EEEE

Covid-19 Home Surveillance for Self-quarantine Monitoring System using IoT

Muhammad Zarim Mohamad[1], Zuhairiah Zainal Abidin[1]*

[1]Faculty of Electrical and Electronic Engineering,
Universiti Tun Hussein Onn Malaysia, 86400, Batu Pahat, Malaysia

*Corresponding Author Designation

Abstract: In recent years, the Internet of things (IoT) has developed as a new research topic in a range of academic and industrial fields, notably in healthcare. The IoT revolution is reshaping modern healthcare systems, with implications for technology, economics, and society. Traditional healthcare systems are evolving into more personalized systems that simplify diagnosing, treating, and monitoring patients. Because of the increased likelihood of COVID-19 in the current pandemic, patients must be tracked at various phases of COVID-19. IoT devices can remotely track patients' locations in connection to their treatments and authority stay-at-home orders during this period. The purpose of this project is to develop a monitoring system for a home surveillance system to monitor the movement and location of the COVID-19 patient. This project's development used an IoT-based implementation that can aid in tracking the patient's whereabouts utilizing a GPS tracking system and monitoring their movement. The Cloud Firebase Database may store and access real-time data on the location and information of the patient. This application also has an alert notification mechanism that alerts users when the geofence radius is exceeded. An android-based application with a GPS tracking system based on the IoT has been successfully developed, allowing patients' data and information to be accessible via the Cloud Firebase Database.

Keywords: COVID-19, GPS Tracking, Iot, Cloud Firebase Database

1. Introduction

In recent years, the Internet of things (IoT) has established itself as a new research topic in various academic and industrial disciplines, particularly healthcare. The IoT revolution is reshaping modern healthcare systems, with implications for technology, economics, and society. It is transforming traditional healthcare systems into more personalized ones, making diagnosing, treating, and monitoring patients easier. The Severe Acute Respiratory Syndrome Coronavirus 2 is to blame for the current global pandemic (SARS-CoV-2). The research showed a minimum reduction of 44 % and a maximum reduction of 96 % in the number of people infected with Covid-19. Similarly, quarantine decreases the estimated number of deaths by 31 % on average and 76 % on average [1].

Since the pandemic outbreak, IoT technology has been one of the most advanced technologies to address this global problem. There has been a rapid push in many research communities to do so. By tracking patients' movements during their quarantine period, IoT-enabled applications can be utilised to prevent the COVID-19 virus from potentially infecting others. Tracking confirmed or suspected COVID-19 patients and implementing lockdowns can also aid in reducing the number of COVID-19 infections spread by isolating contaminated individuals from others. People who have been exposed to Covid-19 or are at risk of contracting it should practise self-quarantine. It is suggested that self-quarantine last 14 days because those two weeks will allow them to determine whether they will become ill and endanger others. According to MOH's ruling, positive patients without symptoms must be quarantined for 7 days, those with symptoms must be quarantined for 14 days, and positive suspects must be quarantined for 14 days [2].

In the current pandemic, as the contingency of COVID-19 is high, there is an essential need for patients to be monitored in different phases of COVID-19. One of the phases, called the quarantine period, is an important period of this disease after the patient has been diagnosed with COVID-19. They should be isolated and monitored for the course of treatment. The current Home Surveillance Order (HSO) for COVID-19 patients is inefficient and ineffective. This is because the patient is not monitored to see if they violated the HSO when leaving their home or place of isolation. The current HSO for COVID-19 patients is inefficient and ineffective. This is because the patient is not monitored to see if they violated the HSO when leaving their home or place of isolation.

Previous research conducted to monitor multiple COVID-19 patients shows the need for IoT technology [3]-[4]. In this work, a tracking and monitoring system utilizing IoT has been developed.

2. Materials and Methods

In line with the goals of this project, the implementation of IoT-based quarantine monitoring using a GPS tracking system has been developed. This system can track the movement of the COVID-19 patient who is required to self-quarantine to be monitored for violating the Home Surveillance Order (HSO) under the conditions set by the Malaysian Ministry of Health (KKM).

2.1 Android-Based Application Development

Android Studio Ink is the official integrated development environment (IDE) for Android applications [5]. Android Studio offers a single environment for developing Android apps compatible with the Android operating system, such as an emulator, code templates, and GitHub integration [6]. The Android Studio platform was utilized to construct the Android-based application. The Java language was utilized in the construction of this application since it is compatible with all software development tools and fully compatible with the JavaScript Object Notation (JSON) used in database development.

2.2 Cloud Firebase Database

Firebase was used to develop the real-time database for the patients. The real-time database enables the user to access and upload the patient's data information, which can be synced from all users in real time. The patient's data is stored in the online platform Cloud Firestore for Database Cloud Storage as JavaScript Object Notation (JSON). The Google Firebase Database is a Google-backed application development software that enables developers to develop iOS, Android, and Web apps, that can be used to track analytics, report, and fix app crashes [7].

2.3 Geofencing

Geofencing is a location-based service that sends a notification to smartphone users who enter a defined geographic area. Geofencing enables the software application to alert or trigger a specified response when the tracked asset enters or leaves the geofenced area. Geofencing can combine awareness of the user's location with awareness of nearby features. The patient coordinates can be specified to mark the patient location, and the location's proximity can be adjusted by adding the radius, which is the 15-meter radius used in this project [8]. The geofence monitoring can be requested by requesting

the ACCESS_FINE_LOCATION and ACCESS_BACKGROUND_LOCATION [9]. Figure 1 shows the architecture diagram for this project.

Figure 1: Architecture of the project.

2.4 Alert Notification System

To create an alert notification system, the Location Services Provider needs to send out the INTENT, which can be used as a Broadcast receiver to define the geofencing event transitions and determine the types of Geofence transitions. In this project, the Broadcast receiver sends a notification as output when a geofence transition occurs, which is the users have exited the geofence radius. Figure 2 shows the alert notification system that will show as the notification system on the user's mobile phone.
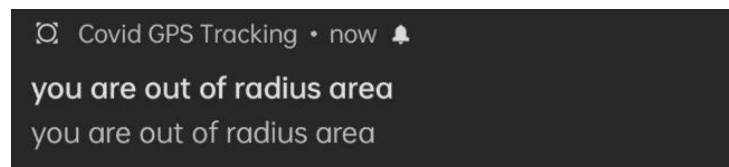

Figure 2: Alert Notification System

2.5 Google Location Services Permissions

To access the Google Map Services, the application needs to request permission by adding the relevant Android location permission into the application. The Android offers two location permission which is ACCESS_COARSE_LOCATION and ACCESS_FINE_LOCATION. The permission that will be used in this project is android. permission.ACCESS_FINE_LOCATION. This permission is more precise and accurate for detecting the location because it allows the API to determine the location as precisely as possible from the provided location services, which include the Global Positioning System (GPS) and Wi-Fi and mobile phone internet data [10].

3. Results and Discussion

The results and discussion section presents data and analysis of the study. The data analysis and collection outcome were recorded and analyzed concerning the project's overall goal.

3.1 Application Testing

When the GPS sensor acquires permission from the mobile phone, the location of the user's current location is detected, and the user needs to enable permission to access the location to allow the time to detect it in real-time. When the button 'MAP' is clicked, the location of the user appears on the screen display of the mobile device that shows the Google Map of the application. Figure 3 shows the user data collected at Jalan Kota Bharu – Pengkalan Kubor, Taman Murni, 16210 Tumpat Kelantan, Malaysia, with the Latitude and Longitude of 6.1432838 and 102.167342, respectively. The data were captured in a house at Kampung Bendang Luas.
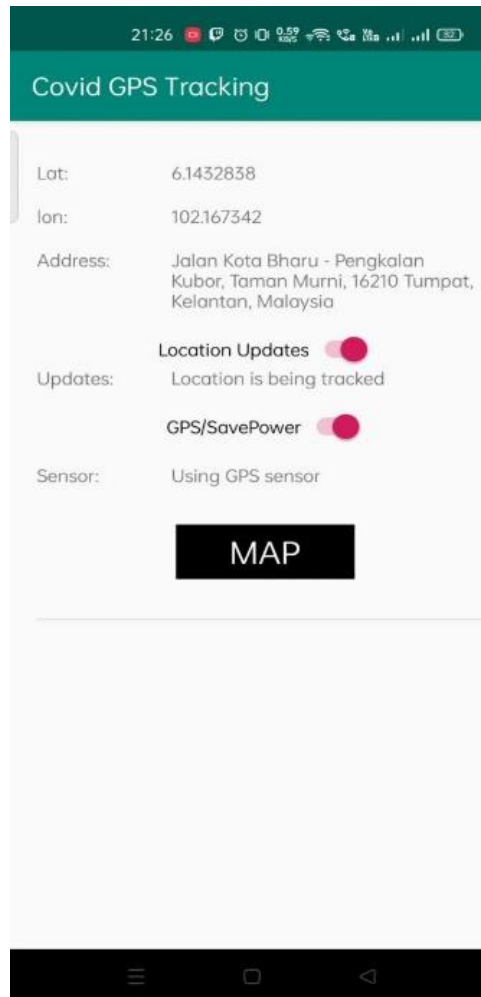

Figure 3: Main page for the data application

Once the MAP button in Figure 3 is pressed, the Google Map layout displays the user's location (pin indicator) within the geofence radius, as shown in Figure 4. The pin map indicator will move according to the user's movement within the house. If the user is within the area of the house, the database data will display "no action needed" as shown in Figure 5. In Figure 6, the geofence system has detected that the users have left the house and thus exited the geofence radius, and a notification has been sent to the user's mobile phone. The data for the user exiting the geofence is sent to the Firebase database and will be displayed for the authorities as "the user has exited the area, please take action" as shown in Figure 7.

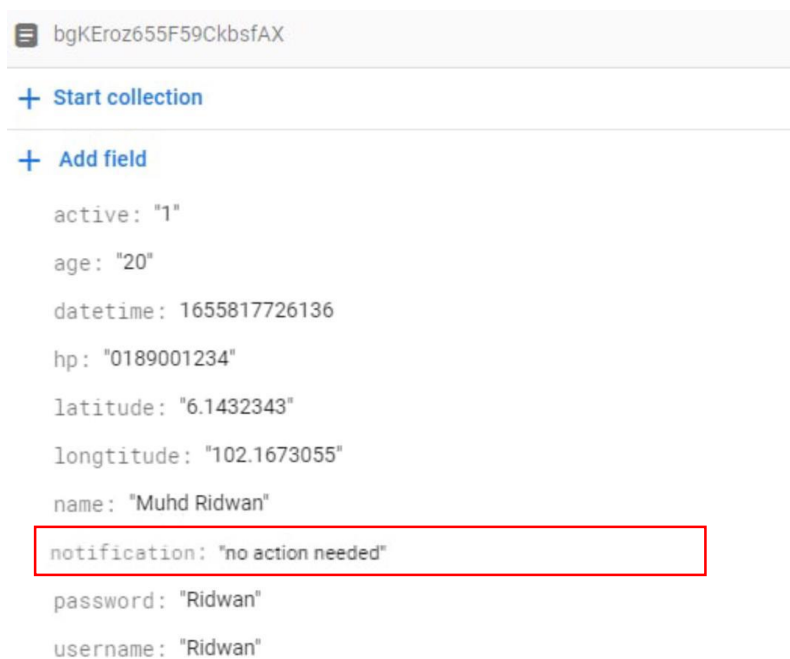**Figure 4: Layout for Google Maps page data.**

Figure 5: Firebase database of data application when user stays within the radius.
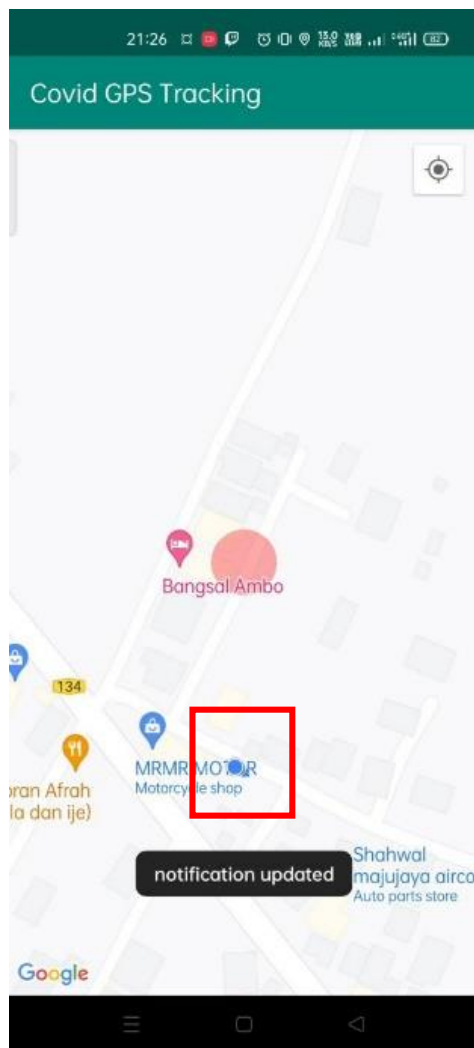
Figure 6: Layout for Google Maps page data application when the user exited the radius.
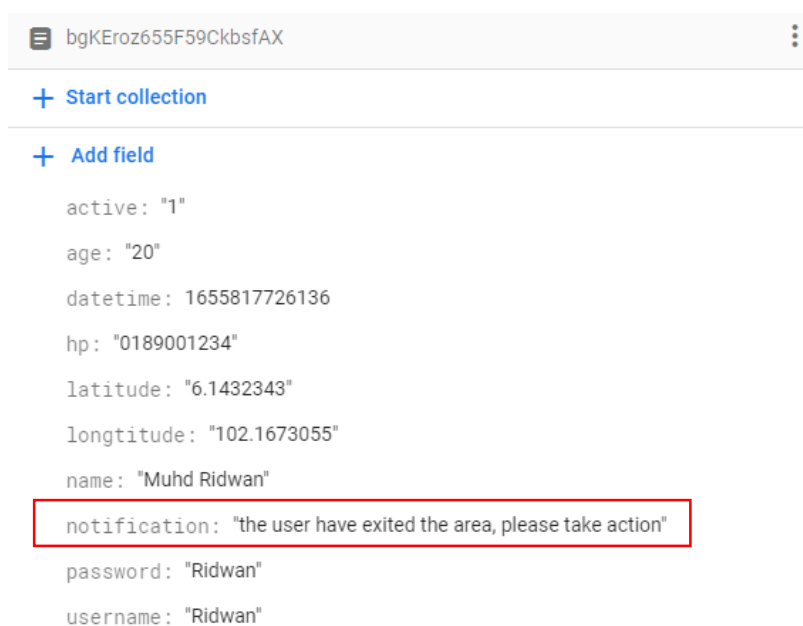

Figure 7: Firebase database of data 1 when user exited the radius.

3.2 Cloud Firebase Database

The Cloud Firebase Database is developed to store the user's data when registering for the application. The details of the users when registering consist of the age, datetime, phone number, latitude and longitude, name, password, and username. The data is stored and synced in real-time.

3.3 Alert System Notifications

The application alert notification system was created as an indicator to inform users. This warning system will be activated once the users leave the 15-meter geofence radius. Nothing will be triggered if the users are within the geofence radius. The authorities can monitor the changes in the users' movement in real-time from the database and will take action according to their work instructions. They can hand over the changes of the user's data from the database to those accordingly.

4. Conclusion

Finally, the Android-based application with a GPS tracking system has been constructed successfully. The overall objectives of this project were obtained and examined as a result of the outcome analysis. This includes launching and testing the application from different places and with different users. The Cloud Firebase database has been successfully added to the Android application, where it may be stored and retrieved in real-time. Following that, the Geofence system was added as an indicator for monitoring user movement inside the desired radius. The Geofence system has also successfully built a notification system, which was used to send notifications to the user's mobile phone whenever the user exited the radius of 15 meters geofence system.

Acknowledgement

References

[1]   Nussbaumer-Streit B et. al. "Does quarantine, alone or in combination with other public health measures, control coronavirus (COVID-19)?" [Online] Available: https://www.cochrane.org/CD013574/INFECTN_does-quarantine-alone-or-combination-other-public-health-measures-control-coronavirus-covid-19. [Accessed January 11, 2022]

[2]   Yiswaree Palansamy "Health minister: Over 500 check-ins breaking quarantine in a week, 18PC checked in at supermarkets" [Online] Available: https://malaysia.news.yahoo.com/health-minister-over-500-kedah-075309975.html. [Accessed January 11, 2022]

[3]   Ullah F, Haq HU, Khan J, Safeer AA, Asif U, Lee S. "Wearable IoTs and Geo-Fencing Based Framework for COVID-19 Remote Patient Health Monitoring and Quarantine Management to Control the Pandemic" Electronics, vol. 10, no. 6, 2021, doi: 10.3390/electronics10162035

[4]   Wurzer D, Spielhagen P, Siegmann A, Gercekcioglu A, Gorgass J, et al. "Remote monitoring of COVID-19 positive high-risk patients in domestic isolation: A feasibility study" PLOS ONE, vol. 16, no. 9, 2021, doi: 10.1371/journal.pone.0257095

[5]   Android Studio features : android developers. [Online] Available: https://developer.android.com/studio/features, [Accessed January 11, 2022]

[6]   Contributor, T. T "What is Android Studio?" October 9, 2018. [Online] Available: https://searchmobilecomputing.techtarget.com/definition/Android-Studio [Accessed January 11, 2022]

[7]   Rosencrance, L. "What is Google Firebase", April 25, 2019, [Online] Available: https://searchmobilecomputing.techtarget.com/definition/Google-Firebase, [Accessed January 11, 2022]

[8]   Aravind, M. "Geofencing in Android. Medium", September 20, 2018, [Online] Available:https://medium.com/@manuaravindpta/geofencing-in-android-3d5e624ea1ba, [Accessed January 11, 2022]

[9]   Android Developers, "Create and monitor geofences," [Online] Available: https://developer.android.com/training/location/geofencing, [Accessed May 13, 2022]

[10]   Google   Developers   "Location   Data",   [Online]   Available: https://developers.google.com/maps/documentation/android-sdk/location, [Accessed May 13, 2022]