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Medical Chatbot using NLP

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***Abstract*— Natural language processing has enabled the development of intelligent medical chatbots, which fundamentally altered the healthcare industry. These chatbots enhance patient engagement, expand healthcare accessibility, and enable efficient communication between patients and medical personnel. They simplify the healthcare process by answering medical inquiries, providing health information, scheduling appointments, and reminding patients when to take their medications. The medical chatbot uses natural language processing to understand text and generate human-like responses. This research tries to foster a state-of-the-art conversational computer-based intelligence framework, to encourage consistent correspondence among patients and clinical experts with the end goal of illness prediction. With effective communication, this intelligent chatbot will assist doctors and patients by asking people to describe their symptoms and assisting medical professionals in making diagnoses and treatment recommendations. With the help of natural language processing and medical data analysis, this product will function as a virtual collaborator in medical care by improving patient outcomes through rapid and accurate disease forecasts, speeding up the diagnosis process, and improving accessibility to healthcare.**

***Index Terms*—Disease prediction, NLP, conversational AI and patient-doctor interaction.**

I. Introduction

A novel endeavor in healthcare is creating a conversational system using natural language processing in collaboration with physicians, patients, and a chatbot. This novel approach responds to the pressing need to transform disease prediction, patient-doctor communication, and access to medical knowledge. Traditional healthcare systems in the modern world are frequently beset by issues like remote access, lengthy wait periods, and inefficiency in quickly detecting medical ailments. Meanwhile, online health platforms may offer information but lack the personalized guidance required for accurate assessments. Patients can convey their symptoms and medical history to the chatbot, which will, in turn, communicate with doctors to enhance disease prediction and diagnosis. This system will empower individuals to seek medical advice, transcending geographical barriers, and ensuring quick, precise responses. By creating an accessible, efficient, and AI-driven healthcare solution, this paper aims to redefine healthcare, making it more convenient, accurate, and readily available for everyone, thus improving overall well-being and healthcare outcomes.

II. Related Work

In 2019 Pereira J, Díaz Ó. [1] proposed a chatbot in mental health that provides enhancements and advancements of the technology in low-income countries.

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Covid-19 has raised many mental health issues which increased stress, anxiety, and depression. Chatbots are created for the benefit of self-adherence and psychoeducation. Existing chatbots like MYLO and WoeBot have been used to improve depression prevention and management which uses strategies like Perceptual Control Theory and Cognitive Behaviour Therapy. Most of the studies focus on the prevention of mental health. A thematic analysis is needed to evaluate the existing chatbots. In 2019 Bendig, Eileen, et. al., [2] concentrated on the internal workings of the chatbot, which comprises information from the conversion of messages from NLP. NLP translated the input language into the chatbot's understandable language. This will make it easier to comprehend the suitable reactions that the chatbot provides based on the stored scripts. The response will be made available to the individual via an interface such as an application.

In 2019 Vaidyam AN, et.al., [3] proposed chatbots for monitoring mental health. Chatbots are defined as digital tools that help perform tasks as human beings by providing a framework that can have conversations. chatbots are sometimes called conversational agents where they talk and interact like humans which helps to relieve their stress or mental health. This paper explores the potential of conversational agents for diagnosing and identifying mental health problems. This paper concludes that chatbots can help to build conversations, and psychoeducation and provide an interactive tool.

In 2020 Safi Z, et.al., [4] demonstrated specific technical aspects of developing medical chatbots. This review helped specialists and experts make decisions about the applications. Certain limitations may have prevented some chatbots from being included in book chapters, workshop proceedings, conference abstracts, and other research venues only. Rather than focusing on the methods that affect patients, this focused on the development of the chatbot. In 2020 Abd-Alrazaq AA, et.al., [5] discussed the development and usage of chatbots to address mental health issues. Only security and effectiveness are taken care of by ignoring the comprehensive analysis during the extensive research. It lacks to provide significant evidence and provides inconsistent results.

In 2020 Almalki, M., & Azeez, F [6] proposed a health chatbot for fighting the COVID-19 epidemic by having the ability to combat the pandemic. The authors used existing applications, emerging technologies, issues, and features that help research chatbots in the healthcare domain to address the issue and provide suggestions for continuous improvement. Mental health is a concern in today's world. There is still a problem with accessing the services and treatment. There are many cases in today's world that cause the death of people. In 2021 Vaidyam AN et. Al., [7] focused on the current use of health chatbots, which focus on treating illness. Several articles analyzed from 2014-2018 revealed the facts that affect human competency for chatbots. The primary areas like nutritional and neurological disorders are addressed. This paper doesn't review sociological implications. In 2021, Min-Hua Chao, et. al., [8] aimed to review the emerging technologies of the chatbot like NLP which provides a framework for effective patient management. It starts with ontology construction and a patent management map. Several text mining techniques, such as K-means, and LDA are used to reduce human interference.

In 2022, Tham YC, et.al, [9] proposed a study to analyze conversational agents like text-based and voice-based for patients who are suffering from anxiety, depression, bipolar disorder, and schizophrenia spectrum. Though the disease's popularity has been raised, some unanswered questions remain. Research on this focused on understating the issues of conversational agents. In 2022 Ogilvie L, et. al., [10] analyzed how chatbots are being utilized to help people who are suffering from SUD which mainly focuses on related to drugs. Irrespective of the chatbots which focus on nicotine or gambling. This study aims to understand how the technology of the chatbots helped the individual to get rid of the consequences of SUD such as physical withdrawal, impaired judgment, and behaviour.

In 2023 Ahmed A., and Hassan A., [11] identified 42 research studies that were conducted on chatbots that are related to depression and anxiety with the purpose of diagnosis, mental therapy, and education. This paper supports the patients' outcomes, but there is a lack of understanding and transparency. The role of chatbots is expected to increase following the COVID-19 pandemic. They offer a promising future. In 2023 Haque M, Rubya [12] examines the use of chatbots in chronic diseases like diabetes, hypertension, asthma, and mental health. This study reviews twenty relevant studies that can improve medical adherence, reduce heart rate, and enhance the system. The study also aims to examine the potential applications of chatbots in areas like unprivileged communities with limited access. This study underestimated the impact on healthcare chatbots. Further research is needed to evaluate the long-term issues surrounding the healthcare chatbot.

In 2023 Jahirul Islam, et. al., [13] proposed a mobile application that is helpful for eyecare by helping patients to manage their health effectively and successfully. This paper reviewed the storage of treatment plans and patient data records for the medical field. Patients who are suffering from eye disorders can monitor their progress. This will send interactive reminders to patients. In 2023 Aggarwal A, et. al.,[14] showed that AI chatbots have high efficacy in providing people by giving them healthy lifestyles, smoking cessation, treatment, and substance

misuse. To implement behaviour change theories expert consultation was used to monitor and on-demand support. These AI chatbots will offer non-judgmental, communication, and scalability but the result should be cautiously interpreted due to internal risks.

In 2023 Bays, H. E., et.al., [15] developed chatbots that are useful for obesity medicine by providing people with clinical and scientific information. This model can facilitate programming and analyzing advanced techniques like enhanced education and assist in telemedicine. AI helps to detect patterns by enabling the assessment of value-based delivery. This drawback has been taken care of by providing effective communication with the chatbots which provides the individuals with self-disclosure and support for the individuals to cope with mental health. Chatbots can also help individuals to educate themselves regarding mental health issues.

The current system relies on in-person consultations and diagnoses, which causes delays and prevents patients from seeking a diagnosis. These applications and systems rely on the information at their disposal, they frequently lack precise and tailored guidance, which causes the information to be misguided and produce incorrect output, which results in incorrect self-diagnosis.

- Limited Understanding: Chatbots may find it difficult to grasp inquiries subtle or sophisticated, causing miscommunication and inaccurate replies.
- Data Privacy Concerns: If sensitive medical data is not sufficiently safeguarded, handling it may present serious privacy hazards.
- Dependency on Technology: Relying too much on artificial intelligence (AI) could lessen the importance of humans in healthcare decision-making and weaken the patient-physician bond.
- Accuracy Issues: If models aren't always able to predict diseases with enough accuracy, it could impact people's health.
- Lack of Emotional Intelligence: Patients' trust and happiness in healthcare encounters may suffer if chatbots lack empathy.

III. Proposed Model

The envisioned conversational AI system revolutionized healthcare interactions. In real-time, dynamic communication between patients and healthcare providers is made easier by this technology. With an easy-to-use chatbot interface, patients can describe their symptoms and medical history, and clinicians can provide knowledgeable advice. The system will prioritize accessibility, accuracy, and timely healthcare delivery, redefining the approach to medical consultations and enhancing overall patient care. Figure 1. Shows the functionalities of the proposed model.

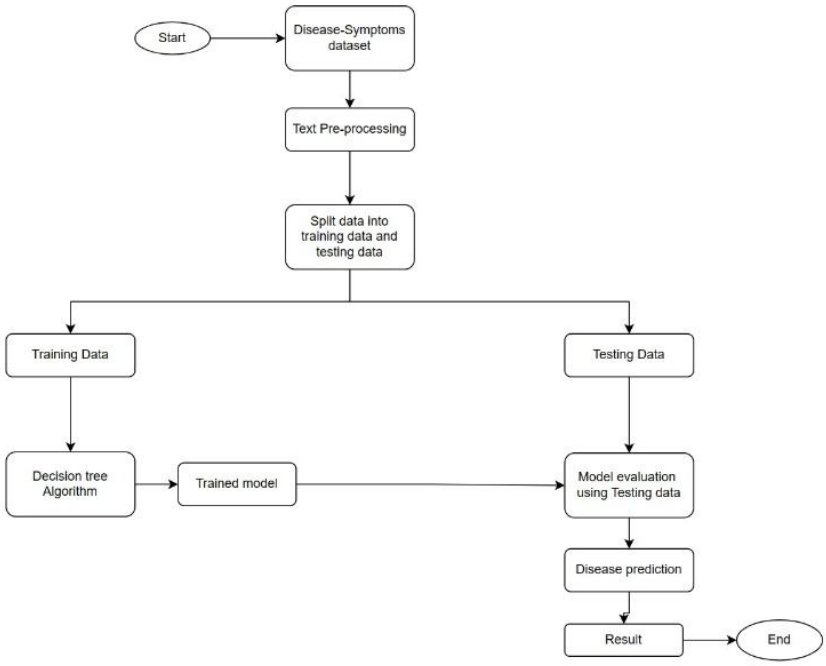

Figure 1. Features of the proposed method

This system aims to understand and generate human-like text interactions, offering seamless, context-aware, and relevant responses. The primary goals are to enhance user experience, automate customer support, and facilitate efficient information retrieval. Additionally, the model seeks to continually improve and adapt the AI's conversational abilities through machine learning, ensuring it remains up-to-date and versatile in understanding and responding to various user queries and contexts. The key phases of the development process are data collection and preprocessing to feature extraction, model choice, and evaluation measures.

A. Datasets

The method uses four datasets where the input of symptoms detects the disease. Here we make use of these four datasets namely, the symptom dataset, symptom severity dataset, symptom description dataset, and disease dataset based on these we make use of the chatbot to give the result by using machine learning and classification algorithms. The disease dataset consists of 3921 rows and 17 columns and contains information related to 41 diseases with 10 different combinations of symptoms. Table I describes symptoms related to some diseases.

TABLE 1. EXAMPLE OF THE DISEASE DATA SET

Disease	Symptom	Symptom
Fungal infection	Itching	Skin rash
Allergy	Shivering	Chills
Diabetes	Weight loss	Fatigue
Migraine	Indigestion	Headache
Jaundice	Vomiting	Fatigue

The symptom severity dataset contains the symptom's severity. Based on the severity the chatbot either recommends precautions or consults the doctor. Table II describes a sample of data present in the severity dataset.

TABLE II. EXAMPLE OF THE SYMPTOM SEVERITY DATASET

Symptom	Severity
Itching	1
Shivering	5
Fatigue	4

The symptom precaution dataset consists of precautions to be taken to reduce the symptoms of the disease. Table III describes sample precautions to be taken for a particular disease from the symptom precaution dataset.

TABLE III. EXAMPLE OF SYMPTOM PRECAUTION DATASET

Disease	Precaution1	Precaution2	Precaution3
Malaria	Stop irritation	Consult the nearest hospital	Stop taking drug
Allergy	Apply calamine	Cover the area with a andage	
Acne	Bath twice	Avoid fatty spicy food	Drink water
Arthritis	Exercise	Use hot and cold therapy	Try acupuncture
Tuberculosis	Cover mouth	Consult doctor	Medication

The symptom description dataset contains a detailed description of the disease. The chatbot uses this detailed description when the person is diagnosed with a particular disease. Table IV describes a sample description for a specific disease from the symptom description dataset.

TABLE IV. EXAMPLE OF SYMPTOM DESCRIPTION

Disease	Description
Malaria	Disease which is spread by a bite of an anopheles mosquito, contaminated needles, or transfusion.
Allergy	An allergy is the body's immune system reacting to something foreign that isn't usually bad for you.
Acne	The development of comedowns, papules, pustules, nodules, and/or cysts resulting in pilosebaceous units (hair follicles and the sebaceous gland surrounding them) becoming obstructed and inflamed is known as acne vulgaris.
Arthritis	Your joints will swell and become tender if you have arthritis. The primary signs and symptoms of arthritis are stiffness and joint pains, which are usually worse with age.
Tuberculosis	Mycobacterium tuberculosis (MTB) cases are the typical cause of tuberculosis (TB), an infectious disease.

B. Algorithms

In medical chatbots (commonly known as chatbots), artificial intelligence (AI) is used to comprehend user queries, group similar symptoms, and forecast probable diseases.

- Decision tree algorithm: Used for regression and classification issues. This supervised learning method recursively divides the dataset into subsets based on the data characteristics. As they are easy to understand, and summarize, decision trees are a prior choice for many applications. It Helps in decision-making processes, like determining the next best question to ask a user based on their previous responses. A decision tree plays a role in the decision-making process particularly when getting the relevant question to ask after the preceding reply. A tree-like structure with each internal node is a case where a test is taken, an attribute is decided, and each leaf is a final decision or class label. The routes that run exactly the root and the leaf mark the laws of classification.
- Entropy

$$\boldsymbol{E(S) = \sum_{j=1}^{c} Pi \log_2(Pj)}$$

- Information Gain

$$\boldsymbol{IG(S, A) = Entropy(S) - \sum \frac{|Sv|}{|S|} * Entropy(Sv)}$$

- Gini Impurity

$$\boldsymbol{ini(S) = 1 - \sum_{i=1}^{c} (Pi)^2}$$

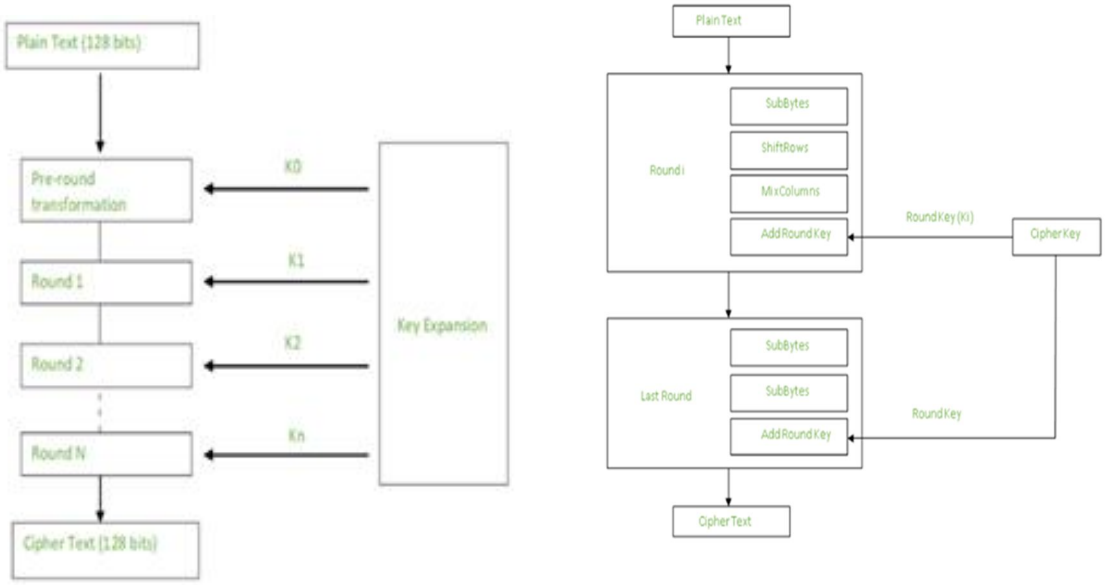

Figure 2. Process of round key creation

- Random Forest: For symptom-based disease prediction, a set of symptoms is input and predicts the likelihood of various diseases. In symptom-based illness prediction, the identification of symptoms, and the probability of a set of diseases can be determined. In its ensemble learning process, Random Forest makes several decision trees through the training and then chooses a class that stands for the mean or mode of each tree.
- SVM: used for classifying user queries like general questions, symptom descriptions, or appointment requests.
- AES Algorithm: The AES algorithm protects sensitive medical information during storage transformation, allowing authorized users to access original details. Instead of working with bits, AES works with bytes of data. The encryption analyzes 128 bits, or 16 bytes, of the incoming data simultaneously since the block size

is 128 bits. This algorithm ensures the privacy and security of medical information transferred like prescriptions and reports. For encryption and description round keys will be used. The process for creating round keys is described in Figure 2.

C. Results

Table V describes a case study representing how the model predicts a disease. The same process is described with the help of a decision tree in Figure 3.

TABLE V. DISEASE PREDICTION PROCEDURE OF THE MODEL

S.NO	Symptom 1	Symptom 2	Symptom 3	Symptom 4
D1	Itching	Vomiting	Fatigue	Jaundice
D2	Vomiting	Fatigue	Weight loss	Jaundice
D3	Fatigue	Weight loss	Yellowish skin	Jaundice
D4	Vomiting	Weight loss	Headache	Malaria
D5	Chills	Vomiting	Nausea	Malaria
D6	Itching	Chills	Weight loss	Malaria
D7	Fatigue	Weight loss	Headache	Dengue
D8	Chills	Fatigue	Nausea	Dengue
D9	Vomiting	Fatigue	High fever	Dengue
D10	Chills	High fever	Headache	Dengue

Accuracy is the performance metric used to assess the suggested system's performance. It is calculated using positive and negative classes. The model got an accuracy of 97% using the decision tree classifier.

$$\textbf{Accuracy} = \frac{TP+TN}{TP+TN+FP+FN}$$

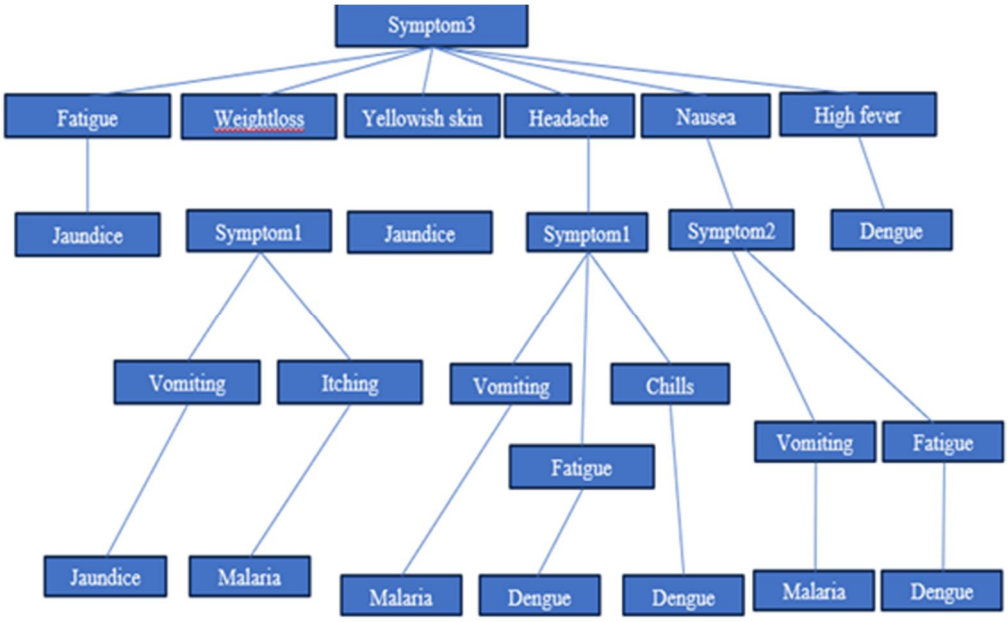

Figure 3. Sample case study with decision tree

IV. CONCLUSION

In conclusion, the Conversational system has emerged as a transformative technology in communication and automation. It enables human-like interactions, making it indispensable in customer service, virtual assistants, and more. Challenges such as privacy and ethical concerns persist. As models improve, the system's potential to revolutionize customer engagement and streamline various industries becomes increasingly evident, promising a future where machines seamlessly converse with humans, delivering personalized interactions.

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