International Journal of
INTELLIGENT SYSTEMS AND APPLICATIONS IN ENGINEERING
ISSN:2147-6799 www.ijisae.org Original Research Paper

Implementing Artificial Intelligence-Based COVID-19 Chatbot in the Kingdom of Bahrain

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Submitted: 22/**0**7/**2022** **Accepted:** 25/**0**9/**2022**

Abstract: The sophistication in technology has provided a smart solution through the conversational AI-powered chatbots. Chatbots help the healthcare sector minimize operational costs and improve the quality and speed of healthcare services. Chatbots assisted the patients during the recent pandemic crisis by managing patients' needs during the COVID-19. Due to the rapidly changing technology, these chatbots need to keep pace with the emerging technologies. Several chatbots were created to fight the pandemic. We studied these chatbots, identified their functions, strengths and weaknesses and proposed a state-of-the-art chatbot model based on machine learning. For the proposed chatbot, free and open-source tools and frameworks are used. Several criteria were applied to classify the chatbots. Further, these criteria were thoroughly defined and explained by the programming syntax. We also presented the performance analysis of the proposed chatbot. In this analysis, some characteristics of the chatbots were analyzed. These features include accuracy and reliability of the information, tailored assistance, ability to spread awareness, symptoms monitoring, mental health support, pressure on customer care executives, and some other key features. The chatbot can be updated and adapted according to future needs. We are confident that these features have made the proposed chatbot better than several other chatbots that exist in the market.

Keywords: *Artificial Intelligence, chatbot, Natural Language Processing, Machine Learning.*

1. Introduction

As defined in the dictionary, automation is "the technique of making an apparatus, a process, or a system operate automatically." Automation is an old term usually referred to with heavy industrial machinery automation. Today, we consider automation as a form of artificial intelligence (AI), where computer technologies such as machine learning and deep learning exist to process almost any kind of data and come up with results.

In the era we are in, the word automation describes a wide range of software and technologies that significantly or even slightly reduce human interaction and/or human intervention in their processes. Software programmed to reduce human interaction by meeting a predetermined decision criterion, sub-process relationships, and related actions by implementing those predeterminations into machines.

Machine learning is described as a section of AI that involves development of applications that learn from information incorporated and improve accuracy over time without the intervention of programs. In the realm of data science, an algorithm is defined as a series of steps used in statistical processing. In the case of machine learning, algorithms are programmed to identify patterns and features in a pool of data and aid in decision making and facilitating predictions [1].

The healthcare setting has an array of chatbots to choose from to facilitate their activities. That makes chatbots to be essential in ensuring effective interactions with users are achieved. Smart communication, which involves the use of chatbots incorporates the use of natural language understanding, processing of the language, and the machine being able to learn from trends [2].

Chatbots are systems that are automated and they engage in replication of the behaviour of users with the scripts incorporated on the other end. That means that chatbots can mimic and imitate conversations that happen between two persons. The technology provides users with a simulated platform where they can engage in smart communication. A wide range of chatbots exist and they serve different settings. They can be used in the financial industry, entertainment industry, and travel and hospitality industry, among others. Alexa, a chatbot developed by Google Corporation is a good example of the technology that facilitates smart communication [3].

This research's design and implementation main idea involve creating an AI-based chatbot using free and open-source tools and frameworks. The main programming language used is Python, which is an open-source, high-level, easy to read and learn programming language. The framework to create the AI-powered chatbot is called Rasa, a Python framework that uses Natural Language Processing

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(NLP) and machine learning libraries like TensorFlow to create and generate a chatbot. Then this chatbot will be programmed and tailored to function as required by our research, in this case, to be a helpline contact for people in need of attention and information regarding the COVID-19 virus. The mentioned open-soured tools and frameworks use a branch of AI called Machine Learning, where it uses both pre-trained datasets and interactive datasets to train models for the computer program to learn and predict how users will interact with it.

As we are currently in a pandemic and as a programmer, the need to automate and keep the social distance is essential, especially in our situation. So far, the local news has reported that more than 75% of governmental services have shifted to an online platform instead of going to a government building in person to receive their services. This pandemic has sparked developers worldwide to innovate and develop technologies using automation, AI, and machine learning, where human interactions are at a minimum to keep up with social distancing and staying at home.

The main objective of the research is to create a helpline chatbot that is available to users 24/7 to help people get the necessary attention and information needed to cope with the rising demand of COVID-19 patients. This chatbot will be able to inform users if asked about basic COVID-19 guidelines, such as if a user is sick and does the user has any symptoms like coughing, fever, or/and shortness of breath. Additionally, the users can ask it where to register for the COVID-19 vaccine, and it will reply with the official link for registration.

As it is a computer that is doing the work, it means that it can cover large scales of inquiries or users simultaneously without any waiting time. It minimizes employee effort and allows the employees to focus on other more demanding tasks. The chatbot can also be easily integrated with other messaging platforms and can also be integrated with voice-based messaging platforms.

This research primarily focuses on the questions people may want to inquire about in a helpline situation, where questions are asked about how a person is feeling and wants to verify whether their ill-feeling is due to the COIVD-19 virus or just a symptom of the flu. After meeting the requirements of inquiry with the chatbot, it will assess and inform the user to remain isolated at home and contact the appropriate authorities to take a COVID-19 test or not.

2. Related Literatures

Although some different kinds of chatbot technology are distinguishably different from most natural language processing (NLP), the chatbot technology can only really advance as quickly as the NLP develops further. That is where most chatbot applications of NLP find difficulty with complexities upon a machine's ability to construe human words essential in aspects of speech such as metaphors and emojis. Despite the challenges, chatbots are increasingly becoming complex, reactive, and more natural.

A quick search on the literature revealed the many applications of a chatbot system for specific kinds of people regarding the context of the conversations. We shall mention a few of these chatbot applications made by companies around the world to specific kinds of target audiences. Below are comparisons, descriptions, and examples for the different chatbot applications that companies have created for intended target audiences:

Endurance chatbot has been specifically created and programmed for people with either dementia or Alzheimer's disease, or both. The company Endurance Robots made this chatbot application. Their whole concept of applying the chatbot is with memories and reminders to notify the patients by reminding them of their doctor's instructions because the patients tend to forget about these basic doctor instructions.

A company called Casper created a chatbot named "Insomnobot 3000," which aims to give insomniacs someone to talk to while the rest of the world is asleep. Their slogan on their website says, "A friendly, easily distracted bot designed to keep you company when you can't fall asleep" [4].

A chatbot application was designed by Disney for a younger target audience. It incorporates aspects that appeal to the targeted audience such as the presence of characters from popular animated films. Disney offered fans of the movie the possibility of solving crimes with the characters from the movies, where the children helped the detective character solve the crime [4].

Marvel, large comic books and Film Company, generated Marvel's comic books and movie tickets selling bot. this chatbot was made for the 2016 movies. This chatbot was programmed to play the main character from the movies' role as Star-Lord. Several outlined conversational branches exist that the chatbot can pursue with the influence of the user. However, the main focus of the chatbot was to popularize and sell film tickets and comic books.

Roof AI chatbot application aims to help real-estate salespersons to enhance interactions with potential clients through automation. The function of the bot includes identification of potential buyers via social media platforms and providing responses that they can resonate with. Based on the user's input, it assigns the buyer to a sales agent in their company.

Many studies [5][6] focused on enhancing service delivery in the healthcare industry. That includes increasing the speed of medical diagnosis and making the outcomes transparent to patients. The studies are powered by machine learning systems that introduces an aspect of accuracy in terms of identifying COVID-19 patients and detecting COVID-19' norm violators.

Conceptual literature brings us back to our research, which is based on the Rasa framework, which is an open-sourced

machine learning framework for automated text-based conversations. It allows an automated initialization of machine learning libraries to create powerful, industrial-grade conversational bots or chatbots. These chatbots can understand the user's messages, respond accordingly, hold conversations with users, and be integrated into other messaging platforms [7]. The framework of AI-based chatbot should have three main components: Machine Learning, Natural Language Generation (NLG), and Natural Language Understanding (NLU).

Machine Learning predicts what the chatbot should respond to a user's message in the conversation. Since programmers cannot write rules for every path a user may take while chatting or talking with the bot, so instead of using rules and enforcing them on the user, Rasa Core uses machine learning to "learn" the conversational patterns from conversational data provided by the programmers or through "training" the bot by using the interactive learning feature.

This process of handling the conversational flow and responding appropriately in a Rasa chatbot is called Dialogue Management, and in the Rasa Core, there are three forms of predictions:

- Responses: Here, programmers must define the responses we want the chatbot to respond with, which is correlated to the question inputted by the user.
- Actions: Here, define the chatbot's actions to respond appropriately to the user's inputted questions.
- Stories: Here, define example conversations between a user and the AI-powered assistant. This provides training data for the Dialogue Management System in Rasa Core.

The Rasa NLG is a part of the framework that responds to the user in natural language, which can also contain pieces from structured data available. NLG is a category or AI whose goal is to limit gaps in communications involving humans and machines. The technology receives input that is in non-linguistic format and turns it into formats that humans can understand, like reports, documents, and text messages, among others [8].

The main aim and goal of Rasa's NLU are to extract structured information from user messages, or in other words, to understand the user's messages. This usually includes the user's intentions and any categories of information the user's message may contain.

The Rasa NLU is only concerned with understanding the user's input or message and does not concern itself with Dialogue Management or predicting responses. To understand the user's inputs or messages which are usually unstructured texts, Rasa NLU uses two main forms of structured or programmed data for further processing:

- Intents: Using a supervised training approach of training a sentence classifier, Intent is defining classes of intentions a user may chat or talk about. In other words, teaching the chatbot about what kind of path a user will chat or talk about with the bot. For example, a user asks, "what's the price of an iPhone X?" Here, "price" can be defined as intent.
- Entities: Here, define categories of objects or topics where the chatbot can identify the purpose of the user's input or message. For example, a user asks, "what's the price of an iPhone X?" Here, "iPhone X" can be defined under a "smartphone" entity.

3. Design Specifications

The Rasa Stack is developed to facilitate short massaging and that makes it able to perform the specified tasks. That means that a single idea makes it possible for a framework to be filled with sentences that construct a dataset that facilitates the functioning of the chatbot. After that, the NLU model can be configured to create dialogue patterns and a framework from which conversations and dialogues can be developed using the stories feature of Rasa [9].

We must understand how the bot works, and to comprehend how the chatbot functions, it is essential to know the elementary drift of the conversation:

- The user provides input.
- The bot parses the input using an NLU task to classify intents and extract entities.
- The bot provides a response to the user grounded on the article extracted from the user's input.

Intents maps user input to responses. In each intent, there are defined examples of user inputs and the response to be provided. The entities make up keywords used to recognize and extract valuable information from user inputs. On the other hand, intents facilitate the ability of the chatbot to comprehend the motivation behind input provided by users. Also, entities are used to identify specific pieces of data that the user mentions.

For this prototype, the proponent needs a computer that can run the Linux operating system without any issues. We chose the Raspberry Pi 4 because it has the best-performing CPU of all the other Raspberry Pi models. It has a four-core 1.8GHz CPU with 8GB of RAM, and as for the other two Raspberry Pi models we looked at before using the 4th model is that the Raspberry Pi 3 B+ has only 1GB of RAM, and the Raspberry Pi 3 has only a mere 512MB of RAM. So, going for the most CPU power and memory handling, we chose the Raspberry Pi 4.

The chatbots used by the telecom, marketing sectors, or most of the small to medium type businesses for customer services, are scripted types of chatbots [9]. They assist the clients with queries that are predefined [11][12]. The selection of an appropriate method to develop a chatbot is grounded on the purview of the chatbot, the functions it intends to accomplish, the language of communication, the end-user, etc. All these concerns need to be considered while implementing a chatbot system.

Traditional monotonous chatbots need to be made to be

communicative, responsive and a natural language in communicating with users. For that to happen, a scripted type of chatbot is not enough, and it requires the inclusion of NLP and Machine Learning techniques in the system. There are several various ways to implement it.

Many business entities are using already developed customizable bots for their daily businesses. Building contextual assistants and chatbots that really assist clients is hard. That is why the study involves the use of Rasa. This open-source, machine learning framework helps make automated texts and voice-based assistants easier as it provides the infrastructure and tools essential for a high-performing, robust, and exclusive contextual assistant [7].

The "Ears" is the NLU to understand the input, the "Brain" is the Core where the Dialogue Management predicts responses and actions of the bot and the "mouth" or NLG, where the response is generated or/and programmed to be sent to the user.

The Rasa NLU is a module that understands natural language. It incorporates coupled modules that connect several NLP and machine learning libraries in a reliable method of sending information to web servers.

The Rasa NLU includes the following:

- Intent Classification: Converts test to Vectors and classify intent.
- Entity Extraction: For this process, the NLU converts the incoming texts to tokens using a Tokenizer, then using a part-of-speech tagger and chunker to recognize the entity extracted.
- Part-of-speech tagger: It involves in the development of a sequence of words and it facilitates the connection of a part of the speech tag to each word.
- Chunker: The aim of chunker is to group words into noun phrases. The phrases are made up of one or more word that incorporate a noun and in some instances verbs, descriptive words, or adjectives. The purpose is to ensure that nouns are grouped with words that relate to them.

Through the extraction of entities and intent from text introduced in the system, a disruption of existing data happens and that develops new actions. The resulting new actions are restructured to the state and create outputs that are relevant for next input [9].

The constraints of our design are the single-board computer (Raspberry Pi). As it is a small single-board computer, its performance and computing power are not at par with other recommended machine learning computers with high-performance components for training AI-based programs. This means if we trained the chatbot on the Raspberry Pi itself, it would freeze and get stuck. So, the solution to the chatbot's machine learning model training will be done on our home server, and then the trained model to the Raspberry Pi will be uploaded.

4. Design Procedure and Implementation

As for the hardware part of this research, the research will involve the use of a single-board computer (Raspberry Pi 4) to host the source code of this conversational bot, or chatbot, which will be able to serve a webserver to demonstrate the working functions of the chatbot.

As for the code part of the bot, we shall research both online and locally for different types of questions people have for a normal COVID-19 helpline. This will help us to incorporate the questions and responses into the program of the bot.

For demonstration purposes, we will temporarily host a website online on the internet using the graphical user interface of the Rasa framework for people who wish to use the text-based feature to chat with the bot instead of talking to it.

During the development of this chatbot, we searched for a few of the most common questions people generally asked a COVID-19 helpline. We programmed the chatbot to answer these common questions, and they are as follows: where to register for the vaccine, what to do if showing symptoms, and want information for precautionary measures to take against the virus.

To analyze the custom COVID-19 chatbot, first, run the Rasa-X web framework and the Rasa actions server. Next step is initiating an example conversation with the chatbot by greeting. As example, we programmed the chatbot to understand if a user wants to register for the vaccine. If asked so, the chatbot will provide a link to the online registration for vaccine form.

In Figure 1, we initiated a conversation by saying "Hello" to which the chatbot greets back, then we provided a sentence that the chatbot recognized as the programmed intent for registration of the COVID-19 vaccine.

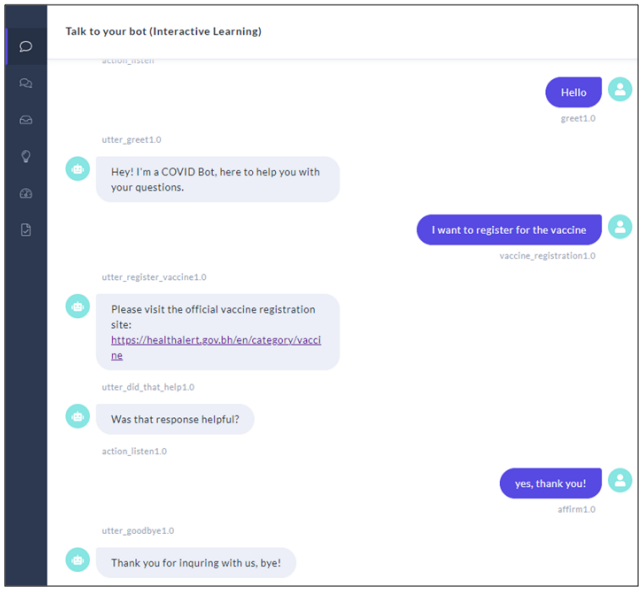

Fig. 1. Example of Bot Conversation-Vaccine Registration Intent.

Also, a new story has been generated for further training the model, as shown in Figure 2. This is because sometimes, people say new words with similar meanings, but if the chatbot does not know this word, it may use the Fallback Policy and no reply at all. Save this story for the next training session of the chatbot, so the conversational path between the user and the bot becomes clearer, in other words, machine learning.

Fig. 2. Story Generated for Training-Vaccine Registration Intent.

The structure for the story path is clear for anyone who reads it. As seen in Figure 3, the steps for a story are made by user intent and then the chatbot's action, both of which we must program into the code. Looking into how to train and teach the chatbot in the next section, where to add or program the other intents and responses of this COVID-19 chatbot.

Figures 4 and 5 show some examples for requesting information from the chatbot. Of course, sometimes, one example is not enough for a computer or any artificially intelligent bot. As with any AI or machine learning program, information must be provided to it with incredible amounts of data for accuracy and precision. Add multiple examples of each intent for the chatbot to understand multiple inputs from various users.

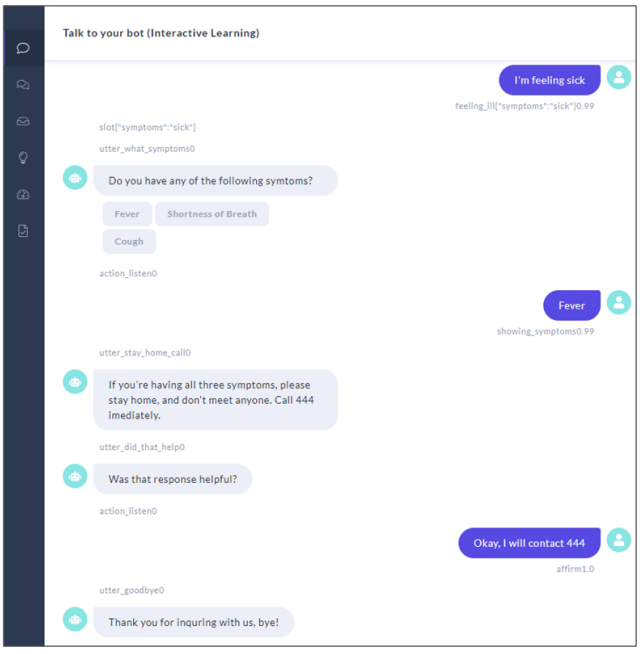

Fig. 3. Example for conversation showing Symptoms Intent.

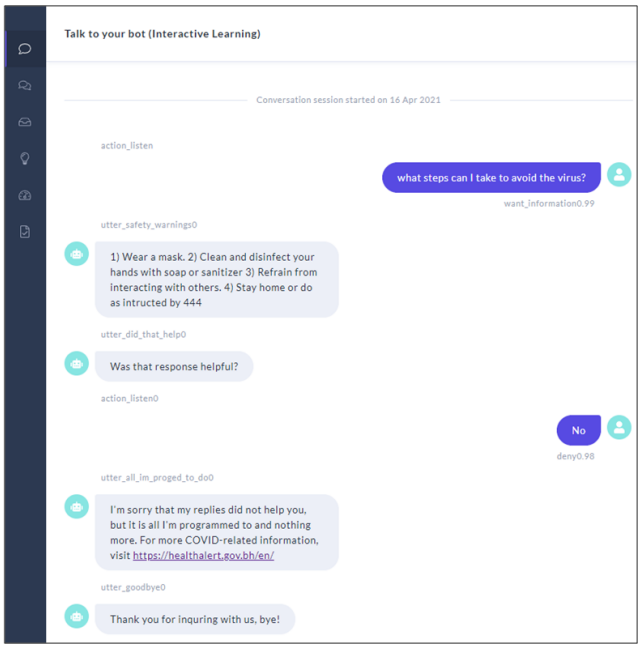

Fig. 4. Conversation requesting information from the chatbot.

5. Performance Analysis of the Proposed Chatbot

With the emergence of digital technologies, chatbots evolved at an unprecedentedly rapid pace in almost all key sectors, including marketing, finance, education, healthcare, entertainment, hospitality, manufacturing, and many other important sectors. Considering the significance of such chatbots, many leading multinationals have started chatbots to serve their customers even better. The present thesis also aimed at developing such a dynamic chatbot that would be beneficial to address different issues related to the COVID-19 pandemic. We confident that the proposed chatbot will play a crucial role in identifying and meeting the core needs of the patients during the pandemic. This paper aims to conduct a performance analysis of the proposed chatbot and provide evidence to prove that the proposed chatbot is perfect and all-inclusive to address pandemic-related issues and challenges. We will evaluate the performance using the following criteria.

- Disseminating accurate and reliable pandemic-related information.
- Providing tailored assistance and information
- Spreading awareness
- Monitoring symptoms and severity
- Mental Health Support
- Reducing the pressure and burdens on call centers.
- Other Features

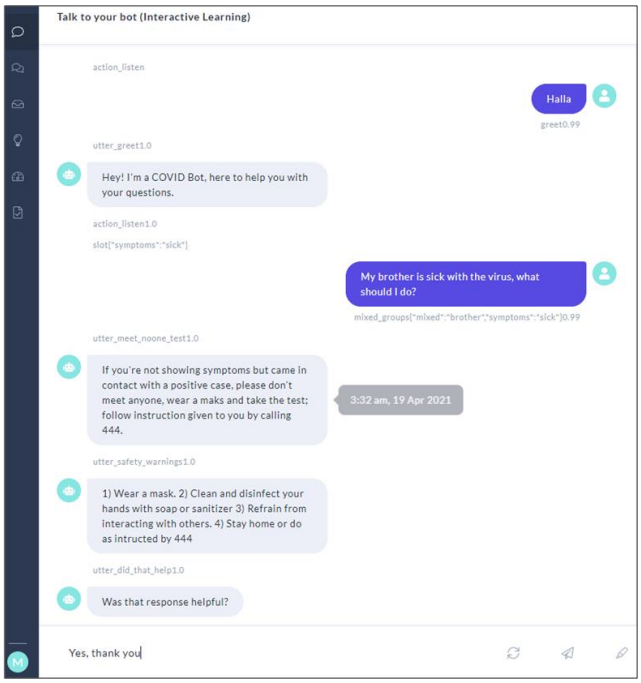

Fig. 5. Conversation requesting information from the chatbot.

5.1. Disseminating Accurate and Reliable Pandemic-Related Information

The key issue during the pandemic was the rapid spread of false information and rumors on social media. The speed of spreading rumors is much faster than the outbreak of the pandemic. The pandemic related accurate information was not easily accessible. The developed chatbot would be able to provide concise information, and for that, it will use credible sources. The overall functioning of the chatbot is so simple and user-friendly that even a person having difficulty using the internet can also access accurate information through the developed chatbot. To provide accurate information and assist the patients, it is also important to obtain precise and accurate information from the patients. The chatbot has a simple facility where the patient can choose the right option from multiple-choice questions. For example:

The chatbot: Do you have any of the following symptoms?

- Fever
- Shortness of Breath
- Cough

The user can choose the alternative/s from that is/are applied to him or her. This facility helps to identify the health issue of the user and helps to strengthen the interaction between humans and computers.

5.2. Tailor-made Assistance

The proposed chatbot can also tailor the massage to suit the users' pandemic-specific demands. The chatbot is equipped with special features to understand the users and their health problems. It is a contextual chatbot, an advanced version of a chatbot that precisely determines the users' intent. To make it contextual and intelligent, we focused on training in which the programmers can provide the chatbot with the right dataset. We proposed a sophisticated classification model that monitors the new data and input. The proposed chatbot will be able to retrieve critical data related to specific contexts. These features have made the proposed chatbot more customized.

5.3. Spreading Awareness

On the rapidly spreading rumors and fake news, it was challenging for the doctors during COVID-19 to spread awareness among people with facts. This chatbot will widen its reach. The intuitive interface of the proposed chat box will use to present a low-friction approach for spreading awareness through critical information. Through dialogues and interaction, the patients can access real-time information. For example, the proposed chatbot will help make the people aware of the COVID-19 protocols (wearing masks, washing, and disinfecting hands, social distancing and staying home). If the information is not within its limit, the chatbot will direct the user to the proper website. The importance of vaccination will also be given to the users, and thus, this chat box will help spread awareness about the vaccination.

5.4. Monitoring Symptoms

During a pandemic, the person wishes to be informed about the infection and its spreading rate. Usually, they fear that such information may harm their social and professional lives. The people are also feared to be sick. The institutions, especially the hospitals, need to monitor COVID-19 patients to prepare themselves with the required infrastructure and equipment. The monitoring of symptoms is also essential for the government to make decisions on lockdown. However, many infected people hid that they were COVID-19 positive during the pandemic.

According to [13], people are comfortable in interacting with the chatbot and disclosing confidential information about their health-related issues, and they do not wish to disclose it with the human agent. The proposed chatbot is the assistant and friend of such people. Our proposed COVID-focused chatbot will be the assistant and virtual friend. The highly advanced interactive system of the chatbot will answer more than 70 per cent of users' queries.

5.5. Mental Health Support

The proposed chatbot has immense potential to help the users fight their depression and anxiety caused by the pandemic and consequent lockdown. Emergency psychological support and mental health practitioners were the key challenges during this health crisis. We addressed the mental and psychological issues while developing the chatbot design. The chatbot can be updated so that the users can disclose their concerns and worries and receive a positive response from the virtual agents. The chatbot can

reduce the mental stress, and other symptoms of COVID patients and others stuck in lockdown.

Gabrielli et al. [14] has researched the chatbot as an intervening tool for university students during the COVID-19 pandemic. The proposed chatbot can be programmed with such interaction in which the users will share their frustration of lockdown and pandemic, and the chatbot will come up with solutions. Some audio and videos will be programmed in the chatbot. They will help the users soothe and relax, thus reducing the pandemic's tension.

The function of the proposed chatbot as a mental health supporter is possible using the chatbot development cycle. The Rasa X Web server and action server will be run first. In the next step, the intents will be trained in psychological and mental healing regarding the COVID patients and other users. The responses will be added to allow the bot to respond with the intended message. For example:

Chatbot: Do you feel low? Is your mind occupied with negative thoughts?

User: Yes.

Chatbot: Spend time watching this video. It will help you to get relaxed.

In the forth step, the rules will be added to deliver accurate information to the users. In the fifth step, the example conversations (e.g., asking about the negative thoughts and coming up with the solutions for relaxation). In this developmental cycle, it is also important to train the bot with necessary and updated information like intents (users' common expectations) and entities (keywords). Finally, this new and updated method will be tested. The mistakes will be identified and corrected and thus make the healing process more effective.

5.6. Reducing Burden on Call Centers

The proposed chatbot will be equipped with up-to-date information. The chatbot is prepared with a maximum number of questions important for the customers. The proposed chatbot will try to cover seventy per cent of the customers' queries. Consequently, the human call centers assistants will be free to deal with more complex issues. Such a sophisticated chat box can reduce the pressure on the call center executives, who will quickly respond to complicated queries by going live with other patients.

5.7. Other Features

While developing the proposed chatbot, we kept in mind its personality, which is vital. The chatbot will have a pleasing attitude throughout his interaction with the humans. It has been ensured that the tone of the conversation would be humorous, light and engaging. We also taken care of keeping the language simple. The bot is also trained in dealing with unusual and complex queries. It will immediately divert them to the human agent. We also considered the safety and privacy issues. The API will be secured, and appropriate care is taken to avoid leaking or hacking the data.

5.8. Summary

To summarize, the proposed chatbot is a comprehensive solution, and while developing it, we thoroughly studied major challenges and issues during the COVID-19 pandemic. The chatbot is designed as a response to these issues. The excellence of the chatbot lies in its ability to disseminate appropriate and accurate information about the pandemic, spread awareness, provide tailor-made assistance, monitor symptoms, and be the virtual buddy of the users. The adaptability and sophistication of the chatbot have made it excellent. We are confident that this chatbot has tried to remove the weaknesses of other similar chatbots used in the healthcare sector.

6. Conclusion

Machine learning-based chatbots in the healthcare sector provide different services. It has become the virtual assistant and friend of the patients and healthcare professionals. During the COVID-19 crisis, chatbots were effective interactions and information dissemination tools. Considering their crucial role, our key objective was to create a helpline chatbot that would serve the users 24/7. The effectiveness of the chatbot was evaluated with a systematic performance analysis in which we determined some criteria to find whether the newly proposed chatbot fulfils them. The proposed chatbot will provide entire COVID-19 related information and the protocols to be followed. It will also help them to keep away from rumors. The chatbot can also be programmed to be the users' mental health assistant during the pandemic. The chatbot implementation cycle was developed to assess the chatbot's performance in varied pandemic-related situations. The proposed chatbot is observed to be flexible, adaptable, dynamic, contextual, and upgradable. Through this proposed chatbot model, we proved that it will also meet future needs in the healthcare sector.

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