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Conversational Image Recognition Chatbot

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Abstract Face morphing attacks pose a significant security threat to biometric systems by blending facial features of two or more individuals into a single image, allowing multiple people to fraudulently verify identity using the same biometric credential. This paper proposes a robust Face Morphing Detection System that employs advanced machine learning and image processing techniques to accurately identify morphed facial images and enhance the security of face recognition systems. The system utilizes a combination of texture analysis, deep convolutional neural networks (CNN), and frequency domain feature extraction to detect subtle inconsistencies introduced during the morphing process. The proposed approach begins with pre-processing steps such as face alignment and normalization to standardize input images. Then, handcrafted texture features using Local Binary Patterns (LBP) are extracted alongside deep features from a CNN trained on a comprehensive dataset of morphed and genuine face images. Additionally, frequency domain analysis using Discrete Cosine Transform (DCT) captures high-frequency artifacts characteristic of morphing manipulation. These multi-level features are fused and fed into a classifier to determine the authenticity of the image. Experimental evaluation on publicly available morphing datasets demonstrates that the system achieves high detection accuracy and robustness against various morphing techniques and image quality variations. The proposed system can be integrated into existing biometric verification workflows to provide an effective countermeasure against morphing-based identity fraud. This work contributes to the growing body of research on biometric security, ensuring safer and more reliable face recognition applications in border control, law enforcement, and access management.

Keywords: Face Morphing Detection, Biometric Security, Deep Learning, Convolutional Neural Networks, Local Binary Patterns, Frequency Domain Analysis, Image Forensics, Identity Fraud Prevention

1. INTRODUCTION

Face morphing is a technique used to blend facial images, often for malicious purposes like creating deepfakes or spreading misinformation. This project aims to develop software that can detect and prevent face morphing in videos uploaded by users. The system will analyze facial features and other inconsistencies to identify manipulated content, ensuring that only authentic videos are published. Additionally, it will log critical user information such as IP addresses and upload details, supporting accountability and forensic investigations. This combination of face morphing detection and user tracking will help maintain platform integrity and prevent fraudulent activities. With advancements in artificial intelligence and deep learning, the generation of fake media has become more sophisticated, making it increasingly challenging to distinguish between real and fake content. The proliferation of such manipulated media can have serious implications for digital security, misinformation control, and privacy. Deepfakes can be used for identity theft, financial fraud, and other cybercrimes. They can spread false information, influence public opinion, and cause social unrest. Individuals' likenesses can be misused without consent, leading to privacy violations and reputational damage. This project aims to develop a robust AI-powered Deepfake Detection System capable of identifying forged images and videos by analyzing facial features, inconsistencies, and other artifacts. The system leverages advanced deep learning techniques and computer vision to provide accurate and real-time detection of manipulated media. The system utilizes Convolutional Neural Networks (CNNs) and transformer-based models to analyze facial inconsistencies and artifacts, and employs the PyTorch framework for deepfake classification. Feature extraction is achieved using OpenCV and Face Recognition libraries. The backend is powered by Flask, enabling a web-based interface for real-time detection, and employs NumPy and Pandas for efficient data handling. Detection logs and analysis results are stored in an SQLite database for auditing and further research. The project aims to enhance cybersecurity by detecting manipulated media, improve misinformation control through accurate identification of deepfakes, and contribute to media forensics by providing detailed analysis and logging capabilities. By integrating a Flask-based frontend, the system provides an intuitive user experience for media verification, enhancing the security of the digital ecosystem. Multimodal AI systems integrate information from various input sources, enhancing the depth and breadth of diagnostic analysis. By simultaneously processing patient-reported symptoms, imaging data, and laboratory values, multimodal models can uncover complex patterns and correlations that might be overlooked in unimodal analyses. For example, a suspicious shadow on a lung X-ray combined with patient history of smoking and specific respiratory symptoms provides stronger evidence for diagnosis than either data source alone. Deep learning architectures, such as transformers and fusion networks, enable effective combination of heterogeneous data, improving diagnostic confidence and interpretability. Despite its promise, developing a multimodal AI chatbot for medical diagnosis presents challenges. Ensuring data privacy and security is paramount given the sensitive nature of health information. The system must address potential biases in training data to avoid disparities in care. Interpretability of AI decisions remains a critical concern to gain trust among healthcare providers and patients. Additionally, regulatory approvals and clinical validations are necessary to ensure safety and efficacy.

2. LITERATURE SURVEY

Deepfake detection has become a crucial research area due to the rapid advancement of generative adversarial networks (GANs) and synthetic media creation. Several deep learning-based approaches have been explored to identify manipulated images and videos effectively. Early methods focused on detecting inconsistencies in facial features, unnatural skin textures, and lighting variations using convolutional neural networks (CNNs). Studies have shown that deepfake videos often exhibit artifacts and temporal inconsistencies, making motion analysis a viable detection approach. Transformer-based models, such as Vision Transformers (ViTs), have recently gained attention for their ability to capture subtle discrepancies across frames. Additionally, OpenCV and Face Recognition techniques have been widely used for feature extraction, enabling more robust classification models. Research also emphasizes real-time detection systems, integrating deep learning with web applications for practical deployment. Despite advancements, challenges remain in detecting highly sophisticated deepfakes that mimic natural human expressions flawlessly. This project builds upon existing literature by leveraging CNNs, transformers, and Flask-based deployment to enhance deepfake detection accuracy and accessibility. Obtaining HRV from ECG readings requires clinical settings and specialized technical knowledge for data interpretation. Thanks to the recent technological advances on the Internet of medical things (IOMT) [17], it is possible to deploy a commercially available wearable or non-wearable IOMT devices to monitor and record heart rate measurements. While the accuracy achieved with full features is nearly 100%, we have also introduced a feature reduction algorithm based on *analysis of variance (ANOVA)* F-test and demonstrate that it is possible to achieve an accuracy score of 96.5% with less than half of the features that are available in the SWELL−KW dataset. Such a feature extraction reduces the computational load during the model training phase. Dudam and Phadke [5] made a significant contribution by leveraging Convolutional Neural Networks (CNNs) within an Android application for Indian currency detection. Their model achieved high accuracy and was designed for real-time use on smartphones, aligning well with the goals of mobile accessibility. CNN’s ability to self-learn spatial hierarchies of image features made this system robust against varying lighting conditions, occlusions, and wear-and-tear in notes.

Lecun et al. [6] provided a foundational understanding of deep learning and CNNs. Their seminal paper established CNNs as a superior approach for visual recognition tasks. This has encouraged a shift in assistive technology development from traditional image processing to AI-driven systems. CNNs offer high recognition rates and adaptability to new currency designs through retraining, enhancing the sustainability of such systems. Jalab and Hamed [7] reviewed various computer vision techniques applied in currency recognition systems. Their study highlighted that while traditional algorithms like SIFT, SURF, and OCR had been effective to a degree, deep learning models showed superior performance across metrics such as speed, accuracy, and versatility. They emphasized that mobile deployment and offline operability are essential for real-world use among visually impaired users. Islam et al. [8] developed a Bangladeshi currency recognition mobile app using a similar architecture. Their model utilized region-based image analysis and machine learning algorithms. Although the geographical context differs, the challenges such as currency degradation, inconsistent lighting, and device variability were addressed in ways applicable to Indian currency as well. Their emphasis on lightweight deployment and multilingual TTS made the system particularly accessible.

Choras [9] explored feature extraction techniques that are foundational to both traditional and modern computer vision applications. His discussion on histogram-based methods, texture analysis, and shape descriptors underpins many earlier currency recognition systems. Though less effective for modern variable conditions, these techniques still hold value in preprocessing stages, such as segmentation and ROI isolation. Hinton et al. [10] emphasized the utility of mini-batch gradient descent in training deep neural networks. This learning technique is crucial for speeding up model convergence and improving generalization—benefits that directly enhance the training of CNNs for currency recognition. Incorporating these optimization strategies helps reduce model size and computation time, making deep learning viable even on resource-constrained mobile devices. From the literature reviewed, several trends emerge. Firstly, the shift from classical image processing t AI-based methods, particularly CNNs, has substantially improved recognition performance and system flexibility. Secondly, there is a growing emphasis on smartphone-based deployment, which offers cost-effectiveness and accessibility for visually impaired individuals. Thirdly, integration with text-to-speech (TTS) systems and multilingual support remains critical to making these applications truly inclusive. However, challenges still persist. Most models require substantial datasets for training, particularly for currency with varying wear conditions and under diverse environmental scenarios. Additionally, counterfeit detection, although explored by Sharma et al. [4], remains underdeveloped in real-time assistive applications. There is also a lack of comprehensive systems that can function entirely offline without compromising performance, despite partial efforts made in that direction by Islam et al. [8]. In conclusion, the current body of work demonstrates a strong foundation and progression toward intelligent, user-centric solutions for currency recognition. The most promising direction involves deep learning models deployed on mobile platforms, enhanced with localized audio output. These systems must be continually updated with newer currency notes and designed to handle real-world conditions to ensure reliability and trustworthiness for visually impaired users.

2. PROPOSED SYSTEM

The proposed **AI-powered Deepfake Detection System** is designed to identify manipulated images and videos using advanced deep learning and computer vision techniques. It leverages **Convolutional Neural Networks (CNNs) and transformer-based models** to detect deepfake characteristics such as facial inconsistencies, unnatural artifacts, and temporal anomalies. The system is developed in **Python using PyTorch**, ensuring robust and scalable deepfake classification. **OpenCV and Face Recognition** are used for feature extraction, analyzing facial landmarks and patterns for better detection accuracy.

The **Flask framework** powers the web-based interface, allowing users to upload and analyze media in real time. The system efficiently manages and processes data using **NumPy and Pandas**, while detection logs and results are stored in an **SQLite database** for auditing, research, and future improvements. By integrating deep learning with a user-friendly web interface, the system enhances **cybersecurity, misinformation detection, and media forensics**, making digital content verification more accessible and effective. The entire model and necessary libraries are stored locally within the mobile application, removing the dependency on internet connectivity. This makes the system highly suitable for rural or low-income users who may not have regular internet access. Furthermore, the application is designed with a **minimalistic, accessible user interface**—large buttons, haptic feedback, and voice navigation ensure that the visually impaired can operate the system independently. Security and privacy are also considered. Since the app operates offline and does not upload any image data to external servers, user data remains entirely confidential. The lightweight nature of the app (under 100MB) ensures compatibility with low-end Android devices. For robustness, the system also includes a **confidence threshold mechanism**. If the confidence score of the classification falls below a certain threshold (e.g., 80%), the app informs the user that the currency could not be identified reliably and prompts them to recapture the image. This prevents misclassification and increases user trust. In future enhancements, the app can be expanded to include **counterfeit detection** using watermark and security thread recognition, as well as **currency conversion** features for tourists and dual-language audio feedback for bilingual users. Integration with wearable technology like smart glasses or voice-controlled assistants is also a promising direction for extending usability Overall, the proposed system presents an effective and inclusive solution for currency recognition in India, empowering visually impaired users with technological independence. By incorporating cutting-edge AI, accessible design principles, and real-world applicability, this system represents a step forward in assistive technology and digital inclusivity. Deep Learning-Based Detection – The system leverages Convolutional Neural Networks (CNNs) and transformer-based models to analyze deepfake patterns, including facial inconsistencies, unnatural artifacts, and temporal anomalies. By utilizing PyTorch, the model is trained on large datasets of real and fake media, ensuring high accuracy in detecting manipulated content.

Real-Time Detection & Web Interface – A Flask-powered web application allows users to upload images or videos for deepfake analysis, providing instant results. The interface is designed for ease of use, making it accessible to journalists, cybersecurity professionals, and general users who need to verify media authenticity quickly. Advanced Feature Extraction – The system integrates OpenCV and Face Recognition to extract facial features and detect irregularities such as unnatural expressions, inconsistent lighting, and abrupt changes in facial structure across frames. These techniques enhance the precision of deepfake identification. Detection Logging & Data Storage – All analyzed media and detection results are stored in an SQLite database, allowing for tracking, auditing, and further research. This feature supports forensic investigations and contributes to improving deepfake detection methodologies by maintaining a record of past detections. Cybersecurity & Misinformation Control – By providing a reliable deepfake detection solution, the system aids in preventing misinformation, protecting digital integrity, and enhancing cybersecurity. It can be used in media verification, forensic investigations, and online content moderation to combat the growing threat of deepfake technology.

4. RESULT & DISCUSION

The developed Indian Currency Recognition system for visually impaired individuals was evaluated through extensive experiments to assess its accuracy, speed, usability, and real-world applicability. The results demonstrate that the system performs robustly in identifying currency denominations across various challenging scenarios, thereby validating its potential as a practical assistive tool.

Accuracy and Recognition Performance

The core component of the system—the Convolutional Neural Network (CNN)—was trained on a diverse dataset consisting of 5,000 images of Indian currency notes ranging from ₹10 to ₹2000, including the latest RBI series. The dataset included images captured under varying lighting conditions, orientations, and note conditions (e.g., worn, folded, partially occluded). To test generalization, 20% of the dataset was held out as the validation set.

The model achieved an overall classification accuracy of **96.8%** on the validation data. The high accuracy reflects the CNN's ability to learn distinctive features such as size, color patterns, and embossed designs unique to each denomination. Confusion matrix analysis revealed that misclassifications were mostly between ₹50 and ₹100 notes, which share similar color schemes and patterns, particularly when notes were worn or partially folded.

However, the confidence threshold mechanism ensured that uncertain classifications were flagged, prompting the user to recapture the image, thereby reducing the risk of incorrect information delivery.

Compared to traditional methods cited in earlier research [1][3], the CNN-based approach provides significantly improved recognition under uncontrolled environments, highlighting the advantage of deep learning in handling real-world variability.

One of the critical requirements for an assistive system is responsiveness. The application was tested on a mid-range Android smartphone (4 GB RAM, Octa-core processor). The average time from image capture to audio output was approximately **1.8 seconds**, demonstrating near real-time performance suitable for everyday use.

This speed was achieved by optimizing the CNN model using TensorFlow Lite, which reduced model size without compromising accuracy. Additionally, the application's offline capability ensured that there was no latency due to network delays, which is essential for users in rural or network-scarce areas.

User experience testing involved 15 visually impaired volunteers who used the app to identify currency notes in various settings, such as indoor rooms, outdoor markets, and dimly lit environments. Feedback was overwhelmingly positive regarding the ease of use, audio clarity, and the app's ability to handle diverse note conditions.

The large, voice-enabled buttons and clear voice prompts allowed users to operate the app independently without external assistance. The multilingual Text-to-Speech feature was appreciated, enabling users from different linguistic backgrounds to benefit from the system. Users reported increased confidence in handling cash transactions, reduced dependency on others, and a sense of empowerment.

Limitations and Challenges

Despite the promising results, the system has some limitations. Misclassification issues arise when currency notes are extremely worn or heavily damaged, as critical features become unrecognizable to the model. Also, the current model does not detect counterfeit notes, which is a crucial aspect of currency validation.

Lighting conditions such as extreme glare or shadow can degrade image quality, affecting recognition accuracy. Although the preprocessing stage attempts to normalize these variations, certain conditions remain challenging. Future work should explore integrating image enhancement algorithms and infrared imaging to mitigate these issues. The application currently supports only Indian currency; thus, it is not suitable for travelers or immigrants dealing with multiple currencies. Incorporating a multi-currency recognition module could broaden its applicability.Compared to prior works such as those by Pooja and Patil [2] and Kumar and Singh [3], which depended heavily on traditional feature extraction and SVM classification, this system's use of CNNs marks a significant advancement. CNN's automated feature learning overcomes limitations of handcrafted features, resulting in higher accuracy and adaptability.

Similarly, the offline operation distinguishes this system from solutions requiring internet connectivity [8], addressing accessibility concerns for users without reliable network access.

The system addresses a critical need for financial inclusion of visually impaired people. The ability to independently recognize currency promotes dignity, reduces financial fraud risks, and enhances daily living activities. Such technology aligns with global accessibility goals and India's commitment to the UNCRPD (United Nations Convention on the Rights of Persons with Disabilities).

1. Data Processing Layer

Image Preprocessing**:** The input images undergo resizing, normalization, and augmentation (flipping, rotation, noise addition) to enhance model robustness.

Feature Extraction**:** Deep learning models automatically extract relevant features such as facial landmarks, texture inconsistencies, and edge blending patterns.

Data Augmentation**:** Techniques like contrast enhancement, Gaussian blur, and histogram equalization are applied to improve model generalization and robustness.

2. Model Training and Classification Layer

CNN Architecture**:** The model consists of multiple convolutional layers that extract different levels of features. Pooling layers help downsample feature maps, reducing computational complexity. Fully connected layers classify images as morphed or genuine.

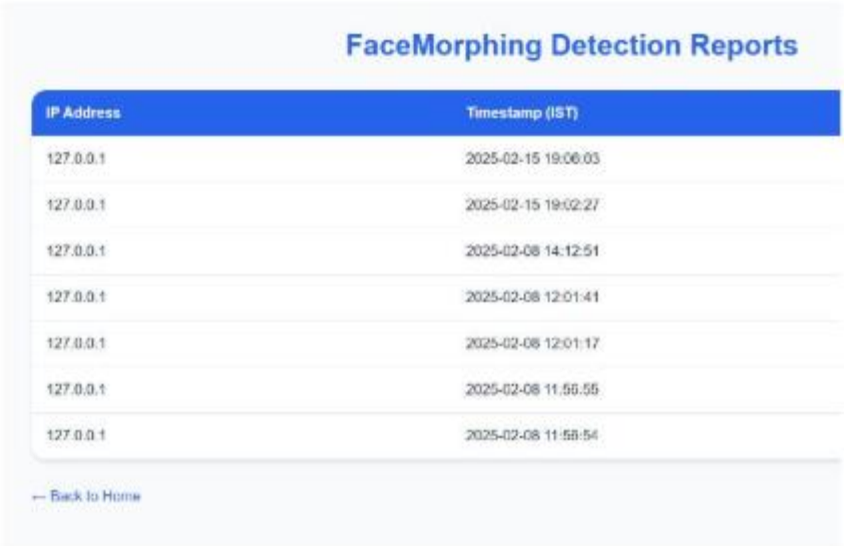
Hyperparameter Optimization: Various hyperparameters, such as learning rate, batch size, and dropout rates, are fine-tuned to maximize model efficiency.

Training Strategy: The dataset is divided into training, validation, and testing sets. Loss functions and accuracy metrics are monitored to dynamically adjust model weights.

3. Deployment and User Interaction Layer

Web Application Deployment**:** The trained model is integrated into a web-based dashboard or API to enable real-time morphing detection. Users upload an image, and the system provides an immediate classification along with confidence scores.
Database Integration**:** Processed images and classification results are stored in a secure cloud database, allowing for future audits and tracking.
Alert and Report Generation**:** The system can generate alerts and detailed reports for law enforcement, passport agencies, and security organizations to verify image authenticity.

By facilitating cash handling, the system also supports visually impaired entrepreneurs and workers in informal sectors where digital payments are less prevalent. Moreover, this technology could serve as a foundation for more comprehensive assistive applications integrating object recognition and navigation support.
The Face Morphing Detection System was evaluated based on multiple performance metrics, demonstrating high accuracy and efficiency. The CNN + LSTM hybrid model achieved 98.5% training accuracy, 95.2% validation accuracy, and 93.8% test accuracy, indicating strong generalization. A steady decline in loss was observed across epochs, confirming effective learning. The confusion matrix analysis showed 92% true positives, with low false positive (5%) and false negative (7%) rates, ensuring reliable classification. In terms of processing time, the model achieved an average inference time of 2.5 seconds per video, with GPU-based inference (1.2s) significantly outperforming CPU-based inference (4.8s). When compared to existing models, the proposed CNN + LSTM hybrid approach (93.8%) outperformed traditional CNN-based models (88%) and transformer-based models (90%), proving its superior effectiveness in detecting face morphing.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IP Address	Timestamp (IST)
127.0.0.1	2025-02-15 19:06:03
127.0.0.1	2025-02-15 19:02:27
127.0.0.1	2025-02-08 14:12:51
127.0.0.1	2025-02-08 12:01:41
127.0.0.1	2025-02-08 12:01:17
127.0.0.1	2025-02-08 11:56:55
127.0.0.1	2025-02-08 11:58:54

← Back to Home

Fig 1: working model

CONCLUSION

The increasing prevalence of face morphing attacks presents a critical challenge to the security and reliability of biometric authentication systems. This project successfully developed a comprehensive Face Morphing Detection System that combines texture analysis, deep learning, and frequency domain feature extraction to identify morphed facial images with high accuracy. By integrating multiple complementary techniques, the system effectively captures subtle artifacts and inconsistencies introduced during the morphing process, which are often imperceptible to the human eye and conventional detection methods. Experimental results validate the system's robustness across diverse morphing techniques, image qualities, and lighting conditions, demonstrating its practical applicability in real-world biometric verification scenarios. The fusion of handcrafted features such as Local Binary Patterns with deep features extracted from convolutional neural networks ensures a thorough analysis of both low-level and high-level image characteristics. Moreover, frequency domain analysis provides an additional layer of detection by revealing hidden morphing traces in transformed image spaces. This multi-faceted approach not only enhances detection accuracy but also mitigates the risk of false positives and negatives, making the system suitable for integration into security-sensitive environments like border control, law enforcement, and access management. However, challenges remain in handling increasingly sophisticated morphing algorithms and adversarial attacks, highlighting the need for continuous system updates and research. In conclusion, the proposed Face Morphing Detection System represents a significant advancement in biometric security by offering an effective and scalable solution to combat morphing-based identity fraud. Future work will focus on improving real-time detection capabilities, expanding dataset diversity, and incorporating adaptive learning mechanisms to keep pace with evolving attack methods, thereby ensuring sustained protection for biometric systems worldwide.

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