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IoT based COVID De-Escalation System using Bluetooth Low Level Energy

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***Abstract*—An Internet-of-Things (IoT) can be an effective solution to de-escalate the spread of a pandemic/epidemic using open source technology - Bluetooth Low level Energy. The major objective of this contribution is to monitor real time cases and prevent the contagious spread of this viral disease. The entire paper focuses on cross checking the data fed by the user with the IoT database which consists of the data from the COVID RADAR application. The experimental model uses MCU and a Bluetooth module, which are easy to realize and cost effective as well. The realization and prediction of the pandemic hotspots is also facilitated using this data.**

Keywords—component; COVID, IoT, Bluetooth Low Level Energy, MCU.

I. INTRODUCTION

Plagues and pandemics have ravaged humanity throughout its existence, often changing the course of history based on how it is controlled and at times even signaling the end of certain civilizations. COVID-19 pandemic is currently the latest threat to plague the human race with everyday being a constant battle against it. It has already claimed millions of lives and continues to do so. Given the novelty of the virus, the vaccine is still in the making, and there is a long way to go before obtaining a successful one. The pandemics in history from the Spanish Influenza to AIDS have taught us a lot. The recent outbreak has given rise to the awareness regarding the best preventive practices. Frequent washing of hands, social distancing and the government mandated stay-at-home measures and quarantining of the afflicted patients are a few of many measures that are currently following as the need to survive this pandemic becomes the primary concern to the entire world. While these measures are good, there are still diseases that exist without no vaccines found, and the only solution to it is taking preventive measures. Given such a scenario, a technological solution to de-escalate the number of cases would genuinely help bring the situation under control.

Here are some other applications which can help us fight COVID [1] talks about usage of drones to transport blood, when in need. This can apply to plasma supply as study shows plasma cells have a good chance in fighting against coronavirus although there is a huge dependency on high disbursement.

Aarogya Setu Application is another solution to fight against Covid-19, but it doesn't provide accurate information [2]. It was stated that the vision over which an IoT system can act as a solution is vast [3]. There are a few IoT-based applications which state how beneficial IoT systems can be in the medical field .[4-7].

. COVID-19 situation and how it is bringing out more technological solutions to fight it is elaborated [8]. As surveillance and monitoring crowds is an efficient way to fight Coronavirus, a system which can prevent escalation of cases is really beneficial [9]. This can be used to control future pandemics and other various outbreaks. Current technological initiatives include tracking, screening, contact tracing, quarantine and self-isolation and finally clinical management. Others include fighting misinformation, finding drugs and contact less delivery. This paper presents a technological solution to combat the pandemic.

II. METHODOLOGY

The system deals with MCU and a Bluetooth module which targets the of BLE tags. A BLE tag is a 48-bit MAC (Media Access Control) address which is unique for every device. The IoT system receives the BLE tags and communicates with the database. The database has a set of pre acquired data which is collected from COVID RADAR app. By pre acquired ,it means the Tags of covid positive users.

If the acquired tag matches with the pre acquired tag ,the MCU alerts the authorities and all nearby users in that proximity of the IoT system. Similarly, the COVID RADAR application alerts the users in that particular locality.

A. System requirements and circuitry connection

Here, Node MCU ESP8266 V3 Lua CH340 and HC-05 are considered. The ESP acts as a WI-FI module, which enables us to communicate with the database. The HC-05 is a Bluetooth module which can retrieve Bluetooth addresses using simple AT commands.

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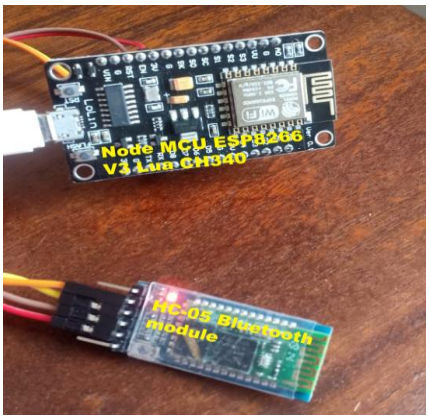

Fig.1. Experimental System diagram

The Tx and Rx ports of the ESP and HC-05 are connected; a 3.3v supply is given to the HC-05 from the ESP and the ground pin of the HC-05 is grounded. Both modules go well in hand and communicate using UART mode of communication [10].

The range of detecting a BLE tag is from 10 meters to 100 meters depending on the caliber of the Bluetooth module. HC-05 can detect tags up to 10 meters only. The system works on the basis of an indoor tracking system as stated in literature and was used [11] [12], but we don't require to locate the users; instead retrieve just the BLE tags. We are using the following AT commands for retrieval purposes.

Table 1. AT commands for HC-05

AT Commands	**Functions**
AT+CMODE=1	Allows to connect to any device
AT+ROLE=1	Setting module to master
AT+INQM	Detects the Bluetooth tags

The tags are further communicated to the database along with the timestamp log.

B. Flow Chart and implementation.

This system follows five-layer IoT architecture - when a user enters the proximity of HC-05 (Perception Layer) the module retrieves the tag and communicates with the ESP (Transmission Layer). The ESP checks the BLE tags with the database as shown in Fig.2. If the acquired data matches with the pre-recorded data present in the database, The ESP and COVID RADAR application warns all users in that locality. The data log is then stored in the database. If the BLE tag is not present in the pre-acquired data, the system continues to detect other tags. The pre-acquired data is collected using the COVID-RADAR application. The application acquires Bluetooth tags of Covid positive patients.

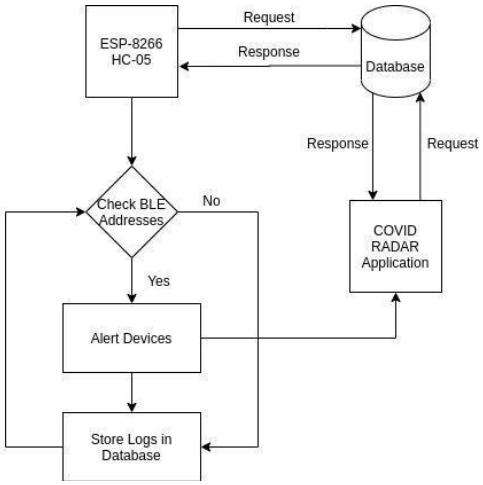

Fig.2. Flow diagram of the experimental process implemented

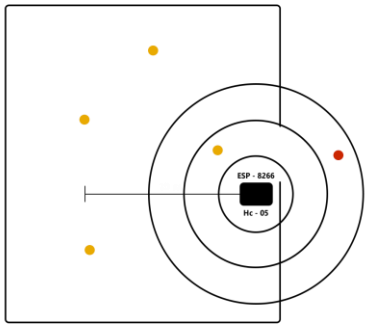

Fig.3.IoT system diagram used in the framework

C. Database Connectivity

The system uses Firebase Authentication and Real-time Database to authenticate, store and retrieve user data. Database is stored in JSON format and is synchronized with clients in real time. The cross-platform client is the fundamental platform of this database where all clients (Android App and IOT device) share the same resource from Firebase server and is automatically updated when any data is stored or changed [13].

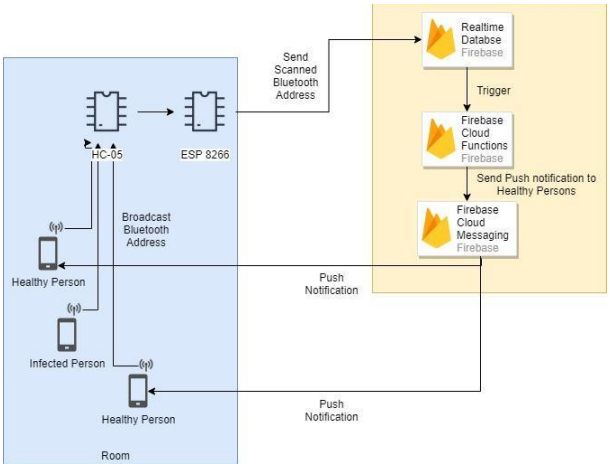

Fig.4. Database flow diagram

The application on Firebase is maintained even with the interruption of internet connection. Once the data is written to the cloud, it is stored in the local database of Firebase. After the internet is reconnected, client's activities will be updated immediately and synchronized with the server promptly. Fig.4. elaborates about the database connectivity with ESP in the project.

If a user with Covid positive enters the store area the Store ESP detects the covid tag and sends it to the Firebase Realtime Database which then triggers the Firebase Cloud Function [14][15] to scan and check if the tag detected is covid positive. If it detects the bluetooth tag is associated with covid positive person it sends out targeted notification to all the Covid Radar Application users in that store area using the Firebase Cloud Messaging to warn them about the possible transmission.

D. Covid Radar Application

Covid Radar App acts as an interface between the system and the end-user. Initially, the user is asked to register via the app by inputting mobile number and their email ID, after which, information of the user is asked such as First Name, Last Name, Aadhar Card(for further development), Covid Status, and Bluetooth id(automated function in the app).After the registration is complete the Covid Radar Application connects with firebase authentication system to generate a unique token for the user which is used to send targeted notification. This Data is then stored in the Realtime Database which can be seen in Figure 5. Users will be logged into the app throughout the use and will not be asked to log in again unless deletion of the app.

Once Logged in, the User lands on the functionality page. Here User is shown the list of Tags in the store area along with their Covid Status.

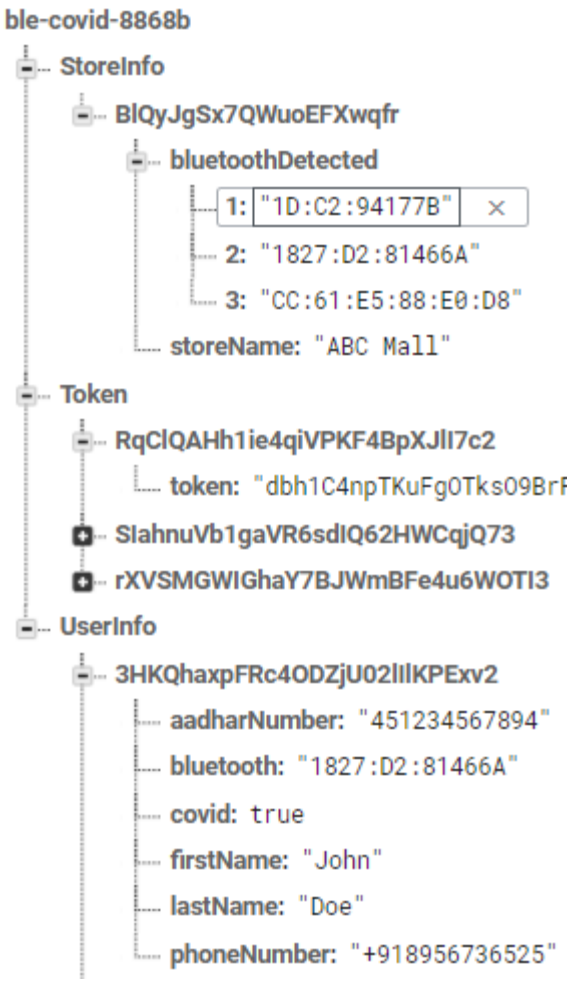

Fig.5 Database Schema

III. RESULTS AND DISCUSSIONS

The IoT system works according to the methodology mentioned above. The Output from the Node MCU Fig.5 depicts the BLE tags of users in that particular proximity. The Fig.6 is a line graph taken from our database for the time period of 24 hours. The spikes represent the number of COVID positive users in that particular time line. Here you can see at 10 A.M, the system detects a COVID Positive patient and accordingly in the further timeline it detects more users. The data log is stored along with the timestamp and Bluetooth tags in the database. This data can be further used in analytical applications to predict COVID escalation patterns and to come up with better strategical plans to de-escalate the cases.

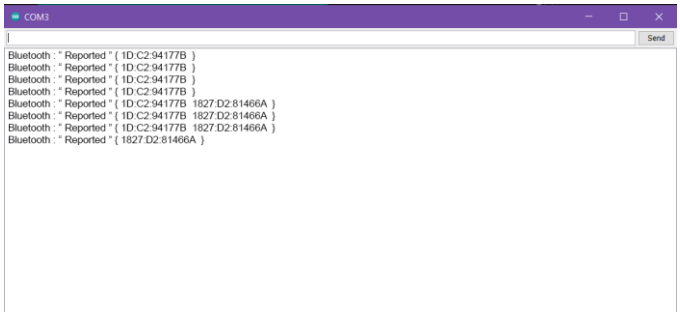

Fig.5.Output data log from the MCU (Arduino IDE)

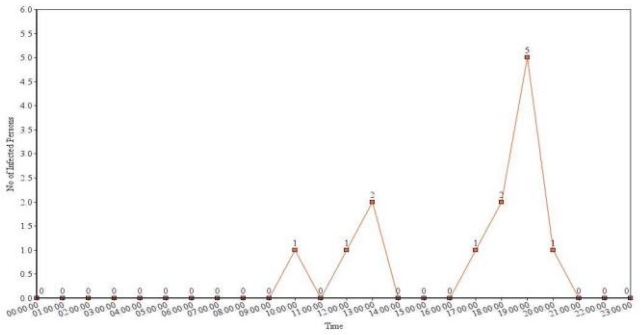

Fig.6. Data output variations from database

The ESP can be updated with an alarm when a COVID-positive user is present in the proximity but here we just alert all nearby users. The Firebase database seamlessly sends the data to the COVID RADAR Application which alerts the users in that locality of the detection.

IV. CONCLUSIONS

The given system acts as a preventive method to help with epidemics and pandemics such as the current COVID-19 situation. With easy integration and budget friendly options, it can be implemented in real time, thereby using technology in lieu of assigning a human task force for identification of the infected. The application developed is fairly straightforward and say to use - it alerts users of COVID patients nearby, right after the one-step registration. This data can be used for further research in identifying the exposure time and transmission of such epidemics. With this information, necessary precautions can be made to restore normalcy to ensure economic stability. The same information can be used in the medical field for essential workers taking care of COVID patients.

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