An Interactive AI-Powered Web Healthcare System

Bishab Pokharel
School of Computer Science and Engineering
Lovely Professional University
Punjab, India
bishabpokharel503@gmail.com

Ganesh KC
School of Computer Science and Engineering
Lovely Professional University
Punjab, India
ganesh.timilsina777@gmail.com

Bigyan Timilsina
School of Computer Science and Engineering
Lovely Professional University
Punjab, India
tbigyan9@gmail.com

Yunish Pokharel
School of Computer Science and Engineering
Lovely Professional University
Punjab, India
yunishpokharel299@gmail.com

Mahesh Makam
School of Computer Science and Engineering
Lovely Professional University
Punjab, India
makammahesh01082000@gmail.com

Veerpal Kaur
School of Computer Science and Engineering
Lovely Professional University
Punjab, India
khaira.veerpal@gmail.com

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***Abstract*—The Covid-19 pandemic has brought many changes in the healthcare industry lately. As things are going normal with time, many health projects designed and used during emergencies are left unexploited. To make the perpetual use of those technologies, the current need should be taken into consideration along with necessary ideas and frameworks to evolve the existing system into. To demonstrate the same, in this paper, we have presented a package of healthcare services powered by Artificial Intelligence via a chatbot system, where a user can entertain the services either by an interactive Graphical User Interface or a conversational chatbot system. This proposed system showcases how a similar Covid-19 system can be developed into a sophisticated healthcare service. This paper emphasises adding Artificial Intelligence to any conventional software via chatbot services which would broaden the services it provides even further. In order to find out the probable best technology to integrate AI with, about 50 papers have been analysed and out of which 27 relevant papers have been included in the literature review. In future, we intend to add medical support and other intelligence-based services to our system in order to meet user requirements and essential features in the field of healthcare.**

***Keywords*—Medical chatbot, Healthcare system, RASA, NLU, RASA Custom Action, Django, ReactJS, Covid-19 Self-Assessment**

I. Introduction

Health and health-related services are ubiquitous in today's world. The wide accessibility to the internet and gadgets has eased how people get proper health treatment, all in very little time. Vendors and owners are connected in a way that was otherwise not achievable in the past. A system that can interact with the user while giving the required services in a parallel fashion is not uncommon in the market. However, most of such proposals lose the true essence of interactivity either in the process of making it advanced or during when a developer gets focused on a single service his/her product provides, leaving rather important issues untouched. This proposed system provides users with a package of health services, all equally interactive backed by Artificial Intelligence via a chatbot service, owing to the above concern. A comprehensive healthcare system is not a new approach [1] in technology. There have been several developments in different aspects of health software. However, the expertise of those intelligent systems is reliable only on a single or a couple of services, especially in this pandemic situation where we need a plethora of services together in a system. Therefore, after research [2, 3] over different platforms about what services are less prominent and more in need amongst the people, this system aims to showcase a collection of required and vital services to the people under one hood as a comprehensive healthcare project.

Almost everyone owns the internet these days. People utilise different apps to contact vendors, making it easier for sellers to reply to several clients [4] without devoting much time. Because of the extensive usage of messaging systems, automation [5] and the improvement of Artificial Intelligence and Natural Language Understanding [6], chatbots services have lately gained much popularity. To this date, message applications are used by over 3 billion individuals. Chatbots, cutting-edge technology in the service-based market, has been adopted by almost every domain that needs staffing due to their ability to handle many people, thereby reducing physical cost and workforce while providing intelligence-based responses to the live interaction with its users. Since its development, chatbot development has been a fundamental element of many application areas, dating back to some decades ago. Chatbots are being utilised in various applications, including marketing and the provision of various services. However, chatbots must be as efficient as possible to do various jobs. They have grown commonplace in retail and customer service, but only recently have they begun to make inroads into health care [7]. Patient triage, clinical decision support for providers [8], directing patients and staff to appropriate resources are some of the scopes of healthcare where chatbots have been the game-changer.

This paper proposes the architecture of a RASA chatbot [9] backed by a responsive web framework for health in this system that provides an efficient and correct response to health services our research aims to serve via this proposed system. The chatbot serves the principal purpose of the Covid-19 self-assessment based on user symptoms. The other services it incorporates are providing users with real-time Covid-19 data, displaying the nearest blood bank as per the user's live location, and allowing users to view and delete the appointment booked in a hospital prior to booking appointments with the interactive Graphical User Interface. The ReactJS framework is used for this dynamic user interface, while Python's Django framework is used for the system's REST APIs and database. FAQs, live cases, news and hospital-related data are sourced from the public APIs issued and managed by different governmental and public forums. Deployed on Microsoft Azure's Virtual Linux Server, the system can be accessed all across the globe on any device with the internet Building the proposed technology as a web

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system solves the issue of relying upon the host system's memory and CPU. This service is easily accessible to anyone across the globe with the internet and a primary device that supports a browser, which in many ways solves the problem of inaccessibility due to the device configuration of the user.

The proposed system primarily focused on Covid-19 and related services, not just remains intact to one sole purpose of Covid self-assessment but provides an excellent demonstration of how many healthcare services can come under one hood as a healthcare system [10]. With that being said, users of this system can choose between an interactive and user-friendly chatbot system and a robust graphical user interface for their services.

The following Section II of this paper presents the literature review. Section III details the proposed system, followed by experiments and results in Section IV. Conclusion and future work will be summarised in Section V thereafter.

II. Literature Review

Siddhant Singh et al. [1] have surveyed various AI chatbots and the technologies they have used. Likewise, Mohammad Nuruzzaman et al. [2] surveyed the abundance and implementation of deep learning-based chatbots in the customer service industry. These two papers helped to grasp the scenario of the recent adaptations in the chatbot domain.

Yong Xu et al. [3], through a big data tool, scraped keywords to investigate the papers published on Covid-19. This paper visualised the scenario of research being performed over Covid-19 across the globe. The paper by Manik Rakhra et al. [4] has used Natural Language Understanding to propose a software system for eCommerce tested over different cross-platforms. Sasha Fathima Suhel et al. [5] proposed a chatbot system showcasing a nice implementation of IBM Watson as a conversational bot engine. The paper by Lekha Athota et al. [6] demonstrates a nice practical implementation of Natural Language Understanding in its proposed chatbot system.

Likewise, the review by Dr Shailendra Narayan Singh et al. [7] over Artificial Intelligence techniques in medical sciences in their paper states that the most used AI technology is data mining while ANN and K-Means take the second and third position, respectively. Rohini.M et al. [8], in their paper, present the result of Coronavirus prediction using K-Means Clustering algorithm that outperforms SVM and other ML algorithms. Jahnvi Gupta et al. [9] propose a healthcare chatbot system with RASA framework that provides an accurate and safe chat response along with robust disease recognition. We have taken different references from this paper in our research work. Noura BACCAR and Ridha BOUALLEGUE [10] sketch a design of a web-based E-Health platform in their paper. They were able to integrate IoT with a software system for diagnosis and other medical aids. Ayman Odeh et al. [11] propose a patient appointment management system that gives insights into how an overall appointment system for healthcare is to be developed.

Daniel Carlander-Reuterfelt et al. [12] propose a data science chatbot implementing yet another NLU platform Dialogflow integrated with their own UI, demonstrating accuracy and behavioural intentions via a chat framework. Prof. Dr Siddharth Bhorge et al. [13] discuss NLP methods for getting better results in AI bots. Saurabh Srivastava et al. [14] proposed a chatbot giving proper implementation of intent management features. Likewise, Namrata Bhartiya et al. [15], in their paper, discuss the usage of Entities in any chatbot architecture. Ayah Atiyah et al. [16] research on context-based chatbot systems providing detailed findings on context-based responses.C Koushik et al. [17] researched symptoms based early clinical diagnosis of Covid-19 with Ensemble techniques. They were able to achieve an average score of 87% with Gradient Boosting and Random Forest algorithms. Mr M. Ganesan et al. [18] were able to showcase the implementation of the text-based query into a text-to-voice response.

Wistiani Astuti et al. [19] propose FAQs and their responses predictor with a Diet Classifier algorithm. Prof. Darshan A. Patel et al. [20] propose a university chatbot system integrated with a functional database for storing user responses and other details. Likewise, Dr Ashok Kumar K et al. [21] propose a smart college chatbot that stores user data with a properly administered database. Petre Anghelescu et al. [22] proposed a chatbot application integrating it with the JavaScript library Laravel. They were able to obtain a proper AI speech interaction with this developed system.V Akshatha Prasad et al. [23], in their paper, propose a chatbot system for automation and lab security and are able to demonstrate a proper user menu with speech-recognition menu options.

Shreya Bhutada et al. [24], in their paper, propose the development of an AI-powered healthcare kit with RASA framework, which is further deployed over AWS IoT. Fayezah Anjum et al. [25] demonstrate in their paper an implementation of a full-fledged healthcare service removing tediousness to visit the clinic/hospital for minor prescriptions. Likewise, P. Manikandan et al. [26] propose a smart nursing robot targeted to Covid-19 patients that integrates an SMS notifier with different IoT tools to update the guardian about the patient's user situation over time. Jawad Albatein and Nayyar Ahmed Khan [27], in their paper, are able to propose an AI bot that serves the purpose of providing patients information based on their responses.

III. Research Gap

A subtle comparison is carried out between the existing systems and our research work in order to visualize the efficiency of the system developed. Following are the key questions the comparison aimed to find out.

- A similar system developed with RASA framework [9] lacks the information regarding the flexibility of the chatbot to integrate with other systems.
- A similar AI chatbot built with Python [21] showed an excellent training result on a limited instance of a dataset. However, it seemed to have failed drastically while performing training on a large corpus group.
- An advising related bot [27] based on a similar architecture to our proposed system provided a way to harness Covid-19 solutions, but some of the crucial areas were yet to be touched.

These are the general research gap in this domain we found among the research works done so far. We have tried to minimize this research gap by proposing different unique solutions to the above issues and implementing them on our own use case.

IV. Proposed Methodology

In the quest of finding the best solutions to the above issues, after a detailed research, we have enlisted the following solutions to fill the research gap via our research work.

- RASA chatbot could be integrated with a number of different frameworks and environments with the help of webhooks and RESTful APIs. This would further broaden the scope of this chatbot.
- For an NLP or a text-based model, only the training results do not impact as a whole. The other counterparts of the training process such as tuning the best hyperparameters and training the model on batch (for a large dataset) also plays a giant role. To demonstrate the same, we have compared our NLU model with the results from various other models.

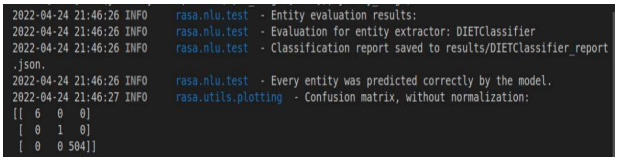

Figure 1: Model Evaluation Result

TABLE 1. Comparison of Model Performance

S.N.	Paper Ref No	Methodology	Prediction	Performance
1	[8]	Decision Tree	Recall of 0.85	moderate
2	[6]	SVM	Accuracy of 0.87	moderate
3	Proposed System	RASA's Diet Classifier	Accuracy of 1	Very good

V. Proposed Work

This healthcare system consists of three major constituents- a web application [11], a centralised database and an AI chatbot. The database plays the role of connecting patients with hospitals while performing CRUD operations simultaneously with REST APIs. The chatbot performs several different services described in detail further in the paper.

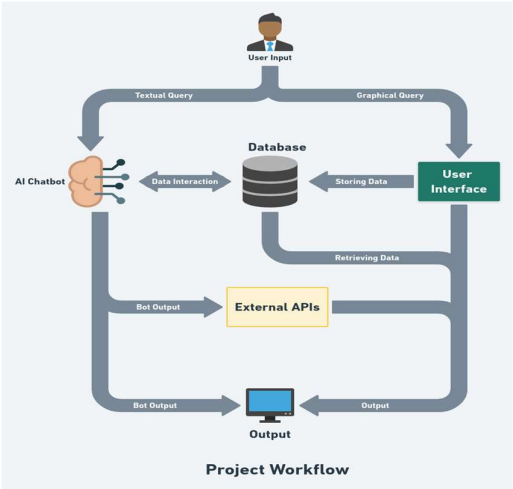

Figure 2: System Workflow

A. Chatbot

1) Overview of RASA:

RASA is one of the widely accepted frameworks for Conversational bots development. It is mostly taken as an open-source alternative to Google's Dialogflow [12] and IBM Watson [5]. Flexibility and its simple architecture make it adaptable in every development environment. Natural Language Understanding (NLU) [13] is what it uses as its central concept in Artificial Intelligence.

a) Intent: User messages are categorised based on intents [14].

b) Entity: Entities [15] serve as the structured information pieces inside intent sent as a response.

c) Stories & Rules: Stories and rules represent the conversation sequence between the user and the bot.

d) *Domain:* It defines all the factors RASA uses to operate the bot.

e) Action: This comes under Custom Actions used primarily for making API calls adding tweaks and buttons to the chat flow. We define actions under different classes we maintain in an actions.py file, as shown in fig 2.

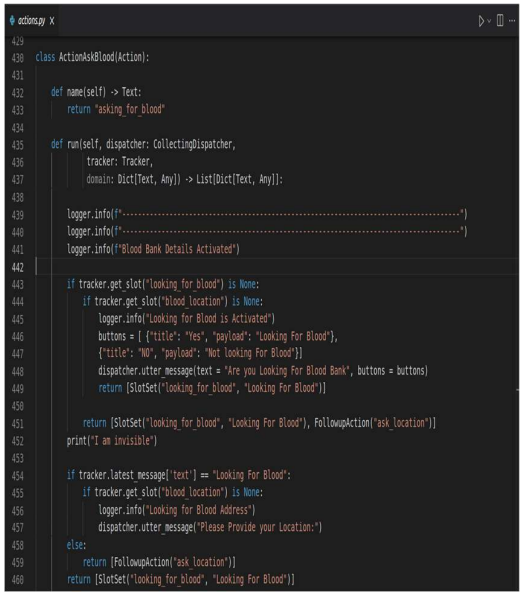

Figure 3: Code Snippet of Actions.py

The combination of these features written inside different formats acts as a chatbot dataset.

However, the working of the chatbot has a different mechanism. In this proposed system, RASA NLU is used for intelligence and context-based [16] responses (nearest hospital/blood bank locations), whereas RASA Custom Action is used for fulfilment-based responses (Covid-19 self-assessment test [17]). Each conversation has its unique conversation tracker element that gets stored in RASA's Tracker Store, which maintains the unique flow for each user while providing isolated responses [18] to everyone. The dialogue policy defines which action the bot must select in a conversation. Action server has been used for making API

requests for services like fetching live Covid-19 data and blood bank information, interacting with affiliated hospital's servers and displaying user's appointment history, all in a conversation.

2) Bot Implementation:

a) Covid-19 self-assessment bot:

This fulfilment-based bot service is developed with reference to the Covid-19 Self-assessment questionnaire issued by the Government of Ontario (Ontario.ca). Users will be prompted a set of questionnaires based on which the NLU Engine decides whether or not that user is safe from probable infection of Covid-19.

b) Blood bank and appointment-related information:

API calls are maintained from the Action Server for the blood bank-related information. Hospitals connected to the system provide the diagnostics and booking essentials. Likewise, the other public APIs provide live global data, Covid-19 FAQs [19], news and health-related information.

B. Database & REST APIs

Python's Django framework is used for storing user data [20] and maintaining the API calls. GET, POST, PATCH, PUT and DELETE methods are used for the CRUD operation to the database. These operations are executed from the frontend and the chatbot environment as per the need. A unique Patient ID is given to the users in the registration process [21], which will later act as the relation between patient information and his/her appointment to a hospital, ensuring that proper data flow is carried out with minimal chances of error.

C. User Interface

This healthcare system is a web application developed with ReactJS, one of the open-source front-end JavaScript libraries [22] backed by Python for AI and database. Mantine UI Component is profusely used to give the dynamics in the user interface [12]. The website handles and makes API requests and calls whilst interacting with the user. Another interactive library named React Chat Widget is used for the chat interface.

Users can book the appointment to the hospitals directly from the main user menu [23]. The connection to the hospitals can be performed via accessing the API endpoints managed by the Hospitals. The website also serves live Covid data visualisation rendered with updated Covid-19 APIs. Developed with the D3 library, this segment showcases live active, critical and death data on the website. The website's news section serves as the informants for the live Covid-19 Cases, while the FAQs section demystifies concerns and confusions regarding Covid-19.

D. Deployment

All the healthcare system services are deployed [24] under one single server of Microsoft Azure, which ensures that the system is entirely accessible from anywhere with the allocated IP address.

VI. Experiments & Results

A set of different cross-device testing [4] for the website is carried out with the help of the Blisk browser to ensure the robustness of the system. Upon testing the website on iOS, Windows Mac and Android operating systems supporting engines, the website showed flawless performance. The operation of this system showed very bare requirements of host memory like any other website. Fig. 3 demonstrates a fully working chatbot on an interactive user interface.

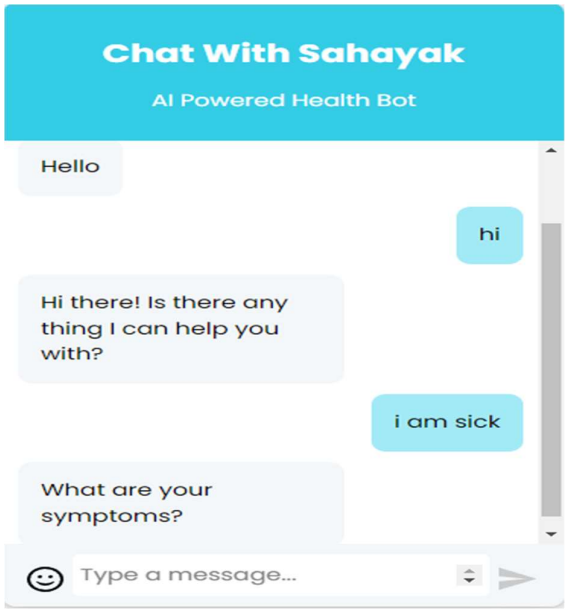

Figure 4: Live chat demonstration

For browser-based software, loading and up-time always play an enormous role. These two factors could result as the constraint to any browser-based service. The test successfully achieved an A grade performance with 1.5 seconds of loading time.

VII. Conclusion & Future Work

A robust healthcare system has been sketched and implemented successfully in this paper. The motive was to bring many essential health services under a single system that could help during the Covid-19 pandemic and afterwards. Our research can justify the proposal and concept with this interactive system as per the motive.

The end of this pandemic of Covid-19 is set to leave us many websites developed once for small yet essential purposes. Those websites and services might remain unused for other purposes afterwards. This demonstration of developing a Covid-19 system to a full-fledged healthcare service could be an example of many of those systems [25] that would otherwise be of no use. Collaboration with different hospitals and medical vendors to initiate a pharmaceutical service in this health system could be one of many future-works the paper intends to integrate. Likewise, improving the chatbot's intelligence with more data and a sophisticated NLU engine is always a prominent work to carry out in the system. SMS service could be added to inform patients about their health situation [26, 27]. Our proposed system could also be integrated with other IoT services for regular monitoring of patient data, thereby providing patients with a hassle-free and quick diagnosis from the hospital.

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