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Medicine Identification, Reminder and Consultation Android Application for Visually Impaired People

Purva Sarange[1], Ishita Shete[2], Dhanshri Thorat[3], Neha Warghane[4], Prof. Anjali Kadam[5]

Student, Department of Computer Engineering, BVCOEW, Pune, Maharashtra, India[1,2,3,4]

Professor, Department of Computer Engineering, BVCOEW, Pune, Maharashtra, India[5]

Abstract: Adherence to prescribed medication schedules and accurate identification of medicines are crucial for effective healthcare management. This paper introduces an Android-based application, Medicine Consultation Reminder and Identification, aimed at simplifying medication management for users. The application provides two primary features: a medicine identification system using Tesseract Optical Character Recognition (OCR) technology to scan and recognize medicine labels and a personalized reminder system to alert users about their medication schedules. Developed after multiple consultations with healthcare professional, the application addresses challenges such as missed doses and incorrect medicine usage. The Tesseract OCR-based medicine identification feature ensures users can verify medicine details quickly, reducing potential errors. Meanwhile, the reminder system is customizable, allowing users to schedule alerts based on their prescriptions. Additionally, the app is designed to be fully voice-command compatible, enabling hands-free operation, making it more accessible for users with mobility impairments or those who prefer voice interaction. It is also customized to assist visually impaired individuals by reading aloud medication details and reminders, ensuring they can manage their health independently. The app's user-friendly interface and voice control features make it accessible for individuals across different age groups. Its development focuses on integrating advanced scanning technology while ensuring data privacy and usability. By bridging the gap between technology and healthcare, this project strives to improve medication adherence and support patients in managing their health. The proposed solution has the potential to enhance healthcare outcomes and reduce risks associated with medication non-compliance or errors, making it a valuable contribution to the digital health domain.

Keywords: CNN, OCR, Text-to-Speech, Cloud-based storage, Image processing, Notifications

I. INTRODUCTION

Medication adherence is vital for good health but often difficult for visually impaired individuals due to challenges in reading labels and managing schedules. This can lead to serious risks like missed or incorrect doses [1][2]. Our Android app, "Medicine Consultation, Reminder, and Identification," addresses these challenges with a voice-controlled interface and Tesseract OCR for accurate medicine identification [3][4]. It extracts text from labels, even in complex fonts or multiple languages, helping users avoid confusion between similar-looking medicines. Using NLP and NER, it verifies medicine names to ensure safety [5][6].

The app is fully voice-enabled, allowing users to set reminders, scan medicine labels, and manage schedules hands-free via Google's Speech-to-Text API [7][8]. With this seamless voice control, users can perform all tasks without manual input, supporting those with mobility or visual impairments [9][10].

While tailored for the visually impaired, it benefits all users through features like customizable reminders, Google's Text-to-Speech, and a consultation log to track medication history. Firebase ensures secure, cloud-based storage of personal medical data. By integrating AI, OCR, and voice technology, the app improves medication safety, promotes independence, and helps reduce healthcare errors and costs.

II. LITERATURE SURVEY

A. Related work

In terms of medication adherence, Kripalani et al. (2019) proposed an illustrated medication schedule aimed at improving individuals with low literacy. This schedule uses pictorial icons and pill illustrations to simplify dosage instructions, with results showing that 92% of participants found it user-friendly and 94% reported better recall of medication details [1].

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Silva et al. (2020) introduced UbiMeds, a smartphone application integrated with Patient Health Information (PHI) systems. It automates medication scheduling and alerts caregivers and doctors about missed doses. The study highlighted high user acceptance and improved adherence rates among elderly and disabled users [2]. For visually impaired users, McCann et al. (2021) developed a medication self-management system using Braille labels and audio alerts. The approach demonstrated a significant increase in adherence rates in controlled studies [3]. Similarly, Benjamin et al. (2022) introduced a camera-based system that identifies medication boxes using image matching algorithms. The system achieved an accuracy of over 90% in trials, providing auditory feedback for visually impaired users [4]. In IoT-enabled solutions, Hasanuzzaman et al. (2021) presented a dual-layer RFID and video-based medication monitoring system. The RFID tags log usage, while cameras ensure compliance by analyzing real-time habits. This system targeted elderly users with promising results in adherence tracking [5]. Salgia et al. (2022) designed a smart pillbox with capacitance-based sensors and GSM technology to send reminders via text messages and notifications. The low-cost device significantly improved medication management among elderly users [6]. In mobile applications for visually impaired users, Jayashree et al. (2023) developed an app that scans medication strips using a smartphone camera and converts the information into auditory feedback. It also features reminders and scheduling functionalities, increasing user autonomy [7]. Berger et al. (2023) explored wearable technology for medication management, such as Google Glass, using visual recognition algorithms to identify pills and provide audio notifications, alongside location-based reminders [8]. For advanced systems, Farhadyar et al. (2023) proposed a deep learning-enabled smart medication management system integrating wearable glasses, mobile applications, and cloud platforms. The system achieved a 95% success rate in medication identification and adherence improvement during trials [9]. In systems tailored for visually impaired individuals, Rokade et al. (2024) developed SmartMedBox, a smart medicine box using IoT and computer vision techniques. By combining RFID technology and computer vision, the system identifies medication containers and verifies dosages. Voice-assisted notifications guide users through the process, with trials highlighting significant improvements in adherence and ease of use [10].

B. Problem Statement

Visually impaired individuals face significant challenges in managing their medications due to an inability to read labels, differentiate between medicines, and follow complex dosage schedules. This can lead to medication errors such as missed doses, overdoses, or taking the wrong medicine, which may result in serious health complications. Existing solutions often lack full accessibility features or fail to provide a hands-free, user-friendly experience tailored to their needs. Therefore, there is a critical need for a comprehensive, voice-enabled mobile application that assists visually impaired users in accurately identifying medicines, receiving timely reminders, and maintaining a structured medication history to ensure safe and independent medication management.

III. PROPOSED SYSTEM

The proposed system is a voice-enabled Android application designed to help visually impaired users manage their medications safely. It uses Tesseract OCR to identify medicine labels, and NLP/NER to verify medicine names accurately. Users can interact with the app through voice commands using Google's Speech-to-Text API, while Text-to-Speech reads out medicine details. It includes customizable reminders, a consultation tracker, and secure cloud storage via Firebase. The app offers a complete, accessible solution for medication identification and adherence.

1. **Voice-Controlled Navigation**: The app is fully voice-enabled, allowing users to navigate through different sections of the app, set medication reminders, scan medicine labels, and manage their health records entirely through voice commands. This feature is powered by Google's Speech-to-Text API, ensuring a hands-free, accessible experience for users with mobility impairments or those who prefer voice interaction.

2. **Optical Character Recognition (OCR) for Medicine Identification**: The app utilizes Tesseract OCR to scan and extract text from medicine labels. It can read complex fonts and multilingual packaging, ensuring that visually impaired users can correctly identify medicines, even if the labels are intricate or in different languages. This reduces the risk of confusion between similar-looking medications.

3. **Natural Language Processing (NLP) and Named Entity Recognition (NER)**: After the OCR extracts the text, NLP and NER techniques are used to verify and interpret the scanned text. These technologies ensure that the app accurately identifies medicine names and matches them to a database, eliminating the risk of errors when interpreting labels.

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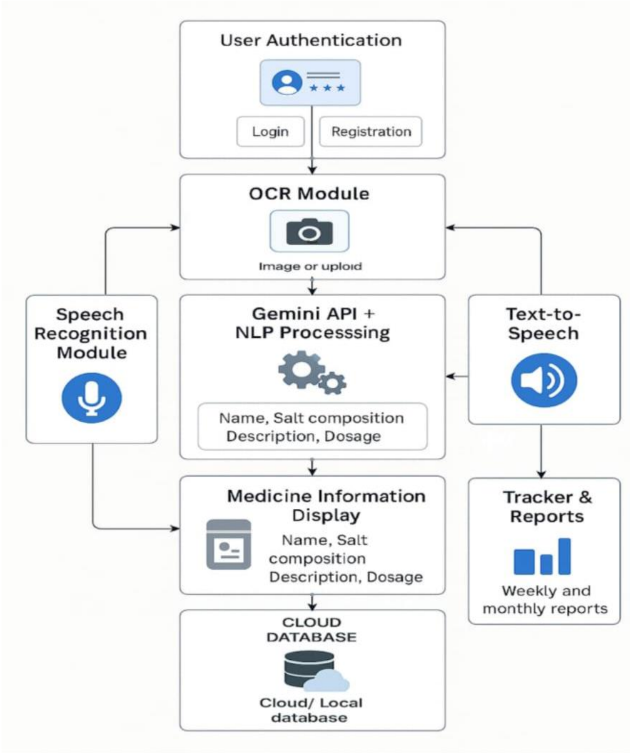
4. **Text-to-Speech (TTS) for Audio Output**: The app uses Google's Text-to-Speech API to read aloud important information such as medicine names, dosage instructions, and reminders. This feature enhances accessibility, allowing users to follow their medication regimen without needing to read text on the screen, making it especially useful for users with visual impairments.



5. **Customizable Medication Reminders**: Users can set medication reminders based on their specific schedules. The app will send voice alerts at the set times, ensuring users take their medications on time. The reminder system is customizable, allowing for flexibility based on individual medical needs, such as varying doses or multiple medications throughout the day.

6. **Consultation and Medication History Tracking**: The app stores a structured database of users' medication history, helping them track their adherence patterns. Users can review their past medication intake, adjust their schedules if necessary, and share their medication history with healthcare professionals during consultations. This helps ensure better healthcare management and communication with doctors.

7. **Secure Cloud-Based Data Storage**: The app utilizes Firebase for secure cloud-based storage of user data, ensuring that personal information, medication records, and schedules are kept encrypted and private. Only authorized users can access their data, and the cloud storage ensures that medication information is available from any device

IV. METHODS AND MATERIALS

1. Image To Text Methodology

- Teserract OCR
  Tesseract OCR extracts text from images through a multi-step process involving image processing, character recognition, and text reconstruction. Here's how it works in more detail:

1. Image Preprocessing
   Converts the image to grayscale to reduce noise and improve contrast. Applies thresholding (binarization) to distinguish text from the background. Uses techniques like deskewing and denoising to correct slanted or noisy images.
2. Text Segmentation
   Divides the image into distinct text blocks, lines, words, and individual characters. Identifies connected components (regions that resemble text). Uses projection profiles and contour detection to isolate text.

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3. Feature Extraction & Pattern Recognition
   Extracts character edges, strokes, and shapes. Compares extracted features with trained language models. Uses LSTMs (Long Short-Term Memory networks) in newer versions for better recognition.
4. Character Recognition
   Matches detected shapes against a trained dataset (trained data files). Uses adaptive thresholding to handle different fonts and distortions. Supports multiple languages via language-specific training data.
5. Post-processing
   Applies contextual analysis to correct misrecognized words. Uses dictionary-based correction to improve spelling accuracy. Outputs the extracted text as UTF-8 encoded text.

- Gemini API

The Gemini API works well when the label of the medicine is torn or blurred.

1. Text Processing-
   After the text is recognized from the image it is processed to get the exact medicine name from the detected.
2. Data Acquisition and Preprocessing-
   The dataset consists of structured information about medicines, including product name, salt composition, medical description, and dosage. The data is sourced from a verified pharmaceutical database and stored in a CSV format. To facilitate text-based similarity computation, preprocessing is performed, which includes:
3. Text Normalization: All text is converted to lowercase, and special characters, punctuations, and extra spaces are removed to ensure uniformity.
4. Feature Consolidation: Relevant textual attributes (product name, salt composition, and description) are concatenated into a single field for efficient matching. Mathematically, this can be represented as:

Ti = PNi + MDi + DiTi
Where:
Ti is the consolidated text for medicine
PNi is the product name,
MDi is the medicine description
Di is the dosage.

- Text Representation Using TF-IDF Vectorization

1. To enable machine-driven text similarity computations, Term Frequency-Inverse Document Frequency (TF-IDF) vectorization is applied to transform textual descriptions into numerical feature vectors. The TF-IDF score for a term tt in document dd is computed as:
2. Cosine Similarity Computation
   Cosine similarity is employed to measure the textual relevance between the input medicine description and each medicine in the database. Given two TF-IDF vectors AA and BB, their similarity score is computed as:

   Cos(theta) = A.B/ ||A|| ||B||
   Where,
   A.B is the dot product of the vectors,
   ||A|| and ||B|| represent their respective magnitudes.
3. Fuzzy String Matching Using Levenshtein Distance
   To accommodate typographical errors, OCR inaccuracies, and spelling variations, fuzzy string matching is integrated.
4. The Levenshtein distance is used to compute the minimum number of single-character edits (insertions, deletions, or substitutions) required to transform one string into another.

- Aggregation and Ranking of Results

The final match score for each medicine entry is computed as a weighted combination of cosine similarity and fuzzy matching scores:

$$S_i = \alpha \times CS_i + \beta \times FM_i$$

Where:
Si is the final score for the i-th medicine,
CSi is cosine similarity,
FMi is the fuzzy matching score,
α and β are empirically determined weighting factors.

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2.2.4 Output Generation

To enhance readability and usability, the retrieved medicine description is truncated to the first 50-60 words, ensuring that the user receives concise yet informative results. The final output includes:

1. The best-matched medicine name.
2. Key attributes such as salt composition and dosage.
3. Confidence scores from cosine similarity and fuzzy matching.

2. Speech Processing:

1. Google Speech-to-Text API

- Description: Google's Speech-to-Text API converts spoken language into text. It is highly accurate and supports multiple languages.
- How to Use:
  Integrate the Google Cloud Speech-to-Text API into your app.
  Use the Speech Recognizer class in Android to capture voice input and send it to the API for processing.
- Advantages:
  1. High accuracy.
  2. Supports real-time and offline transcription.
  3. Easy to integrate with Android apps.

3. Reminder

- Firebase
  a) The proposed application leverages Firebase Firestore to manage users' medication schedules, storing essential details such as the medicine name, dosage, prescribed time, and remaining pill count. When a user sets a reminder, this data is securely stored in Firestore, ensuring synchronization across multiple devices.
  b) For notification delivery, the application employs Firebase Cloud Messaging (FCM) or Android Alarm Manager:
  c) If FCM is used, the server sends a push notification to the user's device at the scheduled time, ensuring real-time reminders.
  d) If Alarm Manager is used, the application schedules local reminders, functioning even without an active internet connection.
  e) Additionally, the application tracks user interaction with reminders:
     1. If the user confirms taking the medicine, the pill count is reduced by one, and Firestore is updated accordingly.
     2. If the user dismisses the notification, it is recorded as a missed dosage in the database.
     3. If the pill count reaches a low threshold, the application triggers an alert to notify the user about restocking.
     4. This approach ensures a robust and reliable medication adherence system, offering real-time tracking and alerts to enhance user compliance.

4. Report and tracker

- The Report and Tracker section of the application provides a weekly overview of each medicine added by the user, enabling efficient monitoring of medication adherence. Additionally, a monthly report is generated, incorporating a graphical representation to track the user's medication intake. This report visually distinguishes between doses taken and missed, offering valuable insights into the user's adherence patterns.
- The system ensures comprehensive tracking by maintaining detailed records of confirmed dosages and missed intakes, which are subsequently used to generate analytics-driven insights. The graphical report aids users in identifying trends, improving medication compliance, and facilitating better health management.

V. CONCLUSION

The "Medicine Consultation, Reminder, and Identification" Android application provides an accessible and efficient solution for visually impaired individuals to manage their medications. By combining OCR for accurate medicine identification, voice command navigation, NLP for verification, and secure cloud storage, the app ensures safe and independent medication management. Its customizable reminders and consultation tracking further enhance user adherence to prescribed regimens. This app bridges a critical gap in healthcare accessibility, empowering users to take control of their health while reducing the risk of medication errors and improving overall well-being.

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