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Smart Voice Based Medical Chatbot for Disease Prediction

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Abstract - The global shortage of medical resources has intensified in recent years, exacerbated by a growing and aging population, particularly following the pandemic. However, advancements in robotics and artificial intelligence have empowered healthcare professionals to address these challenges. Intelligent Speech Technology (IST) is one such innovation that has helped doctors and patients enhance medical efficiency and reduce cumbersome tasks. Despite this, complex hospital environments with background noise and variations in patient pronunciation have limited IST's broader application. Yet, as machine learning technologies rapidly advance intelligent speech recognition capabilities, these obstacles are expected to be overcome in the near future. This project focuses on the concept of an AI-based voice-assisted chatbot for medical disease prediction. Deployed on a Raspberry Pi as a standalone hardware device, it utilizes natural language processing (NLP) and machine learning (ML) techniques to detect diseases by interacting with users through a series of questions. A groundbreaking innovation, the Speech-Assisted Chatbot for Medical Infectious Disease Prediction, promises to transform healthcare delivery. By leveraging AI-driven algorithms and natural language processing, it facilitates quick diagnosis and prescription generation through spoken interactions with patients. This simplifies and accelerates procedures, reduces error risks, improves patient care standards, saves valuable time for healthcare professionals, and enhances service availability, all contributing to better outcomes and more efficient healthcare processes..

***Key Words*:** chatbot, NLP, Machine learning, Medical diagnosis, Speech, Artificial Intelligence etc.

1.INTRODUCTION

As living standards and medical technology improve, the average human lifespan continues to increase. This has led to a significant rise in the elderly population worldwide, with projections suggesting that by 2050, 22% of the global population will be aged 60 or older. The growing number of elderly individuals presents major challenges for healthcare systems, including escalating costs and resource shortages. Additionally, this aging phenomenon amplifies existing disparities in medical care due to unequal resource distribution both domestically and globally. Underdeveloped regions often lack access to advanced medical equipment, making effective patient treatment difficult. Furthermore, certain diseases may go undetected until they have significantly progressed, leading to delays in treatment. In summary, while improved living conditions and medical technology have led to longer lifespans, they have also created several healthcare challenges, such as increased costs, limited resources, and inadequate infrastructure. These issues are compounded by unequal access to healthcare, making early intervention difficult and contributing to more complex medical challenges as diseases progress.

The advancement of robotics and AI technologies enables machines to diagnose diseases more efficiently and accurately, thereby alleviating the strain on healthcare resources. Additionally, robots may take over some of the duties traditionally performed by nurses, such as assisting patients with daily routines. For instance, intelligent image processing techniques based on deep learning are being used to diagnose various conditions, including COVID-19 detection, paralysis assessment, and autism screening by analyzing X-ray images or facial features. Language recognition technology is also becoming increasingly important in smart hospitals, as it facilitates natural communication between doctors and patients while providing valuable information such as patient identity, age range, emotional status, and symptoms related to the condition being treated.

Cutting-edge technology is driving progress in healthcare, with significant potential to revolutionize medical disease prediction and prescription processes. One such advancement is the Speech-Assisted chatbot, an AI-powered system that allows patients to engage in natural conversations for accurate diagnoses and prescriptions. This innovation promises to enhance accessibility and precision in healthcare while reducing the burden on medical professionals. This project proposes the development of a speech-assisted chatbot system using NLP and AI technology, specifically designed for accurate disease prediction and comprehensive prescription solutions, aiming to improve the future of medical care delivery.

2. LITERATURE REVIEW

Before starting the project, a comprehensive review of the existing literature related to the subject matter was essential. Numerous studies and research papers were meticulously examined to gain a deep understanding of the topic, with this chapter highlighting several key references.

In the field of medical robotics, several research papers were reviewed, which significantly influenced the design of the intelligent medical assistant robot. Marcin Zukowski et al. [1] developed a humanoid medical assistant and companion specifically designed for children's hospitals. Their work focused on equipping the robot with the ability to express emotions and interact with children through facial recognition, using pictures and text displayed on its chest to tell stories and show educational videos. This 'Bobot' robot autonomously navigates hospital rooms, performing basic medical tests such as measuring body temperature and heart rate while streaming live video feeds to medical staff. The robot operates on ODROID XU and XU4 with an Ubuntu 14.04 operating system, supported by a Raspberry Pi 2 computer dedicated to animating the robot's eyes.

Additionally, Marcin Zukowski et al. [2] presented a method for measuring patients' temperatures using a medical robotic assistant. Their experiments with the MLX90614 infrared thermometer and FLIR Lepton thermal camera revealed limitations when using the thermometer as the sole input source. They concluded that for accurate results, the robot would need to be within 0.3 meters of a patient's face. To overcome this, they developed a hybrid system combining the infrared thermometer and thermal camera, providing both ambient temperature and approximate skin temperature, which are crucial for detecting the presence of a person in front of the robot.

Moreover, Kaveh Bakhtiyari, Nils Beckmann, and Jürgen Ziegler [3] proposed a non-invasive, contactless method for measuring Heart Rate Variability (HRV) with Respiratory Sinus Arrhythmia (RSA) correction. Their approach integrated infrared and RGB cameras to measure the heart rate signal, while a 3D depth sensor captured the respiratory signal to correct the calculated HRV with RSA. They conducted a correlation analysis using various methods and devices to determine the most accurate HRV calculation method based on specific accuracy requirements and applications. Contactless HRV sensors show significant promise for preliminary health assessments.

Sachit Mahajan and Prof. Vidhyapathi C.M [4] developed a medical assistant robot designed to assist patients by carrying necessary medical equipment. Their person-following robot assistant utilizes a Pixy image recognition sensor for person detection and an ultrasonic sensor for obstacle avoidance.

Furthermore, Azeta Joseph et al. [5] provided a comprehensive overview of the current and potential applications of humanoid robotics in healthcare settings. Their paper outlined the essential features required in humanoid robots for healthcare roles, including vision systems, sensing capabilities, mobile platforms, and the ability to perform complex manipulation tasks. The exploration also covered similar human assistant robots fulfilling various roles in hospitals [6-10]

.3. METHODOLOGY

The The software development for the Speech-Assisted Chatbot for Medical Prescription and Infectious Disease Diagnosis involves several key stages. The process begins with data collection and preprocessing, where a comprehensive dataset of medical cases is gathered, cleaned, and formatted to ensure consistency and compliance with privacy regulations. The data is then used to train machine learning and AI models, which are designed to recognize patterns in medical data for accurate diagnosis and prescription recommendations. This involves implementing speech recognition technology and natural language processing (NLP) algorithms to enable the chatbot to understand and respond to spoken queries effectively. The NLP system is further refined to handle medical jargon and maintain the context of conversations, ensuring a seamless interaction between users and the chatbot.

Following the development of machine learning models and NLP systems, extensive testing is conducted to ensure the accuracy, reliability, and usability of the chatbot. This includes unit testing of individual software components, integration testing to verify the interaction between modules, and user acceptance testing to gather feedback from healthcare professionals and patients. The final step involves deploying the system on a Raspberry Pi or similar hardware, with a focus on optimizing performance, maintaining compliance with healthcare regulations, and implementing security measures to protect user data. Post-deployment, the system is continuously monitored and updated to improve functionality and adapt to new data and user feedback, ensuring the chatbot remains effective and relevant in a real-world healthcare setting.

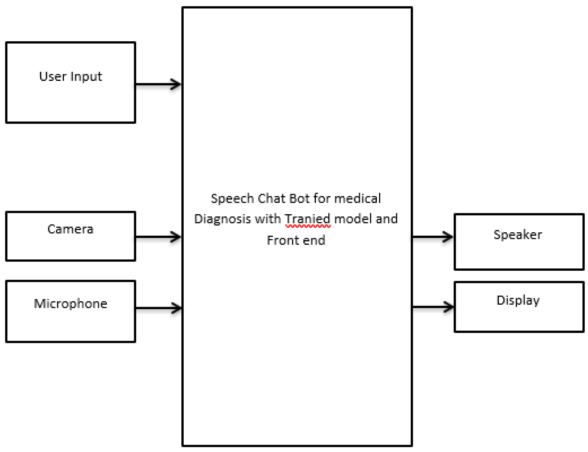

Fig -1 Architecture Diagram of the System

The figure above illustrates the working principle of the chatbot for infectious disease detection. This project involves the development of an interactive chatbot that leverages Artificial Intelligence for intelligent, speech-based illness diagnosis and medical prescription generation. The software component of the project centers on a speech processing system that interacts with patients, identifying them and engaging in natural language conversations. Natural Language Processing (NLP) techniques are employed to initiate and maintain a conversational model, enabling the chatbot to understand the patient's health concerns and diagnose the illness accurately.

The chatbot conducts a series of question-and-answer exchanges with the patient, utilizing trained machine learning models and NLP algorithms to diagnose the illness and generate an appropriate medical prescription. To ensure the safety and authenticity of the prescription, the system includes an IoT-based panel for consulting doctors, allowing them to review and verify the generated prescription before it is provided to the patient. This software-driven approach aims to

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streamline the diagnostic process while ensuring accurate and reliable medical care.

4. SYSTEM DESIGN

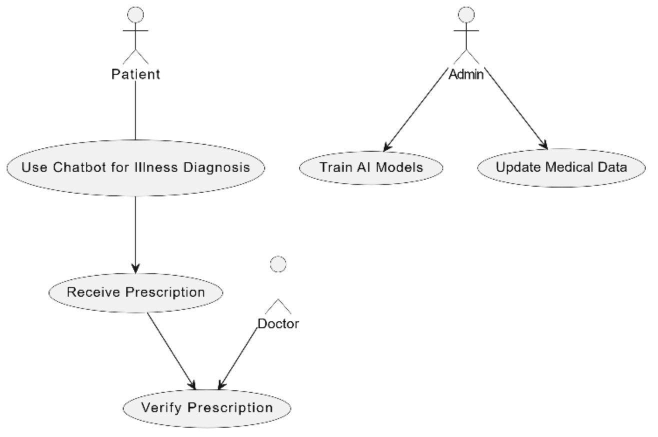

Fig -2:System Use Case

The use case diagram illustrates the interactions between the key actors—Patient, Doctor, and Admin—with the chatbot system designed for illness diagnosis and medical prescription. The Patient engages with the chatbot to diagnose their illness, following which they receive a prescription generated by the system. The Doctor is responsible for verifying the prescription to ensure its accuracy and authenticity before it is provided to the Patient. Meanwhile, the Admin oversees the training of AI models and the updating of medical data, ensuring that the system remains accurate and up-to-date for ongoing use. This diagram encapsulates the workflow and roles within the AI-driven chatbot system for healthcare..

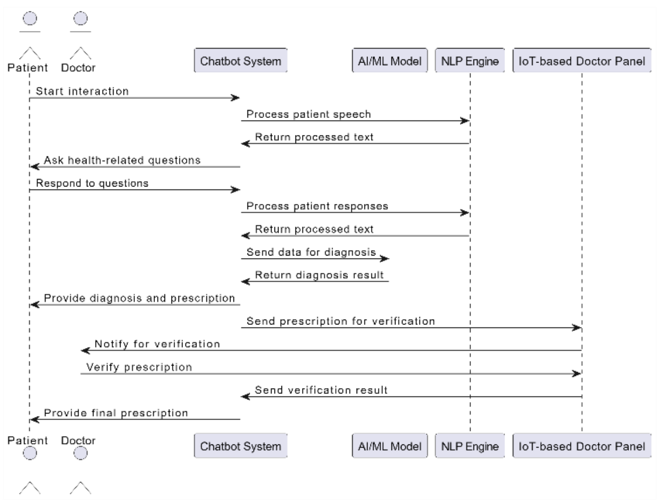

Fig -3:Sequence Diagram

This sequence diagram shows the interaction flow between the Patient, Chatbot System, NLP Engine, AI/ML Model, and the IoT-based Doctor Panel. The Patient interacts with the chatbot, which processes the patient's speech and queries using the NLP Engine. The AI/ML Model provides a diagnosis based on the patient's input. The chatbot then generates a prescription, which is sent to the Doctor for verification via the IoT-based panel. Once verified, the final prescription is provided to the Patient.

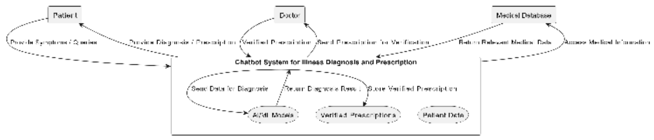

Fig -4: Data Flow diagram

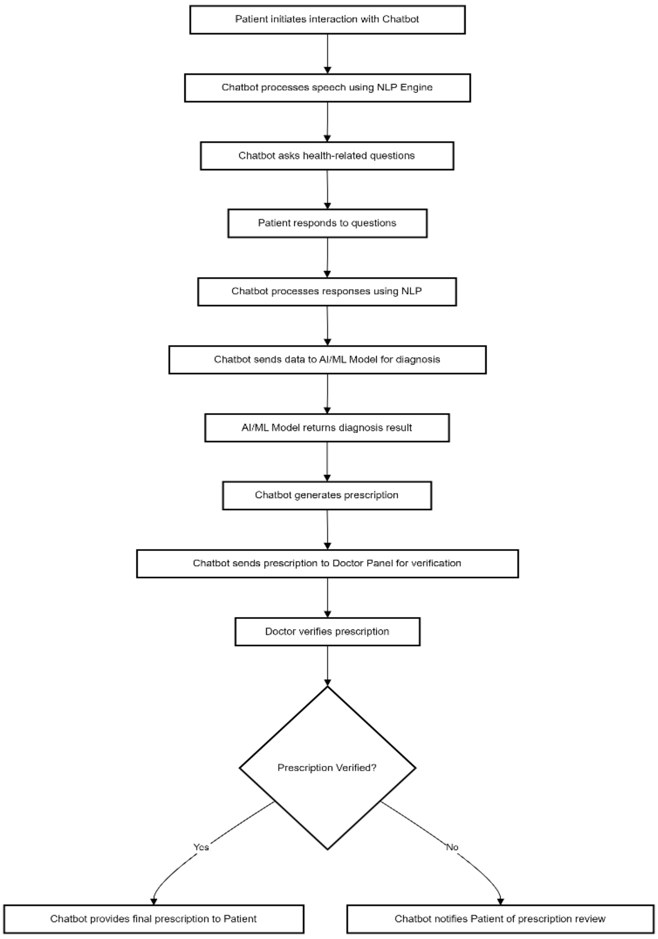

Fig -5:Process Flow Diagram

The process flow diagram shown in figure 5 illustrates the sequence of interactions within the chatbot system for medical diagnosis and prescription. It begins with the patient initiating interaction, followed by the chatbot processing the patient's speech using NLP (Natural Language Processing) and asking health-related questions. The patient's responses are processed, and the chatbot sends this data to an AI/ML model for diagnosis. Based on the diagnosis, the chatbot generates a prescription, which is then sent to a doctor for verification via a doctor panel. The flow branches at a decision point where, if the prescription is verified, the chatbot provides the final prescription to the patient; otherwise, the patient is notified that the prescription requires further review. This diagram effectively captures the key steps and decision points in the system's operation.

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5. RESULTS AND DISCUSSION

The model training was performed using the collected dataset after filtering and preprocessing. The Distribution of disease data in the collected dataset is shown using a heat map in the figure

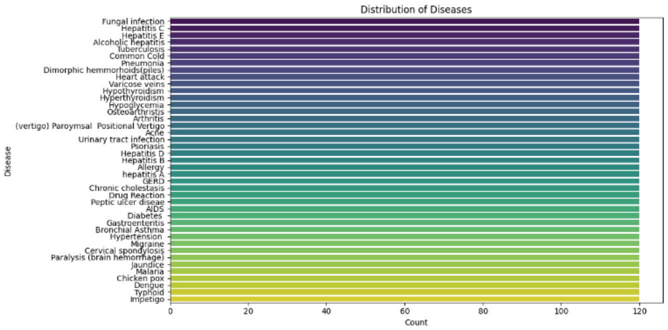
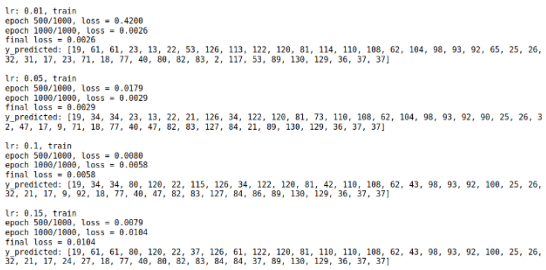


Fig -6. Distribution of the Diseases

The training on the above said dataset is done for 1000 epochs and the training procedure logs are plotted to the terminal. The image below shows the training Logs for 1000 epochs:



```
lr: 0.01, train
epoch 500/1000, loss = 0.4200
epoch 1000/1000, loss = 0.0026
final loss = 0.0026
y_predicted: [19, 61, 61, 23, 13, 22, 53, 126, 113, 122, 120, 81, 114, 110, 108, 62, 104, 98, 93, 92, 65, 25, 26,
32, 31, 17, 23, 71, 18, 77, 40, 80, 82, 83, 2, 117, 53, 89, 130, 129, 36, 37, 37]

lr: 0.05, train
epoch 500/1000, loss = 0.0179
epoch 1000/1000, loss = 0.0029
final loss = 0.0029
y_predicted: [19, 34, 34, 23, 13, 22, 21, 126, 34, 122, 120, 81, 73, 110, 108, 62, 104, 98, 93, 92, 90, 25, 26, 3
2, 47, 17, 9, 71, 18, 77, 40, 47, 82, 83, 127, 84, 21, 89, 130, 129, 36, 37, 37]

lr: 0.1, train
epoch 500/1000, loss = 0.0080
epoch 1000/1000, loss = 0.0058
final loss = 0.0058
y_predicted: [19, 34, 34, 80, 120, 22, 115, 126, 34, 122, 120, 81, 42, 110, 108, 62, 43, 98, 93, 92, 100, 25, 26,
32, 21, 17, 9, 92, 18, 77, 40, 47, 82, 83, 127, 84, 86, 89, 130, 129, 36, 37, 37]

lr: 0.15, train
epoch 500/1000, loss = 0.0079
epoch 1000/1000, loss = 0.0104
final loss = 0.0104
y_predicted: [19, 61, 61, 80, 120, 22, 37, 126, 61, 122, 120, 81, 110, 110, 108, 62, 43, 98, 93, 92, 100, 25, 26,
32, 21, 17, 24, 27, 18, 77, 40, 80, 82, 83, 84, 84, 37, 89, 130, 129, 36, 37, 37]
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Fig -7. Training Of model

Post training the graph is plotted for train and test errors for different learning rates.

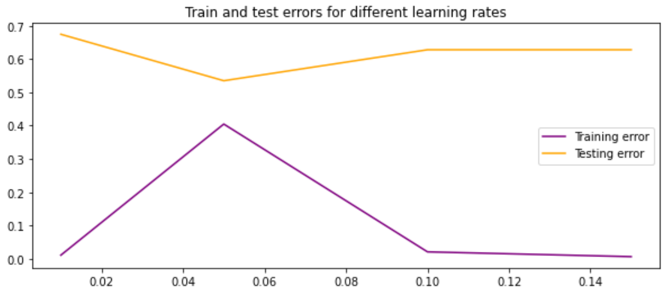

Fig -8. Train vs Test Errors

The Confusion matrix is plotted based on the results of evaluation as shown below.

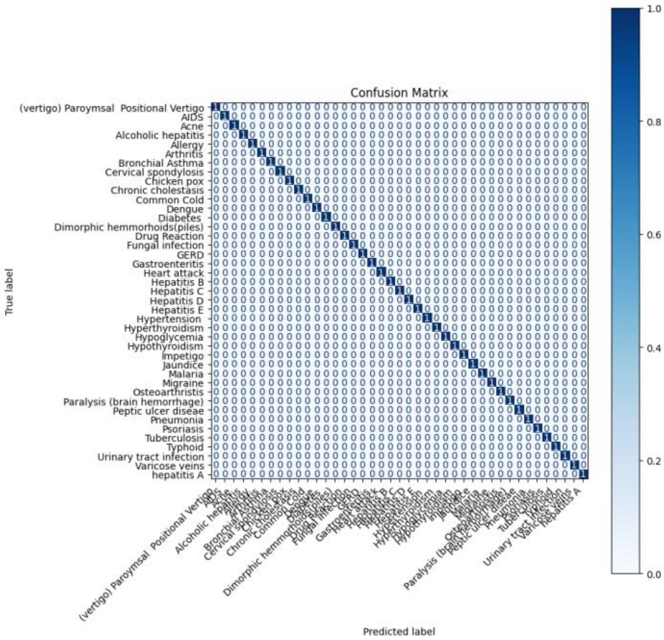

Fig -9. Confusion Matrix

Finally the deployed model in the form of software application I as shown below. The app consists of a window to interact with the users via speech and then respond to their queries using Trained chat bot capable of handling medical queries.

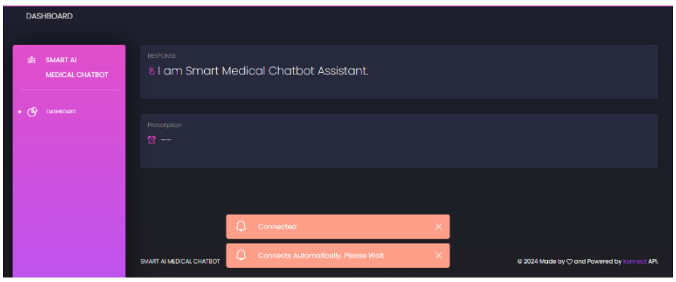

Fig -8. App Window

6. CONCLUSIONS

In conclusion, the development of a Speech-Assisted Chatbot for Medical Prescription and Infectious Disease Diagnosis represents a significant advancement in healthcare technology. By integrating Natural Language Processing, machine learning, and AI, the chatbot offers an efficient, accessible, and reliable method for diagnosing illnesses and providing medical prescriptions. The system's ability to interact naturally with patients, process complex medical data, and ensure the accuracy of prescriptions through verification by healthcare professionals underscores its potential to alleviate strain on medical resources, enhance patient care, and improve the overall efficiency of healthcare delivery. This innovation not only streamlines diagnostic processes but also ensures that patients receive timely and accurate medical advice, marking a promising step towards the future of healthcare.

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