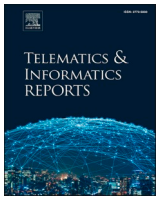
Telematics and Informatics Reports 15 (2024) 100153

Contents lists available at ScienceDirect

Telematics and Informatics Reports

journal homepage: www.elsevier.com/locate/teler



Network-integrated medical chatbot for enhanced healthcare services

Sara Hemdi Alqaidi *, Shahad Mohammed Albugami, Waad Saeed Alzahrani, Sahar Badri, Arwa Wali

Department of Information Systems, College of Computer Sciences and Information Technology, King Abdulaziz University, Jeddah, Saudi Arabia

ARTICLE INFO

Keywords:
Artificial intelligence
Chatbot
Dialog flow
Medical care

ABSTRACT

Technology has a significant role in improving medical care, such as enhancing communication between patients and healthcare virtual assistants. By including artificial intelligence and natural language processing (NLP), the main aim of this research paper is to design a medical chatbot framework, and application design prototype, and use the Dialog Flow tool to build an auto-response system known as a chatbot. The goal is to provide medical services and meet patients' needs. It will communicate with the user in the language they follow. With the help of keywords such as symptoms entered by the patients, it will help to identify the disease. Moreover, the application provides the patients with the ability to record their medicine to remind them to take it. Additionally, it will make it easier for patients to learn more about their disease and motivate them to take the necessary precautions to stay healthy.

1. Introduction

Artificial intelligence (AI) possesses the capability to revolutionize numerous dimensions of our lives [1]. It encompasses algorithms and models that can drive conclusions from historical data to formulate predictions for the future [2]. The interest has been raised in healthcare providers toward adopting new technologies [3]. Chatbots are among various applications of AI that are virtual conversational agents that empower users to engage with AI-drive computers through text-based communication methods [4]. After 2016 chatbots were narrated as essential technological software and now health care providers are utilizing medical-related chatbots for question and answer, saving patient records, providing information regarding the disease, taking action depending on the patient responses, and discussing the outcomes of clinical tests [4]. Chatbots successfully convey information to the individual that can be understood and comprehended by everyone. Moreover, the current opinion of the public and continuous improvement in machine learning, NLP, and technologies related to the internet indicated that chatbots can become more advanced and have the potential that it can surpass humans both in accuracy and speed [5]. Medical bots can communicate with the individual to provide guidance related to health-related issues, further, if it cannot detect the requirement of the individual, the chatbot can give a list of options for guidance purposes [6].

Medical chatbots were developed to engage patients in a discussion about their health concerns and symptoms and employ a question-and-answer approach. Based on the provided symptoms, patients can ascertain their diagnosis [4]. Among all those technologies, chatbots, empowered by AI, have potentially impacted us the most and have a crucial role in our daily lives and in changing the world for the better. The majority of chatbots read user input using natural language processing (NLP), keywords from the text are matched over a predefined pattern and then it delivers a response based on the results [7,8]. Previous research studies have documented the effectiveness of medical chatbots in tasks like prompting and monitoring medical adherence. The satisfaction level of patients suffering from cancer has been noted to increase after engaging in conversation with chatbot [9]. When the COVID-19 pandemic occurred, medical chatbots diagnosed correctly more than 96% of patients infected with coronavirus patients [10].

Divya et al. [8], proposed an idea to create a conversational framework using artificial intelligence to assist patients in reducing consultation with a doctor. The goal was to build a budget-friendly system that saves the time and traveling costs of the patient. The patients can interact directly with the chatbot by entering their symptoms and retrieving knowledge about their medical conditions. A recent study states that with the help of a voice recognition chatbot, any individual can excess these services from any geographical location. This software is designed to respond to the query of users using [11]. In addition,

* Corresponding author.
E-mail address: skbadri@kau.edu.sa (S.H. Alqaidi).

https://doi.org/10.1016/j.teler.2024.100153
Received 26 December 2023; Received in revised form 22 May 2024; Accepted 5 July 2024
Available online 6 July 2024

Divya et al. [8] proposed a self-diagnosis medical chatbot with the help of AI that can assist patients in reducing doctor's appointments. It was designed to diagnose the patient's disease and deliver them related information such as disease identification and treatment.

Moreover, another group of researchers developed a chatbot-related medical application that will lessen the burden on the physicians delivering the answer to the user and also save their important time in consulting the expert using an AI-based system. Chow et al. [12] developed an AI-based chatbot that makes knowledge of radiotherapy accessible to the public with the use of the IBM Watson Assistant platform on IBM Cloud. The author states that there is still a need to improve the conversation approach of chatbots to enhance the interaction of users. By adding the ability of translation to deal with the first language of the individual. The IoT-based chatbot can be developed by utilizing a dialogue tree and layered structured approach in the field of radiotherapy for education purposes. With the help of features of AI and NLP offered by platforms like IBM Watson Assistant, the education chatbot can be developed with a humanoid character. However, it requires to update on a regular basis to answer the needs of the user [13]. IoT has provided interaction with a high number of datasets around the globe with the help of utilizing the internet [14].

Despite these notable advantages, medical chatbots confront various obstacles including the delivery of correct information and maintaining patients' privacy [4]. Patients could potentially be provided with incorrect diagnostic outcomes and treatment recommendations, thereby prompting apprehension regarding the reliability of the service provider [15]. If the personal information falls into the possession of unauthorized individuals' patients can face potential discrimination [16]. Even with advancements in Chatbot technology, patients will still require access to care overseen by human professionals [17]. The ChatGPT has the capability to enhance access to services of healthcare. One of the concerns is the reliability and accuracy of the medical information given by Chatbot, as it does not contain any licensed medical professional there are chances that it does not have access to the latest knowledge related to medical issues [18]. Healthcare organizations are applying novel technologies significantly. However, the consideration of security and privacy has been overlooked, which puts organizations of healthcare at risk for issues related to privacy and security which damage their reputations. The author stated that it is necessary to re-examine architectural design in the setting of healthcare to ensure the security and privacy of the patient [19].

Healthcare has become very important for living a good life in today's world. However, it has become difficult to obtain a doctor's advice due to some circumstances, such as the high costs of medical consultations that some patients cannot afford, transportation, or the lack of available appointments. Most of the previous solutions focused on applying chatbot systems to diagnose specific types of diseases such as COVID-19 or cancer [20,21]. Additionally, the implementation of medical Chabot strongly relies on AI algorithms rather than applications. For this reason, the current study aims to build a text-to-text bot using Dialog flow which will communicate with the patients about their health issues and give them a diagnosis based on the symptoms they will provide, hence, revolutionizing health care. Furthermore, it will send a reminder message to prompt the user to take the medicine.

2. Literature review

We review the previous literature in which Malik et al., [22] examine the factors that influence the surrounding perception of social bot fairness and the influence of these elements on the experience of the user with the help of data gathered by professionals coming from various backgrounds. The outcomes of the study revealed that the users had positive experiences after using AI-based social bots. The participants stated that the utilization of these bots has undeniable benefits like the ability to work consistently, lessen cost, interaction in natural language, and management of tasks. Several participants stated that instant messaging was more helpful as compared to the internet or email. A study developed the framework of MarkBot, a chat robot on principles of design management. The study utilizes applications of AI to answer the visitors of the website through the catalog of products. The study utilizes the long short-term memory recurrent neural network (LSTM) algorithm of deep learning to predict the responses of the user with the help of a chatbot. The study made an important contribution to the practical aspects of the conversation with a chatbot, particularly focusing on the language domain [23].

Another study evaluates how chatbots are driven by AI and influence the experience of the user. The research gathered data from 1064 customers who have utilized the service of chatbot from top brands in the USA. The outcomes of the study indicated that social presence media appeal, and entertainment-related information utilized from chatbots by customers had satisfied experience. It also revealed that satisfaction with the user experience positively impacted both the loyalty of customers and the continual service of chatbots [24]. Recently a study discussed how responsible AI for organizations, stakeholders, and customers is because still the vulnerabilities of AI can be reduced. The study reveals that AI cannot compete with emotional intelligence or humans in the economy. However, since the bias research of AI is still ongoing in all domains of management and future there will be more novel opportunities for the organization, policies, or more searches that can be initiated to reduce the bias [25]. A study integrates anthropomorphic methods in designing the chatbot. They found that the quality of the system, quality of information, and self-efficacy contribute higher amount of Cognitive absorption among chatbot users. The outcome indicated how a minor amount of improvement in anthropomorphic chatbots can improve the perception of chatbots, and alter the interaction of human-computer [26].

Based on previous studies, there is a diversity in the purposes of medical chatbots and various techniques used. Each study has its features and limitations, the common limitation is the lack of a mobile application with a simple and modern user interface, also most of the diagnosing frameworks don't provide the feature of medicine time reminder.

3. Method

3.1. Study design

The data was collected from different sources such as IEEE and Google Scholar within a specific time frame of 2018 – 2022. The keywords used to search were "Framework", "Chatbot", "Application", "DialogFlow", "System", "Medical", "Medical Diagnosing" and "Healthcare". A different combination of these keywords was used to discover the medical framework-based research papers.

3.2. Storing data

The data about the diseases and their symptoms were gathered from the Kaggle website with two datasets that contain diseases, their symptoms, and precautions to be taken. Udyawar [27], created the first dataset, which includes 18 columns and 314 rows of different symptoms of the diseases. Patil [28], has created the second dataset, which includes 18 columns and 4921 rows. The data will be used in training the chatbot, as the symptoms of various diseases will be included in the chatbot so that the chatbot can distinguish the symptoms of disease entered by the patient using keywords and provide the patient with the correct diagnosis.

3.3. Designing and software

The operational and non-operational requirements were identified, and the main components of the framework were defined. The operational requirements are the main operations or activities the structure

should perform to achieve its goal such as the chatbot allows the user to answer frequently asked questions related to symptoms. It allows the user to interact effectively with a chatbot to get knowledge about the disease easily. Non-operation requirements outline structure behavior and properties that affect the user experience. The two non-operational requirements in this project are System security and privacy, and Usability. The Software resources required to carry out the chatbot are Adobe XD (Adobe Inc) and Dialog Flow (Google Cloud Platform) which is a platform that permits users to design and integrate a conversational graphical user interface into a smartphone application. It will be used to build a chatbot.

3.4. Proposed framework

Our conceptual framework of the medical chatbot consists of three main components which are the end-user (manages natural language dialog with the user), Dialog flow (extracts user intents), and fulfillment (supports database). It was designed and chosen after looking at various frameworks with similar ideas to ours. The proposed structure helps to develop a conversational representative analyzed by its ability to respond to any medical conditions with different common illnesses by extracting the proper intent based on symptoms entered. Fig. 1 shows the steps of the framework and is presented as follows: A user sends a text message with symptoms to the device. Dialog flow receives this message from the device which will be processed by Dialog flow and matches a corresponding intent. Dayglow sends a request to an external API to fetch related information and Extract data from the database. Dialog flow receives the processed information and the data will be sent to the output device containing the appropriate diagnosis. The user will get a response in the form of text.

The medical chatbot proceeds from the extraction of symptoms to mapping symptoms based on the keywords predefined in the database. During this process, each symptom will be compared with symptoms of common diseases that are stored in the database. Once the first symptom has been checked, the next is checked until a match is found. A shortlist of diseases is generated depending on the input end users made on the evaluation of the question. Finally, the chatbot will identify and specify the accurate disease to the end user.

The most popular terms used in Dialog flow are intent and agent. The intent describes an end-user's intention for each chat where the agent is built to handle different questions from the end users. For each agent, the question may have multiple purposes, where purposes can answer a specific question. When an end-user writes or possesses a question, indicated as an end-user expression, the agent in Dialog flow will match this expression with all intents and allocate the best. This workflow is also known as intent classification. Fig. 2 below shows the basic flow for matching the intents when the user asks a question in the Dialog Flow.

4. Results

The individual will engage based on text communication with the medical chatbot, either to diagnose the symptoms or to set reminders for the medicine. In the first case shown in Table 1, the user will enter their symptoms and the chatbot will match the keywords to provide an appropriate diagnosis.

In the second case, the chatbot will question the individual regarding the medicine details, then a notification will be sent to remind the patient. As shown in Figs 3 and 4, a fast test was conducted during the training process to quickly assess how the chatbot responds. Moreover, the chatbot was tested with 10 diseases to evaluate its performance and all tests were passed.

5. Discussion

In this study, we design and train a virtual assistant (Chatbot) to interact with the patients using Dialogflow which will help patients diagnose their disease by just writing the symptoms. Similarly, Madhu et al. [29] proposed a novel AI approach to provide medical assistance for patients via a trained chatbot to ascertain the correct treatment for their medical condition. In the model, AI plays a key role in identifying a range of treatments depending on the disease determined by the symptoms that patients entered into a chatbot. Dharwadkar [30], proposed the idea of developing a medical chatbot using Natural language processing (NLP) that can help patients to solve problems related to their health. Specifically, by leveraging the text-to-voice conversion and voice-to-text in Google API. Another researcher, Khilji [31], proposed the idea to provide a prototype system architecture with a sufficient dataset. The prototype system architecture with its self-created dataset will be analyzed using different parameters by a variety of experts. A recent study observed that chatbots save time by taking on repetitive tasks that contribute to clinician burnout. Hence this study coincides with the aim of our study which was to reduce waiting time in making an appointment in a hospital and and lessen traveling costs. Medical chatbots represent a promising avenue for delivering healthcare facilities, and healthcare institutes should be aware of the factors that drive individuals to utilize chatbots. Research revealed that perceived convenience and health information are predictive of individuals toward medical chatbots [32].

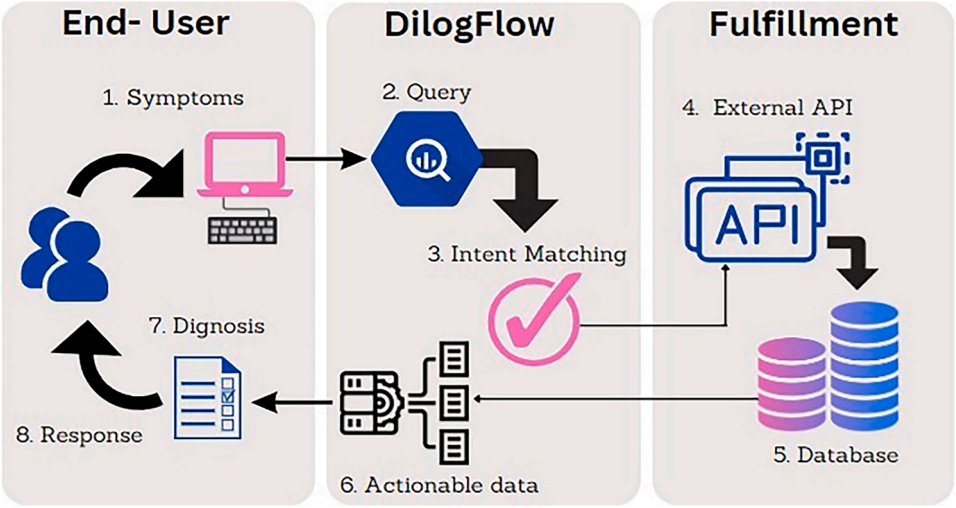


Fig. 1. Conceptual framework.

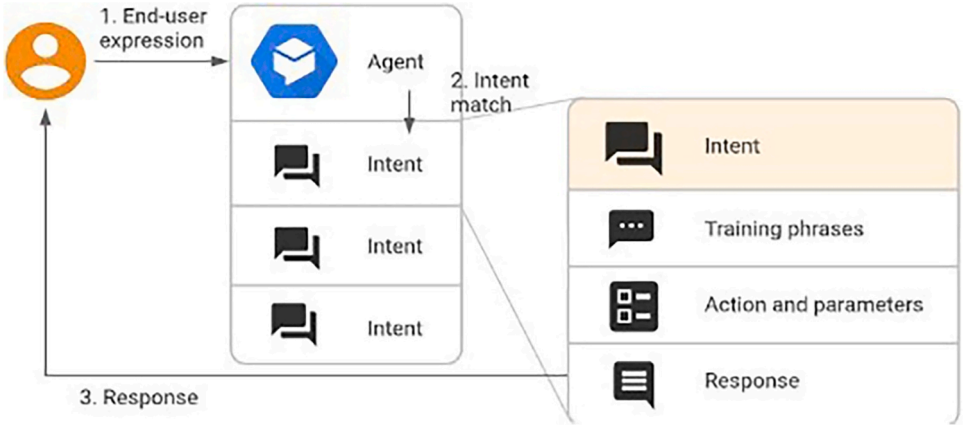


Fig. 2. Workflow.

Table 1
Results of application

Disease	Symptom 1	Symptom 2	Symptom 3	Result
Dengue Fever	Skin rashes	Vomiting	Fatigue	✓
Hypertension	Dizziness	Lack of concentration	Headache	✓
Diabetes	Weight loss	Urinary frequency	Lethargy	✓
Anemia	Irregular heartbeat	Loss of balance	Pale skin	✓
Bronchitis Asthma	Cough	Breathlessness	Mucoid sputum	✓
Eczema	Itching	Drought	Skin irritation	✓
Alopecia Areata	Black spots on the scalp	Scalp pain	Baldness	✓
High Cholesterol	Migraines	Leg pain	Shortness of breath	✓
Helicobacter Pylori	Abdominal pain	Heartburn	Lack of appetite	✓
Vitamin D Deficiency	Tiredness	Bone pain	Depression	✓

Mathew et al. [7], proposed the idea was creating a medical chatbot system. The system allows patients to log in, and the patient engages with the framework, words are identified using NL, and then the K-Nearest Neighbor (KNN) algorithm can identify the disease based on the information and suggest the appropriate treatment for the patient. Athota [33], proposed the idea of a chatbot for the Healthcare System using AI that recognizes the keywords of sentences, inquires, and provides the answer. Additionally, the similarity of N-gram, TF-IDF, and cosine is used to calculate the similarity of sentences and ranking. In the past few years, several healthcare chatbot applications have entered the market.

Many mobile applications have also been built recently such as Google Bert, A BERT language model is based on machine learning techniques which is considered a Transformer developed by Google researchers for natural language processing (NLP). It was developed for utilizing question-and-answer data, similar to Squad. BERT unlike various deep learning models, including long short-term memory networks (LSTM) takes the whole sentence as insert consecutively [34]. Another application was established known as Mandy which is a smartphone chatbot that engages with users using natural language, takes their symptoms, makes a preliminary diagnosis, and produces reports. It will provide a report on the patient's symptoms and their potential causes and offer the doctors a desktop application to examine their patients' records and reports [35]. During COVID-19 times, the CoronaGo website was designed and created to assist patients suffering from coronavirus. It assists by providing citizens with government helpline numbers. Additionally, it assists patients by presenting all the World Health Organization's recommendations (WHO) [36].

Furthermore, Medbot was created to use chatbot technology to provide medical consultation services. The chatbot of the system uses an intent-based approach and is deployed in the Line application for Instant Messaging (IM). Conversational phrases are sent to the application by the user. The application then sends the message to Dialogflow, the chatbot's engine. To determine the intent, the message is extracted. The training phrase is used to specify the response to the message's intent. The system may sometimes need to retrieve data from an external database or other APIs to respond to the request message. The necessary coding is required to accomplish this. Following that, the systems will produce actionable data that the user can recognize and send back to the application. In the end, the user will get responses in text, image, audio, or video formats [37].

Moreover, a framework Chameleon created conversational agents designed for medical training objectives, utilizing Dialogflow. The purpose of this framework was to build a chatbot based on virtual patients to allow medical students to demonstrate their clinical skills within a standardized medical scenario. The main components in the framework were the intents, generic clinical questions, and medical experts. Each question has its intent that can be extracted from 180 intents [38].

Mahajan et al. [39] developed a chatbot for healthcare that can identify diseases using Natural Language Processing, a branch of Artificial Intelligence. First, the discussion can be initiated by an individual with the chatbot and the symptoms will be stored in the database for further use. A series of questions will be used by the chatbot to identify the individual symptoms. If it's major, the user will be given recommendations for a nearby doctor for additional care, shown the analgesics, and given advice on what foods they should eat to recover from the disease. If it's minor, the chatbot will display the disease and analgesics.

A study reports the latest advancement in the technology of chatbots in the field of medicine. The outcomes of the study found that even after developing the efficacy of medical chatbots, the element of humans cannot be replaced. Hence chatbots have the capability to lessen the cost and can work along with the health care practitioners, enhancing the efficiency of workflow and outcomes of the patient. The study further stated that more improvement in patients' quality care, and clinicians' workload can be enhanced by advancements in the technology [40].

Based on previous studies, there is a diversity in the purposes of medical chatbots and various techniques used. Each study has its features and limitations, the common limitation is the lack of a mobile application with a simple and modern user interface, further, most of the diagnosing frameworks do not provide the feature of medicine time reminder. To solve these gaps, the research developed a framework for a medical chatbot that recognizes the symptom and identifies the disease

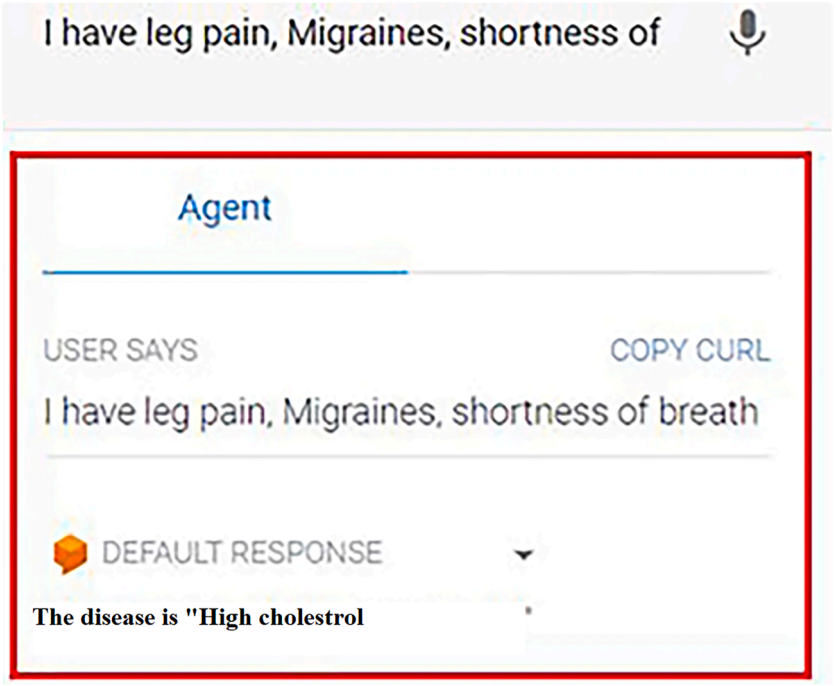


Fig. 3. Agent section.

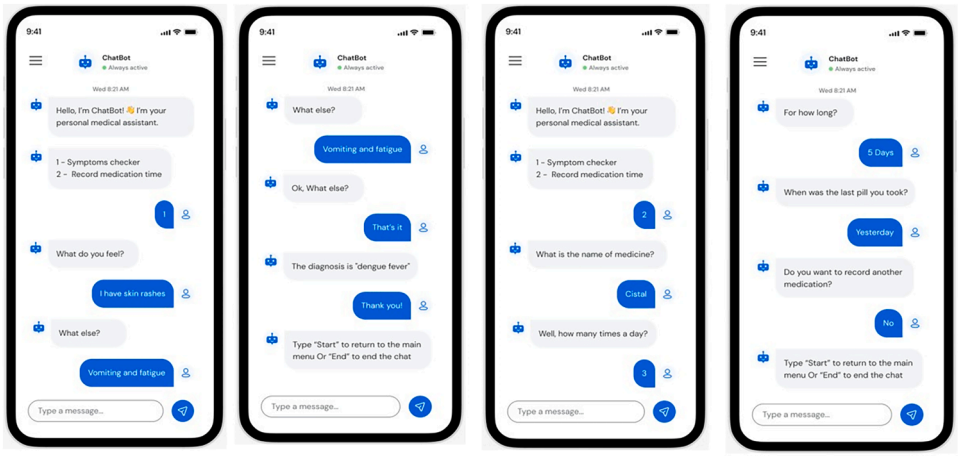


Fig. 4. Response of chatbot.

while also having a function of medicine reminder which details will be added by the patient.

AI and chatbots are revolutionizing the automation of marketing and healthcare by streamlining processes, improving efficiency, improving outcomes for patients, and lessening the cost of healthcare. The AI and medical chatbot allow to planning of diagnosis of disease and treatment which assists physicians in making improved and informed decisions and offering more personalized care. The analytics of AI and prediction are utilized to identify the risk factors and improve the care of patients including the customer and patient experience [41]. Individuals can certainly benefit from AI-powered chatbots if they identify numerous kinds of diseases and extract essential information. These bots allow users to examine their medicinal problems and provide a personalized examination report concerning the symptoms [42].

In marketing, customer interaction generates leads, and provides 24/7 customer support, freeing human representative to focus on complex issues. Additionally, AI can analyze engagement metrics, while predictive metrics can identify customer behavior, and preferences, enabling proactive marketing strategies. The combination of AI models with techniques of natural language processing (NLP) has been trained on large data from several organizations and industries, in the sector of digital marketing which gain insights from preferences, behavior, and conversations of customers [43]. This helps organizations to make more significant and effective marketing strategies, which provide personalized services, and improve decision-making for cost-effectiveness. NLP techniques can examine the customer's conversation in real time, enabling organizations to collect timely data on the preferences and sentiments of customers [44].

The present study makes a significant contribution to the development of AI chatbots in healthcare by introducing medicine feature innovation. This innovation has the potential to improve medication adherence rate, reducing the risk of treatment failure. By providing personalized healthcare reminders and management tools, the chatbot enhances patient engagement and empowerment, supporting individuals in taking control of their health. Additionally, the chatbot streamlines patient communication and reduces the burden on

administration as it advances the field of digital health and patient care. It contributes to the growing body of knowledge on the intersection of technology and healthcare by addressing the healthcare challenges.

One notable limitation of the study lies in the ethical concern associated with relying fully on an AI-powered medical chatbot for disease diagnosis and medication reminders. While the technology holds great promise, the potential for misdiagnosis or error introduces ethical considerations that cannot be overlooked. Dependence on AI for medical decisions raises questions about accountability, transparency, and the ethical responsibility of healthcare providers and developers. Users may place undue trust in the chatbot, and there is a risk of overlooking the importance of human expertise in complete medical sceneries. Additionally, concerns related to privacy and data security must be carefully addressed to safeguard sensitive health information.

6. Implications

6.1. Theoretical implications

The integration of disease diagnosis based on user-entered symptoms and a medicine time reminder feature into the medical chatbot carries several theoretical implications that extend our understanding of human interaction, healthcare delivery, and the role of technology in shaping health outcomes.

The study contributes to the HCI theories [45] by exploring the effectiveness of NLP and AI in facilitating meaningful interactions between users and the medical chatbot. Insights gained from user interactions, feedback, and the usability of the diagnostic and reminder feature can inform the evolution of HCI principles in the context of healthcare technology.

Theoretical frameworks like the Technology Acceptance Model (TAM) [46] can be used to assess users' acceptance and adoption of medical chatbots. Understanding factors influencing user acceptance, such as perceived usefulness and ease of use, contributes to the broader discourse on the integration of advanced technologies in healthcare.

The framework related to health behavior change, such as the Health Belief Model or the Theory of Planned Behaviour can be applied to understand how the chatbot's diagnostic insights and medication reminders influence user behavior. The study may provide insights into the mechanism through which technology can positively impact health-related discussion-making and adherence to prescribed health regimens.

6.2. Practical implications

Firstly, the diagnostic functionality significantly contributes to early symptom recognition and health awareness. Users can input their symptoms, and the chatbot, leveraging AI and NLP can provide preliminary insights into potential health conditions. This not only empowers users to proactively their health but also facilitates early intervention potentially improving health outcomes. Moreover, by enabling users to access health information promptly, the chatbot may alleviate the strain on traditional health systems, particularly for non-emergency cases.

Secondly, the medicine time reminder feature addresses a critical aspect of healthcare medication adherence. for individuals managing chronic conditions, timely and consistent medication intake is crucial. the chatbot's reminder system assists users in adhering to their prescribed medicine schedules, promoting better disease management. this can have cascading effects on health outcomes, reducing the risk of complications a hospitalization.

The combined functionality of diagnosis and medication reminders creates a comprehensive and personalized health management tool. user only gain access to health information but also receive proactive support in adhering to their treatment plan.this holistic approach aligns with the broader paradigm of patient-centered care, promoting a more engaged and empowered patient population.

However, it is paramount to address certain considerations. the accuracy and reliability of the diagnostic feature must be rigorously validated to ensure that users receive trustworthy information. Moreover, privacy and data security must be prioritized, given the sensitive nature of the health-related data compliance with healthcare regulations and standards, such as the Health Insurance Portability and Accountability Act (HIPAA), is essential to establish trust among users and healthcare professionals.

7. Conclusion

This study discusses the implementation of a medical chatbot application based on Dialog flow and predefined training data, in order help individuals to conserve time in seeking healthcare solutions from doctors. One of the most powerful features of the application is the presence of a chatbot which is developed using Dialog Flow technology and Natural Language Processing which will help patient to diagnose their disease. the chatbot was trained for 10 diseases. A review of various journals indicates that chatbots are user-friendly and can be used by anyone who has access to a computer or a mobile device, regardless of their native language. Finally, the medical profession would be improved by implementing personalized medicine successfully.

Due to time constraints, the application relies on a text-based conversation between the chatbot and the patient, in which the user specifies the symptoms and the chatbot shows the appropriate diagnosis. However, in the future, to handle all types of diseases, the medical chatbot's efficiency could be expanded by augmenting additional lexical combinations and making more utilization of the information. Moreover, voice-based conversation can be added to the system to make it easier to use.

Funding source

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

CRediT authorship contribution statement

Sara Hemdi Alqaidi: Funding acquisition, Formal analysis, Data curation. **Shahad Mohammed Albugami:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision. **Waad Saeed Alzahrani:** Supervision, Software, Resources, Project administration. **Sahar Badri:** Resources, Project administration, Methodology, Investigation. **Arwa Wali:** Visualization, Validation, Resources, Project administration.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

References

[1] C. Wang, T.S. Teo, M. Janssen, Public and private value creation using artificial intelligence: an empirical study of AI voice robot users in Chinese public sector, IJIM 6 (2021) 102401.

[2] S. Yasar, C. Colak, S. Yologlu, Artificial intelligence-based prediction of Covid-19 severity on the results of protein profiling, 2021.

[3] T.B. Kim, C.T.B. Ho, Validating the moderating role of age in multi-perspective acceptance model of wearable healthcare technology, Telemat. Inform. 61 (2021) 101603.
[4] A. Rese, L. Ganster, D. Baier, Chatbots in retailers' customer communication: How to measure their acceptance? J. Retail. Consum. 56 (2020) 102176.
[5] N. Rebelo, L. Sanders, K. Li, J.C. Chow, Learning the treatment process in radiotherapy using an artificial intelligence–assisted chatbot: development study, JMIR 6 (2022) e39443.
[6] D. Kovacek, J.C. Chow, An AI-assisted chatbot for radiation safety education in radiotherapy, IOP Sci. Notes 2 (2021) 034002.
[7] R.B. Mathew, S. Varghese, S.E. Joy, S.S Alex, Chatbot for disease prediction and treatment recommendation using machine learning, in: 2019 3rd International Conference on Trends in Electronics and Informatics, 2019, pp. 851–856.
[8] S. Divya, V. Indumathi, S. Ishwarya, M. Priyasankari, S.K. Devi, A self-diagnosis medical chatbot using artificial intelligence, J. Web Dev. Web Des. 3 (2018) 1–7.
[9] E. Hussein, S. Daoud, H. Alrabaiah, R. Badawi, Exploring undergraduate students' attitudes towards emergency online learning during COVID-19: A case from the UAE, Child Youth. Serv. Rev. 119 (2020) 105699.
[10] Z. Deng, X. Mo, S. Liu, Comparison of the middle-aged and older users' adoption of mobile health services in China, Int. J. Med. Inform. 83 (2014) 210–224.
[11] S.J. Du Preez, M. Lall, S. Sinha, An intelligent web-based voice chatbot, in: IEEE Euro Conference, 2009, pp. 386–391.
[12] J.C. Chow, V. Wong, L. Sanders, K. Li, Developing an AI-assisted educational chatbot for radiotherapy using the IBM Watson assistant platform, InHealthcare 11 (2023) 2417. MDPI.
[13] J.C. Chow, L. Sanders, K. Li. Design of an educational chatbot using artificial intelligence in radiotherapy. 4 (2023) 319-32.
[14] A. Kumari, S. Tanwar, S. Tyagi, N. Kumar, Fog computing for Healthcare 4.0 environment: opportunities and challenges, Comput. Electr. Eng. 1 (2018) 1–3.
[15] M. Herz, P.A. Rauschnabel, Understanding the diffusion of virtual reality glasses: the role of media, fashion, and technology, Technol. Forecast. Soc. Change 138 (2019) 228–242.
[16] H. Jafarkarimi, R. Saadatdoost, A.T.H. Sim, J.M. Hee, Behavioral intention in social networking sites ethical dilemmas: an extended model based on the theory of planned behavior, Comput. Hum. Behav. 62 (2016) 545–561.
[17] M. Bates, Healthcare chatbots are here to help, IEEe Pulse 10 (2019) 12–14.
[18] J.C. Chow, L. Sanders, K. Li, Impact of ChatGPT on medical chatbots as a disruptive technology, Front. Artif. Intell. 6 (2023) 1166014.
[19] S Tanwar, S Tyagi, N Kumar, Security and privacy of electronic healthcare records: concepts, paradigms, and solutions, IET (2019).
[20] "JMIR cancer - Chatbot for health care and oncology applications using artificial intelligence and machine learning: systematic review." https://cancer.jmir.org/2021/4/e27850/(accessed Sep. 26, 2022).
[21] A.K. Pandey, R.R. Janghel, R. Sujatha, S. Sathish Kumar, T. Sangeeth Kumar, J. M. Chatterjee, zCoronago website integrated with chatbot for covid-19 tracking, in: CEUR Workshop Proceeding, 2021, pp. 521–527.
[22] N. Malik, A. Kar, S.N. Tripathi, S. Gupta, Exploring the impact of fairness of social bots on user experience, Technol. Forecast. Soc. Change 197 (2023) 122913.
[23] A.K. Kushwaha, MarkBot-a language model-driven chatbot for interactive marketing in post-modern world, Inf. Syst. Front. (2021) 1–18.
[24] Y. Cheng, H. Jiang, How do AI-driven chatbots impact user experience? Examining gratifications, perceived privacy risk, satisfaction, loyalty, and continued use, J. Broadcast. Electron. Media 64 (2020) 592–614.
[25] P.S. Varsha, How can we manage biases in artificial intelligence systems-A systematic literature review, Int. J. Inf. Manag. 3 (2023) 100165.
[26] S. Singha, H. Arha, A.K. Kar, Healthcare analytics: a techno-functional perspective, Technol. Forecast. Soc. Change. 197 (2023) 122908.
[27] K. Udyawar, Disease symptom prediction Kaggle. (2022). Retreived from: https://www.kaggle.com/datasets/itachi9604/disease-symptom-descriptiondataset?select=dataset.csv.
[28] P. Patil, Predict disease symptom. (2022). Retrieved from: https://www.kaggle.com/datasets/karthikudyawar/disease-symptom- prediction.
[29] D. Madhu, C.N. Jain, E. Sebastain, S. Shaji, A. Ajayakumar, A novel approach for medical assistance using trained chatbot, in: 2017 international conference on inventive communication and computational technologies, 2017, pp. 243–246.
[30] R. Dharwadkar, N.A. Deshpande, A medical chatbot, IJCTT 60 (2018) 41–45.
[31] A.F.U.R. Khilji, S.R. Laskar, P. Pakray, R.A. Kadir, M.S. Lydia, Bandyopadhyay, Healfavor: Dataset and a prototype system for healthcare chatbot, in: 2020 International Conference on Data Science, Artificial Intelligence, and Business Analytics, 2020, pp. 1–4.
[32] I.C. Chang, Y.S. Shih, K.M. Kuo, Why would you use medical chatbots? interview and survey, Int. J. Med. Inform. 165 (2022) 104827.
[33] L. Athota, V.K. Shukla, N. Pandey, A. Rana, Chatbot for healthcare system using artificial intelligence, in: 2020 8th International Conference on reliability, info com technologies, and optimization, 2020, pp. 619–622.
[34] E. Amer, A. Hazem, O. Farouk, A. Louca, Y. Mohamed, M. Ashraf, A proposed chatbot framework for COVID-19, in: 2021 International Mobile, Intelligent, and Ubiquitous Computing Conference, 2021, pp. 263–268.
[35] L. Ni, C. Lu, N. Liu, J. Liu, Mandy: towards a smart primary care chatbot application. In International symposium on knowledge and systems sciences, Singapore. (2017) 38-52.
[36] A.K. Pandey, R.R. Janghel, R. Sujatha, S.S. Kumar, T.S. Kumar, J.M. Chatterjee, CoronaGo Website Integrated with Chatbot for COVID-19 Tracking, ISIC (2021) 521–527.
[37] N. Rosruen, T. Samanchuen, Chatbot utilization for medical consultant system, in: 2018 3rd technology innovation management and engineering science international conference, 2018, pp. 1–5.
[38] A.H. Abutaleb, B. Yun, Chameleon-a framework for developing conversational agents for medical training purposes, in: Proceedings of the 21st International Conference on Autonomous Agents and Multiagent Systems, 2022, pp. 1887–1889.
[39] P. Mahajan, R. Wankhade, A. Jawade, P. Dange, A. Bhoge, Healthcare chatbot using natural language processing, in: 8th International Conference on Reliability, Infocom Technologies and Optimization, 2020.
[40] L. Xu, L. Sanders, J.C. Chow, Chatbot for health care and oncology applications using artificial intelligence and machine learning: systematic review, JMIR. Cancer 7 (2021) 27850.
[41] B. Rathore, Impact of Green Marketing on Sustainable Business Development, Cardiff Metropolitan University. Presentation., 2022.
[42] B. Nigam, N. Mehra, M. Niranjanamurthy, Self-diagnosis in healthcare systems using AI chatbots, InIoT AI Technol. Sustain. Living (2022) 79–91.
[43] B. Rathore, Digital transformation 4.0: integration of artificial intelligence & metaverse in marketing, Eduzone: Int. Peer Reviewed/Refereed Multidiscip. J. 12 (2023) 42–48.
[44] B. Rathore, Textile Industry 4.0 transformation for sustainable development: prediction in manufacturing & proposed hybrid sustainable practices, Eduzone: Int. Peer Reviewed/Refereed Multidiscip. J. 11 (2022) 223–241.
[45] J.M. Carroll, Human computer interaction (HCI), Interact. Des. Encycl. 6 (2010). Retrieved on June.
[46] F.D. Davis. User acceptance of information systems: the technology acceptance model (TAM).