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Development Of An Intelligent Chatbot For Patient Appointment Booking System

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Abstract*: This study focuses on the development of an intelligent chatbot simplify appointment scheduling for students and staff at the Federal Polytechnic Kaltungo Clinic, using AI and automation to address common challenges in appointment management, reduce no-show rates, and enhance healthcare delivery. The chatbot was developed using natural language processing (NLP) and machine learning techniques, allowing it to understand user queries and improve its responses through learning. It provides a user-friendly interface, allowing people to easily book, reschedule, or cancel appointments through their portal or popular messaging apps. The chatbot also offers personalized reminders and basic health information. Results showed that the chatbot successfully reduced administrative burdens, improved patient satisfaction, and received positive feedback for its ease of use and contribution to a more efficient healthcare experience. The study concludes that AI-powered solutions like this chatbot can significantly enhance healthcare delivery by automating key tasks and providing valuable health guidance.*

Keyword: Appointment management, Artificial Intelligence, Chatbot, Healthcare, Machine learning.

1.0 INTRODUCTION

The swift adoption of digital health technologies, especially following the COVID-19 pandemic, has hastened the integration of technology into healthcare services. A major area of emphasis is appointment scheduling, which is essential for improving patient access and overall healthcare efficiency. With ongoing challenges in managing patient appointments, automated systems such as chatbots have emerged as promising solutions [1]; [2].

Chatbots, created to mimic human conversation, greatly alleviate the administrative burden of appointment scheduling. Utilizing technologies like natural language processing (NLP) and machine learning (ML), these chatbots can handle patient inquiries and automate the booking process [3]; [4]. This prompt response capability improves patient satisfaction and lowers no-show rates. Additionally, automated messaging systems connected to clinic booking platforms facilitate smooth appointment confirmations and rescheduling [5]; [6]; [2]; [7].

AI underpins chatbots by integrating machine learning with technologies such as natural language processing to enable human-like interactions [8]. Chatbots showcase the practical use of computational linguistics online, frequently functioning as virtual assistants on portable devices [8]. Their fundamental process involves receiving questions in natural language, connecting these queries to a knowledge base, and delivering suitable responses [9]. General-purpose chatbots, like Google Assistant, Siri, and Alexa, are versatile and not limited to particular fields. In contrast, ELIZA, one of the earliest chatbots, is a basic psychotherapist with limited programmed responses. Medical chatbots, however, are specifically designed to address patient inquiries and provide automated responses. They are increasingly gaining attention in the healthcare industry for their potential to transform the delivery of medical services [10].

In recent years, chatbots have seen considerable advancements in development and are now widely used across various healthcare applications. They are capable of educating patients on disease prevention, promoting healthy habits, and encouraging self-care [11]. When immediate access to a doctor is challenging, chatbots can offer basic information about diseases, enabling users to assess their symptoms before seeking consultation with a healthcare provider [11]. Patient satisfaction is crucial for effective healthcare, and chatbots are becoming increasingly popular for enhancing healthcare delivery by offering 24/7 access to information [12]. Patients can get automated responses anytime and from anywhere, with the chatbot retrieving information from health databases [13].

The Federal Polytechnic Kaltungo Clinic, like many educational clinics, faces challenges in managing appointments and patient attendance. Studies show that automated reminders, such as email or SMS notifications, can significantly reduce missed appointments [5]; [6]. Implementing a chatbot at the clinic could improve patient compliance by delivering personalized reminders and notifications, ultimately enhancing healthcare delivery [14]; [15]. Additionally, chatbots can collect essential patient information prior to appointments, enabling healthcare providers to deliver more effective care [16]. This paper aims to develop an intelligent chatbot specifically designed to facilitate appointment scheduling for students and staff at the Federal Polytechnic Kaltungo's clinic. By harnessing the power of AI and automation, the clinic can address common challenges in appointment management, reduce no-

show rates, and provide a more student-centered healthcare experience. The integration of such technology aligns with current digital health trends and equips the clinic to better meet the evolving healthcare needs of its student population.

2.0 LITERATURE REVIEW

2.1. OVERVIEW OF MACHINE LEARNING

Machine learning, a subset of artificial intelligence (AI), enables computer systems to learn from data without being explicitly programmed. With advancements in computing power, the availability of large datasets, and the refinement of algorithms, deep learning has emerged as a highly effective tool for prediction [17]. In recent years, the field of Natural Language Processing (NLP) has also seen significant growth.

Natural Language Processing (NLP), as noted by [8], is a branch of artificial intelligence that enables machines to learn, read, and interpret human languages. Various sectors, such as banking, education, and finance, are utilizing chat applications to address their challenges and promote their products. Many countries, including Germany, Spain, China, India, and Korea, have their own native languages, creating language barriers during interactions [8]. To overcome these barriers, NLP-based autonomous systems support multiple languages, making verbal and non-verbal communication easier. In healthcare chatbots, NLP is applied for text processing, and its features are particularly valuable in the medical field [8].

2.2 Chatbot

A chatbot is a software program designed to simulate human speech, both written and spoken, allowing interaction between machines and people without human intervention. It achieves this through machine learning algorithms and Natural Language Processing [8]. A medical or healthcare chatbot is a conversational AI-driven tool specifically created to enhance interactivity and proactivity in healthcare services [18].

2.2.1 Types of Chatbot

A Chatbot has three types as highlighted by [8];

i. Simple chatbots, also known as rule-based or decision-tree chatbots, operate using predefined rules and options to handle straightforward dialogues. They are designed to respond to queries with fixed choices based on established rules.
ii. Smart chatbots utilize natural language processing (NLP) to understand and interact with users more dynamically. These chatbots are programmed with advanced techniques to grasp human language, emotions, and interactions.
iii. Hybrid chatbots combine the capabilities of both rule-based and AI-driven approaches. They manage rule-based tasks while also understanding user intentions and context. By integrating AI, hybrid chatbots can handle complex issues, while their rule-based component ensures consistency and accuracy in responses.

2.2.2 Chatbot in Healthcare System

In the past, the field of artificial intelligence was less advanced, but the advent of chatbot systems has significantly reduced the time needed to address user problems. The use of automated chatbots in healthcare web applications is now rapidly expanding worldwide. Patients often face various health issues and visit hospitals for treatment, but sometimes doctors are unavailable, leading to delays in care [19]. To address this challenge, medical chatbots have been developed. These chatbots can schedule appointments based on doctors' availability, collect data, create medical records, and assist with insurance processes [8]. They offer 24/7 access to healthcare services and information [20], providing medical advice and prescription refills. By delivering efficient, equitable, and personalized medical services, chatbots can enhance the quality and experience of healthcare [21].

AI-based conversational agents use natural language processing and machine learning to provide personalized health advice, support education, and encourage behavior changes [22]. By analyzing medical histories and symptoms, these chatbots deliver tailored recommendations specific to each patient’s needs. They offer actionable suggestions to help maintain overall well-being, making them especially valuable for individuals in areas with limited access to healthcare professionals, those with time constraints, or those who have concerns about traditional hospital visits. The popularity of text-based communication systems for remote healthcare is growing [23].

Furthermore, chatbots are more cost-effective than traditional healthcare methods. They have significant potential to extend healthcare access beyond conventional medical facilities, particularly benefiting marginalized communities facing transportation issues or long wait times for consultations. By providing personalized healthcare recommendations, chatbots can improve patient outcomes and reduce costs [24]. During a pandemic, chatbots can offer symptom diagnosis, mental health support, nutritional

information, and more. For example, the WHO partnered with WhatsApp to use chatbots for COVID-19 guidance and misinformation control [25].

Chatbots are available in multiple languages through platforms like WhatsApp, Viber, and Facebook Messenger, reaching over 12 million people [26]. They are programmed to recognize when a patient requires urgent assistance, such as in emergencies or medical crises, and provide preliminary diagnoses based on the information given by patients. Some chatbots function as medical reference tools or preliminary diagnostic aids, helping patients understand their conditions and improve their health [27]. Additionally, chatbots assist in monitoring chronic disease patients and reminding them to take their medications [28]. They enable effective evidence-based therapies and have shown potential in providing social and psychological support when real-world human interaction is not possible or preferred [29].

2.3 Related Work

Study by [30], examined the role of artificial intelligence (AI), particularly machine learning (ML), in improving healthcare delivery, especially for underserved areas. The study proposed an AI-powered chatbot using natural language processing (NLP) to diagnose diseases and provide health information. This chatbot would lower healthcare costs, enhance accessibility, and act as a virtual medical assistant, empowering patients with better health understanding. It would engage patients in online conversations, collect symptom data, provide personalized diagnoses, and connect users with specialists. The study highlighted the chatbot's potential to address healthcare challenges and improve service delivery through accurate diagnoses and efficient appointment booking. The authors concluded that by leveraging NLP to process patient data, the chatbot could help address healthcare challenges and improve access to medical services.

Another study by [31], introduced Bookazor, a web-based application for appointment scheduling across various sectors, such as parlors, hospitals, and architecture firms. The application was built using the Ionic framework for hybrid mobile app development, integrating CSS, HTML, and JavaScript technologies. Firebase played a key role in fetching and managing data for appointments, offering functionalities like analytics, database management, messaging, and crash reporting. NodeJS was responsible for handling appointment requests, verifying availability, and adding new jobs to schedules. A built-in scheduler updated routes periodically to generate new appointment sets and avoid duplication, ensuring efficient appointment management.

Similarly, [32] introduced Dr. Vdoc, a medical chatbot designed to function as a virtual doctor. The chatbot leverages natural language processing and pattern matching algorithms to provide responses to patient inquiries related to various diseases. Dr. Vdoc aims to bridge the healthcare gap in areas with limited access to doctors by offering disease awareness and information. The chatbot demonstrated an impressive 80% accuracy in answering user questions based on the results, showcasing its potential to provide valuable medical assistance.

Study by [33], proposed a novel approach to enhance patient-bot assistant interactions. The study introduced a Conditional Entropy Retrieval Based model for effective answer retrieval and an Attitude Modeling framework based on Popitz Powers. By combining these models, the authors aimed to identify attitude changes during dialogues between patients and doctors. The research demonstrated the successful application of these models in facilitating meaningful and informative interactions between patients and bot assistants, highlighting their potential to improve patient care.

Another study by [34], developed "MR.Dr.," a healthcare chatbot aimed at diagnosing minor ailments, which account for 60% of doctor visits. The chatbot allows users to check symptoms and schedule appointments remotely. In a usability evaluation with 30 respondents, "MR.Dr." received an excellent rating of 87.6% on the System Usability Scale, with users particularly valuing its 24/7 availability and overall functionality.

3.0 PROPOSED SYSTEM

The proposed system involves the development of an intelligent chatbot that can be integrated into a web application and popular messaging platforms such as WhatsApp and Telegram. This chatbot is designed to assist users in booking appointments with doctors, rescheduling appointments, and deleting previously scheduled appointments. In addition to appointment management, the chatbot will be equipped to interact with users by answering health-related questions, offering basic information on common medical conditions, and providing guidance on next steps. The system aims to simplify the appointment scheduling process, reduce administrative burden, and improve user experience by offering a convenient and accessible platform for healthcare interactions. The chatbot's integration with multiple platforms ensures that users can easily access the service from their preferred communication channels, enhancing its usability and reach. Furthermore, the chatbot will utilize natural language processing (NLP) to understand user queries and provide timely, accurate responses, contributing to a more efficient and patient-centered healthcare system.

3.1 Sequence Diagram

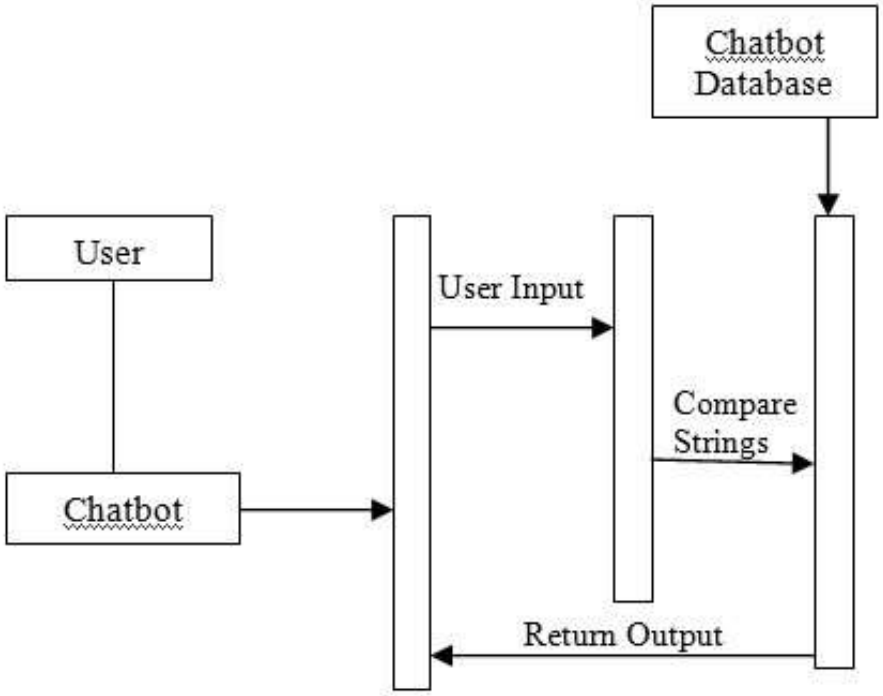

Figure 1: Sequence Diagram of the proposed Chatbot

As shown in figure 1, The user is the individual interacting with the chatbot, providing input through text or speech. The chatbot, powered by AI, processes this input and generates appropriate responses. When the user submits their input, it goes through the compare strings process, where the chatbot compares the input with the stored data in the database. This database contains relevant information, such as FAQs, specific topics, or pre-defined responses, which the chatbot uses to understand and respond to the user's queries.

Once the user's input is compared to the data, the chatbot generates a return output, providing the user with a relevant response. This exchange repeats in a conversational manner, allowing the user to interact with the chatbot to obtain the desired information or assistance. Through this process, the chatbot delivers efficient and personalized support based on the user's input.

3.2 System Flowchart

The illustrated flowchart as shown in figure 2 represents the interaction process of the FPK Appointment Bot, starting with a welcome message and offering three main options: booking, rescheduling, and deleting an appointment. If the user chooses to book an appointment, the bot requests the user's full name, email, and appointment date, followed by details of their medical condition. After receiving the information, the bot sends a congratulatory message to confirm the booking. For rescheduling or deleting appointments, the bot requests relevant details and proceeds accordingly. Finally, the bot sends a confirmation message for completed actions, concluding the interaction at the end of the flow. This structured process ensures that users can efficiently manage their healthcare appointments while providing necessary information.

Figure 2: Flowchart of the System

3.4 Design and Architecture

The development of a healthcare chatbot for the Federal Polytechnic Kaltungo Clinic was implemented using an online platform, Engagi Bot Developer. The chatbot was designed to store and manage biodata for both students and staff of the institution, including essential information like registration numbers, file numbers, and school emails. This ensures that when users interact with the chatbot using their school email, it can instantly identify them and provide personalized services, including health-related inquiries, appointment booking with doctors, rescheduling, and appointment cancellations. The chatbot's cloud functions was designed to check for any overlapping appointments, ensuring no conflicts exist. If the requested time is available, the backend creates the new appointment.

Once an appointment is successfully booked, a push notification is sent to the relevant the patient via the school email. The patient can then either accept or delete the appointment through the front-end interface, and the outcome is updated in the backend.

The chatbot does not rely on complex algorithms but rather uses various modules to handle front-end operations, backend processing, and scheduling. It utilizes Google Charts to visualize busy hours for doctors in real-time, and the Ionic framework ensures mobile-readiness for easy access on various devices.

The chatbot was train and built using natural language processing (NLP) with the Chatterbot library, which allows it to engage in conversations with users, answer their health-related questions, and manage their appointments. During the chatbot's training phase, user queries, such as common ailments (e.g., cold, headache, cough, malaria), were inserted into a database. This data is used to improve the accuracy of the chatbot over time, with additional data added as new symptoms and diseases are encountered.

4.0 IMPLEMENTATION

When the user opens the chatbot, a welcome message immediately appears, followed by a list of available services. These services include options such as: "Book an Appointment with Doctor," "Reschedule Appointment," and "Delete Appointment," as illustrated in Figure 3. The chatbot offers a user-friendly interface, making it easy for users to navigate and select the desired service.

Figure 3: Chatbot Interface

4.1 Patient's End

Whenever user requests for an appointment booking, the chatbot prompts the user to enter their name, and school email suggesting that personal information is required for the appointment process as illustrated in figure 4 and figure 5.

Figure 4: User Input

Figure 5: User Input

After a valid school email is inputted, the user is prompted to select a date for their desired appointment date. The date selected in this case is September 11, 2024. The bot confirms the appointment booking with a congratulatory message, reminding them that the appointment is scheduled for 2024-09-11 and advising them to arrive between 10:00 AM to 6:00 PM.

Following the confirmation, the bot prompts the user to provide more details for the doctor, specifically requesting information about the user's medical condition. As illustrated in figure 6 and figure 7, the illustration emphasizes a user-friendly, conversational interface where students or staff can easily book and manage medical appointments while providing relevant health information for better care.

Figure 6: Appointment Date Selection

Figure 7: Appointment Confirmation and Medical Condition Input Interface

Following confirmation appointment, assist doctors understanding user's medical condition better, the bot requests additional details about their health concerns. The user is prompted to start by describing their symptoms as shown in figure 8. The bot confirms that a confirmation email has been sent to the user's email address, and then asks if any further information is needed with a "Yes" or "No" option to continue the conversation.

Figure 8: Mail Confirmation

4.2 Admin's End

As illustrated in figure 8 is the Admin's end of **FPK Appointment Bot** messaging interface, showing all the interaction including appointments between the user and the bot. The interface includes a left sidebar displaying two different conversations from different patients. At the bottom, there is a text input field for typing messages or selecting quick replies, along with options to send attachments and use keyboard shortcuts like **Ctrl + Enter**. The interface is designed to manage healthcare appointments and streamline communication between the user and the bot.

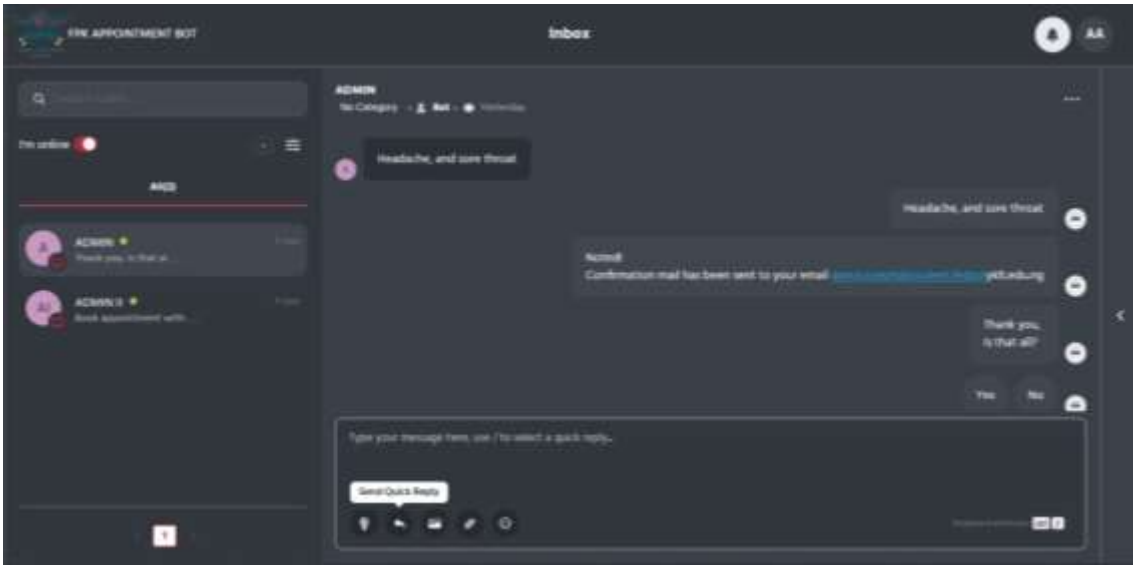

Figure 9: Admin's end

5.0 CONCLUSION

The development of an intelligent chatbot for managing patient appointments at the Federal Polytechnic Kaltungo Clinic is a timely solution, given the increased integration of digital technologies in healthcare. Appointment scheduling plays a vital role in improving

access and operational efficiency in healthcare. Automated systems, like chatbots, are becoming indispensable due to their ability to streamline administrative tasks, such as appointment bookings, using AI-powered natural language processing (NLP) and machine learning (ML). These technologies facilitate real-time interactions between patients and healthcare systems, leading to reduced no-show rates and better patient satisfaction. Chatbots provide 24/7 access to information, automate the booking process, and send reminders or confirmations to patients. Integrating such a system at the clinic could significantly enhance appointment management, reduce administrative burdens, and personalize healthcare services for students and staff. This paper aims to develop a chatbot capable of managing bookings, rescheduling, and cancellations, while also providing basic health information. The chatbot can be deployed on the school portal and social media platforms like WhatsApp and Telegram, ensuring ease of access and seamless interaction with users. The design focuses on reducing appointment conflicts and improving patient engagement with timely notifications, providing a robust and efficient healthcare appointment system at the institution.

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