

# Azure Health Bot based Support System for Personal Healthcare and Monitoring

Jamal Uddin Tanvin, Nurshat Fateh Ali, Md Rifat Islam, M Akhtaruzzaman\*, Hosney Jahan,

Md Abdus Sattar, T Gopi Krishna, Ramisha Fariha Baki, and Md Shofiqul Islam

Department of Computer Science and Engineering, Military Institute of Science and Technology, Dhaka-1216, Bangladesh

jamaluddintanvin@outlook.com, nurshatfateh@gmail.com, rifat010bushra@gmail.com, \*akhter900@gmail.com,

jahan@cse.mist.ac.bd, masattar@cse.mist.ac.bd, gopi.mistbd@gmail.com, ramisha@cse.mist.ac.bd, and

shafiqcseiu07@gmail.com

## ABSTRACT

Healthcare is one of the fundamental human rights, but most of the people do not have quick and easy access to the services. In many cases, it is challenging to recognize significant disorders and locate a qualified doctor. An AI-integrated system can help in these cases by providing some pre-suggestions when necessary. The proposed system combines a health companion app and a dedicated external module, offering instant access to general health information. This system utilizes Microsoft Azure Health Bot to provide information about various diseases, to predict exact disease name, and to determine urgency of any problem. The system also provides features to find home remedies for disease, search doctors' contact information, send SOS messages, and monitor important physical conditions, including temperature, pulse rate, respiration rate of human body through an external module. The proposed application serves as a healthcare companion accessible to low-income individuals, allowing a convenient and rapid access to healthcare services. Experimental findings with average 96.25% of access rate affirm system's feasibility for general use.

## CCS CONCEPTS

• Computing Methodologies • Artificial Intelligence • Machine Learning • Mobile Application Development

## KEYWORDS

Healthcare, Artificial Intelligence, Azure Cloud Service, IoT, Medical diagnosis

## ACM Reference format:

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## 1. Introduction

Even in the modern era, it is still hard to get healthcare services for many people around the world, especially in rural areas. Cost factor is one of the main obstacles to obtain basic healthcare services. In many cases, even after having the availability of healthcare services and financial abilities, many people ignore their minor symptoms in early stages which may end up with a serious disease. A smart and artificial intelligence (AI) based system can help to resolve these problems effectively.

This paper introduces a prototype of a healthcare companion smartphone application accompanied by an Internet of Things (IoT) based dedicated hardware device for physical checkups. The system leverages Microsoft Azure Health Bot service, employing a superior algorithm and a dedicated database to ensure provision of current and precise information [1, 2]. The service is adaptable for various scenarios for disease prediction, supported by a 99.9% up-time Service Level Agreement (SLA) guaranteed by Microsoft. The system utilizes a dataset from Infermedica which is recognized for its high safety scores in the market with nearly 14 million checkups data. With an impressive Net Promoter Score (NPS) of 84, the system achieves a 94% engine accuracy [3]. The security protocols of Azure Health Bot adhere to organizational and industry standards, complying with HIPPA, HITRUST, ISO27001, COC2, GDPR, and over 50 global industry compliance frameworks.

With the help of Azure Health Bot service, the proposed application can chat with users to collect symptoms for predicting possible diseases, its severity, and suggests necessary steps for initial treatment. The chatbot provides various information and symptom lists based on any query. The application also provides contacts of expert physicians along with necessary suggestions of home remedies for certain health issues. The hardware module of this proposed system is for collecting health metrics, like body temperature, pulse rate, and respiration rate, where the application keeps track of the metrics. To handle emergency situations, this application also facilitates SOS button to inform close relatives and nearest hospitals for available help and services.

The goal of this application is to provide access to healthcare services for general people. The contribution of this project is to design and develop of a health companion system based on the Azure Health Bot service. Moreover, a dedicated external module is proposed for physical health checkup and monitoring.

## 2. Literature study

Growing trend of developing chatbot-based systems is being observed nowadays [4], especially for personal healthcare companions, as chatbots offer an interactive way to address the health concerns. A text-to-text chatbot-based disease prediction system was present by Divya *et al.* which employed natural language processing (NLP) to extract symptoms, providing personalized disease details before consulting a doctor [5]. With the collected symptoms, this system categorizes diseases as minor or major and suggests appropriate physicians with their details.

The promising potential of automated medical chatbots are also realized by Srivastava *et al.* and introduced a system with recall and precision scores as 0.65 and 0.71, respectively [6]. Another research study introduced a system called Baymax, which mainly an Android application for interactive interactions between general physicians and patients [7]. Baymax aimed to enable a real-time health data recording and access, replacing traditional paper-based methods. The system employed a secured database, and ensured reliable communication.

Another chatbot system was presented as an IoT based system aiming to provide accuracy of responses as 90% of user queries, while in real case, the system showed an 80% accuracy rate [8]. The system also was integrated with smart pill dispensers for better medication maintenance and healthcare coordination. It also provides personalized medical requests, a preliminary diagnosis, and symptom checker features. According to recent research, the integration of AI and IoT in personalized healthcare offers several promising possibilities [9-12].

Existing healthcare systems have some limitations as many of them are limited to fewer functions, such as keeping records or recommending diagnoses. Integration of IoT devices has limited their potential influences. Furthermore, user-friendly interfaces are hardly being found. Most importantly, none of the reviewed systems are integrated with multiple functions, making them incapable of meeting all health-related needs of a user. On the other hand, this proposed system presents user-friendly interface with multiple features, various options, AI integration, and real time health diagnosis through IoT based modules. Among various

features, personal medical-information storage, disease prediction, urgent care evaluation, home remedies, finding specialists, and SOS are most significant.

## 3. System architecture and prototype development

Overall architecture of the proposed system is illustrated in Figure 1. This project develops an Android application and a hand glove as an external device equipped with various sensors and necessary electronics. The app is developed using Flutter, an open-source framework developed by Google. It utilizes Firebase for data storage and retrieval, employing real-time database and Cloud Firestore features. The Firebase database enhances efficiency by eliminating the needs for server-side coding and enabling real-time synchronization. The Azure Health Bot is deployed on Azure Cloud server that gathers user symptoms and provide disease predictions, ensuring a highly reliable system with minimal downtime.

### 3.1 Developing Mobile Application

Mobile application of the system is divided into six distinct modules as shown in Figure 2 where Figure 2(a) is the homepage with six individual options.

**3.1.1 Module-1 (Chatbot):** Azure Health Bot is used in this module through which the system predicts diseases and its urgency based on the provided symptoms during chat. The chatbot uses Language Understanding (LUIS) [13] to understand user's intent. Datasets were collected from Infermedica [3] for disease predictions and for providing information on various diseases. The chatbot is hosted in Azure Cloud server.

In this proposed system, users can ask questions about various diseases, such as "What is asthma?", "What are the symptoms of asthma?" etc. Users can also discuss about any symptoms, such as "I am having a bad cough...". The chatbot takes prompt action by asking relevant reply questions to users and after gathering all the necessary information, it predicts the most probable disease name, suggests cares and required steps for possible treatments. The greeting page is shown in Figure 2(b).

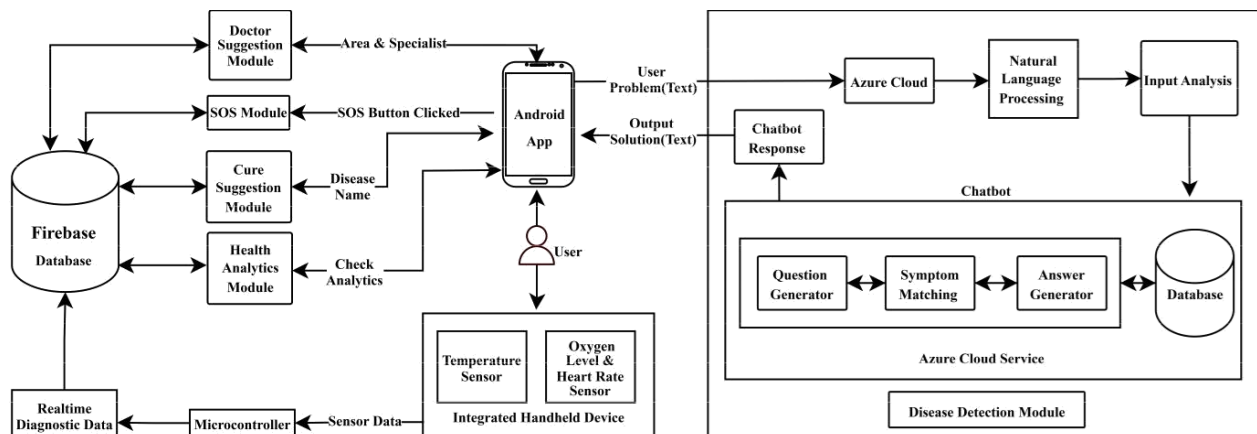


Figure 1: Overall Architecture of the proposed system

**3.1.2 Module-2 (Finding Experts):** Users can find information about various specialized doctors from this module, shown in Figure 2(c). Based on the Firebase database, this app presents information about an expert with possible location and times. Users also able to make a call by using a call button.

**3.1.3 Module-3 (Cure Suggestion):** This module provides relevant suggestions of home remedies for various diseases, to users based on the user request. An example screen of this module is illustrated in Figure 2(d). User is asked to select the disease name from a list and after confirmation, user receives relevant home remedies for that particular disease.

**3.1.4 Module-4 (Health Analytics):** This module collects various information of users' physical conditions with the help of custom designed Hand Glove and saves necessary information into the Firebase database. The information is then presented in a graph and suggestions are generated. This module has two sub-modules. The first one is used for measuring health parameters. If a user

presses this button, the system establishes a connection with external device and the app shows body temperature, heart rate, and oxygen rate on the screen in real time, as shown in Figure 2(e). The second sub-module is for viewing historical information of previous measurements in a graph, as presented in Figure 2(f).

**3.1.5 Module-5 (Personal Data):** A registered user's profile information is stored in the Firebase database. This page shows saved information such as users' name, email, age, SOS number, saved hospital information, and contact number with authorized edit/update option.

**3.1.6 Module-6 (Emergency SOS):** This module is used for sending SOS messages by pressing dedicated SOS buttons as shown in Figure 2(g). Upon pressing the SOS button, system immediately sends an SOS message to a pre-saved contact number for help, and to any closest hospital for emergency support. The app detects user's location from the mobile device and finds nearby hospital in that region.

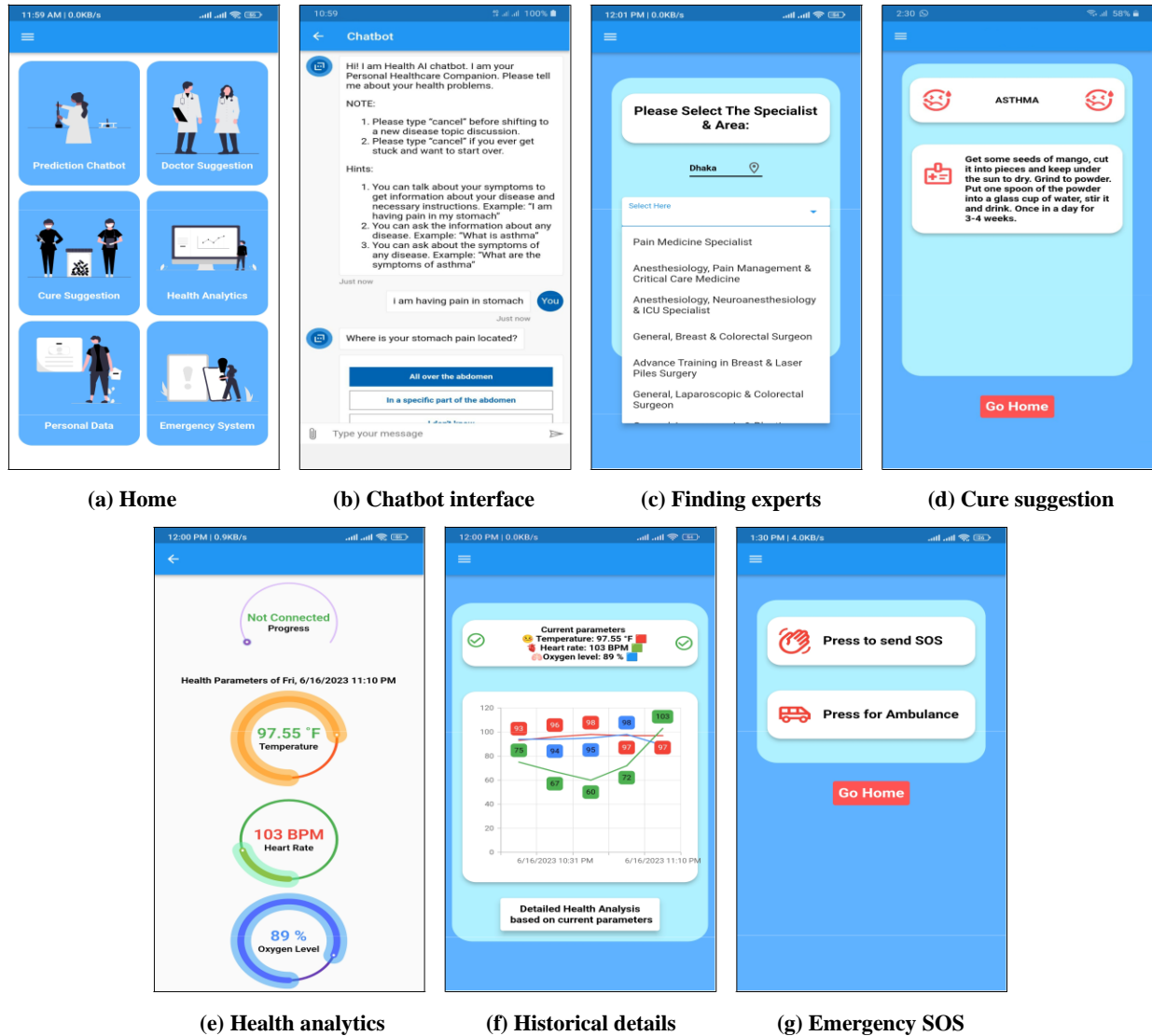


Figure 2: Mobile Application Interfaces of home page and other individual modules

### 3.2 Developing Hardware Module

Prototype of a hand glove as an external device is developed for this project which is equipped with various sensor modules and circuitry. The system measures body temperature, pulse rate, and oxygen level. For pre-processing of sensor data, NodeMCU ESP32 is used as a microcontroller that also has a built-in WiFi module through which the measured data is uploaded into Firebase database [14, 15]. A DS18B20 temperature sensor ( $\pm 0.5^\circ\text{C}$  accuracy from  $-10^\circ\text{C}$  to  $+85^\circ\text{C}$ ) is used to measure body temperature. The MAX30100 Pulse Oximeter Heart Rate Sensor is used for measuring pulse rate and oxygen level of user's body. It is an optical sensor that derives readings by emitting two wavelengths of light from two LEDs, red and infrared, to measure the absorbance of pulsing blood. The external system prototype is depicted in Figure 3 and corresponding circuit diagram of the hardware prototype is illustrated in Figure 4. Pin connections among ESP32s, MAX30100, and DS18B20 are shown in Table 1.

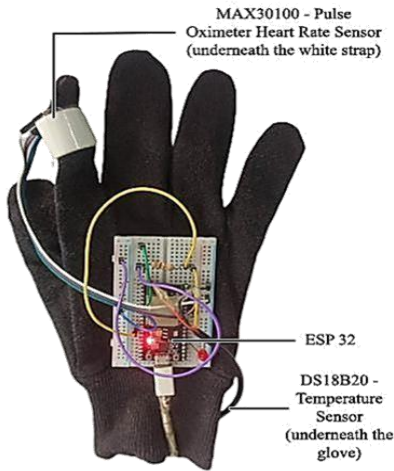


Figure 3: Prototype of the external module

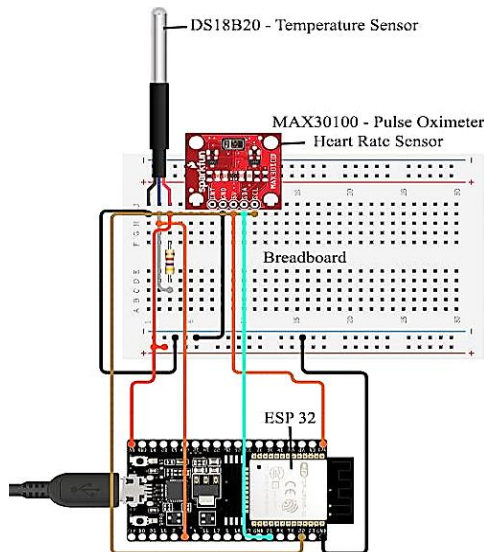


Figure 4: Circuit diagram of the external module

Table 1. Pin connection of ESP32s, MAX30100, and DS18B20

ESP32	MAX30100	DS18B20
3v3	Vin	-
5V	-	Vcc
GND	GND	GND
Data Pic	-	GPIO 0
SDA-21	SDA	-
SCL-22	SCL	-

### 4. Results and Discussions

The proposed system underwent a user test case study in a regular environment to assess functional accuracy and usability. Test case scenarios with repeated five trials of each primary functionality test determine the success rate. Four adult individuals have participated in this trial as regular usability test. Evaluation includes a brief presentation about the study and its objectives, a demonstration of the system, and a 5 to 8 minutes basic hands-on session. The participants performed designated tasks and provided feedback on usability and effectiveness. Corresponding results are recorded, analyzed, and summarized as presented in Table 2.

Table 2. Result of Usability Evaluation Study

Tasks	Modules	Access Results	Number of Attempts (M $\pm$ SD)	Task Completion time (M $\pm$ SD) second	Number of times Asking Help (M $\pm$ SD)
T1: Log in	S/W	100%	1 $\pm$ 0	15.25 $\pm$ 3.56	0 $\pm$ 0
T2: Start chat		100%	1 $\pm$ 0	1 $\pm$ 0	0 $\pm$ 0
T3: Find doctor		100%	1 $\pm$ 0	8.25 $\pm$ 2.04	0 $\pm$ 0
T4: Find cure		100%	1 $\pm$ 0	6.25 $\pm$ 1.47	0 $\pm$ 0
T5: View Profile		100%	1 $\pm$ 0	1 $\pm$ 0	0 $\pm$ 0
T6: Send SOS		95%	1 $\pm$ 0	2.75 $\pm$ 0.43	0 $\pm$ 0
T7: Measure Health matrices	H/W	75%	1.25 $\pm$ 0.43	51.5 $\pm$ 3.20	1.25 $\pm$ 0.43
T8: View Health Analytics	S/W	100%	1 $\pm$ 0	2.75 $\pm$ 0.83	0 $\pm$ 0

S/W (software module); H/W (Hardware module); M (Median); SD (Standard Deviation)

Results show that the proposed system is convenient and easy to use most of the time, especially for using the mobile application with  $\approx 100\%$  access rate. This reflects that each participant was able to perform designated tasks with a relatively minimal number of attempts. When accessing the mobile application,  $\approx 87.5\%$  (7 out of 8 tasks) required no assistance. On the other hand, use of the external module shows an access rate of  $\approx 95\%$ , reflecting a minor

difficulty for the first-time users. This can be overcome if the external module can be integrated with mobile device(s). Overall feedback of the participants is satisfactory in terms of system performance, functionality, and usability of the proposed system.

Results of determining body health parameters of four participants are shown in Figure 5. Heart rate and temperature variations for four different individuals in various times are demonstrated in Figure 6 and Figure 7. Two samples of chatbot conversations are presented in Figure 8 and Figure 9.

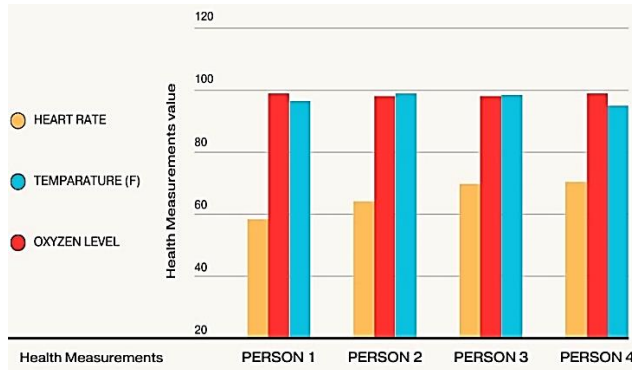


Figure 5: Body health measurements of four individuals

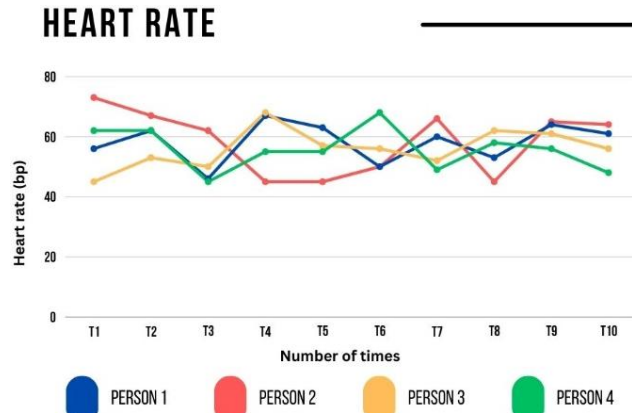


Figure 6: Heart rate variations of four individuals

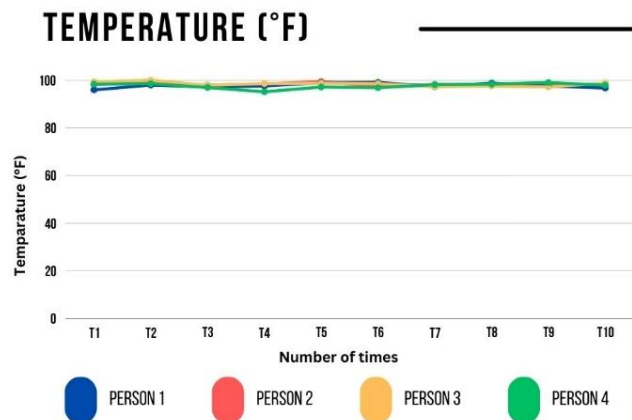


Figure 7: Temperature variations of four individuals

#### Scenario: Stomach ache

**User:** I am feeling stomach ache  
**Chatbot:** Please enter your age:  
**User:** 23  
**Chatbot:** Where is your stomach pain located?  
 (All over the abdomen; In a specific part of the abdomen; I don't know)  
**User:** All over the abdomen  
**Chatbot:** How long have you had stomach pain?  
 (Less than 2 days; Between 2 and 7 days; Between 8 and 14 days; More than 2 weeks)  
**User:** More than 2 weeks  
**Chatbot:** How strong is the stomach pain?  
 (Mild; Moderate; Severe)  
**User:** Severe  
**Chatbot:** Do you have abdominal pain when you stand on your toes and then drop down hard onto your heels? (Yes; No; Don't know)  
**User:** Yes  
**Chatbot:** **Suggested Care: Visit Emergency Department**  
 We have found some possible causes for your problem.  
 1. Irritable bowel syndrome [less common]  
 2. Crohn's disease [very rare]

Figure 8: Chatbot conversation for Stomach Ache

#### Scenario: Bad cough

**User:** I am having bad cough  
**Chatbot:** Please enter your age:  
**User:** 23  
**Chatbot:** How long have you had a cough?  
 (Less than 3 weeks; Between 3 and 8 weeks; More than 8 weeks)  
**User:** More than 8 weeks  
**Chatbot:** Do you have a high BMI, i.e., you weigh too much in relation to your height? (Yes; No; Don't know)  
**User:** Yes  
**Chatbot:** How would you describe the cough?  
 (Dry cough, without phlegm or mucus; Wet cough, with phlegm or mucus; Both a dry and wet cough, with phlegm or mucus)  
**User:** Wet cough, with phlegm or mucus  
**Chatbot:** Do you smoke or have you smoked cigarettes in the past for at least 10 years? (Yes; No; Don't know)  
**User:** No  
**Chatbot:** How would you describe the wet cough?  
 (The phlegm or mucus is thick, and it's yellow or green; The phlegm or mucus is pink and frothy; Often comes in the morning)  
**User:** The phlegm or mucus is thick, and it's yellow or green  
**Chatbot:** Which of the following do you experience that makes it hard to speak, if any?  
 (Voice is hoarse or raspy; Inability to produce sounds; Discomfort or pain in the lower half of the face or mouth while speaking; Rapid and concerning worsening of speaking skills, i.e., rapid onset of slurring and stuttering)  
**User:** Voice is hoarse or raspy  
**Chatbot:** Has the hoarse or raspy voice lasted more than 2 weeks? (Yes; No; Don't know)  
**User:** Yes  
**Chatbot:** Do you feel like you have a lump in your throat? (Yes; No; Don't know)  
**User:** Yes  
**Chatbot:** **Suggested Care: Doctor Routine Check-up Required**  
 We have found some possible causes for your problem.  
 1. Laryngopharyngeal reflux [less common]

Figure 9: Chatbot conversation for Bad Cough

## 5. Social impact

The proposed system is dedicated to support the principles of universal healthcare. Affordability of the external module contributes to eliminate financial barriers to healthcare. By using this system, the most financially underprivileged individuals will be able to receive basic and substantial health supports. This aligns with the project's goals of democratizing healthcare and improving health outcomes for underserved communities. By prioritizing social concerns, this project hopes to have a positive impact not only on the individuals but also on the general community and the world.



## 6. Conclusion

In addressing the issues caused by the limited access to healthcare services and information, the proposed system aims to improve the interactions between general people and healthcare services by combining AI, NLP, and cloud technologies. Existing systems designed to improve access to healthcare services have certain limitations and lack of integration with emerging technologies like IoT, resulting in the need for more comprehensive and user-centric solutions. This project offers a comprehensive approach to access healthcare services by providing basic health information for both general and clinical users. However, due to financial limitations and difficulties in access to clinical scenarios, the system is not tested for a wide range of diseases. Presented prototype is mainly designed as Android mobile application. Platform independence and scalability are not tested for the current prototype.

There is a tremendous potential to enhance this proposed system with some additional features, for instance, establishing a medical drug information database, implementation of medical report archives, incorporating telemedicine services, etc. The presented system also can be enhanced with a dedicated circuit board with rechargeable power supply unit. Moreover, design of an external module compatible with mobile devices will enhance usability of the proposed system. This system has potential to benefit individuals, researchers, and society as a whole by supporting better health outcomes and to create an educated and proactive approach to maintain better personal health with further development and integration of emerging technologies.

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