Medication Identification and Assistive System for the Visually Impaired: Vismed

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ABSTRACT
Visual impairment poses significant challenges for individuals in independently managing their everyday activities and medication regimens. 39 million people are designated as blind by the World Health Organisation (WHO), out of an estimated 285 million people who have visual impairment. Many people have to face difficulties in interpreting prescriptions, recognizing medications, and administering them properly, which can lead to serious health hazards and reduce the sense of autonomy. An innovative Artificial Intelligence (AI)--driven Blind Assistive System, VISMED has been developed to address these critical problems. This advanced system empowers visually impaired individuals to scan their prescriptions and extract medication details using Optical Character Recognition (OCR) technology by accessing a comprehensive database. It also optimizes the prescription writing process for healthcare professionals by incorporating an online prescription service and primary disease predictive model using machine learning. Furthermore, the application has a provision for emergency communication with caregivers in times of dire need. Combining these features, it seeks to significantly improve the independence, health, and overall quality of life of individuals with visual impairments. By leveraging cutting-edge technologies, this system meets the needs of the visually impaired population in terms of accessibility and healthcare management. The necessity of such a system is of supreme importance, as it improves drug safety and accuracy in medication use while encouraging greater autonomy and self-reliance among visually impaired individuals, ultimately contributing to their better state of health and increased involvement in society.

General Terms
Assistive Technology, Optical Character Recognition (OCR), Machine Learning, Mobile Development, Predictive Analysis, Accessibility.

Keywords
Health Care Systems, Blind Assistive Systems, Voice Search, Image scanning, Optical character recognition (OCR), Mobile Application Development, Medicine Identification, Accessibility, Machine Learning.

1. INTRODUCTION
In contemporary society, the requirement for creative healthcare solutions in today's world is more important than ever, especially for those who are visually impaired. With 39 million of the world's 285 million visually impaired individuals being blind, there are substantial obstacles that these individuals must overcome in order to carry out daily duties and activities related to their health. The growing prevalence of chronic illnesses, the ageing of the global population, and the complexity of healthcare systems all contribute to these difficulties. Therefore, the proposal for VISMED, a blind assistive system that uses cutting-edge technology to provide ample assistance for medication administration and healthcare accessibility, is made. The Blind Assistive System is a pioneering creation in attempts to improve blind individuals' access to healthcare, especially in the critical field of medicine administration. This paper highlights the noteworthy progress made by this system and emphasizes how crucial it is for facilitating patient-provider communication. The main objective is to describe the significant advancements and emphasize how the Blind Assistive System has revolutionized how the visually impaired community manages their medications. The system's innovative features are crucial in bringing doctors and patients together in a collaborative healthcare environment. Process simplification not only gives visually impaired individuals a self-sufficient and accessible way to manage their drugs, but it also makes it easier for healthcare professionals to write prescriptions. This convergence raises the bar for healthcare experiences, improves communication, and elevates the standard for healthcare as a whole. The technology provides patients with an easy-to-use platform that enables them to independently control their prescription regimen. Regardless of visual impairments, it allows for the scanning of prescriptions, precise medication identification, and access to extensive medication information, all of which contribute to improved autonomy and efficient health management. Healthcare professionals can view the system as an effective tool for writing prescriptions since it incorporates a primary disease prediction model, an ML-based system, and a drug name autocomplete feature to ease up the procedure. It also facilitates appointment scheduling and has an emergency calling feature for quick patient help, thereby improving workflow and patient communication. VISMED transcends its role as a mere application, as it becomes a force for change that closes the healthcare gap between clinicians and patients. It makes healthcare more inclusive and patient-centred by promoting smooth collaboration and communication, which improves health outcomes and everyone's quality of life.

2. LITERATURE REVIEW
Jiaji Wang , Shuihua Wang, and Yudong Zhang [1] in their paper "Artificial Intelligence for the visually impaired" published in February 2023 discussed that the application of digital technologies and deep learning algorithms has significantly enhanced the quality of life for individuals with visual impairments.

Tariq S Almurayziq, Gharbi Khamis Alshammari, Abdullah Alshammari , Mohammad Alsaffar and Saud Aljaloud [2] in the paper ‘Evaluating AI Techniques for Blind Students Using Voice-Activated Personal Assistants’ published on January 2022 aimed to develop an AI-based model to assist blind students with their academic registration needs. The model allowed blind students to easily submit academic service requests and tasks.

D.Dhinakaran, D.Selvaraj, S.M.Udhaya Shankar, S.Pavitrah and R.Bhoomika [3] in their paper published on 2022 titled as "Assistive System for the blind with Voice Output Based on Optical Character" discussed that modern technological innovations are focused on enhancing the autonomy of individuals with disabilities. Although the braille system has proven effective, it can be a lengthy process. In response to this challenge, the researchers have created a groundbreaking interactive reading device that utilizes optical character recognition (OCR) technology.

Muhammad Farid Zamir, Khan Bahadar Khan, Shafquat Ahmmad Khan, and Eid Rehman in their paper " Smart reader for visually impaired people based on optical character recognition" [4] discussed about the development of a system based on Raspberry Pi that converts text into voice signals, aiding visually impaired people. Optical Character Recognition (OCR) is used to detect printed text through a camera, converting it into machine-encoded text. This smart real-time device serves as an image-to-audio converter, enhancing accessibility for the visually impaired.

Stacy M. Branham, and Antony Rishin Mukkath Roy [5] in their paper "Reading Between the Guidelines: How Commercial Voice Assistant Guidelines Hinder Accessibility for Blind Users" Published in 2019 discussed about Voice-Activated Personal Assistants (VAPAs)— like Apple Siri and Amazon Alexa. They have rapidly become common features on mobile devices and in the homes of millions of people around the world. They have demonstrated significant benefits, especially for individuals with sight-related challenges, enhancing their daily experiences and independence.

Rinkal Keniya, Aman Khakharia, Vruddhi Shah, Vrushabh Gada, Ruchi Manjalkar, Tirth Thaker, Mahesh Warang, and Ninad Mehendale discussed how the timely and precise evaluation of any health-related concern is crucial for the prevention and management of the condition in their paper "Disease prediction from various symptoms using machine learning"[6] They proposed that the conventional diagnostic approaches might not suffice in the case of a severe ailment. Implementing a medical diagnosis system powered by machine learning (ML) algorithms for predicting diseases which can facilitate a more accurate diagnosis compared to the traditional methods.

In the paper "Sensor-Based Assistive Devices for Visually-Impaired People: Current Status, Challenges, and Future Directions" [7] by Wafa Elmannai and Khaled Elleithyi on 2017 discuss in detail the most significant devices that are presented in the literature to assist this population and highlights the improvements, advantages, disadvantages, and accuracy. Researchers aim to address and present most of the issues of these systems to pave the way for other researchers to design devices that ensure safety and independent mobility to visually-impaired people.

" Design of a Mobile Face Recognition System for Visually Impaired Person"[8] by Shonal Chaudhry and Rohitash Chandra in 2015 present the design and implementation of a face detection and recognition system for the visually impaired through the use of mobile computing. This mobile system is assisted by a server-based support system. The system was tested on a custom video database. Experiment results show high face detection accuracy and promising face recognition accuracy in suitable conditions.

Ashwani Kumar , Ankush Chourasia published a paper "Blind Navigation System Using Artificial Intelligence" [9] where they focus on the field of assistive devices for visual impairment people. It converts the visual data by image and video processing into an alternate rendering modality that will be appropriate for a blind user.

3. METHODOLOGY

The proposed methodology for developing this inclusive and comprehensive healthcare management system begins with the creation of a mobile application featuring an intuitive, user-friendly interface. This interface incorporates a dual-profile selection mechanism, catering to both patients and caregivers, ensuring tailored experiences for each user type. For patients, the system leverages advanced Optical Character Recognition (OCR) technology, specifically using Google's ML Kit, enabling the scanning of prescriptions and medication labels. This feature is augmented with voice feedback, enhancing accessibility for visually impaired users. An integrated appointment booking system allows patients to schedule consultations with their preferred healthcare providers, streamlining access to medical care. Additionally, a rapid-response feature enables patients to initiate immediate contact with their designated caregiver in case of emergencies. For healthcare providers, the system implements an advanced prescription writing interface with intelligent autocomplete functionality, enhancing efficiency and reducing errors in medication prescribing. A sophisticated disease prediction system is developed using machine learning techniques, utilizing an open-source dataset containing disease-symptom correlations. Multiple ML models, including Random Forest, Decision Tree, Naive Bayes, and K-Nearest Neighbor, are trained and evaluated, with the Random Forest algorithm ultimately selected due to its superior accuracy in disease prediction.

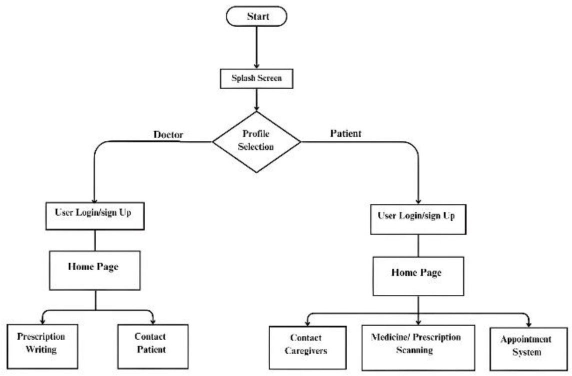

Fig 1: Basic Flowchart of the Application

3.1 Mobile Application Development

React Native was instrumental in developing this cross-platform healthcare management system, enabling the creation of a single codebase for both iOS and Android devices. The application leverages React Native's component-based architecture and declarative programming paradigm to design complex, intuitive user interfaces for presenting medical information and interactive features. Native modules are utilized for implementing critical functionalities such as prescription scanning via camera integration and text-to-speech for voice feedback, ensuring optimal performance and seamless device integration. The app's navigation is implemented using React Navigation, facilitating smooth transitions between key interfaces like the home screen, prescription scanning, appointment booking, and the doctor's prescription writing module. This approach streamlined development, maintained cross-platform consistency and delivered a robust, user-friendly application serving both patients and healthcare providers efficiently.

3.2 Optical Character Recognition

Google ML Kit's Optical Character Recognition (OCR) technology is integral to the system's prescription and medication scanning functionality, enhancing accessibility for visually impaired users. The process initiates when a user captures an image of a prescription or medication label. The ML Kit's OCR engine then analyzes the image, detecting and isolating text regions, segmenting them into individual characters or words, and applying machine learning models to accurately transcribe the text. This technology efficiently recognizes and extracts both printed and handwritten text from various document types. The system integrates text-to-speech functionality, converting the extracted and processed information into audible speech. This feature allows visually impaired users to hear the contents of their prescriptions or medication labels, providing crucial medical information in an accessible format. The OCR implementation significantly improves medication management and overall user experience by bridging the gap between written medical information and user comprehension.

3.3 Prescription Autocomplete

The prescription autocomplete feature in this healthcare management system is a sophisticated tool designed to enhance the efficiency and accuracy of prescription writing for healthcare providers. The system utilizes a comprehensive database of medications, including generic and brand names. As the healthcare provider begins typing a medication name, the autocomplete function activates, offering real-time suggestions based on the input. The autocomplete algorithm employs predictive text techniques, analyzing the characters entered and matching them against the medication database.

3.4 Disease Prediction

This disease prediction system employs supervised learning, leveraging its efficacy with labeled data, particularly in binary classifications where symptom presence and absence are denoted as 1 and 0, respectively. This methodology is preferred for its ability to learn from historical patient data and make accurate predictions. The selection of supervised learning over unsupervised and reinforcement learning is predicated on its suitability for tasks with specific outcome predictions based on known input-output pairs. Supervised learning is particularly advantageous in this context due to the availability of a comprehensive dataset of symptoms and corresponding diagnoses, allowing the model to learn direct mappings between clinical presentations and diseases. Unsupervised learning, while useful for pattern discovery, cannot make specific disease predictions, which is crucial in a clinical decision support system. Reinforcement learning typically applied in dynamic, interactive environments, is ill-suited for the static nature of medical diagnostic data. Moreover, supervised learning aligns with the traditional medical approach of learning from past cases, making it more interpretable and trustworthy for healthcare professionals. The chosen models—Naive Bayes, Decision Tree, Random Forest, and K-Nearest Neighbors (KNN)—were selected for their distinct advantages: Naive Bayes for its parsimony and effectiveness with smaller datasets assuming feature independence; Decision Tree for its high interpretability; KNN for its intuitive, non-parametric approach based on proximity of training examples; and Random Forest for its ensemble learning capabilities. These were favored over alternatives like Logistic Regression, Support Vector Machines (SVMs), Neural Networks, and Gradient Boosting Machines due to various factors including computational efficiency and model complexity. Random Forest, which demonstrated superior accuracy, utilizes bootstrap aggregating (bagging) and random feature selection at each node, employing metrics such as Gini impurity or information gain. This approach reduces inter-tree correlation and enhances generalization capability. The final diagnosis is determined through majority voting among constituent trees, effectively leveraging the collective intelligence of multiple decision trees trained on diverse data subsets and features. This makes Random Forest particularly adept at handling the intricate complexities inherent in symptom-disease relationships, thereby emerging as the optimal choice for this sophisticated healthcare management system.

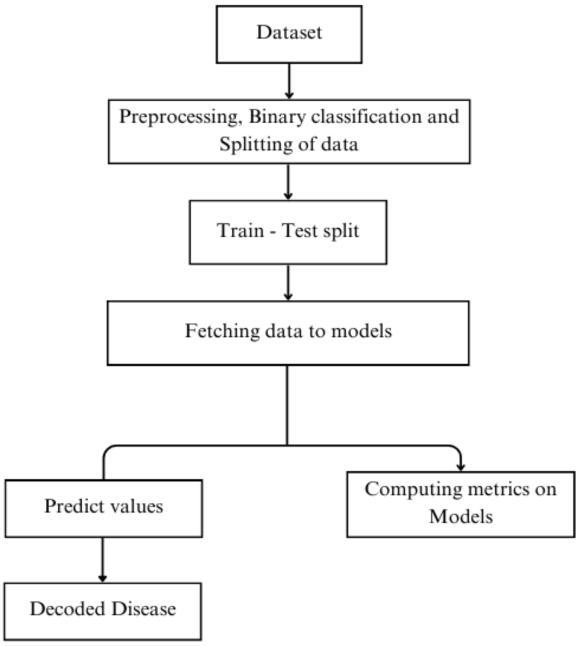

Fig 2: Steps followed in the disease-predicting system

Table 1: Accuracy comparison of different classifiers

MODEL	ACCURACY(in %)
Decision Tree	**95.1**
Random Forest	**97**
Naïve Bayes	**93**
K-Nearest Neighbors	**96.4**

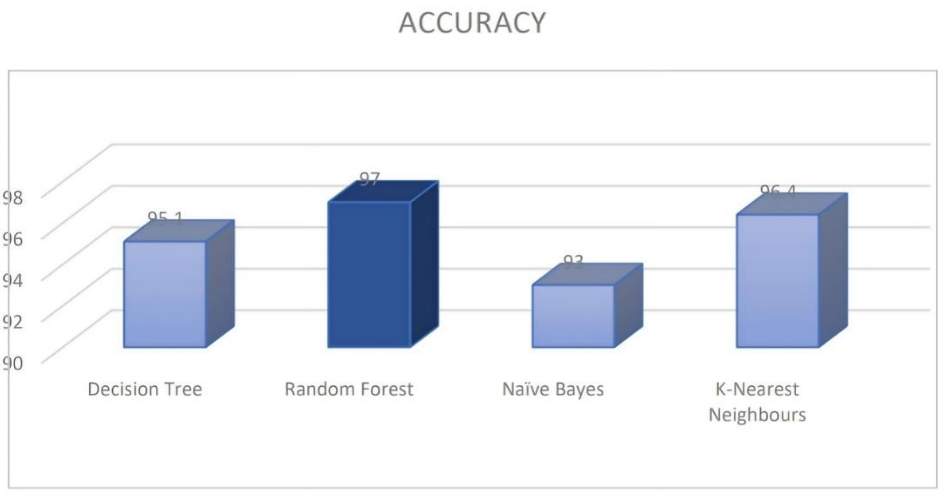

Fig 3 : Bar diagram on accuracy comparison of different classifiers

4. CONCLUSION

In conclusion, this innovative healthcare management system marks a significant advancement in medical technology integration. By combining React Native for cross-platform development, Google ML Kit's OCR for prescription scanning, and a Random Forest algorithm for disease prediction, it offers a comprehensive solution to various healthcare challenges. The system enhances accessibility through features like voice-enabled prescription scanning and streamlines healthcare provider workflows with intelligent prescription writing tools. The machine learning-based disease prediction component demonstrates the potential of data-driven approaches in supporting medical diagnosis. While promising, the system should be viewed as a supportive tool rather than a replacement for professional medical judgment. This healthcare management system represents a crucial step towards digitizing and optimizing healthcare processes, with the potential to improve patient outcomes and healthcare delivery efficiency. Its success will depend on continuous evaluation, refinement, and adherence to medical ethics and data privacy standards.

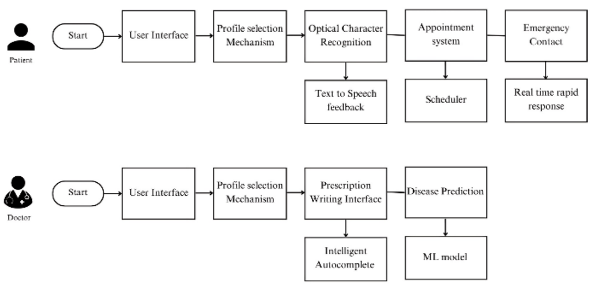

Fig 4: Technical Workflow

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