

Contactless IoT Doorbell for Covid-safe Household

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Abstract—The Covid-19 pandemic has proven to be the most disastrous pandemic in the history. Millions of people have lost their lives sending nations into lockdown and economic slowdowns. Given the fact that no specific anti-viral treatment is yet suggested for treating Covid-19 infection, “Social distancing” is probably the most effective tool so far in stopping the virus spread. This paper has proposed an IoT based doorbell which alerts the house owner about arrival of a visitor having fever and who could be a Covid-19 patient. The system uses NodeMCU and MLX90614 non-contact infrared temperature sensor. Firebase online database is used to log all the readings of the system and a companion mobile App is also provided. The system was extensively tested using an experimental set up under various conditions. The system works with 99% average accuracy of body temperature measurement.

Keywords—IoT, Contactless temperature measurement, COVID-19, Firebase, Node mcu.

I. INTRODUCTION

Covid-19 crisis has been affecting nations world-wide for past 16 months. Since the WHO country officer in China reported a “Pneumonia of unknown cause” on December 31, 2019 [1], over 143 million persons have been infected and over 3 million people have lost their lives [2]. The global economic effects of the pandemic are severe and long lasting. According to CRS report [3], the global economic growth has dwindled to an annual rate of -4.5% to -6.0% in 2020, with a partial recovery of 2.5% to 5.2% projected for 2021. Following the second surge in the cases, most of the nations have seen renewed restrictions on transport and businesses.

Currently, there is no specific anti-viral treatment licensed for Covid-19 patients. Care is given only to patients only for relieving symptoms and manage respiratory and other organ failures [4]. However, in certain parts of the world there’s acute shortage of this medicines, facilities and even hospital beds. Several cases have been reported where patients have lost their lives because of lack of timely help or unavailability of medicines. In a recent incidence in India, at least 24 Covid-19 patients on life support died after a leak in a medical oxygen tank disrupted the supply of the gas [5]. Although the vaccines are being considered as the best hope for ending the pandemic, it is still not clear the degree to which the vaccines can protect not only against disease but also against infection and transmission [6]. Considering this scenario, it can only be said that the prevention is better than the cure. “Social distancing” has been the most effective tool so far in stopping the virus spread. CDC has enlisted several precautions to be taken during the pandemic to avoid getting infected [7]. Although it is absolutely essential to follow these guidelines

on daily basis, at times it becomes tedious to keep yourself reminding about them and can easily be forgotten.

Internet of Things (IoT) is one such domain where cyber world gets seamlessly connected with the physical world. Large variety of sensors are available which are used in sensing various parameters, the sensor data can be further stored, processed, visualized to gain useful insights and make critical decisions. The market of IoT in healthcare is projected to grow nearly 39% from 2020’s \$72.5 billion to a 2025 estimated projection of \$188.2 billion [8]. Leveraging this exciting technology and the power of contactless temperature sensors, we propose this contactless doorbell, which will not only avoid direct touch of outsider to the doorbell but also will alert the inmates of a house about body temperature of the person who has arrived at their doorstep.

The system was developed with easily available, affordable IoT components like NodeMCU and MLX90614 non-contact infrared temperature sensor. The system was extensively tested using an experimental set up under various conditions. The system works with 99% average accuracy of body temperature measurement.

The rest of the paper is organized as follows. Section II explains review of the related literature. Section III describes the system design while concepts of contactless temperature monitoring are discussed in section IV. Section V is dedicated to results and delated discussion. The paper is concluded with the future scope in section VI.

II. LITERATURE REVIEW

There are a few IoT based doorbell systems proposed in the literature. Qian *et al* [9] have presented design of a doorbell system in order to eliminate unnecessary ringing noise. Employing artificial intelligence for face recognition, the IoT doorbell system categorize the visitors as complete strangers or someone who is expected. The next step operates based on this result; the doorbell system will either ring or send out notification to the users’ phone depending on the familiarity of the visitor and the user. Quadros *et al* [10] have developed a low-cost smart doorbell using Amazon Dash button. The Dash-bell enables the home owner to see the pictures of a visitor to remotely ascertain their identity. Besides, it allows the home owner to admit or reject a request anywhere when connected to the Internet. Both these systems offer remote monitoring to the home owner and also allow access to the house based on familiarity of the guest. However, objective of our research work is to categorize guests as per their body temperatures.

The core of this research work is contactless temperature monitoring. Till now, such measurements were used only in industry. But owing to physical distancing in household body temperature measurement also contactless devices are required. Rahimoon *et al* [11] have developed a system using temperature sensors LM-35 and MLX-90614. The measurements are sent to display devices via wi-fi network. Al Mamun *et al* [12] have used MLX-90614. The measured temperature can be read directly and easily, on OLED. Both of these systems are just for reporting body temperatures in contactless way. However, our system not only measures the temperatures in contactless way but also alerts in inmates of the house if body temperature of the guest is above the normal value.

III. SYSTEM OVERVIEW

The proposed system is developed on a NodeMCU open source IoT platform. As seen from the Fig. 1, there are 4 modules in this system – doorbell module, server, in-house module and the companion mobile App. The doorbell module is controlled by NodeMCU unit and senses body temperature of a visitor with the help of MLX90614 non-contact infrared temperature sensor. The doorbell module, after collecting the temperature data of the visitor and depending on the level of temperature takes the appropriate action. Also, logs in the current reading in the FireBase real time database in the server. NodeMCU is open source platform, it's hardware design is open for edit/modify/build. NodeMCU Dev Kit/board consist of ESP8266 wifi enabled chip. The ESP8266 is a low-cost Wi-Fi chip developed by Espressif Systems with TCP/IP protocol. It can be used for a wide variety of IoT applications. Nodemcu is used because the members of the house can be notified if the member has a wifi connectivity anywhere outside the house as compared to Bluetooth module HC-05 it is used in a smaller range ,hence the members wont be notified if they are at a significantly long distance.

The in-house module, displays the body temperature of the visitor in a 7-segment display for ease of the house owner and provides an interface between server and a companion mobile App for the doorbell.

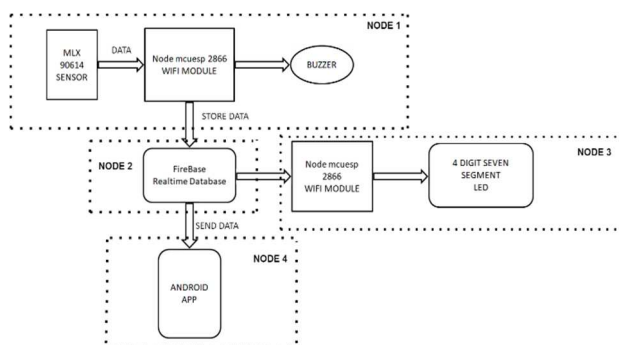


Fig. 1. System overview of IoT based doorbell

Fig.2 shows an activity diagram of the IoT doorbell. There are two agents in this system, namely - owner (user) and the visitor. As the visitor approaches the door of the owner's home in order to gain entry, they have to hold their hand in front of the MLX90614 sensor.

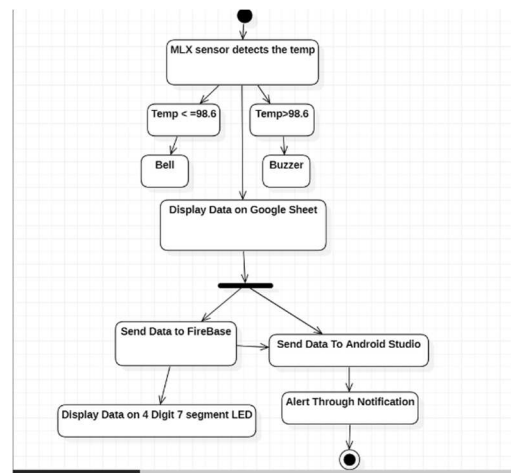


Fig. 2. Activity diagram

The non-contact temperature sensor then detects the body temperature of the visitor. If the temperature exceeds the normal human body temperature, indicating fever, the IoT doorbell will give an alert by way of sounding a buzzer displaying the body temperature on the 7-segment display. If the body temperature is within the normal range, then it will give a normal door-bell sound that will notify that the visitor doesn't have fever.

The doorbell module also sends the body temperature data on the Firebase online database for log and future analysis work. This data is fetched by indoor module as well as the Android app. The app also gives an alert notification if the temperature is more than the threshold.

IV. RESULTS AND DISCUSSIONS

The system described in previous section is implemented in an experimental set-up. Fig.3 shows doorbell and indoor modules. As currently the system is being tested, the circuit has been assembled on the breadboard and not on a PCB. Fig.4 shows a laptop with Arduino IDE where serial monitor is showing real time readings from doorbell module.

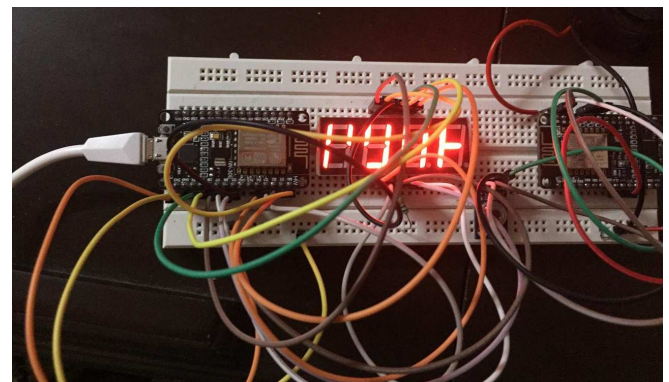


Fig.3. Doorbell and Indoor modules of IoT based Doorbell

Readings were taken for several cases and response of the system was noted. Percentage error and accuracy was also determined as a performance parameter.



Fig.4. Real time contactless temperature sensing

As seen from Table I, average accuracy obtained by the system is 99%. Accuracy of the system can be further improved by using better temperature sensor.

TABLE I. SYSTEM'S RESPONSE AND ACCURACY

Body Temperature	Reading by IoT Based Doorbell	Bell Sound	Buzzer Sound	%Error	Accuracy
96 F	95.878 F	ON	OFF	0.2%	99.7%
97 F	96.97 F	ON	OFF	0.1%	99.97%
98 F	97.99 F	ON	OFF	0.1%	99.987%
99 F	98.98 F	OFF	ON	0.1%	99.98%
102 F	101.99 F	OFF	ON	0.1%	99.987%
103 F	103 F	OFF	ON	0%	100%

Fig.5 shows the screenshot of the Android app named "Bell" which displays real-time body temperature of the visitor if it is above the threshold. This app can be easily modified for iOS also.

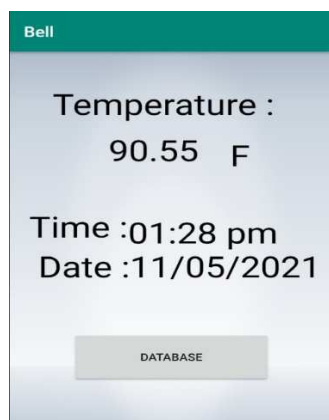


Fig.5. Android app screen displaying body temperature

The Android App also makes the log of previous readings available as seen in Fig. 6. Along with the date and time of arrival, body temperature and system response (bell sound or alarm sound) is recorded.

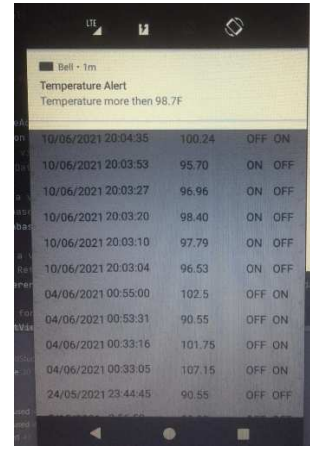


Fig.6. Screen shot of Android app showing log

These readings can be further used by the system for analysis like number of visitors per day, number of visitors having fever in past week etc. This information can prove extremely useful in contact tracing of a Covid-19 infected person.

$$\text{Accuracy} = \frac{\text{True Positive}}{\text{True Positive} + \text{True Negative}} \times 100$$

Different temperature records have been taken from thermometer, infrared sensor and MLX 90614 non-contact infrared temperature sensor. The best result is obtained from MLX 90614 with less percent of error and more percent of accuracy and it is more preferred as it is a touchless sensor which is more useful in the current pandemic.

V. CONCLUSION AND FUTURE SCOPE

Given the fact that no specific anti-viral treatment is yet suggested for treating Covid-19 infection, "Social distancing" is probably the most effective tool so far in stopping the virus spread. To protect our household and premises from a close contact with a probable Covid-19 carrier is now possible with the help of IoT applications.

This paper has proposed an IoT based doorbell which alerts the house owner about arrival of a visitor having fever and who could be a Covid-19 patient. This system uses NodeMCU and MLX90614 non-contact infrared temperature sensor. Firebase online database is used to log all the readings of the system and a companion mobile App is also provided. The system was extensively tested using an experimental set up under various conditions. The system works with 99% average accuracy of body temperature measurement.

The IoT based doorbell can be enhanced further by incorporating a camera and identifying the visitor by face recognition. Identity of the visitor can be stored in the log too.

REFERENCES

- [1] World Health Organization, "Pneumonia of unknown cause – China", 2020.[online]. Available: <https://www.who.int/csr/don/05-january-2020-pneumonia-of-unknown-cause-china/en/> (Accessed: April 22, 2021)
- [2] H. Pettersson, B. Manley and S. Hernandez, "Tracking Covid-19's global spread", 2021. [online]. Available: <https://edition.cnn.com/>

- [interactive/2020/health/coronavirus-maps-and-cases/](#) (Accessed: April 22, 2021)
- [3] Congressional Research Service, “Global Economic Effects”, 2021.[online]. Available: <https://fas.org/sgp/crs/row/R46270.pdf> (Accessed: March 30, 2021)
- [4] “COVID-19 Overview and Infection Prevention and Control Priorities in non-US Healthcare Settings”, 2021. [online]. Available: <https://www.cdc.gov/coronavirus/2019-ncov/hcp/non-us-settings/overview/index.html> (Accessed: March 30, 2021)
- [5] S. Banerjee, “24 COVID-19 patients in Nashik die without oxygen as gas leaks”, 2021. [online]. Available: <https://www.thehindu.com/news/national/other-states/several-covid-19-patients-die-after-oxygen-tank-leak-at-nashik-hospital/article34375163.ece> (Accessed: April 22, 2021)
- [6] World Health Organisation, “COVID-19 Vaccines”, 2021, [online]. Available:<https://www.who.int/emergencies/diseases/novel-coronavirus-2019/covid-19-vaccines> (Accessed: April 22, 2021)
- [7] Centers for Disease Control and Prevention, “How to Protect Yourself and Others”, 2021. [online]. Available: <https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/prevention.html> (Accessed: April 28, 2021)
- [8] N. Mendoza, “2025 forecast: Global IoT healthcare market looks good—a \$188.2 billion opportunity”, 2021. [online]. Available: <https://www.techrepublic.com/article/2025-forecast-global-iot-looks-good-a-188-2-billion-opportunity/> (Accessed: April 28, 2021)
- [9] M.Qian, Y. Sun and F. Zhang, “An Intelligent Internet of Things (IoT) Doorbell System for Smart Notification Alert”, CSIT, AIRCSSE, Vol.9, No.12, Sep. 2019
- [10] B. Quadros, R. Kadam, K. Saxena, W. Shen and A. Kobsa, Alfred, “Dashbell: A Low-cost Smart Doorbell System for Home Use”, 2017. [online]. Available: https://www.researchgate.net/publication/318009810_Dashbell_A_Low-cost_Smart_Doorbell_System_for_Home_Use
- [11] A. Rahimoon, M. Abdullah, I. Taib, “Design of a Contactless Body Temperature Measurement System using Arduino”, Indonesian Journal of Electrical Engineering and Computer Science, Vol. 19, No. 3, Sep. 2020, pp. 1251-1258
- [12] M. Hossain, M. Rahman, M. Abdullah, M.Hossain, “Design and Development of Arduino Based Contactless Thermometer”, 2020. [online]. Available: https://www.researchgate.net/publication/342304809_Design_and_Development_of_Arduino_Based_Contactless_Thermometer