Low-Cost Remote Sensing IoT based Smartphone Controlled Robot for Virus Affected People

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Abstract

This modern era is the era of IoT and Robotics. In current times the whole world is suffering from the Covid-19 pandemic. This paper represents an IoT based Robot that will help the virus affected people. This robot will be able to collect data from virus affected people and send those data to a cloud database. The collected data can be analyzed from the cloud platform. The robot is designed as a low-cost device and can be controlled via smartphones. Bluetooth sensors, temperature sensors, and other sensors are used to collect data from the patient and to control the robot. Wi-fi communication is used to send the collected sensor data to cloud database. The prototype is successfully worked and showed good results.

1 Introduction

This project will result in a robot that can move with the instructions from your smartphone and can go to a remote abstruse place, virus affected area, and virus affected people to collect data and help people. The Robot will be Bluetooth controlled having 360 movements and can be controlled from a distance place remotely. The robot can get the instructions from the mobile throw the Bluetooth module. Then it will process the instruction through microcontroller Arduino and move the robot by following the instructions. Then it will collect data from there and send the collected data to the cloud database via Wi-Fi and the internet. In our system, we have designed a low-cost Microcontroller Based Android controlled Robot. The robot will move forward, backward, left, and right direction by following the instructions given from the mobile. This system can be helpful for various purposes.

We tried to make an HRI device. By human utilizing a machine in a significant way by interacting with it named as Human-Computer Interaction (HCI). Two main characteristics of the HCI device is Functionality and Usability. When we designed our project we tried to maintain that. We followed the principles of HCI devices which makes our project useful for humans. Also, the suitable balance between functionality and usability makes our system powerful and influential performance. People use sign languages and gestures to communicate with people and machines. We made the device able to get the instructions from the mobile. This robot can go to a remote abstruse place where a man cannot go. It receives data from the abstruse remote place then transmits data to the cloud database via Wi-Fi and the internet. This robot can be controlled by a smartphone via Bluetooth. Also, it can be used for disabled persons. It is a wireless android control robot that is suitable to integrate with other electronic devices. This robot can be used in helping mankind by taking remote data as well as in the health sector. This robot will be able to collect data from virus affected people and send that data to the cloud. Then the affected person can be monitored from a remote place. Nowadays this project can help Covid-19 affected people. This can take body sensor data like temperature, humidity, pulse, pulse oxygen level, and other things and send them to the cloud database.

The population of the entire world is constantly rising. Along with the rise of population industrialization and urbanization are also increasing at a mentionable rate. The consequences of these activities are

global warming which has severely affected the health issues of the people around the world. Under these circumstances, it has become very much essential to keep people's health parameters in constant observation. In Bangladesh, from a statistical analysis, it has been found out that one out of every eight people is suffering from serious health issues which could be avoided if their health were monitored more often. Faced with these issues, in many developed countries as well as in our country, home-based and community-based healthcare services have been identified as necessary to maintain the quality of services delivered and to create much better healthcare facilities at less time. Analyzing all of these conditions, we decided to create such a beneficial project from the health perspective. The robot can serve society. It can collect data from a remote place and from patients. Quantified health should be the future of health care since measured health can be improved better. So taking advantage of quantified health technology is wise. We also know that data affects performance, so for better results, object measurement and health monitoring are needed. Health is considered as one of the basic human needs. If the sound health of mass people can be guaranteed, then the overall productivity is obvious to enhance. This will have a great positive impact on our society.

This work has the following objectives:

1. Designing and implementing an IoT based low-cost robot that can be controlled via smartphones.
2. That robot can collect data from an abstruse place and from virus affected people where general people can not go, that collected data will be sent and stored to a cloud database.

In this first part, we have discussed the Introduction. The rest of the paper is organized as follows: Literature review is in Sect. 2, the methodology is presented in Sect. 3, outcomes and results are discussed in Sect. 4, conclusion and future works are discussed in Sect. 5. Acknowledgment and References are stated at last.

2 Literature Review

IoT systems and Robotics can help in medical science. Authors of [1] made an IoT based system for patient management. IoT systems can send data Remotely for EVM [2] and can serve good results with electronic data for voting [3]. Simple low-cost robots can send data to a remote place [4]. IoT systems can also be used in animal control and help people [5]. We can use robots as nurses in hospitals [6]. Gesture controlled robots can help disabled patients [7]. Android controlled robots can collect data from remote places [8]. One of the major issues for a successful mobile based robot application is Real-time obstacle avoidance [9]. Mobile based robots feature some sort of collision avoidance, using some kind of primitive algorithms that can stop the robot when an obstacle is found in front of him or can avoid the obstacle from collisions. This algorithm is very much complex, because it detects an obstacle and also takes measurements based on obstacle dimensions [10]. Devices interact with each other through machine to machine communications, which allows data exchange and collection. It helps us to obtain a vast number of data and helps automation technologies across a wide variety of industries. Amid the Fourth Industrial Revolution, the Internet of Things is now being used at industrial level in the fields of precision

farming[11], safety monitoring[12] and smart grids[13]. There has also been extensive research on the use of IoT to develop intelligent systems in areas including structural health monitoring [14]. Although these areas vary from healthcare, the work performed within them verifies the likelihood of a healthcare system based on IoT [15]. IoT technologies in [16] are considered to be very effective in tracking patients suffering from Parkinson's disease. This work shows that wearable sensors for patient observation could be used by combining them at home to monitor Parkinson's progression with vision based technologies. The authors also suggested that future treatment plans could be enhanced by using machine learning. We are living in the era of robotics. Remote tracking of objects with data collection and reporting is possible, as many existing systems have shown [16]. Through this, we can monitor the health of individuals and report it to relevant parties such as doctors, emergency services and health centers [17]. We have applied IoT in Robotics. Which robot may be applied in healthcare too as well as remote sensing. Research in other related areas has shown that remote monitoring of health is possible, and the benefits it can bring in various areas are enormous. For noncritical patients, we can provide remote health monitoring at home rather than in hospitals, that help to reduce hospital resources like doctors, beds, and costs. Those who are living in rural areas can be a better option for them, or elderly people can stay home but can take the support of healthcare experts remotely. It can improve access to healthcare resources, and it can give people better control over their health at all times [18]. There are more advantages than disadvantages of health monitoring remotely. One of the disadvantages is when we have a large amount of data that is stored in database it comes with a security risk. Also, there is a need for regular monitoring of individual sensors that will ensure that everything working perfectly, and patients may run out of cellular range, or devices may run out of battery. We are fortunate that these issues are solvable. As we progress the disadvantages of IoT based healthcare systems will be less in near future. Researchers have found the Internet of Things' potential to use it on the healthcare system, as there are many benefits of remote health monitoring systems [19]. Lots of researchers has developed IoT healthcare systems for their specific needs, this include diabetes management, assisted ambient living, rehabilitation and more. While this IoT based systems designed for various different purposes, they are connected by the similar technologies. Several researchers found their interest in rehabilitation for particular reasons [20]. In [21], this paper demonstrates how to build a program that produces a person-specific recovery plan based on their symptoms. It compare the state of the patient, ailments and symptoms of data stored beforehand on database in order to achieve this. This program needs a doctor to insert relevant data manually and then authorize suggested care. In 87.9 percent of doctor cases agreed with the treatment offered by the program, there is also no need to change the proposed treatments. While, in [22], some models using mathematics have been proposed for angles in physical hydrotherapy that enable improved joint motion to be tracked through therapy. Consciously or unconsciously, we are using many types of robots in our everyday routine.

3 Methodology And System Design

We have used a low-cost microcontroller ATmega328 integrated with development board Arduino for the main controlling unit. For connecting the robot with the smartphone bluetooth sensor HC-05 is used. To

run the prototype we used motor driver L298N and DC gear motors with DC batteries. To collect the data of temperature and humidity we have used a DHT11 sensor, later other sensors will be used also. To show the collected value we have used an Oled display. We are sending the collected data to a free cloud server Thingspeak via post method by Wi-Fi connection. To send the data with Wi-Fi we have used wifi module ESP8266. The unit circuit diagram of the prototype robot is given in Fig. 1.

We can use any android or smartphone app which can communicate with arduino. Then we receive the data and put them into our algorithm and robot runs. Let the app send us F, B, L, R and S. We have the circuit combination as Fig. 1 then the algorithm of our system is as follows:

Step 1. Turn the system on.

Step 2. Establish connection with smartphone via bluetooth.

Step 3. If connection established turn off the red led and turn on the green led.

Step 4. Establish connection with router for the internet via Wi-Fi and ESP8266.

Step 5. Wait for receiving the instruction.

Step 6. If receive data = = F then Forward going function works.

Step 7. If receive data = = B then Backward going function works.

Step 8. If receive data = = L then Left going function works.

Step 9. If receive data = = R then Right going function works.

Step 10. If receive data = = S then Stop function works.

Step 11. If connection is ok collect data with sensor.

Step 12. DHT11 sensor collects temperature and humidity values.

Step 13. It shows the values in the oled display.

Step 14. Then sends the data to the declared cloud server

Step 15. Monitor the data and take actions.

The system methodology by which the robot moves is described by the following block diagram mentioned in Fig. 2.

The programming language C + + is used in the microcontrollers. The unit system follows the flow diagram mentioned in Fig. 3.

The diagram mentioned in Fig. 4 shows how the data are collected with sensors and sent to the server via node MCU ESP8266. Power supplies are also mentioned.

A pulse sensor also added with the system then with optical pulse sensor and DHT11 the system for collecting data looks like Fig. 5. The sent data to the cloud can be monitored from mobile devices, smart phones and computers from all over the world. We have also developed an android app to see the values and monitor a particular patient. That output will be discussed in the results section.

4 Results Discussion

Finally this system achieved the following features as output:

1. It can go to a remote abstruse place and to a virus affected people where general people cannot go.
2. Receive and transmit data from an abstruse remote place and virus affected people.
3. Receive instructions and data via Bluetooth from a smartphone.
4. Move the robot by the received information with 3600 degree movement.
5. Suitable to integrate with other electrical devices.
6. Collects data and sends the collected data to the cloud database via Wi-Fi and the internet.
7. The collected data can be seen from mobile apps also.
8. The cloud channel where realtime data are displayed is here:

<https://thingspeak.com/channels/739817>

The cloud home page with data is like Fig. 6. The free server thingspeak can also see the data as graph and gauge. It also show the real times value as numbered figure. As this is prototype we have used free server to check its work or not. Later we can use our own server too.

A mobile app is also developed to see the data with a nice look in smartphones. The output of mobile data is shown in Fig. 7.

The data collecting module with sensor and Node MCU ESP8266 are shown in Fig. 8.

We can download the data from the cloud server as csv, json or xml format. The data can be visualized and analyzed with matlab from the cloud free platform thingspeak as shown in Fig. 9. Later we can also use these data for machine learning or in other calculations.

The robot prototype finally looks like Fig. 10.

We have tested the robot as follows:

Test point 1: Bluetooth communication. We have tested it 1000 times and the robot successfully connected with the smartphone for 988 times. So, the success rate is: 98.8%.

Test point 2: 360-degree movement. We have tested it 1000 times and the system recognized the correct instruction and made the correct movement for 989 times. So, the success rate is: 98.9%.

Test point 3: Data sensing and showing in oled display. We have tested it 1000 times and the system sensed the correct data and showed in oled display for 971 times. So, the success rate is: 97.1%.

Test point 4: Data sending to cloud database. We have tested it 1000 times and the system sent the correct data to the cloud database for 955 times. So, the success rate is: 95.5%.

Though the project run very well and showed successful results, we have found the following limitations also:

1. Smooth working depends on battery life.
2. Always show the collected data in oled display but need the Wi-Fi connection to send the data to cloud database.
3. It can do works only in the range of Wi-Fi and Bluetooth.

5 Conclusion

This robot worked successfully during our test. By touching the smartphone screen, it can move 360 degrees. Goes to an abstruse place or a virus affected people and collects data from there. Also, it sends the data to a cloud database that can be accessed from anywhere in the globe. This can be used to make a report about the remote place and virus affected people. From the server, this data can be downloaded in many formats to analyze and use in future.

We have planned for some future works as follows:

1. In a further development the distance range may be increased. Like if XBee is used then the distance range may be 1 kilometer.
2. Adding more sensors to produce more data and help to monitor the patient from a remote place more efficiently.
3. Predicting human and weather conditions that can be done by developing machine learning and artificial intelligence using the collected data.

Declarations

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Figures

Figure 1

Unit circuit diagram of the robot

Figure 2

System methodology to move the robot

Figure 3

The flowchart of the remote sensing part and data sending

Figure 4

System methodology to move the robot

Figure 5

Sensor data sending with Node MCU ESP8266 via wi-fi to cloud

Figure 6

Sensor realtime data showing in cloud server

Figure 7

Sensor realtime data showing in smartphone app

Figure 8

Sensor data sending with Node MCU ESP8266 via wi-fi to cloud

Figure 9

We can download the collected data from cloud server thingspeak and analyze

Figure 10

Final Robot Prototype