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MedVision: Multimodal AI Chatbot for Enhanced Medical Diagnosis

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Abstract The increasing complexity of medical diagnosis and the growing volume of patient data necessitate intelligent systems capable of assisting healthcare professionals in making accurate and timely decisions. MedVision is a multimodal AI chatbot designed to enhance medical diagnosis by integrating natural language processing, computer vision, and machine learning techniques. Unlike traditional diagnostic tools that rely solely on textual input, MedVision processes multiple data modalities including patient history, symptoms described in text, medical images such as X-rays and MRIs, and laboratory results. This multimodal approach enables a more holistic understanding of patient conditions, improving diagnostic accuracy and reducing human error. MedVision utilizes advanced deep learning models to interpret medical images and combines these insights with symptom analysis derived from conversational interactions. The chatbot engages patients and healthcare providers through an intuitive conversational interface, delivering personalized diagnostic suggestions, possible conditions, and recommended next steps. Additionally, the system incorporates continuous learning capabilities, adapting to new medical knowledge and evolving patient data trends. Extensive testing on diverse datasets shows that MedVision achieves high diagnostic accuracy across various diseases and image types, outperforming unimodal systems. By providing real-time, reliable diagnostic support, MedVision aims to reduce the burden on healthcare systems, enhance early disease detection, and improve patient outcomes.

Keywords: multimodal AI, medical diagnosis, chatbot, deep learning, computer vision, natural language processing, medical imaging, healthcare AI, diagnostic support, patient interaction.

1. INTRODUCTION

Healthcare systems worldwide are under immense pressure to provide accurate, timely, and cost-effective medical diagnosis and treatment. With the rapid advancement of technology, artificial intelligence (AI) has emerged as a transformative tool capable of revolutionizing healthcare delivery. AI-powered diagnostic systems, particularly chatbots, have gained popularity for their ability to interact with patients, process complex medical data, and assist healthcare professionals in clinical decision-making. However, most existing AI diagnostic tools rely on a single data modality, such as text-based symptom analysis or image interpretation, limiting their ability to provide comprehensive insights. The integration of multiple data modalities—combining textual information, medical images, and clinical test results—has the potential to significantly enhance diagnostic accuracy and clinical usability. MedVision, a multimodal AI chatbot, aims to fill this gap by leveraging advances in natural language processing (NLP), computer vision, and machine learning to support enhanced medical diagnosis.

The Need for Multimodal Diagnostic Systems

Medical diagnosis is inherently complex, involving the integration of diverse information types. Patients present symptoms verbally or in written form, but these descriptions often lack specificity or may be ambiguous. Clinical images such as X-rays, MRIs, or CT scans provide crucial anatomical and pathological information, while laboratory results offer quantitative biochemical data. Traditional diagnostic workflows rely heavily on physicians' expertise to synthesize these heterogeneous data sources into a coherent clinical picture. However, growing patient loads, limited specialist availability, and the increasing volume of medical data pose challenges for timely and accurate diagnosis. AI-based tools that can process and integrate multiple modalities offer a promising solution by augmenting clinicians' capabilities, reducing diagnostic errors, and expediting patient care.

Overview of Existing AI Diagnostic Approaches

Current AI diagnostic systems primarily focus on single modalities. NLP-driven chatbots analyze patient symptoms and medical histories expressed in text to suggest possible diagnoses or recommend further tests. For instance, symptom checkers like Babylon Health employ rule-based or machine learning models to interact conversationally with patients. Meanwhile, computer vision algorithms, powered by convolutional neural networks (CNNs), have shown remarkable success in interpreting medical images for disease detection, such as identifying pneumonia in chest X-rays or tumors in MRI scans. However, these unimodal approaches have limitations. Text-only systems may miss critical visual clues, and image-only systems lack contextual patient information. Consequently, diagnostic accuracy and reliability can suffer.

The Promise of Multimodal AI

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.

MedVision: Bridging the Gap

MedVision is designed as an intelligent, multimodal chatbot that interacts naturally with patients and healthcare providers to collect symptoms and medical history while analyzing diagnostic images and test reports. It employs state-of-the-art NLP techniques to understand and generate human-like conversational responses, ensuring a user-friendly experience. Concurrently, computer vision models trained on large medical imaging datasets detect anomalies and classify diseases from input images. The integration of these modalities is achieved through a fusion module that synthesizes the outputs into comprehensive diagnostic suggestions. Furthermore, MedVision incorporates continuous learning to update its knowledge base with new medical findings and user feedback, enhancing performance over time.

Benefits and Impact

The implementation of MedVision can lead to several tangible benefits. Firstly, it can improve diagnostic accuracy by providing clinicians with richer, multimodal information synthesized intelligently. Secondly, it can enhance accessibility to quality healthcare, especially in remote or underserved areas where specialists or diagnostic equipment may be limited. Thirdly, MedVision can reduce the cognitive load on healthcare professionals, allowing them to focus more on treatment planning and patient care. Lastly, by engaging patients directly through conversational AI, it promotes proactive health management and adherence to medical advice.

Challenges and Considerations

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

The use of artificial intelligence (AI) in healthcare has rapidly advanced, with significant improvements in diagnostic accuracy, patient care, and administrative efficiency. AI-driven tools such as IBM Watson and Google's DeepMind have revolutionized diagnostic decision-making. Natural Language Processing (NLP) plays a critical role in enabling human-computer interaction within medical chatbots, as evidenced by systems like Babylon Health, which combine NLP with symptom analysis to offer medical advice. Multimodal AI systems, which integrate multiple data types such as text, voice, and images, are gaining popularity for their comprehensive diagnostic capabilities, with studies demonstrating their superiority over single-modality approaches. Automatic Speech Recognition (ASR) systems like Google's Speech-to-Text and OpenAI's Whisper have improved medical transcription accuracy, reducing clinicians' documentation burden. Machine learning, particularly Convolutional Neural Networks (CNNs), has proven highly effective in medical image analysis, offering dermatologist-level accuracy in skin cancer detection and other diagnostic areas. Additionally, medical chatbots are being increasingly used for differential diagnoses, as shown in recent studies. MedVision builds upon these advancements, combining multimodal AI for enhanced medical diagnosis and improved patient-doctor interaction.

Kumar and Singh [3] enhanced currency recognition by integrating Speeded-Up Robust Features (SURF) and Support Vector Machine (SVM) classifiers. Their system was capable of identifying partially visible and rotated currency notes, improving robustness. However, the approach required considerable preprocessing time and was computationally intensive, making it less suited for real-time smartphone applications. Sharma et al. [4] worked on Indian paper currency authentication by analyzing security features such as watermark and latent images using high-resolution imaging. Their work focused more on verifying authenticity than recognition. While highly effective in fraud detection, the model required high-quality image acquisition devices, which may not be feasible for visually impaired users on mobile platforms.

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.

3. PROPOSED SYSTEM

The proposed system, MedVision, is an AI-powered multimodal diagnostic platform designed to enhance medical analysis by integrating various input formats, such as medical images, text, and audio. It leverages advanced machine learning models to analyze medical images and respond to user queries, offering real-time diagnostic insights. The system is designed to mimic a human doctor's response, providing concise and contextually relevant feedback on the medical condition depicted in the input image MedVision incorporates a speech-to-text module for converting patient audio inputs into text using the Whisper model, while the text-to-speech module powered by gTTS enables the system to communicate the diagnosis in an audible format. The image analysis leverages a pre-trained vision model, LLaMA-3.2, to detect medical anomalies in the images and generate human-like responses, enhancing the overall interaction and understanding for patients. The system's modular design ensures seamless integration of audio, text, and image data for a holistic diagnostic process, making it a versatile tool in healthcare environments for both patients and medical professionals The key objective of the proposed system is to assist healthcare professionals by automating routine diagnostic tasks, offering quick and accurate insights, and improving patient engagement through multimodal communication. MedVision aims to minimize the workload of medical practitioners, reduce diagnostic errors, and provide immediate medical assistance, ultimately improving healthcare accessibility and efficiency.The second module, **preprocessing**, standardizes the input image to enhance recognition performance. This includes converting the image to grayscale, resizing it to a fixed dimension, normalizing pixel values, and removing noise using Gaussian blur. Data augmentation techniques such as rotation, brightness adjustment, and flipping are also applied during model training to enhance generalization capabilities of the CNN, enabling it to recognize currency notes under varying conditions. The third module,

feature extraction, is inherently handled by the convolutional layers of the CNN model. Unlike traditional image processing methods that rely on manual feature engineering (e.g., detecting numerals or watermarks), CNNs automatically learn relevant patterns such as textures, shapes, and colors from the training dataset. The model is trained on a labeled dataset containing thousands of high-resolution images of Indian currency notes ranging from ₹10 to ₹2000. Special attention is given to the newer series of banknotes introduced by the Reserve Bank of India post-2016.

The classification layer of the CNN provides the denomination output based on the learned features. The output is a softmax probability vector indicating the most likely denomination class. The model is optimized using categorical cross-entropy as the loss function and trained using the Adam optimizer with mini-batch gradient descent, as suggested by Hinton et al. This approach significantly speeds up convergence while maintaining generalization. Once the denomination is identified, the result is passed to the **audio feedback module**, which uses **Text-to-Speech (TTS)** technology to read the denomination aloud to the user. This module supports multiple languages, including English, Hindi, and regional dialects to accommodate a diverse user base. Users can select their preferred language in the app settings. The audio output is clear, concise, and generated instantly upon recognition, ensuring real-time interactivity. A key design feature of the system is its **offline functionality**. 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.

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.

Processing Speed and Real-Time Performance

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.

Usability and Accessibility

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.

Comparative Analysis

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.

Impact and Societal Implications

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).

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.

Future Work

Future developments should focus on integrating counterfeit detection using watermark and security thread analysis, extending language support, and improving model robustness against extreme wear and lighting conditions. Implementing voice-command activation and compatibility with wearable devices like smart glasses can further enhance usability.

Additionally, expanding the training dataset with more real-world images and exploring newer deep learning architectures such as EfficientNet or MobileNetV3 could improve accuracy and efficiency.

Fig 1: Working Model

CONCLUSION

MedVision represents a significant advancement in the integration of artificial intelligence within healthcare by employing a multimodal approach to medical diagnosis. By combining natural language processing, computer vision, and machine learning, MedVision effectively bridges the gap between textual patient data and complex medical imaging, enabling a comprehensive and nuanced diagnostic process. This system not only supports healthcare providers by enhancing diagnostic accuracy but also empowers patients through accessible, conversational engagement. The multimodal architecture ensures that MedVision can handle heterogeneous data inputs—ranging from symptom descriptions to radiological images—thus providing a richer understanding of patient health compared to traditional unimodal systems. The integration of continuous learning mechanisms allows the system to stay updated with evolving medical knowledge and adapt to diverse clinical scenarios. This adaptability is crucial in the fast-paced and ever-changing medical domain. Experimental results indicate that MedVision performs with high accuracy across various diagnostic tasks and image modalities, demonstrating its practical potential for real-world deployment. Furthermore, the intuitive conversational interface reduces barriers to adoption by clinicians and patients alike, facilitating smoother interactions and better healthcare delivery. Despite these achievements, challenges remain in ensuring data privacy, addressing biases in training data, and maintaining interpretability of AI-driven recommendations. Future work will focus on expanding MedVision's diagnostic repertoire, incorporating multi-language support, and integrating with existing electronic health record systems for seamless workflow integration. In conclusion, MedVision exemplifies how multimodal AI chatbots can transform medical diagnostics by enhancing precision, accessibility, and efficiency. As healthcare increasingly embraces digital transformation, such intelligent tools will be essential in supporting clinicians, improving patient outcomes, and optimizing healthcare resources globally.

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