Journal of Theoretical and Applied Information Technology
30th September 2024. Vol.102. No. 18

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

ENHANCING DIABETES CARE VIA ARTIFICIAL INTELLIGENCE

TURJA BHATTACHARJEE[1], MOHAMED EL-DOSUKY[2,3], SHERIF KAMEL[2,4]

[1]Next Tech Lab, SRM University - AP, Andhra Pradesh, India.

[2]Computer Science Department, Arab East Colleges, Saudi Arabia

[3]Computer Science Department, Faculty of Computers and Information, Mansoura University, Egypt

[4]Department of Communications and Computer Engineering, October University for Modern Sciences and Arts, Egypt

E-mail: maldosuky@arabeast.edu.sa

ID 55425 Submission	Editorial Screening	Conditional Acceptance	Final Revision Acceptance
24-08-24	28-08-2024	06-09-2024	24-09-2024

ABSTRACT

Artificial intelligence (AI) has become a potent tool in healthcare with the potential to completely change the way diabetes is treated. This study investigates how AI affects patient outcomes and diabetes treatment. Healthcare providers can extract insightful information from patient data using machine learning, data analytics, and AI-driven wearable devices, resulting in individualized treatment programs and better glycemic control. AI chatbots and virtual assistants improve patient support and engagement, encouraging improved treatment adherence. Despite privacy and ethical issues, AI is effective at cutting healthcare expenses and improving the quality of life for patients is obvious. Healthcare providers can use AI to develop a patient-centered strategy and improve diabetes care by working with researchers and politicians. This paper proposes a smart chatbot for enhancing diabetes care through natural language interactions. The chatbot's architecture uses pattern matching and keyword identification techniques to follow a multi-level interaction procedure. The proposed chatbot system simplifies diabetes diagnosis by using natural language interactions, asking questions based on previous responses through a multi-level diagnostic flow. It employs AIML-based memory techniques and pattern matching to identify keywords at each level, ensuring relevance and coherence in conversation. The system follows a search engine-like flow, using methods like the Sequence Words Deleted (SWD) technique and Triangular Number equation to optimize keyword matching, with Vpath values guiding the diagnostic path. The chatbot enhances patient diagnosis by providing structured, personalized guidance through these techniques.

Keywords: *Artificial Intelligence, Diabetes, Chat-bot, Care*

1. INTRODUCTION

Diabetes mellitus is a chronic metabolic illness that causes abnormal blood glucose levels [1]. It affects millions of individuals worldwide and has become a major global health burden [2]. Although treatment methods and medical technology have made considerable strides, treating diabetes is still a difficult endeavor for both patients and healthcare professionals. However, the development of artificial intelligence (AI) has given rise to fresh optimism for the transformation of diabetes treatment and the management of this condition.

AI is a cutting-edge technology that combines machine learning algorithms, data analytics, natural language processing, and more to give computers the ability to analyze enormous volumes of data quickly and accurately [3]. AI has the ability to provide healthcare practitioners in the field of diabetes management with vital insights and personalized, precise treatment plans for specific patients. Through wearable technology, virtual assistants, and chatbots powered by AI, this technology also creates opportunities for better patient engagement, self-management, and adherence to treatment programs.

The integration of AI into diabetes care is essential due to the increasing global prevalence of the disease and the limitations of traditional management methods [4]. AI offers the ability to

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

process large amounts of patient data, providing real-time, personalized insights for more effective and timely interventions. It can predict complications, improve continuous monitoring, and reduce the burden on patients and healthcare providers by automating tasks such as glucose monitoring and insulin delivery.

The primary question this work addresses is: How can AI improve the precision, efficiency, and accessibility of diabetes care? This study seeks to fill the gap in understanding how AI can be integrated into diabetes management to overcome the limitations of traditional methods.

This study examines the paradigm shift that AI brings to the treatment of diabetes, including its uses, difficulties, and prospective advantages. This paper intends to shed light on the transformative role of AI in diabetes care and its impact on patient outcomes by evaluating existing papers and ongoing research.

To ensure a responsible and patient-centered approach, ethical issues and data privacy concerns associated to AI adoption will also be investigated. Collaboration between medical professionals, researchers, and policymakers is crucial in the effort to improve diabetes treatment with AI. Together, they can fully use AI technology to develop creative solutions and usher in a new era of patient-centric diabetes management that raises the standard of living for people who have this chronic condition [5].

The proposed chatbot system simplifies diabetes diagnosis by using natural language interactions, asking questions based on previous responses through a multi-level diagnostic flow. It employs AIML-based memory techniques and pattern matching to identify keywords at each level, ensuring relevance and coherence in conversation. The system follows a search engine-like flow, using methods like the Sequence Words Deleted (SWD) technique and Triangular Number equation to optimize keyword matching, with Vpath values guiding the diagnostic path. The chatbot enhances patient diagnosis by providing structured, personalized guidance through these techniques.

The strength of this study is in proposing the use of AI-powered chatbots for diabetes diagnosis, simplifying the process and providing personalized control advice. It uses multi-level diagnostic flow, AIML memory techniques, and efficient keyword matching to improve patient engagement. The scalable framework allows for adaptability to complex diagnostic sessions or additional health conditions, reducing healthcare provider burden and improving patient engagement.

For the weaknesses, the manuscript presents a theoretical framework for a chatbot, but lacks real-world validation or clinical trials. Furthermore, the chatbot's ability to handle complex conversations and non-standard language may be compromised.

The rest of the paper provides literature review, proposed methodology, measuring chatbot effectiveness, before concluding and elaborating on future directions.

2. LITERATURE REVIEW

The possible uses of cognitive computing and AI in the treatment of diabetes are covered in this article. A survey searched the PubMed database for articles from 2009 and later that dealt with diabetes and artificial intelligence. The authors found 450 distinct, clinically pertinent papers that examined the direct application of AI in diabetes prevention, diagnosis, and treatment but omitted studies that were mostly concerned with technical elements of developing AI algorithms. According to the report, diabetes affects 425 million people worldwide and accounts for 12% of all medical expenses. Alarmingly, just half of diabetics receive a diagnosis or treatment. The authors suggest that AI developments can significantly enhance diabetes care for patients, clinicians, family members, and carers in order to address this problem. Although the summary does not go into specific uses of AI in diabetes treatment, it does classify the identified publications according to their primary focus areas. These topics probably include things like early diabetes identification, individualized treatment regimens, monitoring and forecasting blood glucose levels, and tools that help medical professionals make decisions. The overview emphasizes the potential relevance and influence of AI in the management of diabetes but does not include particular findings or conclusions from the study articles. The research was carried out between March and May of 2018, thus it's vital to keep in mind that there might have been new developments and studies in the subject since then [6,7]

Since the last ten years, the combination of continuous glucose monitoring and data from insulin pumps has revolutionized the management of diabetes. More recently, wristbands or watches have been able to track a wide range of physiological characteristics and functions, including heart rate, sleep duration, steps taken, and activity. Future updates will include more information including barometric pressure, hydration, and geolocation.

When all of these factors are considered, it can assist patients and clinicians make decisions. In recent years, there has been a rising interest in the development and implementation of artificial intelligence (AI) technologies to decision assistance and knowledge acquisition. Similar new scenarios have emerged across the majority of medical professions. More and more multidisciplinary research teams including medical professionals and computer engineers are being formed, reflecting the necessity for collaboration in this emerging area [8].

A recent study provides an analysis of current developments in the use of artificial intelligence methods for the management of diabetes. The authors provide a functional taxonomy for AI-powered solutions in this field after carefully examining 141 pertinent articles. The results show encouraging results in the prediction and prevention of problems associated to diabetes. The study emphasizes the increased research interest in this field and the expanding ability of AI techniques to enhance glucose homeostasis. However, issues with data protection and system integration demand more research [9].

The potential of ChatGPT in medicine, specifically in diabetes technology, is examined in research. Discussing innovations like continuous glucose monitoring, artificial pancreas systems, smart insulin pens, and non-invasive glucose monitoring, it emphasizes the optimistic future of diabetes technology. It raises questions about ChatGPT's shortcomings, specifically the poor transparency and quality of the data sources. The review acknowledges ChatGPT as a useful instrument for scientific investigation but stresses the need for careful assessment and data verification by specialists before integration into diabetic research. In general, the article offers insightful information about the function and difficulties of AI-based chatbots like ChatGPT in healthcare innovation [10].

Previous methods used in enhancing diabetes care via artificial intelligence include the following. First, data analysis and pattern recognition. AI algorithms have been used to examine enormous datasets, such as genetic data, medical imaging data, and patient health records. These algorithms can locate patterns, relationships, and risk factors related to diabetes, enabling more precise diagnosis and individualized therapeutic strategies [11]. Second, prediction modelling. Machine learning and other AI approaches have been used to create prediction models that can anticipate how an illness will advance, what complications it will cause, and how it will respond to treatment. These models can offer insights into specific patient outcomes by utilizing past data, assisting healthcare professionals in making defensible choices [12]. Third, decision support systems. AI-powered decision support systems have been created to aid medical professionals in making clinical decisions regarding the treatment of diabetes. These systems combine patient data, recommendations, and medical literature to produce recommendations for diagnoses, treatment regimens, and monitoring that are supported by evidence [13]. Forth, remote monitoring and telemedicine. Telemedicine and remote monitoring have been made possible by AI through the use of wearable technology and sensors. AI algorithms can be used to analyze real-time data gathered from these devices in order to find anomalies and prompt interventions. Platforms for telemedicine that use AI can also help [14].

There are some tools for transforming diabetes care via artificial intelligence that we can use for better result such as Natural Language Processing (NLP), image analysis, and chatbots. First, NLP approaches are used to extract and analyze data from unstructured data sources, including as electronic health records, medical literature, and patient-generated data. NLP can help in the diabetes care context by identifying important data for clinical decision-making. NLP algorithms can extract information from electronic health records, such as patient demographics, symptoms, lab findings, and treatment history, by automatically processing and comprehending textual data. This makes it possible for medical professionals to quickly access and evaluate pertinent data, improving patient care through better diagnosis and treatment planning. Additionally, NLP makes it easier for researchers to uncover and combine pertinent data from the study of medical literature to increase understanding of the treatment of diabetes [15]. Second, medical imaging data can be examined using image analysis methods driven by artificial intelligence (AI), such as computer vision and deep learning. For instance, retinal scans can be examined to look for indications of diabetic retinopathy, a common eye-related consequence of diabetes. Specific traits or anomalies in the photos can be automatically detected by AI algorithms, assisting in early detection and prompt intervention. Similar to this, foot ultrasounds can be used to monitor vascular health and find foot ulcers, which are common in diabetics. Healthcare providers can improve the identification and management of diabetes-related complications by utilizing AI in image analysis, enabling proactive treatment and reducing possible Hazards [16]. Third, chatbots driven by AI have become important aids in the treatment of diabetes, providing individualized support to those who have the condition. These virtual assistants can offer assistance by responding to inquiries and sharing information on managing diabetes, such as dosages of medications, suggested diets, and exercise regimens. Additionally, they can send reminders for managing one's lifestyle and taking prescribed medications, ensuring that patients follow their treatment plans as directed. Additionally, chatbots and virtual assistants can provide behavioral coaching, encouraging people to develop healthy routines and make beneficial lifestyle choices. These AI- powered products help people better manage their diabetes by offering personalized coaching, education, reminders, and guidance. This raises the standard of diabetes treatment as a whole [17].

Let us focus on chatbots. In the field of diabetes care, chatbots have emerged as a paradigm-shifting tool, providing important advantages that transform patient management and assistance. Finding effective and scalable strategies to offer patients individualized support and education is becoming more and more important as diabetes prevalence rises. For a number of reasons, chatbots have grown to be an essential tool in solving these issues [18].

Chat-bots offer round-the-clock accessibility, allowing patients to get help and answers to their questions whenever they need it, no matter where they are in the world. This ongoing accessibility guarantees that patients receive prompt assistance, which is essential for managing diabetes because decisions made in the moment can have an influence on blood glucose levels and general health. Because every diabetic patient is different, their care plans should take this into account.

Chatbots can provide patients with specialized educational content, giving them information about their disease, drugs, food, exercise, and lifestyle changes. Better patient comprehension and adherence to treatment recommendations are fostered by this personalized approach. Patients can communicate with healthcare professionals in real time by integrating chatbots with wearable technology and continuous glucose monitors. This makes it possible for medical personnel to quickly make data-driven decisions and remotely monitor patients, resulting in preemptive interventions and improved glycemic control. Chatbots can help patients keep track of their adherence to their prescription schedules, food, and exercise regimens. The chatbot can help patients and healthcare professionals by analyzing this data over time, enabling better medication modifications and discovering potential trends or triggers that affect blood glucose swings. Managing diabetes can be difficult, and patients can feel frustrated and unmotivated.

Chatbots can continuously encourage patients, remind them to take their medications and attend their appointments, and recognize their accomplishments, which promotes a positive outlook and better self-management. When compared to conventional patient education materials, chatbots provide a more dynamic and conversational experience that can greatly increase patient engagement. Patients who are actively involved in their care are more likely to adhere to their treatment regimens and achieve better health results. By automating regular chores, streamlining procedures, and reducing the need for frequent in-person visits for routine inquiries, integrating chatbots into diabetes care has the potential to save healthcare expenditures. Because of its affordability, diabetes care may be more widely available.

Although diabetes is still incurable with today's medical technology, it can be well managed to allow individuals to live active, healthy lives. The monitoring of blood glucose levels, eating a healthy diet according to dietician recommendations, and patient or guardian motivation are the three main aspects of treating diabetes. Patients should closely watch the appearance of any early symptoms of low blood glucose levels as the first step in regularly monitoring their blood glucose levels. However, if a patient is ignorant about their ailment, those symptoms will not be seen. After that, even if their sickness is under secure management, people must continue to visit the hospital to have a diagnosis regarding those symptoms. As a result, we suggest creating a chatbot that will serve as a virtual diabetes doctor and provide a preliminary diagnosis on diabetic patients [19, 20, 21].

3. PROPOSED METHODOLOGY

Journal of Theoretical and Applied Information Technology
30th September 2024. Vol.102. No. 18

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

The procedure is that the patient will engage in a typical chat session using natural language with the chatbot, asking questions and receiving answers from the patient. This session will continue until patients successfully being diagnosed and then they will get their most suitable control advice for their diabetes condition.

In order to clarify the diagnosis, chatbot will ask several sequence questions and those questions will be selected based on the answers given by the patient. This means chatbot need to know the whole conversation flow. Referring to the literature of a chatbot, the flow of a chatting session is user enters an input, and chatbot will response. The logic of the procedure is similar to a search system in which the user enters a search term, and the search engine then returns results related to that term. Probably a single flow process, where information from the past is unrelated to input from the present and the future. So, there is a way for chatbot technology to remember the past interaction. The chatbot will be able to "copy" some phrases or words that the user inputs and "paste" them in the response that is sent to the user by using "Wildcards" in AIML.By utilizing the that> and topic> tags, AIML-based chatbots also have the capacity to "remember" the topic of a discussion, ensuring that the generated response stays on the same subject. Even though those features are quite useful, chatbots cannot yet recall the entire conversation flow.Figure 1 represents the chatbot's query as the circle with the letter "X" inside of it, and the patient's response as the circle with the letter "Y" inside of it. A three-level diagnosis session with a maximum of nine questions per level is shown in Fig. 1. It should be noted that based on the specific physician diagnosis session that will be detailed later, the session may actually have more levels and fewer questions each level. The patient will only be asked one question for each level, but if the chatbot could not identify any keywords from the response, it will ask additional questions until it does. Keep in mind that the level will only be raised once the chatbot has located the keywords. Fig. 2 describes the process's flow.

Later, actual search results will select the keywords for each inquiry. Note that a question may have many keywords, each of which may be a complete sentence, phrase, or a single word.

For the three levels diagnosis session (as shown in Fig. 1), the total probability of the possible path is 729 (9 * 9 * 9 = 729) with the Vpath value are 111, 112, 113, 114, 115, 116, 117, 118, 119, 121, 122, 123, 124, 125, 126, 127, 128, 129, 131, 132, 133, 134, 135, 136, 137, 138, 139, … until 991, 992, 993, 994, 995, 996, 997, 999. Although the patient has 729 alternative paths to choose from throughout this session, the final result might not add up to 729 because the diagnosis is open-ended and the total number of questions for each level might be fewer than nine. When structuring the session's questions and path with a real diabetes physician, all those factors will be taken into consideration.

Each question has a unique value that is defined by a parameter called a "Qid," and each Qid is multiplied by a specified value for each level, which is an increasing multiple of 10 starting at 1 for level 1, 10 for level 2, 100 for level 3, and so on. Vpath is a total value of Qid that denotes the path along which the interaction occurs. According to Fig. 1, Qid for level one is 3 (3 * 1), level two is 70 (7 * 10), and level three is 100 (1 * 100), resulting in a calculation for Vpath of 173 (3 + 70 + 100). In conclusion, Qid, which has a constant value ranging from 1 to 9 depending on the question number, is used to calculate Vpath. However, because different levels have varying values for the Qid multiplication process, the overall value of Qid for each level varies.

The chatbot uses a pattern-matching procedure for each level to find keywords in the patient's input statement. The process entails the following steps, which must be completed:

• Converting all alphabets into lower case after receiving the patient's input sentence.

• Use a dot, comma, and space to separate words from the sentence.

• Create an array with all the words.

• Replace words with their equivalents using the knowledge base, if applicable.

• Using the Sequence Words Deleted (SWD) technique, create a list of potential input to match (sentence, phrase, and words).

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

• One-by-one matching of the array to the "keywords" database, starting with the complete sentence and continuing through each word (take notice that matching is dependent on the level at which the dialogue is taking place).

• If a match was found, end the loop.

The Triangular Number equation, like in (1), can be used to calculate the total input that could match following the SWD procedure.

• m = Variable for matching

• n = Total words in input data

If a sentence's total word count is five, for instance, there are a total of fifteen possible inputs that could match that text. Table 1 provides a description of it (let's use the example of "Yesterday, my chest hurt a lot" as the input sentence).

The suggested chatbot intends to make diabetes diagnosis easier and give patients individualized control guidance through natural language interactions. The chatbot's architecture uses pattern matching and keyword identification techniques to follow a multi-level interaction procedure.

3.1. Pattern-matching

A pattern-matching process is used by the chatbot to match pertinent questions and answers. The steps are outlined in Table 2.

3.2. Question Selection and Path Calculation

Once relevant keywords are identified, the chatbot selects an appropriate question from the predefined set for the current level. The question selection is influenced by the identified keywords and aims to progress the diagnosis process. Calculating Vpath and Qid:

1. Calculating the Vpath: The Qid value for the path taken during the interaction is represented by the Vpath value. It is figured up by adding up the Qid products and the relevant level multipliers.

2. Calculating the Qid: Each question is given a parameter called Qid, which is determined by the question's ID. In the calculation of Vpath, its value affects the question's overall value.

3.3. Iterative Diagnosis and Interaction

The chatbot asks the patient questions and processes their responses in a series of iterative discussions. It customizes future questions for a more accurate diagnosis using the discovered keywords and conversation context. The procedure keeps going until the chatbot is certain of its diagnosis.

3.4. Collaboration between physicians and flexibility:

The architecture of the chatbot enables customization in terms of the number of levels, the questions asked at each level, and the range of keywords. Working together with diabetes specialists makes sure that the queries, key words, and diagnosis procedure are in line with medical knowledge.

3.5 Diagnostic process of the chatbot

The diagnostic process of the chatbot entails having a natural language conversation with patients in order to accurately assess their diabetes condition and offer helpful control suggestions. The chatbot will ask follow-up questions based on the patient's comments, creating an interactive and dynamic conversation flow. Assuring an accurate diagnosis and providing specialized diabetes management guidance are the objectives. For each diagnostic stage, the chatbot uses a pattern-matching method to find keywords and pertinent data in the patient's input. The steps in the procedure are as follows. First, to guarantee uniformity, all alphabetic characters are changed to lowercase after the patient's input. A word array is produced by separating words with dots, commas, and spaces. When appropriate, the chatbot replaces words with their equivalents using its knowledge base, improving the precision of keyword matching. Using the Sequence Words Deleted (SWD) technique, a list of possible input variations for matching, including sentences, phrases, and single words, is produced. Starting with whole phrases and working down to individual words, the collection of words is methodically compared to a database of "keywords". The matching procedure is customized to the conversation's particular diagnostic level.

Journal of Theoretical and Applied Information Technology
30th September 2024. Vol.102. No. 18

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

If a match is made, the matching loop is terminated, and the pertinent data is then used to direct the dialogue that follows. The Triangular Number equation is used to determine the possible size of input variation. For instance, there are a total of fifteen inputs that could match a sentence of five words if it has five terms. The diagnostic session is divided into levels, each of which has a specific set of questions. Each level's questions are given a special value called "Qid," which is then multiplied by a level-specific factor. The "Vpath" value, which denotes the interaction's path, is obtained by adding these Qid values. It should be noted that while the example shows a three-level diagnostic session, the actual session may have more levels and different quantities of questions. The open-ended nature of diagnosis and varying question counts at each level may cause the actual number of pathways to differ from the initial computed value.

4. MEASURING CHATBOT EFFECTIVENESS

Artificial intelligence and natural language processing have advanced quickly, which has prompted the widespread use of chatbots across a variety of domains. The main metrics and methods for assessing the effectiveness of chatbots are covered in this section and listed in Table 3.

These metrics can be measured using different techniques as follows. Controlled experiments can be used to compare the performance of various chatbot iterations (using various dialogue models or response techniques, for example) in order to determine which strategy is more successful in obtaining desired results. After a chatbot conversation, users can directly comment on their experience, level of satisfaction, and suggestions for improvement. Conversation analysis can assist identify areas where the chatbot may be having trouble and needs to be improved. This can be done manually or with the aid of natural language processing software. Benchmarking can examine the chatbot's performance in comparison to industry norms or those of rival chatbots can assist determine its level of effectiveness and point up potential improvement areas. Tracking over an extended length of time allows for the identification of patterns, seasonal variations, and the effects of any upgrades or modifications made to the chatbot.

Let us focus on response time. Based on how quickly the suggested chatbot system responded to input from simulated patients, its functionality was assessed. From the time the patient's input was received until the chatbot delivered a response, the response time was tracked. The investigation sought to determine how effectively the technology provided prompt and smooth discussions. A variety of simulated patient inputs representing various linguistic and contextual complexity levels were created. These inputs were specifically designed to accommodate a variety of possible user interactions. To record the precise timestamps of when a patient input was received and when the chatbot's answer was generated, a special measurement tool was constructed. The system response time is shown in figure 3 for various degrees of patient inputs.

The analysis of response times provides important information about the effectiveness of the chatbot system. The system exhibits consistent response times across various patient input levels, which points to a sturdy architecture. The response time shows some scalability in handling various user interactions even as the complexity of patient inputs rises. Measuring response times ensures a discussion flows smoothly and naturally and that they are in line with acceptable user experience standards. It's important to note that the response time analysis was conducted under controlled conditions with simulated inputs. In real-world scenarios, network latency and server load could impact response times. Optimization of pattern matching algorithms could be explored to potentially reduce processing time. Implementation of caching mechanisms for frequently matched keywords could lead to faster responses.

The research has significant implications for diabetes care and healthcare technology. By using AI-powered chatbots, it can provide personalized, real-time guidance, reducing the burden on healthcare providers and improving patient outcomes, especially in underserved areas. The approach could be scaled to manage other chronic conditions, potentially lowering healthcare costs by automating diagnostic tasks and enabling continuous monitoring.

However, addressing challenges like data privacy and ethical AI use is crucial for the successful implementation of AI-powered chatbots in healthcare. Ensuring that patient data is securely stored and protected from unauthorized access is essential to maintaining trust in the system. Additionally, the ethical use of AI involves creating

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

transparent algorithms, preventing biases in decision-making, and ensuring that patients fully understand how their data is being used. By tackling these challenges, AI chatbots can be more widely adopted, paving the way for reshaping digital healthcare delivery with reliable and secure systems that respect patient rights and enhance care quality.

5. CONCLUSION

The questions and answers for the virtual diabetes control diagnosis session must first be developed with a real diabetic physician before this chatbot concept can be put into use. In this chatbot design, we suggested using Vpath as a method for the chatbot to retain the conversational flow. We also make the user stay on the conversation topic and refrain from entering any irrelevant input (like any other chatbot program), and if they do, the chatbot will respond that the input was not understandable and keep repeating the previous question (in a polite manner) until the keywords are detected. This way, the conversation is controlled by the chatbot rather than the user (like any other chatbot program). The advice will also be given to the patient as guide for giving the queries in the right way. This design will enable the chatbot to respond to the entire discussion rather than just one input, as it is specifically made to be a virtual diabetic physician for early symptom identification on diabetes control activities.

The chatbot system uses advanced natural language processing and pattern-matching algorithms for personalized advice based on patient input. It ensures accuracy in patient interactions using techniques like keyword matching and regular refinement of language processing algorithms.

6. FUTURE WORK

Despite the chatbots' significant promise in the treatment of diabetes, there are still a number of areas that could use additional research and development to improve their effectiveness. Future studies will focus on a number of crucial topics, including the following.

6.1. Advanced natural language processing

By improving the chatbot's NLP abilities, it will be able to comprehend and react to more intricate and nuanced patient requests. More precise and detailed responses will be provided by the chatbot as its capacity to understand everyday speech and medical jargon is enhanced, resulting in improved patient-bot interactions [22].

6.2. Supporting Multiple Languages

Because diabetes affects people all over the world, support in multiple languages can help patients from a wider range of backgrounds. Future research should concentrate on creating chatbots that can communicate successfully in many languages, so that people who do not understand English can get diabetes care.

6.3. Integration with Telemedicine Platforms

By integrating chatbots with telemedicine platforms, patients and medical professionals will be able to communicate without interruption. During telehealth appointments, chatbots can act as virtual assistants, helping with data collecting, medicine reminders, and enabling remote monitoring [23].

6.4. Utilizing predictive analytics

Chatbots can foresee probable changes in a patient's blood glucose levels based on past data and unique patterns. This preventative approach can assist patients in taking precautions and avoiding serious glucose imbalances.

6.5. Emotional Support and Mental Health

It may be advantageous to increase the chatbot's capacity to offer emotional support and treat mental health issues related to diabetes management. Chatbots can provide coping mechanisms for the stress and emotional difficulties associated with diabetes, enhancing general wellbeing.

6.6. Integration with Smart Home Devices

Chatbots can improve patient convenience and data gathering by integrating with smart home devices like smart scales and glucose monitors. Through voice-activated instructions, patients can obtain real-time updates and insights on their health status.

6.7. Analysis of Longitudinal Data

Long-term research can yield insightful information about patient behavior, adherence, and health outcomes by collecting and analyzing data from chatbot encounters. The skills of the chatbot and its effects on diabetes control can be continuously improved as a result of such data-driven research.

6.8. Research Collaboration

For the development of stable and dependable chatbot systems, cooperation between AI developers, healthcare professionals, and diabetes researchers is essential. Developers can adapt the chatbot's features to suit the unique requirements of patients and healthcare professionals by incorporating medical knowledge and user feedback.

6.9. Ethical Considerations

As chatbots for diabetes treatment are developed and implemented, ongoing consideration must be given to the ethical issues of patient privacy, data security, and informed consent. Future research should concentrate on ensuring that chatbot interactions follow accepted ethical standards and laws.

In conclusion, chatbots will continue to advance in natural language processing, support for several languages, integration with telemedicine systems, predictive analytics, emotional support, and data analysis as they try to improve diabetes care. The full potential of chatbots can only be realized through collaboration between many stakeholders and ethical concerns, which will ultimately result in more efficient and patient-centered diabetes care solutions. Chatbots will become more and more important as technology develops, revolutionizing diabetes care and enabling patients to take charge of their own health.

REFERENCES:

[1] Kumar, Roshan, Purabi Saha, Yogendra Kumar, Soumitra Sahana, Anubhav Dubey, and Om Prakash. "A review on diabetes mellitus: type1 & Type2." World Journal of Pharmacy and Pharmaceutical Sciences 9, no. 10 (2020): 838-850.

[2] Hossain, Md Jamal, Md Al-Mamun, and Md Rabiul Islam. "Diabetes mellitus, the fastest growing global public health concern: Early detection should be focused." Health Science Reports 7, no. 3 (2024): e2004.

[3] Varriale, Vincenzo, Antonello Cammarano, Francesca Michelino, and Mauro Caputo. "Critical analysis of the impact of artificial intelligence integration with cutting-edge technologies for production systems." Journal of Intelligent Manufacturing (2023): 1-33.

[4] Guan, Zhouyu, Huating Li, Ruhan Liu, Chun Cai, Yuexing Liu, Jiajia Li, Xiangning Wang et al. "Artificial intelligence in diabetes management: advancements, opportunities, and challenges." Cell Reports Medicine (2023).

[5] Jawaid, Syed Adnan, and Jamshir Qureshi. "How Artificial Intelligence Technology can be Used to Treat Diabetes." (2024).

[6] Atlas, Diabetes. "International diabetes federation." IDF Diabetes Atlas, 7th edn. Brussels, Belgium: International Diabetes Federation 33, no. 2 (2015).

[7] Dankwa-Mullan, Irene, Marc Rivo, Marisol Sepulveda, Yoonyoung Park, Jane Snowdon, and Kyu Rhee. "Transforming diabetes care through artificial intelligence: the future is here." Population health management 22, no. 3 (2019): 229-242.

[8] Rigla, M., García-Sáez, G., Pons, B. and Hernando, M.E., 2018. Artificial intelligence methodologies and their application to diabetes. Journal of diabetes science and technology, 12(2), pp.303-310.

[9] Contreras, I. and Vehi, J., 2018. Artificial intelligence for diabetes management and decision support: literature review. Journal of medical Internet research, 20(5), p.e10775.

[10] Kerr, D. and Klonoff, D.C., 2023. Using ChatGPT to predict the future of diabetes technology. Journal of Diabetes Science and Technology, 1, p.2.

[11] Abu Sawar, Atwell, "Chatbots: are they really useful? ", LDV-Forum – Band 22(1) – 31-50, 2007. Diabetes Atlas, third edition, International Diabetes Federation, 2006.

[12] Webber, G. M., "Data Representation and Algorithms for Biomedical Informatics Applications, " PhD thesis, Harvard University, 2005.

[13] Dankwa-Mullan, I., Rivo, M., Sepulveda, M., Park, Y., Snowdon, J. and Rhee, K., 2019. Transforming diabetes care through artificial intelligence: the future is here. Population health management, 22(3), pp.229-242.

[14] Ellahham, S., 2020. Artificial intelligence: the future for diabetes care. The American journal of medicine, 133(8), pp.895-900.

[15] Sng, G.G.R., Tung, J.Y.M., Lim, D.Y.Z. and Bee, Y.M., 2023. Potential and pitfalls of ChatGPT and natural-language artificial intelligence models for diabetes education. Diabetes Care, 46(5), pp.e103-e105.

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

[16] Valafar, Faramarz. "Pattern recognition techniques in microarray data analysis: a survey." Annals of the New York Academy of Sciences 980, no. 1 (2002): 41-64.

[17] Wynants, Laure, Ben Van Calster, Gary S. Collins, Richard D. Riley, Georg Heinze, Ewoud Schuit, Elena Albu et al. "Prediction models for diagnosis and prognosis of covid-19: systematic review and critical appraisal." bmj 369 (2020).

[18] Gupta, Aishwarya, Divya Hathwar, and A. Vijayakumar. "Introduction to AI chatbots." International Journal of Engineering Research and Technology 9, no. 7 (2020): 255-258.

[19] Singla, Rajiv, Ankush Singla, Yashdeep Gupta, and Sanjay Kalra. "Artificial intelligence/machine learning in diabetes care." Indian journal of endocrinology and metabolism 23, no. 4 (2019): 495.

[20] Vettoretti, Martina, Giacomo Cappon, Andrea Facchinetti, and Giovanni Sparacino. "Advanced diabetes management using artificial intelligence and continuous glucose monitoring sensors." Sensors 20, no. 14 (2020): 3870

[21] Musacchio, Nicoletta, Annalisa Giancaterini, Giacomo Guaita, Alessandro Ozzello, Maria A. Pellegrini, Paola Ponzani, Giuseppina T. Russo, Rita Zilich, and Alberto de Micheli. "Artificial intelligence and big data in diabetes care: a position statement of the Italian Association of Medical Diabetologists." Journal of Medical Internet Research 22, no. 6 (2020): e16922.

[22] Liednikova, Anna. "Human-Machine Dialogue in the Medical Field. Using Dialog to Collect Important Patient Information." PhD diss., Université de Lorraine, 2022.

[23] Chiru, Alice Lavinia, Imad Alex Awada, and Adina Magda Florea. "A support process of telemedicine applications that integrates a chatbot." In 2021 International Conference on e-Health and Bioengineering (EHB), pp. 1-4. IEEE, 2021.

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

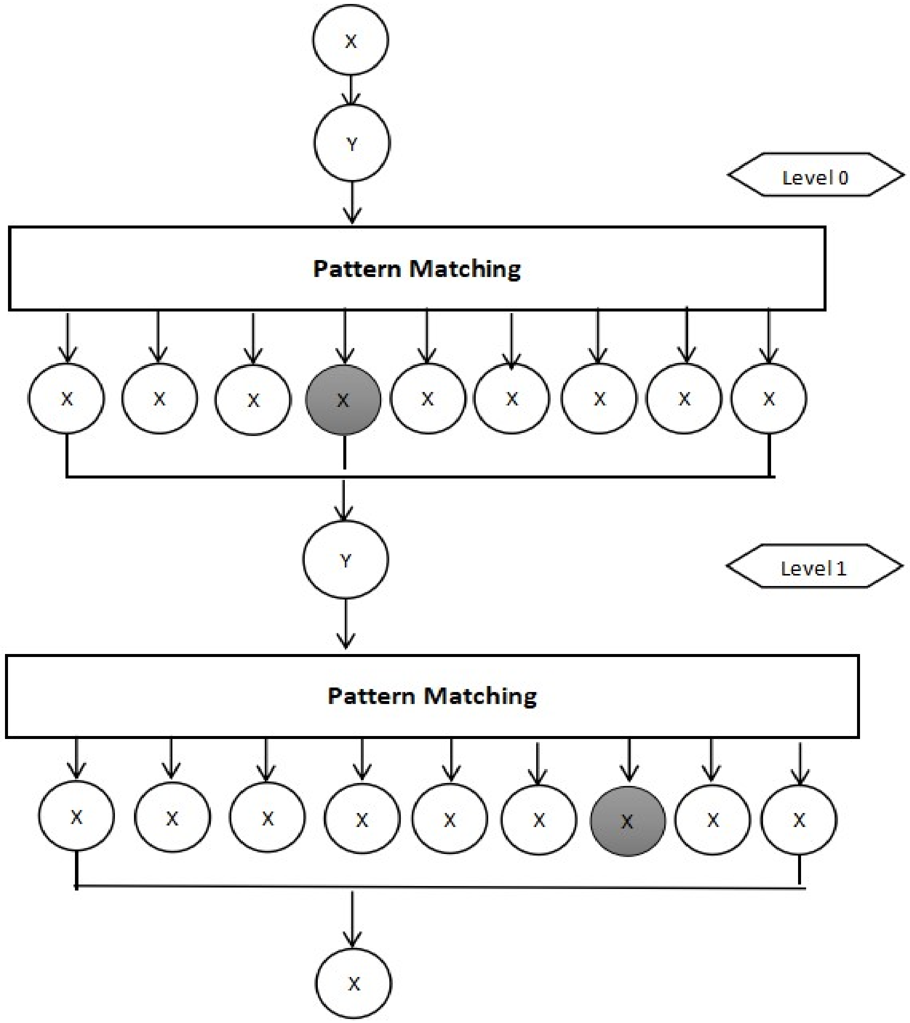

Figure 1: A sample of path taken by patient

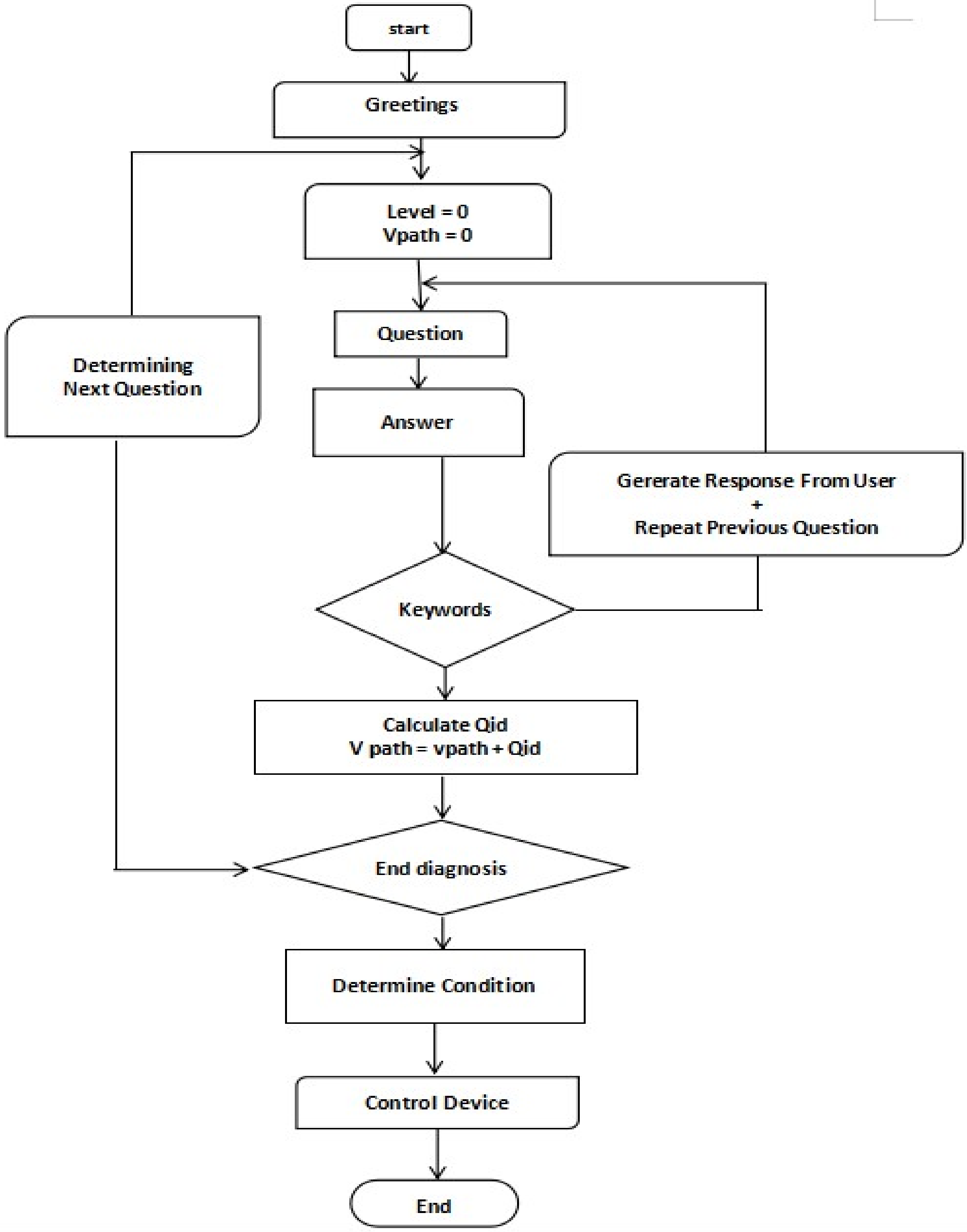

Figure 2: The flow of a patient conversation

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

Table 1: Possible Input to be Match for 5 word Input Sentence

Word 1	Word 2	Word 3	Word 4
Yesterday	My	Hurt	Badly
Yesterday	My	Hurt	
	My	Hurt	Badly
Yesterday	My		
	My	Hurt	
		Hurt	Badly
Yesterday	My		
	My		
		Hurt	
Yesterday		Hurt	Badly
	My		
		Hurt	
			Badly

Table 2: Steps of matching patterns and finding keywords

Step	Description
Normalization	To establish consistency in text processing, the patient's input sentence is changed to lowercase
Tokenization	The input sentence is broken up into its individual words using the separators dot, comma, and space
Keyword Database	A database of keywords relating to the signs, symptoms, and linked terms of diabetes is kept
Word Replacement	Some words in the input may be changed to their keyword database equivalents
Sequence Words Deleted (SWD)	A list of possible input variations (sentences, phrases, and words) is produced using the SWD technique
Matching	The chatbot systematically matches the input array against the keyword database, starting from complete sentences and proceeding to individual words. Matching is context-sensitive based on current conversation level
Keyword Identification	If a match is found, the chatbot identifies relevant keywords in patient's input

Journal of Theoretical and Applied Information Technology
30th September 2024. Vol.102. No. 18

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

Table 3: Metrics of chatbot performance

Metric	Description
Response Time	A chatbot's performance is heavily influenced by how quickly it responds to user inquiries. Faster response times frequently result in higher customer satisfaction and more effective user interactions
Resolution Rate	This statistic shows the proportion of user inquiries that the chatbot effectively answers without human assistance. A chatbot that responds to user needs more effectively has a better resolution rate.
User Satisfaction	Businesses can determine how satisfied consumers are with the service offered by the chatbot by conducting post-interaction surveys or sentiment analyses of user discussions. A successful chatbot will have high user satisfaction
Completion Rate	The percentage of user interactions that are successfully carried out through to completion (for example, making a purchase or addressing a problem) is known as the completion rate. A high completion rate reflects user journeys that are effective. The percentage of conversations that the chatbot cannot handle and must transfer to a human agent is represented by the escalation rate measure. A declining escalation rate suggests that the chatbot is becoming more adept at addressing tough questions.
Engagement Rate	Measuring the number of times users actively interact with the chatbot as opposed to leaving the conversation will assist determine how effective the chatbot is at retaining users' attention and involvement
Churn Reduction	In customer service scenarios, a decrease in the proportion of consumers who leave a discussion early or choose to contact assistance via alternative channels as a result of discontent shows the chatbot is having a positive impact

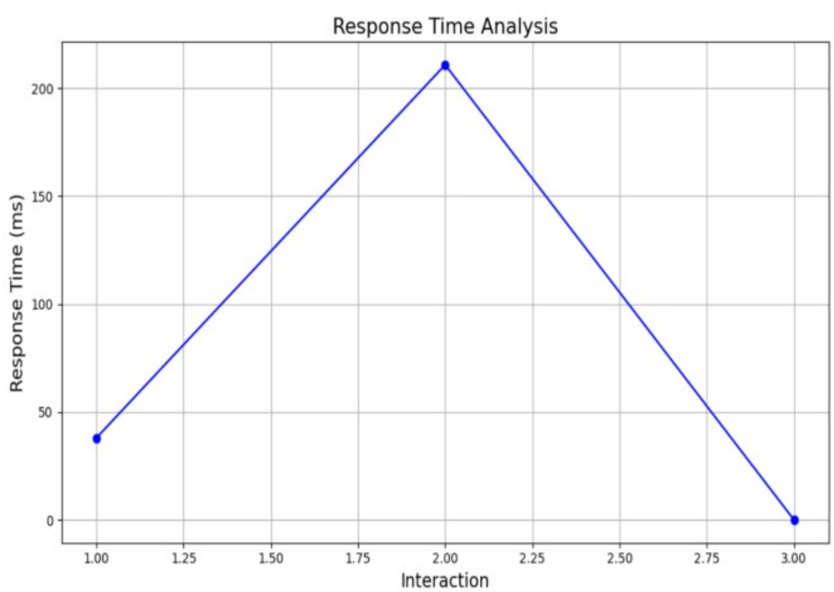

Figure 3: The complexity of patient inputs (level) is shown on the x-axis of the figure, along with the response time (in milliseconds) on the y-axis