. Utilizing NodeMCU, a cost-effective Wi-Fi microcontroller, along with YF-S201 water flow sensors and turbidity sensors, offers an effective solution for real-time monitoring. The YF-S201 water flow sensor, connected to digital pins D8 and D7 of NodeMCU, operates by generating pulses via an integrated magnetic hall effect sensor with each revolution of its rotor. These pulses are interpreted as interrupts by the microcontroller, facilitating accurate measurement of water flow. With each pulse equating to approximately 2.25 milliliters, the flow rate can be precisely calculated, enabling timely detection of anomalies such as leaks or irregular usage patterns. The gathered data from both sensors is

seamlessly transmitted to Blynk, a cloud server tailored for IoT applications.

Additional sensors placed at specific locations to monitor water quality by measuring turbidity levels. Similar to water flow sensors, each turbidity sensor is connected to a NodeMCU microcontroller. Serves as the central hub for collecting, storing, and analyzing data transmitted by the NodeMCU microcontrollers. Blynk provides real-time visualization tools and analytics capabilities for monitoring water flow rates, detecting anomalies, and assessing distance. Enables communication between the NodeMCU microcontrollers and the blynk cloud server. NodeMCU utilizes its built-in Wi-Fi capabilities to establish a connection to the internet. Optional but beneficial for providing stakeholders with a user-friendly interface to access real-time data and analytics generated by the system. This interface can be web-based or mobile application-based, allowing users to monitor the status of the pipeline network remotely. Strategically positioned along the pipeline network, these sensors detect the flow of water through the pipes. Each sensor, like the YF-S201, contains a rotor and a hall effect sensor that generates pulses proportional to the flow rate. These sensors are connected to NodeMCU microcontrollers for data processing.

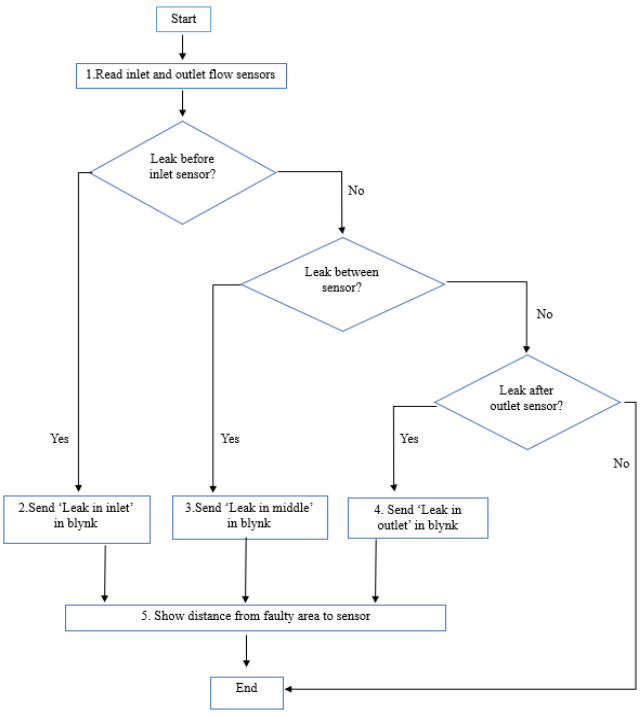

Figure 2: Flow chart of water leakage detection system.

The Figure 2 initiates with system initialization, encompassing the powering up of NodeMCU microcontrollers and the establishment of Wi-Fi connectivity for seamless data transmission. This step involves the continuous monitoring of water flow sensors strategically placed along the pipeline network. These sensors detect pulses indicative of water movement within the pipes. Each pulse corresponds to a specific volume of water passing through the sensor. Following the detection of pulses, the microcontroller calculates the flow rate by counting the number of pulses over a predefined time period. This data is crucial for assessing the flow dynamics within the pipeline and identifying potential leakages or abnormalities.

The recorded water flow rates are then transmitted to the blynk server in real-time. blynk serves as a centralized platform for storing, analyzing, and visualizing the collected data, facilitating proactive monitoring and decision-making. Upon receiving the data, the cloud-based analytics engine analyzes water flow rates for irregularities that may indicate potential leakages or unauthorized water usage. Any deviation from expected flow patterns triggers alerts, prompting further investigation and action.

At this stage, the blynk server receives and stores the transmitted data from multiple NodeMCU microcontrollers deployed across the pipeline network. The data is organized and indexed for efficient retrieval and analysis. Utilizing advanced analytics tools, the cloud-based platform generates visualizations, trends, and statistical analyses of water flow rates and turbidity levels. These insights empower stakeholders to make informed decisions regarding pipeline management and maintenance. Thresholds are set for abnormal flow rates. If these thresholds are breached, the system generates real-time alerts, which are communicated to relevant stakeholders via email, SMS, or push notifications. A user-friendly web interface or mobile application provides stakeholders with remote access to real-time data and analytics. This enables stakeholders to monitor pipeline status, track trends, and respond promptly to any detected anomalies or emergencies. In response to alerts or abnormal data trends, stakeholders take appropriate action to address identified issues. This may involve dispatching maintenance crews to repair leaks, conducting water quality tests, or implementing preventive measures to safeguard the pipeline infrastructure.

The Arduino Integrated Development Environment (IDE) is a software application used to write, compile, and upload code to Arduino microcontroller boards. It provides a user-friendly interface for programming Arduino boards, making it accessible to both beginners and experienced developers.
Key features of the Arduino IDE include:

1. ***Code Editor:*** The IDE includes a text editor where you can write and edit your Arduino sketches (programs). It supports syntax highlighting, auto-indentation, and other features to aid in code writing.
2. ***Sketch Management:*** Arduino programs are called sketches. The IDE allows you to create, open, save, and manage sketches easily.
3. ***Library Manager:*** Arduino libraries provide additional functionalities that can be easily added to your sketches. The IDE includes a library manager that simplifies the process of finding, installing, and managing libraries.
4. ***Serial Monitor:*** The IDE includes a serial monitor tool that allows you to communicate with your Arduino board via the serial port. It is useful for debugging and monitoring the output of your Arduino programs.
5. ***Board Manager:*** Arduino supports a wide range of microcontroller boards. The IDE includes a board manager that allows you to select the type of Arduino board you are using and install the necessary board definitions.
6. ***Sketch Verification and Compilation:*** Before uploading your sketch to the Arduino board, the IDE verifies and compiles the code to check for errors and ensure compatibility with the selected board.

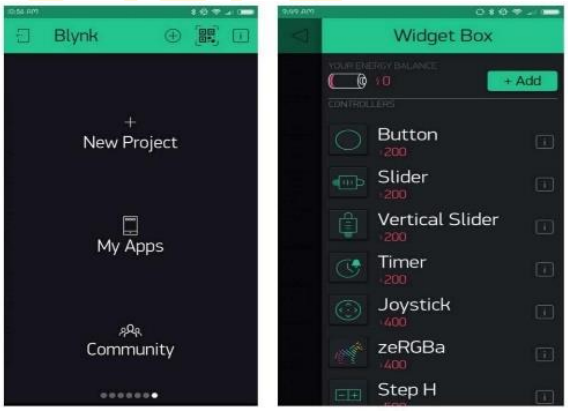

Figure 3: Blynk app

Blynk is a Platform with IOS and Android apps to control Arduino, Raspberry Pi and the likes over the Internet. It provides a user-friendly interface for creating custom dashboards and controlling connected devices using a variety of widgets, such as buttons, sliders, gauges, and graphs. The app offers an intuitive drag-and-drop interface, allowing users to design their own user interfaces with various widgets like buttons, sliders, graphs, and displays, without the need for extensive programming knowledge. Through Blynk's cloud-based platform, users can establish a secure connection between their devices and the app, enabling real-time monitoring and control from anywhere with an internet connection.

III. RESULTS AND DISCUSSION

System performance testing is conducted to determine the performance in monitoring and detecting the location of leaks in an underground pipe water flow system. A prototype is designed to test the system performance using a ½" PVC pipe with a length of 5 meters. This pipe is designed with five holes spaced at varying distances from the sensor: 0.77 meters, 1.55 meters, 2.08 meters, 2.58 meters, and 3.1 meters. The goal is to evaluate the system's ability to accurately detect the location of each leak under different conditions.

The testing setup includes precise measurement tools and sensors to monitor the water flow and detect any leaks accurately. The data collected from these tests are analyzed to determine the system's reliability, sensitivity, and accuracy in leak detection. This thorough testing process ensures that the system is capable of functioning effectively in actual underground water flow scenarios, providing timely and accurate leak detection to prevent water loss and potential damage.
The design of the prototype is shown in Figure 8, which illustrates the layout of the pipe, the positioning of the holes, and the placement of sensors. This figure is crucial for understanding the experimental setup and replicating the test conditions for further validation or improvement of the system.

Figure 4: Prototype of the underground pipe leak detection and monitoring system

IV. CONCLUSION

Computation in science, particularly in fluid mechanics and kinematics physics, is implemented on microcontrollers to enhance various applications. The Node MCU ESP32 is a powerful microcontroller that can be used to detect and locate leaks in pipes by monitoring water flow rates. By utilizing the Node MCU ESP32, the system measures and analyzes the water flow data to detect anomalies that indicate leaks. This microcontroller is equipped with advanced computational capabilities, making it suitable for real-time monitoring and analysis. The average flow rate used for optimal leak detection in this system is 10 liters per minute, ensuring precise identification of leak locations. The system's ability to accurately determine the nearest location of a leak relative to its actual position is a significant advantage, as it aids in quick and effective maintenance and repair.

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Prediction of Silkworm Cocoon Shell Weight Quality using Machine Learning

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ABSTRACT

Sericulture, a vital domain within agriculture, holds immense significance in silk production. This project focuses on leveraging machine learning algorithms to predict cocoon shell weight and quality, crucial factors in determining silk yield and overall cocoon health. The project integrates the YOLO algorithm to assess cocoon state based on dimensions, distinguishing between healthy and unhealthy specimens. Subsequently, the Convolutional Neural Network (CNN) algorithm is employed to delve deeper into cocoon attributes, providing comprehensive insights. The anticipated outcomes not only aid in gauging cocoon health but also facilitate governmental subsidies to farmers, incentivizing quality cultivation. Ultimately, the project aims to predict the final cocoon health status, correlating it with government subsidies and silk yield, thereby optimizing sericulture Practices.

Keywords: Sericulture, cocoon, YOLO, CNN, Silk Yields.

I. INTRODUCTION

Sericulture has become the root for social and economic progress of India. Quality of raw material, reeling machinery, reeling process parameters, human skill involved in manual and mechanical operations and quality of water are the major factors that have direct bearing on the productivity and quality of raw silk. Among these, quality of cocoons plays a major role on raw silk yield and productivity. In order to achieve better reeling performance and quality raw silk the role of reeling technology is significant.

The prevalence of silk as a material fiber has been perceived from the prehistoric time. Silkworm is generally nurtured in different geological locales of India. Cocoons are tougher than coverings of other types of sericigenous insects. The silk fiber delivered by the silkworm is a complex material shaped by fibroin protein and bounded by sericin protein. To get the silk thread from cocoons, removal of sericin is an essential step. As an essential to reeling practice, cooking of cocoon needs to be performed. The cocoon cooking involves boiling of the cocoon in water that helps in the release of sericin protein and a continuous silk filament that is reeled to get a thick thread of silk. Here, cocoon is made softer by decomposing or partially solubilizing the sericin component that ties the protein fibroin strands from which the silk string is reeled. So, it is important to handle each stage of cocoon production in detailed study. Our system makes it easier to process from registering the farmer, information of the cocoon type and providing the subsidy for the good quality and amount of cocoon [1].

The cocoon cooking involves boiling of the cocoon in water that helps in the release of sericin protein and a continuous silk filament that is reeled to get a thick thread of silk. Here, cocoon is made softer by decomposing or partially solubilizing the sericin component that ties the protein fibroin strands from which the silk string is reeled [2]. So, it is important to handle each stage of cocoon production in detailed study. Our system makes it easier to process from

registering the farmer, information of the cocoon type and providing the subsidy for the good quality and amount of cocoon.

The "Smart Sericulture System" aims to revolutionize the ancient art of silk production by merging cutting-edge technology with traditional sericulture practices. This ambitious project envisions a comprehensive system that tackles the key challenges faced by sericulture farmers, boosting efficiency, sustainability, and profitability [3].

- Cocoon shape and size play a pivotal role in determining silk quality, with well-formed, oval cocoons often indicating superior silk.
- Cocoon color serves as a vital indicator, with healthy silkworms typically producing cocoons of consistent white hue.
- Cocoon texture is another key factor, with smooth, uniform cocoons typically yielding high-quality silk, while irregularities may suggest lower quality.
- Cocoon thickness of the silk wall is indicative of silk quality, with thicker walls often associated with superior silk.

II. METHODS AND MATERIAL

The proposed machine learning approach for predicting silkworm cocoon shell weight quality involves data collection using advanced image processing techniques, pre-processing to clean and organize data, and labeling with diseases in mulberry plants and quality parameters for cocoons. Model selection entails choosing appropriate algorithms for disease detection and cocoon quality assessment, followed by model training on pre-processed data to categorize diseases and assess cocoon quality.

The diagram outlines the process for silk production in the Indian state of Karnataka, specifically through the Karnataka Silk Authority (KSA). The KSA seems to play a central role in facilitating silkworm breeding, cocoon production, silk procurement, and printing.

Here's a breakdown of the process based on the diagrams:

Farmer Registration: Farmers interested in sericulture can register with the KSA.

Land and Cocoon Quality Check: The KSA verifies the suitability of the farmer's land for sericulture and the quality of the cocoons produced.

Egg Distribution and Production Details: The KSA likely distributes silkworm eggs to registered farmers along with details on sericulture practices.

Subsidy Details: The KSA may provide subsidies to farmers to support sericulture.

Silk Sale: Farmers can sell their raw silk cocoons to the KSA.

Printing Details: The diagram mentions printing details, but it's unclear from this specific image what this entails.

It's possible the KSA facilitates the printing of designs on finished silk fabric. Overall, the diagram suggests the KSA plays a significant role in supporting sericulture in Karnataka by providing farmers with resources, subsidies, and a guaranteed market for their cocoons.

The flowchart outlines the intricate process of silk production in Karnataka facilitated by the Karnataka Silk Authority (KSA). The journey begins with farmer registration, where individuals interested in sericulture enroll with the KSA, marking the first step towards establishing a robust silk production ecosystem. Once registered, the KSA conducts thorough checks on the suitability of the farmer's land for sericulture and ensures the quality of cocoons produced, emphasizing the importance of cultivating high-quality silk [4].

Following land and cocoon quality checks, the KSA likely distributes silkworm eggs to registered farmers along with comprehensive production details. This step ensures that farmers have access to necessary resources and information to effectively nurture silkworms and produce quality silk. Additionally, the KSA may provide subsidies to farmers to alleviate financial burdens associated with sericulture, further incentivizing participation and promoting the growth of the silk industry [5].

As the silkworms mature and produce cocoons, farmers have the opportunity to sell their raw silk cocoons back to the KSA. This step not only provides a market for farmers to monetize their produce but also ensures a

steady supply of raw material for further processing. However, the flowchart also mentions "printing details," which suggests an additional aspect to the silk production process. While it remains unclear from the image, it's plausible that the KSA facilitates the printing of designs on finished silk fabric, adding value to the final product and catering to diverse market demands.

In summary, the flowchart illustrates the comprehensive process of silk production in Karnataka under the auspices of the KSA. From farmer registration to quality checks, egg distribution, subsidy provision, and eventual silk sale, each step is meticulously designed to foster a thriving sericulture industry. Moreover, the potential inclusion of printing details underscores the KSA's commitment to innovation and value addition, positioning Karnataka as a leader in silk production with a focus on quality, sustainability, and market relevance.

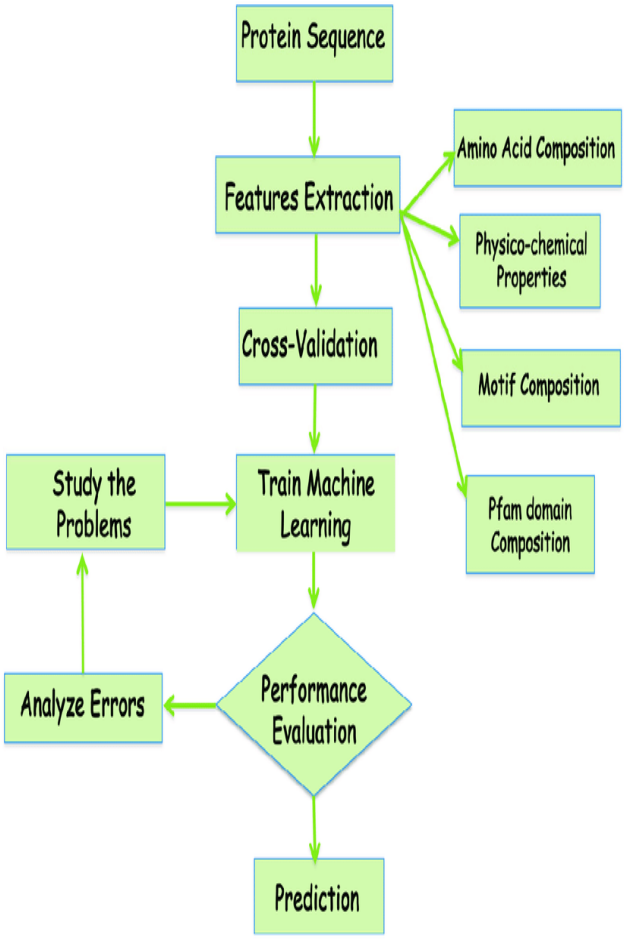

Figure 1: Flowchart of Prediction Model

The process of farmer registration and egg distribution carried out by the Karnataka Silk Authority (KSA). Here's a breakdown of the process as follows:

Start: The process begins with farmer registration.
New Farmer Registration: The system checks if it's a new farmer registering. If yes, the farmer proceeds to register. If not, the process determines if the user is authorized.
Unauthorized User: If the user is not authorized, the system ends the process.
Cocoon Image Upload: Registered farmers upload an image of their cocoon.
Egg Registration and Distribution Details: Farmers then input details regarding egg registration and distribution.
Print Details: The system then initiates a six-step printing process, where all the details are printed multiple times.
End Process: The process concludes after all details are printed.

The figure 1 shows the flowchart of prediction model used in the project. Predicting the quality of silkworm cocoon shell weight using machine learning involves collecting a dataset that includes various features such as the environmental conditions, the type of mulberry leaves fed to the silkworms, the age of the silkworms, and other relevant biological factors. This dataset is then preprocessed to handle missing values, normalize features, and possibly perform feature selection to enhance the model's performance. Several machine learning algorithms, such as regression models, decision trees, or more advanced techniques like support vector machines and neural networks, are trained on this dataset. The model is evaluated using metrics like mean squared error or R-squared to ensure its accuracy and reliability. Once a suitable model is identified, it can predict the cocoon shell weight quality of new silkworm batches based on their input features, enabling better planning and optimization of silk production.

III. RESULTS AND DISCUSSION

Figure 2: Cocoon Quality Check

The introduction of farmer registration for sericulture (silk farming) and the implementation of machine learning for quality checks can have several significant impacts. This system allows for structured data collection and management, which is crucial for the successful implementation of advanced agricultural techniques. Registering farmers creates a centralized database of all participants in the sericulture industry. This database includes information on farm locations, types of mulberry plants cultivated, silkworm breeds, and farming practices. This structured data is critical for feeding machine learning models and ensuring accurate predictions and quality assessments. With registered farmers, the traceability of silk products from the farm to the final product becomes feasible. This traceability is essential for maintaining quality standards and ensuring that only high-quality silk reaches the market.

Machine learning models can analyze the data collected from various farms to provide personalized recommendations to farmers. These recommendations can include best practices for silkworm rearing, optimal feeding schedules, and ideal environmental conditions to maximize cocoon quality and yield. Machine learning models can predict the quality of the cocoon shell weight based on various input features, such as environmental conditions, feeding patterns, and silkworm breed as shown in figure 2. This predictive capability allows farmers to make informed decisions to improve their practices and ensure higher quality silk production. Quality assurance processes can be automated, reducing the need for manual inspections and increasing efficiency. With accurate predictions and data-driven insights, farmers can optimize their use of resources such as water, feed, and labor. This optimization leads to cost savings and more sustainable farming practices. By improving the quality of the silk produced and optimizing resource use, farmers can achieve higher market prices for their products, thereby increasing their income. Machine learning can also identify potential issues early, reducing the risk of crop failure and financial loss.

IV. CONCLUSION

In conclusion, the implementation of machine learning for predicting silkworm cocoon quality and weight holds significant promise for the silk industry. By leveraging advanced algorithms and data analytics, we can enhance the efficiency and accuracy of cocoon assessment, leading to better decision-making in silk production. This technology not only streamlines the evaluation process but also contributes to improved silk quality, increased yields, and ultimately, a more sustainable and profitable sericulture industry. Continued research and development in this area will further refine these predictive models, driving innovation and growth in the silk sector.

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Numerical Simulation on Performance Enhancement of Concentric Tube Heat Exchanger with Swirl Generator

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ABSTRACT

This study investigates the performance enhancement of a concentric tube heat exchanger through the utilization of swirl generators. Concentric tube heat exchangers are widely used in various industrial applications for efficient heat transfer between two fluids. Swirl generators, which induce rotational motion in the fluid flow, offer a promising avenue for improving heat transfer rates within such systems. Theoretical principles governing heat transfer in concentric tube heat exchangers, including conduction, convection, and radiation, are discussed. The introduction of swirl into the fluid flow alters the flow dynamics, leading to increased turbulence, improved thermal boundary layer disruption, and enhanced radial mixing. Numerical simulations using Computational Fluid Dynamics (CFD) techniques are employed to analyze the effects of swirl generators on heat exchanger performance. The results provide insights into the optimal design parameters and operating conditions for maximizing heat transfer while minimizing pressure drop. This research contributes to the development of more efficient concentric tube heat exchangers for various industrial applications.

Keywords: Concentric tube heat exchanger, swirl generator, heat transfer enhancement, computational fluid dynamics, turbulence.

I. INTRODUCTION

Heat transfer enhancement is a process that improves the performance of heat transfer systems by increasing the heat transfer coefficient. It is commonly used in various industries, including process industries, heating and cooling evaporators, thermal power plants, air conditioning equipment, refrigerators, and radiators for space vehicles and automobiles.

To achieve a desired heat transfer rate at an economic pumping power, several heat transfer enhancement techniques have been used in recent years. These techniques include active method, passive method and compound method. A heat exchanger is a device that transfers heat from a hot fluid to cold fluid across an impermeable wall. The principle of a heat exchanger is to facilitate efficient heat flow from hot fluid to cold fluid, which is directly influenced by the temperature difference between the two fluids, the area and conductive/convective properties of the fluid and its state.

In aircraft and automobiles, the volume and weight of heat exchangers should be as minimal as possible for a given heat transfer. The main requirement for any heat exchanger is to transfer the required amount of heat with high effectiveness. Improvements in heat exchanger performance have attracted researchers due to their technical, economical, and ecological importance. Since gases have a thermal resistance that can be 10 to 50 times greater than that of liquids, performance enhancement becomes crucial in heat exchangers that use gases. This means that the gas side heat exchange must have a significant heat transfer surface area per unit volume [1].

Increasing the heat exchanger's surface area or decreasing the thickness of the thermal boundary layer on its surface with two conventional strategies for lowering air-side thermal resistance. Nevertheless, since heat must either be transferred to a cold fluid or a hot fluid must be supplied to the heat exchanger—neither of which is often available—increasing the temperature differential might not be significant [2].

Maximum effort must be done in both situations in order to deliver the hot fluid at a high temperature or the cold fluid at a lower temperature. Moreover, creating an excessive temperature difference between two fluids will result in unfavourable thermal strains on their metal surfaces. This often causes the materials to distort and shortens their lifespan. Given these facts, the optimal engineering technique is often to increase the heat transfer surface area [3]. The creation of a distinct type of heat exchangers called as compact heat exchangers was spurred by the above-mentioned needs. These heat exchangers are linked to high heat transfer coefficients and have a very high surface area for heat transfer relative to their volume. Compact heat exchangers are quite popular in many applications because of their small size and light weight.

Concentric Tube Heat Exchangers: Concentric tube heat exchangers are a type of heat exchanger where two fluids flow in separate tubes, one within the other. Typically, one fluid flows through the inner tube while the other flows through the annular space between the inner and outer tubes. Heat is transferred between the fluids through the tube walls [4].

Principles of Heat Transfer:

Heat transfer in concentric tube heat exchangers occurs through three main mechanisms:

Conduction: Heat is transferred through the tube wall from the hotter fluid to the cooler fluid via conduction.

Convection: Heat is transferred from the fluid to the tube wall (or vice versa) via convective heat transfer. This occurs due to the fluid's movement and the temperature gradient between the fluid and the tube wall [5].

Radiation: In some cases, especially at high temperatures, radiation heat transfer may also play a role.

Enhancement Techniques:

To improve the performance of concentric tube heat exchangers, various enhancement techniques can be employed. One such technique is the use of swirl generators.

Swirl Generators: Swirl generators are devices that impart rotational motion to the fluid flow. This swirling motion can alter the flow field inside the heat exchanger, leading to enhanced heat transfer and mixing. Swirl generators can take various forms, including vanes, blades, or tangential inlets/outlets [6].

Effects of Swirl on Heat Transfer:

The introduction of swirl into the fluid flow can have several beneficial effects on heat transfer:

Increased Turbulence: Swirling flow tends to increase turbulence levels, which can enhance heat transfer rates by promoting better mixing between the fluid streams and increasing the effective surface area for heat transfer.

Improved Thermal Boundary Layer Disruption: Swirl can disrupt the thermal boundary layer near the tube wall, reducing the thickness of the boundary layer and enhancing convective heat transfer coefficients.

Enhanced Radial Mixing: Swirling flow can promote radial mixing between the fluid streams, leading to more uniform temperature distributions and improved heat transfer performance.

Numerical Simulation: Numerical simulation techniques, such as Computational Fluid Dynamics (CFD), are commonly used to study the effects of swirl generators on heat exchanger performance. These simulations involve solving the Navier-Stokes equations coupled with the energy equation to predict fluid flow patterns, temperature distributions, and heat transfer rates inside the heat exchanger [7].

Optimization: Numerical simulations can also be used for optimization purposes, allowing engineers to explore

different swirl generator geometries, operating conditions, and fluid properties to maximize heat exchanger performance while minimizing pressure drop and other undesirable effects [8].
The proposed system design integrates two distinct CNN architectures tailored for image and video forgery detection, namely the CNN Architecture and ResNet50. Each architecture is optimized for discerning between authentic and tampered content, employing advanced convolutional neural network techniques to achieve accurate detection [9, 10].

II. METHODS AND MATERIAL

Data reduction is a crucial step in experimental analysis, where measured quantities such as pressure, temperature, and flow rate are processed to obtain key parameters like Nusselt number (Nu) and friction factor (f). This process involves sequential calculations based on mathematical formulations to extract meaningful results.

In steady-state conditions, the energy balance between heat supplied and heat carried away by water is considered, neglecting minor losses to surroundings. The heat absorbed by water (Q) and convective heat transfer through the tube surface (Qcon) are calculated.

Additionally, parameters such as Reynolds number (Re), mass flow rate (mw), Nusselt number (Nu), and friction factor (f) are determined using relevant equations. These calculations are essential for evaluating the performance of heat exchangers and optimizing their design for efficient heat transfer.

The numerical simulation is conducted to examine the effect of flat strip inserts on fluid flow behaviour in a heat exchanger tube. A 3-dimensional computational fluid dynamics analysis is investigated.

The literature survey is used to select a K-ω SST turbulence model for inserts. CFD codes are structured around numerical algorithms that can tackle fluid flow problems. All CFD codes contain three main elements.

- Pre-processor
- Solver
- Post-processor

Pre-Processor:

Pre-processing consists of the input of a flow problem to a CFD program by means of an operator-friendly interface and the subsequent transformation of this input into a form suitable for use by the solver. The user activities at the pre-processing stage involve:

• Definition of the geometry of the region of interest.
• Selection of physical and chemical phenomenon that need to be modelled.
• Definition of the fluid properties
• Specification of appropriate boundary conditions at cells, which coincide with or touch the domain boundary.

Solver:

The method used for numerical solutions using CFD code Fluent is finite volume method. Basically the solver performs the following steps:

• Approximation of the unknown flow variables by means of simple functions.
• Discretization by substitution of the approximations into governing flow equations and subsequent mathematical manipulations.
• Solution of the algebraic equations

Post-Processor:

Owing to the increased popularity of engineering workstations, many of which have outstanding graphics capabilities, the leading CFD packages are now equipped with versatile data visualization tools. These include:

- Domain geometry and grid display
- Vector plots
- Line and shaded contour plots
- 2D and 3D surface plots
- Colour postscript output
- Animation for results display.

Mathematical modelling:

The mathematical model for numerical analysis of a heat exchanger with flat strip inserts involves solving a set of partial differential equations with initial and boundary conditions. This study focuses on CFD analysis of a heat

exchanger with two or three flat strip inserts at Reynolds numbers ranging from 1000 to 1600.

The analysis, conducted using a k-ω SST turbulence model, assumes uniform heat flux at the tube wall. The computational domain is symmetrical about the centreline, with prescribed boundary conditions including velocity inlet, outflow, and constant wall temperature at the inner surface, and no-slip wall with uniform constant heat flux at the outer surface.

The numerical simulation examines the impact of flat strip inserts on fluid flow in a heat exchanger tube using 3D computational fluid dynamics (CFD), with the K-ω SST turbulence model selected based on literature. The CFD process involves three main components: pre-processor, solver, and post-processor. In the pre-processor phase, the geometry of the region of interest is defined, the physical and chemical phenomena to be modeled are selected, fluid properties are specified, and appropriate boundary conditions at the domain boundaries are set. The solver employs the finite volume method for numerical solutions, approximating flow variables with simple functions, discretizing by substituting these approximations into governing flow equations, and solving the resulting algebraic equations. The post-processor uses visualization tools to display results through various graphical means such as vector plots, contour plots, and animations. For mathematical modeling, the analysis of a heat exchanger with flat strip inserts involves solving partial differential equations under specified conditions using CFD. The K-ω SST model is used to handle turbulence, with key assumptions including uniform heat flux at the tube wall, symmetry about the centerline, steady and incompressible flow, no pressure variation or shear force along the y-direction, and neglect of gravitational force and axial heat conduction in the fluid.

Boundary conditions include a prescribed fluid entry velocity at the velocity inlet, conditions at the outflow, constant wall temperature at the inner surface, and a no-slip wall with uniform heat flux at the outer surface. Discretization of momentum equations is done using second-order upwind differencing, while turbulence transport equations are discretized using first-order upwind differencing. This comprehensive approach aims to provide detailed insights into the heat transfer performance of heat exchangers with flat strip inserts under various flow conditions.

III. RESULTS AND DISCUSSION

The results are as shown in the figures 1-6.

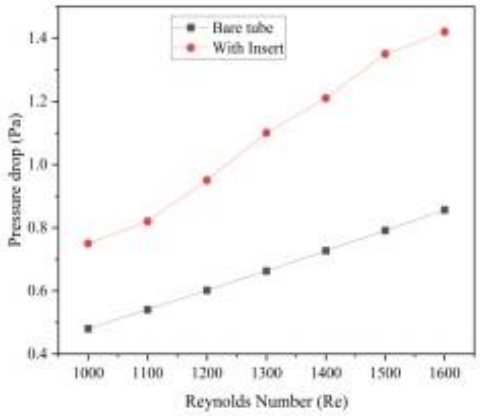

Figure 1: Reynolds Number (Nu) v/s Nusselt Number (Nu)

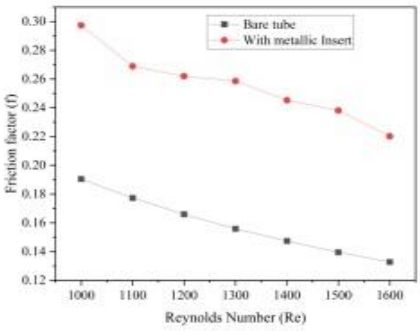

Figure 2: Reynolds Number (Nu) v/s Friction Factor (f)

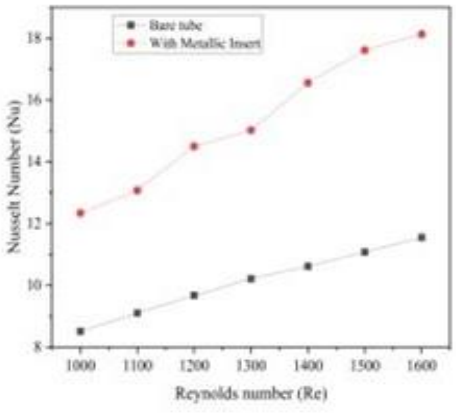

Figure 3: Reynolds Number (Nu) v/s Pressure drop (Pa)

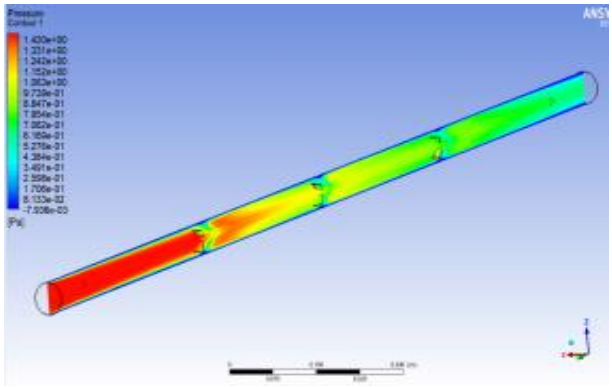

Figure 4: Velocity vector

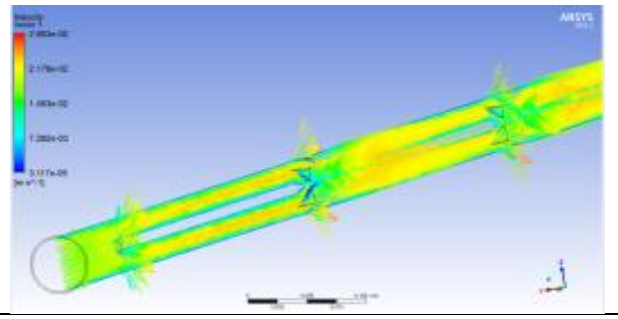

Figure 5: Temperature

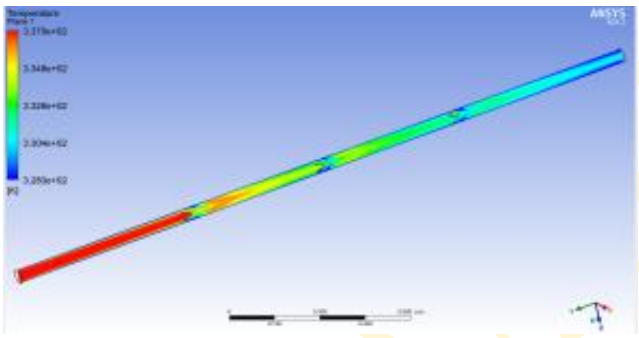

Figure 6: Pressure

Mesh Influence:

- Increased mesh size improves heat transfer coefficient and Nusselt number.
- Highest heat transfer and Nusselt number observed at the finest mesh (65 divisions).

Effect of Reynolds Number (Re):

- Bare Tube:Nu and heat transfer coefficient increase with Re.
- Tube with Insert:
- Significant enhancement in Nu compared to the bare tube.
- At Re = 1500, Nu increased by 37.09%.
- Nu improvement ranges from 31.0% to 37.09% for Re = 1000 to 1600.

Friction Factor (f):

- Bare Tube vs. Tube with Insert:
- Friction factor decreases with increasing Re for both.
- Higher friction factor for the tube with insert, indicating optimized friction conditions.
- At Re = 1500, friction factor increased by 41.38%.
- Friction factor enhancement ranges from 34.07% to 41.38% for Re = 1000 to 1600.

Pressure Drop (ΔP):

- Bare Tube vs. Tube with Insert:
- Pressure drop increases with increasing Re for both.
- Higher pressure drop for the tube with insert, indicating minimal penalty at low Re.

Flow Structure Mechanism:

Flow Patterns:

- Inserts create multi-vortex flow structures, enhancing heat transfer.
- Homogeneous temperature distribution achieved due to complete mixing.
- Potential for high turbulence or pressure drop noted in the analysis.

IV. CONCLUSION

The study reveals that increasing mesh size improves the heat transfer coefficient and Nusselt number, with the finest mesh yielding the highest values. For bare tubes, both the Nusselt number and heat transfer coefficient rise with increasing Reynolds number (Re). Tubes with inserts show a significant enhancement in the Nusselt number compared to bare tubes, with an improvement ranging from 31.0% to 37.09% for Re between 1000 and 1600. However, the friction factor decreases with increasing Re for both configurations, although it remains higher for tubes with inserts, indicating optimized friction conditions. At Re = 1500, the friction factor for tubes with inserts increases by 41.38%.

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Smart Museum Guide for Tourists

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ABSTRACT

The way tourists interact with cultural items in museums is about to be revolutionized with the introduction of Smart Museum Guide Systems. In order to provide visitors to museums with immersive and customized experiences, the system makes use of cutting-edge technology including augmented reality (AR), indoor positioning systems (IPS), and personalized recommendation algorithms. Using indoor mapping and augmented reality assistance, visitors may easily navigate among museum displays, improving their comprehension of the structure of the museum and the placements of the exhibits. Users may explore the historical and cultural value of items in greater detail thanks to the interactive information offered by the system, which includes 3D reconstructions, multimedia. Through the analysis of past visitor data and preferences, the system generates customized display recommendations, guaranteeing a tailored experience that corresponds with the interests of every visitor. Accessibility is given top priority by the system by providing multilingual assistance.

Keywords: Augmented Reality (AR), Indoor Positioning Systems (IPS), Smart Museum.

I. INTRODUCTION

Historical centre gain, ration, research on, show and impart for the necessities of study, training and pleasure, material proof of people and their current circumstance. The museum's collection of objects creates a unified picture of our cultural heritage. When we inherit a museum, there are typically a few different types of guide systems, such as tape or CD guides, touch-screen computers for questions, traditional multilingual tour expositor systems, and special systems for expertise explanations.

Visitors seem to be dealing with different kinds of issues. The cost of training and wages for traditional multilingual guides and special sections for expertise and explanations is high. Through static exhibits and curated collections, museums have traditionally been regarded as repositories of culture and knowledge, providing visitors with a glimpse into the past. However, traditional museum experiences frequently leave visitors yearning for more interaction and engagement.
Public spaces like museums are increasingly important to society. However, how visitors perceive the museum's internal structure is crucial because it influences what they see, where they focus their attention, and ultimately what they learn and experience.

Archaeological sites, art galleries, castles, historic churches, and other cultural spaces like museums are always looking for new ways to enhance the experiences of visitors and are very interested in the most recent technological advancements. 173-179, 2019 ©2022 IEEE

Museum’s ongoing changes consistently demonstrate that they are always driven by spaces from display technologies to audio-enabled mobile guides, multimedia tools for various devices, the introduction of smart phone apps, and a slew of other ever-more advanced innovations. Instead of renting dedicated

mobile audio or multi-media guides, visitors to cultural institutions are increasingly being encouraged to use their own smart phones. The organization saves money by not having to buy and keep their own supply of dedicated audio guides, as well as paying for staff and the space needed to rent out and return the guides. A bold departure from the static, one-dimensional experiences of the past is the concept of a smart museum. These days, individuals' utilization structure is improving consistently. There has been a huge expansion in the quantity of individuals out on visits, for diversion and amusement. The world's strongest and largest industry, tourism employs 200 million people and serves 700 million tourists each year, a number that is expected to double by 2020. It contributes approximately 11% of the world's gross domestic product (GDP).

Smith J [1] Journal of Museum Studies, 2019, "The Evolution of Museum Guides: From Audio Tours to Smart Technology." From traditional audio tours to the development of smart technology, Smith's research traces the history of museum guides. It analyses the development of guest commitment systems and the progress towards additional intelligent and customized encounters worked with by savvy exhibition hall guides. Johnson A [2] "Enhancing Visitor Engagement through Smart Museum Guides: A Case Study," Exhibition Hall The executives and Curatorship, 2020.

Through a comprehensive case study, Johnson's research examines the impact of intelligent museum guides on visitor engagement. By examining guest conduct and criticism, the review surveys how shrewd aides add to expanded communication with shows and more profound degrees of commitment among gallery guests. Brown L [3] International publication titled "Delivering Personalized Experiences with Smart Museum Guides." Diary of Social Legacy, 2021. Earthy coloured's review investigates the idea of customized encounters with regards to shrewd exhibition hall guides. The study demonstrates, through data analytics and machine learning algorithms, how smart guides can tailor content and recommendations to individual visitor preferences, resulting in museum visits that are more meaningful and memorable. Garcia, M., [4] Museum & Society, 2022, "Challenges and Opportunities in Implementing Smart Museum Guides: A Stakeholder Perspective." Garcia's research looks at the opportunities and challenges that cultural institutions face when putting smart museum guides into use.

S. Patel [5] "Future Bearings in Savvy Gallery Guides: Developments and Joint efforts," Diary of Computerized Museology, 2023. The research conducted by Patel sheds light on the possible future paths that smart museum guides will take by focusing on technological advancements and partnerships that could be formed between museums, technology companies, and researchers. The study examines the implications of emerging trends like augmented reality and artificial intelligence for the development of smart guides.

Stefano Gualeni Mauro Arrigo [6] "Evaluating Mobile Guide Design for Smart Museums: A Tale of Two App Iterations". Through iterative development processes, this study evaluates the design and usability of mobile guide applications for smart museums. It talks about client criticism, interface enhancements, and the effect on guest experience.

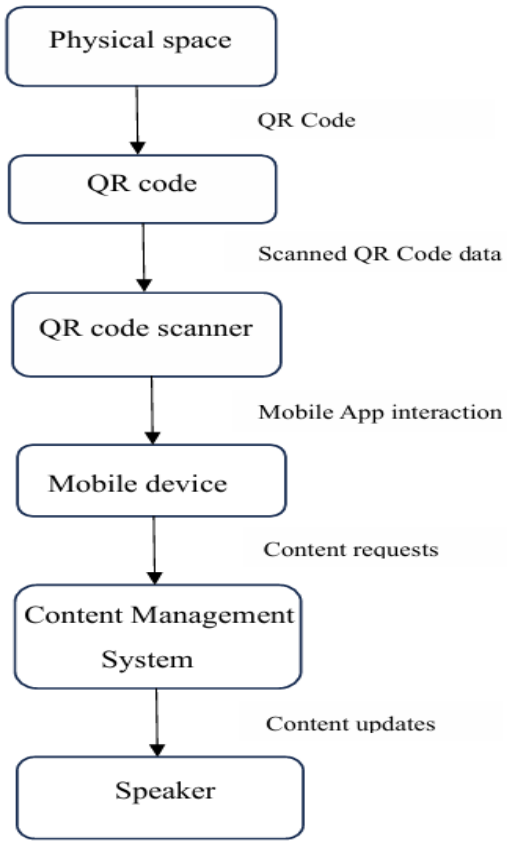

Figure 1: Flowchart of Smart Museum Guide for Tourists

Simon Niedenthal, Maria Engberg, et al [7], A Smart Guide for a Smart Exhibition: A Design Study Exploring Playfulness in a Museum Context, this study looks at how smart museum guides can incorporate playful and interactive elements. It investigates how visitor engagement and learning outcomes can be improved by gamification and playful design. Lynda Kelly, Angelina Russo, et al., [8] "Guest and Specialized Assessment of a Portable Sight and sound Aide for Workmanship Historical centres, 2016", In this study, visitors and technical aspects of a mobile multimedia guide made for art museums are evaluated. It looks at how users interact, how well the content works, and how well the guide system works technically.

II. METHODS AND MATERIAL

Implementing a QR code mechanism for a smart museum guide is a fantastic idea. Tourists can scan QR codes placed near exhibits to access relevant information, audio guides, or multimedia presentations about the artwork or artifacts. This enhances the visitor experience by providing context and additional insights. Plus, it's a convenient way to engage visitors using their smartphones.

Physical Space: Represents the real-world environment where the Smart Guide system is deployed, such as a museum, tourist site, or educational institution.

QR Code: QR codes are strategically placed throughout the physical space, each containing unique identifiers linked to specific digital content.

QR Code Scanner: Users scan the QR codes using their mobile devices equipped with QR code scanning capabilities.

Mobile Device: Represents the user's smartphone or tablet used for interacting with the Smart Guide system.

Mobile Application: The mobile application installed on the user's device facilitates scanning QR codes, accessing digital content, and interacting with the system.

Content Management System (CMS): The backend system manages the digital content linked to QR codes, including uploading, editing, and organizing content.

The block diagram shown in figure 2 illustrates the different components and their interactions within a smart museum guide system. Smart Guide application is installed in the mobile device of the visitor of the museum during their visit time.

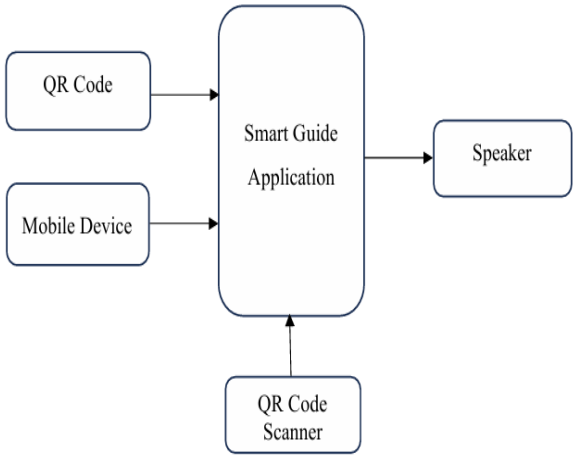

Figure 2: Block diagram of proposed project

The individual QR Code is placed or sticked near the individual museum exhibit. The Smart Guide app has the features of scanning the QR Code, displaying the information and playing the audio. When the visitor came near the exhibit have to open the smart guide app and to allow the camera to scan the QR code.

Visitor should scan the respective QR code of the exhibit. As soon as the QR Code is scanned, the audio clipping information about the museum exhibit start to play in the speaker. Along with the audio the text information will also be displayed in the same mobile device.

This application has the feature to allow the visitor to choose the language of the audio clipping and the same language will be displayed on the mobile device. This contains the information in three different languages i.e., Kannada, English and Hindi. After completing of information, visitor can scan another QR code of further museum exhibit.

The Smart Guide App software is a sophisticated application designed to provide users with interactive and informative experiences in various settings, such as museums, historical sites, tourist attractions, and cultural institutions.

In this application first the scanner will be opened to scan particular QR code of the object. After scanning the QR code the speaker will start to give the complete information about the object.

The audio will be in three languages. The user can select the language of their choice. Along with the audio the information will be display in the user mobile phone. A smart museum guide for tourists' application is a mobile app designed to enhance the museum visiting experience.

It typically provides features like interactive maps, audio guides, augmented reality displays, information about exhibits, historical context, and sometimes even personalized recommendations based on user preferences. These apps aim to make museum visits more engaging, educational, and enjoyable for tourists.

III. RESULTS AND DISCUSSION

Request Permission

When the Smart Guide app is opened for the first time it asks for the museum visitor to access the camera to scan the QR code. To start scanning click on the request permission button shown in the above figure.

Placing the QR code

Figure 3: Scanning the QR code of the exhibit

After allowing the camera permission the QR code should be framed in the transparent region as shown in the above figure 3. After scanning the code will be recognised automatically.

Scanning the QR code

Figure 4: Scanning the QR code of the exhibit

The QR code placed in the frame gets automatically recognised. Above figure 4 is a QR code of museum exhibit, Abdul Kalam.

Playing audio and displaying text

Figure 5: Playing the audio and text is displayed

After scanning the QR code the information regarding the museum exhibit is played through the speaker and the same information is displayed on the mobile phone of the visitor. As shown in the above figure 5, this app allows the user to choose the required language from the set of three languages. After listening it allows to scan the next QR code.

IV. CONCLUSION

The work presented in the implementation of Smart Museums project, has the aim to attract more people in museum from different places and to make advance visitor's experience and make easy for the visitor to explore museum. And also, this gadget can help the visitor to understand better an artwork. In conclusion, a smart museum guide for tourists offers a range of benefits that significantly enhance the visitor experience. From personalized recommendations to interactive learning opportunities, efficient navigation, multilingual support, contextual information, accessibility features, and enhanced engagement through gamification, such a guide transforms traditional museum visits into dynamic and enriching experiences. By leveraging technology to provide tailored, informative, and interactive experiences, smart museum guides cater to the diverse needs and preferences of tourists, ultimately fostering greater appreciation and enjoyment of cultural institutions.

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Design and Estimation of Residential Building using BIM Software

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ABSTRACT

With the progression of technology, software has become a prevalent tool for swiftly addressing problems across various technical disciplines, including those that previously required extensive time to resolve. This advancement is particularly evident in civil engineering, where software technology is increasingly utilized for analyzing, designing, and predicting the behavior of structures throughout their lifespan. Over the past decade, the adoption of software tools in civil engineering has surged, facilitating more efficient and accurate project execution. This project focuses on the design and modeling of a G+1 residential building using Autodesk Revit Architecture, which integrates Building Information Modelling (BIM) technology. BIM provides a comprehensive framework for enhanced design, construction, and documentation clarity by unifying various aspects of building design, construction, and management into a single digital platform. This integration fosters improved collaboration among stakeholders and supports data-driven decision-making processes. The review of existing literature underscores the numerous advantages of BIM-based methodologies over traditional approaches, particularly in cost estimation. BIM enables more accurate and detailed cost assessments, reducing the likelihood of errors and discrepancies. Additionally, BIM facilitates better resource management and project planning, leading to cost savings and more efficient project timelines. By leveraging BIM technology, civil engineers can achieve a higher level of precision and efficiency in their projects, ultimately enhancing the quality and sustainability of the built environment. This project aims to demonstrate these benefits through the practical application of BIM in the design and modeling of a residential building.

Keywords: Components, Reinforced Concrete Elements, cost estimation and 3D modelling.

I. INTRODUCTION

Building Information Modeling (BIM) encompasses the creation and management of digital representations capturing both the physical attributes and functional aspects of locations. Supported by an array of tools, technologies, and contractual frameworks, BIM facilitates decision-making concerning constructed assets through the exchange and networking of BIM models—computer files often proprietary in format and content. BIM software finds utility across individuals, businesses, and government entities involved in the planning, design, construction, operation, and maintenance of a broad spectrum of physical infrastructures, spanning from buildings to utilities like water, electricity, and communication networks, as well as transportation structures like roads, railways, bridges, and tunnels [1].

While the conceptualization of BIM traces back to the 1970s, it only gained standardized recognition in the early 2000s, with the development of standards and its adoption progressing at varied rates across different nations. The historical trajectory of BIM can be traced to the emergence of computer-aided design (CAD) in the 1950s and 1960s [2]. During this era, significant

advancements were made, including Hanratty's pioneering work on commercial computer-aided machining (CAM) in 1957, followed by Ivan Sutherland's creation of Sketchpad—a graphical interface facilitating user interaction through screen manipulation using a light pen and control buttons. The transition from two-dimensional (2D) to three-dimensional (3D) design occurred during the 1970s, catalyzed by the French Aerospace Company's development of CATIA, a software widely employed in aerospace, automotive, and shipbuilding sectors. By the 1980s, CATIA had established itself as a leader in 3D modeling technology [3].

Subsequently, in the 1980s and 1990s, Autodesk emerged as a prominent player in the information technology (IT) industry with its flagship product AutoCAD. Concurrently, Bentley, a competitor of Autodesk, introduced its own suite of products, fostering a landscape of intense competition and innovation within the IT sector [8]. This period witnessed a surge in the development of various software solutions, each offering distinct functionalities and tools tailored to specific needs, thus enabling the transition from 2D to 3D design while addressing a myriad of design challenges [4]. The evolution from 3D modeling led to the introduction of 4D modeling, aimed at aiding stakeholders, particularly in the Architecture, Engineering, and Construction (AEC) industry, in effectively managing schedules and resources in relation to time. Subsequently, 5D modeling emerged, focusing on cost estimating. This iteration proved beneficial for cost estimators and quantity surveyors in verifying project cost estimates. The development of 6D modeling centered on sustainability concerns, while 7D modeling primarily addressed facilities management needs. The expansion beyond 3D modeling is contingent upon specific functionalities. As noted by Beveridge (2012), additional dimensions were introduced to cater to various aspects of project management and design. For instance, 8D was designated for integrated project delivery and maintainability, 9D for considerations regarding acoustics, 10D for enhancing security measures, and 11D for addressing thermal considerations. This progression underscores the ongoing evolution of BIM, which traces its roots back to the 1950s and continues to evolve to the present day [5].

Autodesk Revit serves as leading building information modeling (BIM) software tailored for architects, structural engineers, MEP engineers, designers, and contractors. It empowers users to craft 3D designs of buildings and structures along with their components, annotate models with 2D drafting elements, and access building information stored within the model's database. Revit boasts 4D BIM capabilities, providing tools to plan and monitor various stages throughout a building's lifecycle, from initial concept through construction to eventual demolition [7]. Originally conceived to enable architects and building professionals to design and document structures, Revit facilitates the creation of a parametric 3D model encompassing both geometric and non-geometric design and construction data, a concept now synonymous with Building Information Modeling (BIM). Distinct from other software packages like ArchiCAD and Reflex, Revit stands out in several key aspects. Notably, its parametric components are crafted using a graphical "family editor" rather than relying on programming languages. Additionally, all relationships between components, Views, and annotations are seamlessly captured within the model, ensuring that any modification to one element automatically propagates throughout the model, maintaining consistency and coordination across all documentation [6].

The extensive literature review paved the way for defining the following objectives for this study:

- To achieve parametric modelling.
- To provide detailed scheduling.
- To develop rendering presentation.
- To develop cost effective construction project.

II. METHODS AND MATERIAL

Revit Architecture stands as a prevalent BIM tool within the architecture, engineering, and construction (AEC) sector. Below outlines the procedures essential for initiating a project with Revit Architecture.

Network Setup: During this phase, the server environment undergoes preparation, including the establishment of the project folder structure, granting user access permissions, and mapping network drives.

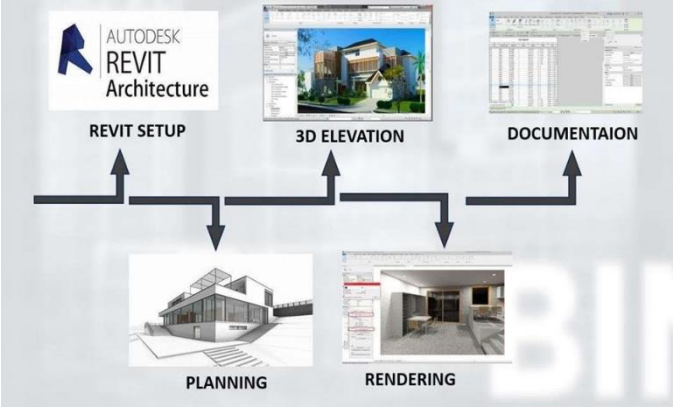

Figure 1: Templates in Revit

Revit Configuration: This phase involves setting up the Revit software for the project, encompassing the creation of a new project file, configuring project parameters, and establishing views.

Design Phase: Utilizing Revit Architecture, architects can craft 3D models of buildings and their elements, facilitating design and visualization endeavors. The software offers tools for constructing parametric models, enabling easy modifications to accommodate design alterations.

Documentation Process: With Revit Architecture, architects can produce comprehensive documentation like floor plans, elevations, sections, and schedules directly from the 3D model. This streamlines the process, minimizing errors and discrepancies in documentation.

Collaborative Efforts: Revit Architecture serves as a collaborative platform for architects, engineers, and construction experts, fostering more efficient teamwork.

III. RESULTS AND DISCUSSION

The software supports simultaneous multi-user collaboration on the same model, enhancing accuracy and coordination. These outlined steps encompass the process of creating a project utilizing Revit Architecture. Specific procedures may vary based on project requirements.

Template and Establishing Levels: The initial phase of the project involves selecting a template and establishing levels. Here are the available template options:

Construction Template: This template in Revit serves as a foundational blueprint for new projects in the construction domain. It simplifies project initiation by providing a consistent structure for organizing, documenting, and modeling construction projects. These templates ensure uniformity, enhance efficiency, and promote adherence to industry standards.

Architectural Template: Tailored for architectural design, this template offers pre- established configurations, standards, views, families, and parameters. It streamlines project initialization by providing a standardized structure for organizing, modeling, and documenting architectural projects. These templates foster consistency, boost productivity, and support compliance with industry standards.

Structural Template: Specifically designed for structural engineering projects, this template provides preconfigured settings, standards, views, families, and parameters. It expedites project startup by offering a standardized platform for organizing, modeling, and documenting structural projects. These templates ensure consistency, streamline processes, and facilitate compliance with industry norms and methodologies in structural engineering.

Mechanical Template: Within Revit, a mechanical template serves as a standardized foundation for mechanical engineering projects. It comprises predefined configurations, standards, views, families, and parameters customized for mechanical design and documentation requirements. These templates streamline project initiation by offering a uniform framework for organizing, modeling, and documenting mechanical systems in Revit. They guarantee consistency across projects, enhance productivity, and facilitate adherence to industry standards and best practices in mechanical engineering.

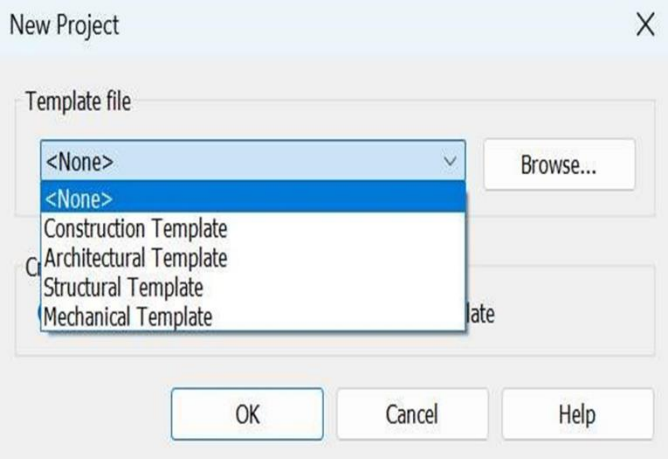

Figure 2: Templates in Revit

Levels serve as fixed horizontal planes that provide reference points for elements hosted within them, including roofs, floors, and ceiling.

- Ground floor is designated as level 1.
- The next level is referred to as the first floor, marked as level 2.
- Subsequently, the second floor is designated as level 3.
- Lastly, the space above, often known as headroom, is labeled as level 4.

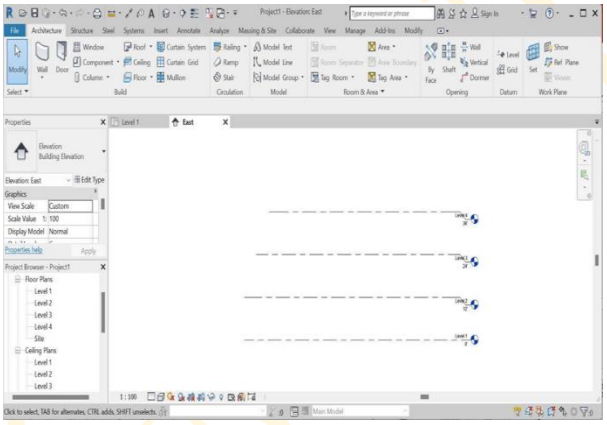

Figure 3: Levels in Revit

Initial Modeling: After establishing the initial design concept, the subsequent step involves creating the foundational 3D model using Revit Architecture. This process entails constructing fundamental elements like walls, floors, roofs, and other architectural components.

- Tools for Various Functions:
  1. Drawing Tool
  2. Manipulation Tool
  3. Editing Tool

- Drawing Tools:
  1. Line: Establishes a start and end point.
  2. Circle: Defines a center point and radius.
  3. Rectangle: Specifies opposite corners.
  4. Arc: Sets start, middle, and end points.

- Manipulation Commands:
  1. Push/Pull: Extrudes a face, specifically perpendicular to it.
  2. Offset: Determines the distance for offsetting concentric shapes.
  3. Rotate: Specifies the reference angle and rotation angle.
  4. Move: Sets the base point and new location.

- Editing Tools:
  1. Cut
  2. Copy
  3. Paste
  4. Delete Create a Component: Consolidates into a single object.
  5. Create a Group: Merges two components into a unified group

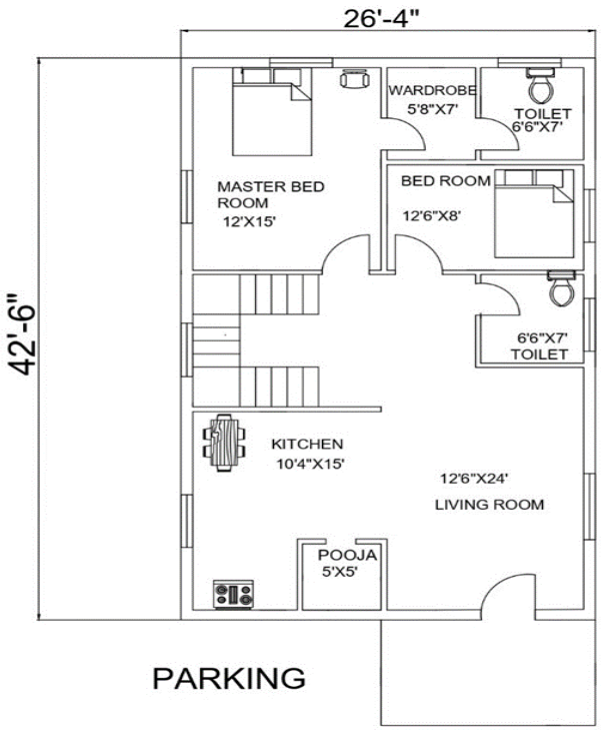

Figure 4: Ground floor plan

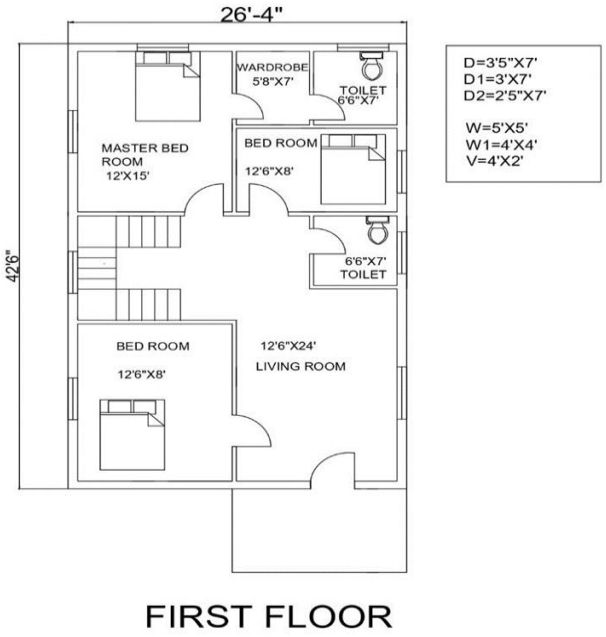

Figure 5: First floor plan

Conceptual Modeling: In this stage, architects frequently utilize massing tools within Revit to investigate various design possibilities and assess their viability. These massing models aid in visualizing the overall structure and spatial connections of the building [9].

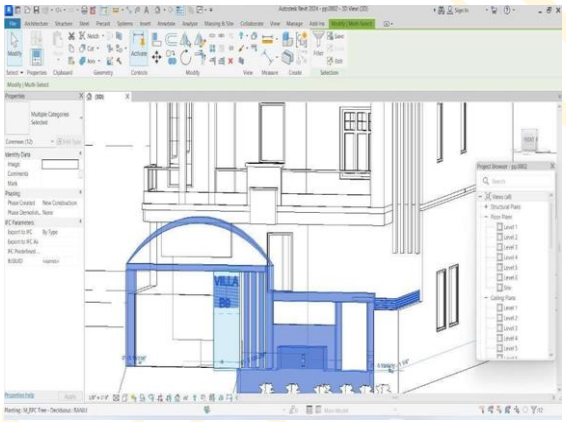

Figure 6: Massing Tools in Revit

Visualization and Rendering: Revit Architecture offers advanced visualization tools, empowering designers to produce authentic renderings and walkthroughs. This capability aids in effectively presenting the design to clients and stakeholders, facilitating improved comprehension and decision making processes.

Figure 7: Rendering in Revit

Documentation: Following this, the subsequent stage involves creating construction documentation. Revit Architecture facilitates the automatic generation of 2D drawings such as floor plans, elevations, and schedules, which can be tailored and annotated as required.

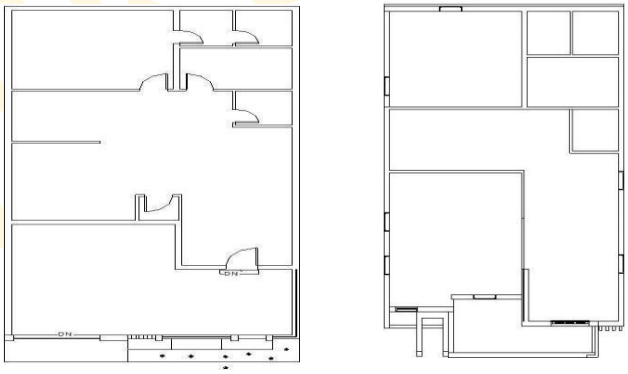

Figure 8: Plan

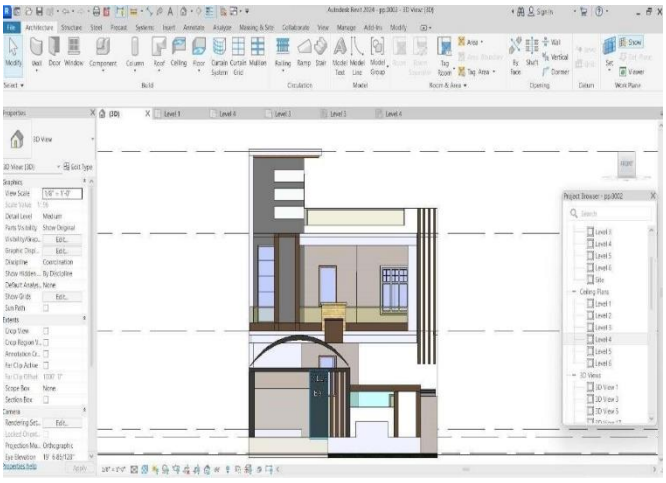

Figure 9: 2D Elevation

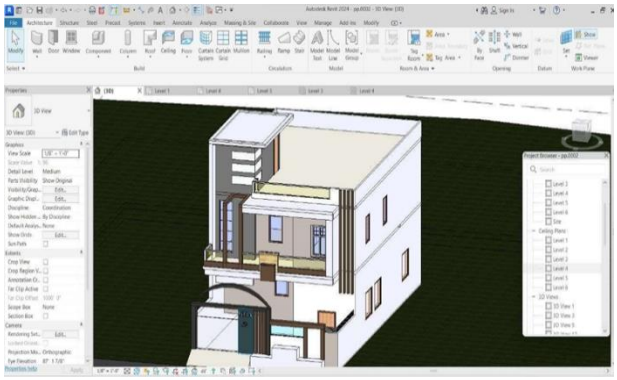

Figure 10: 3D Elevation

Figure 11: Master Bed Room

Figure 12: Living Area

S.NO	DESCRIPTION OF ITEMS	QUANTITY	UNIT	AMOUNT IN Rs
1	EARTHWORK EXCAVATION	1086.09	CUBIC METER	40,000
2	EARTHWORK FILLING	72.85	CUBIC METER	40,000
3	FOOTING			
	STEEL	112.94	KILOGRAM	9,035
	CONCRETE	1.13	CUBIC METER	4,520
4	COLUMN			
	STEEL	58.33	KILOGRAM	4,666.4
	CONCRETE	8.26	CUBIC METER	33,040
5	BEAM			
	STEEL	213	KILOGRAM	17,440
	CONCRETE	10.68	CUBIC METER	42,720
6	WALL	83,697	FEET SQUARE	1,06,666
7	SLAB			
	STEEL	2396	KILOGRAM	1,91,680
	CONCRETE	691.4	CUBIC METER	3,00,00
8	FLOORING			
	GRANITE	1500	METER SQUARE	2,42,189
	VETRIFIED	1000	METER SQUARE	1,00,000
9	TIMBER WORK	36.252	CUBIC FEET	1,25,000
	TOTAL		=	42,92,366

Figure 13: Cost Estimation

IV. CONCLUSION

Utilizing Revit Architecture within a BIM (Building Information Modeling) software environment provides numerous benefits for project. It fosters collaborative design, precise documentation, and efficient coordination across disciplines, and streamlined construction processes. With Revit's parametric modeling capabilities, adjustments and updates can be seamlessly implemented throughout the design phase, ensuring ongoing coordination and accuracy.

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Vision

GM University will have a transformative impact on society through continual innovation in education, research, skill development, creativity, and entrepreneurship.

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To disseminate knowledge and conduct research in academic areas such as science, engineering, commerce, management, health, humanities & social sciences, and legal studies with learner centric approach.

To teach skills such as critical thinking, creativity & innovation, collaboration, communication, technical & digital, flexibility & adaptability, cultural values, and leadership & responsibility.

To develop global citizens by educating students on emotional, physical, social, economic, environmental, spiritual dimensions of human growth in addition to intellectual pursuit.

To address real-world challenges and to establish the groundwork for entrepreneurship and lifelong learning.