Development of an Android application for viewing Covid-19 containment zones and monitoring violators who are trespassing into it using Firebase and Geofencing

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Abstract

The World Health Organization has declared the outbreak of the novel coronavirus, COVID-19 as pandemic across the world. With its alarming surge of affected cases throughout the world, lockdown and awareness (social distancing, use of masks etc) among people are found to be the only means for restricting the community transmission. In a densely populated country like India, it is very difficult to prevent the community transmission even during lockdown without social awareness and precautionary measures taken by the people. Recently, several containment zones had been identified throughout the country and divided into red, orange and green zones, respectively. The red zones indicate the infection hotspots, orange zones denote some infection and green zones indicate an area with no infection.

This paper mainly focuses on development of an Android application which can inform people of the COVID-19 containment zones and prevent trespassing into these zones. This Android application updates the locations of the areas in a Google map which are identified to be the containment zones. The application also notifies the users if they have entered a containment zone and uploads the user's IMEI number to the online database. With this IMEI number, the police can keep an eye on the people who are frequently violating the lockdown rules. To achieve all these functionalities, many tools and APIs from Google like Firebase and Geofence are used in this app. Therefore, this application can be used as a tool for creating further social awareness about the arising need of precautionary measures to be taken by the people of India.

Introduction

Currently there are several research works undergoing to prevent COVID-19. In this paper, we mainly focus on developing an android based application to identify the COVID-19 containment zone in India. We have used Geofencing and Firebase APIs (Application Program Interface) from Google as the base for development of this application.

Geofencing is a tool from Android which is used to create virtual boundaries or fences around geographical locations. The developers can add geofences at different locations by providing the latitudes and longitudes along with radius to highlight the proximity of the location. Geofencing technology senses the user's current location and checks whether that location belongs to the set of pre-identified geofences. After creating the geofences, each geofence has the permission to get information from the location services of Google about entering, dwelling and exit events triggered by the users of the application when they enter or exit the geofence. Upon receiving a trigger event, the geofences can be programmed to notify the user about the information of the location they have entered or exited. These geofences can be useful in preventing its users from trespassing inside the targeted locations.

Firebase is a real time database from google. It is used for development of applications in Google Cloud Platform. Data is stored directly to the firebase and pulled right out of the firebase; hence it is known as Backend-as-a-Service (BaaS). The database provides data to users on the basics of user demand. When an application is linked to Firebase, they are not connected through normal HTTP (HyperText Transfer protocol) but are connected by the use of WebSocket. The Web Socket transfers data at a higher speed than HTTP. The firebase transfers new data to the user as soon as it is updated. When a user's client saves the changes occurred in the database then all connected clients receive the updated data almost instantly.

In this research work we use both Geofencing and Firebase technology in our proposed Android application to efficiently identify and provide alarm to the ones who trespassed the containment zones of COVID-19. We have tested our application with different users in different locations across West Bengal and it works efficiently and is able to attain our target.

Proposed Work

The Android application shows the location of the containment zones to the users. It also notifies the user when he or she trespasses the boundary of a containment zone or stays in the containment zones (Fig.1). All these functionalities are achieved by the help of Firebase and Geofencing tools from Google.

Fig.1 Methodology of the app

Firebase Cloud Firestore

A real-time database is created in Google Cloud Firestore which contains all the data related to the containment zones like latitudes, longitude, radius and zone names. Cloud Firestore features a NoSQL, document-oriented database (Firebase Cloud Firestore). There are no tables or rows. Instead, the location data are stored in documents, which are organized into collections. All the containment zones are stored in a collection in which each containment zone is represented as an individual document. Each document has four fields namely "Lat", "Long", "locationName" and "radius" for storing latitudes, longitudes, location names and radius, respectively. Fig.2 shows the document-oriented Cloud Firestore database with data of few containment zones. The "radius" field in each document is used to indicate the radius of the containment zone. The names of the fields must match the

JAVA objects created in the Android application in order to properly extract each data from the database correctly. The Cloud firestore is connected to the android application by registering the SHA-1 (Secure Hash Algorithm 1) certificate fingerprint of the application in the Firebase project settings. After the database is connected, the location data of the containment zones can be retrieved by the Android application and can be shown in Google map.

Fig.2 Cloud Firestore database with location data of containment zones

Geofencing

As the location data is received by the Android application, geofences are created using the latitude, longitude and radius of the containment zones. Every geofence requires the latitude and longitudes of the geofencing area and a radius to determine the boundary of the geofence. Along with these, a unique id or key is also required to be set to each geofences. This unique key is generated from the names of the containment zones. The locations of the containment zones along with the user's current location are shown using Google maps in the application. The containment zones are shown using markers and circles. The markers are set using the latitude and longitude of the containment zones and the circles are set around the markers using the radius provided. Fig.3 shows a screenshot of the app showing the containment zones in Kolkata. The current location of the user is shown in the map and the changes in the user's location get updated in the map instantly. Whenever a user enters a containment zone, the geofence broadcast receiver gets triggered and notifies the user. A notification is given to the user according to the triggering event that is entering and exiting the containment zones.

The app further extracts the IMEI number of the trespasser and uploads it to the online database. This IMEI number can be useful to the local police to track and identify people who are frequently trespassing the containment zones. The app is programmed to work in background and the geofences get triggered even if the app is not open in foreground.

Fig.3 Containment zones in Kolkata

Results And Discussions

The latitude and longitudes of the geofencing area and a radius to determine the boundary is required for creating each geofences. The locations of the containment zones along with the user's current location are shown using Google maps in the Android application. For testing the application, the GPS (Global Positioning System) signal of the android device has been mocked and set inside a confinement zone.

Tests have been carried out in various containment zones across West Bengal for the validation of the Android application. **Table 1** shows a list of ten containment zones across West Bengal with their corresponding latitude, longitude and radius for creating boundaries by every geofence.

Serial number	Name of the containment zone	Latitude, Longitude	Radius of the containment zone
1	Bamangachi	22.758520, 88.506511	500
2	Belgachia	22.604613, 88.387647	1000
3	Garden reach	22.550435, 88.287495	1000
4	Garia	22.466806, 88.392917	1000
5	Golabari	22.703311, 88.571665	1000
6	Kaikhali	22.629079, 88.431864	1000
7	Mudiali	22.510896, 88.345819	1000
8	Nayabad	22.484053, 88.412027	1000
9	Park circus	22.540659, 88.374265	1000
10	Tikiapara	22.595785, 88.323425	1000

Table 1 Containment zones along with their latitude, longitude and radius of the geofence

The developed android application further extracts the IMEI Number of the trespasser in the containment zones and uploads it in the online database. The identified containment zones chosen for the testing of the application were visited one by one. Table 2 shows the various containment zones identified for conducting the test, the date, time of entry and exit, time of receiving the notification alerts upon entering and exiting the containment zone**.** The notifications given to the user according to the triggering event upon entering or exiting in the containment zones are shown in Fig.4. Table 2 also shows one IMEI Number among the various IMEI Numbers of the trespassers in the containment zones which is extracted by the android application and updated in the online database in real time. From Table 2, it is highlighted that the application sends notification alerts within 30 seconds on entering and exiting the containment zones respectively.

Serial number	Name of the containment zone	Date of entry in the containment zone (dd.mm.yyyy)	Time of entry in the containment zone (hour:minutes:seconds)	Entrance Notification time	Time of exit in the containment zone (hour:minutes:seconds)	Exit Notification time	IMEI Number
1	Bamangachi	21.04.2020	09:30:16	09:30:26	09:45:19	09:45:30	355009081246912
2	Belgachia	20.04.2020	09:45:50	09:46:10	10:00:10	10:00:20	356129106619221
3	Garden reach	22.04.2020	10:55:10	10:55:30	11:20:54	11:21:05	356129106619221
4	Garia	22.04.2020	11:52:19	11:52:30	12:08:22	12:08:34	868134038083612
5	Golabari	21.04.2020	11:20:50	11:21:02	11:35:42	11:35:50	355009081246912
6	Kaikhali	20.04.2020	10:42:12	10:42:25	10:58:13	10:58:24	868134038083612
7	Mudiali	23.04.2020	09:46:00	09:46:20	10:01:05	10:01:15	356129106619221
8	Nayabad	23.04.2020	10:58:21	10:58:40	11:13:26	11:13:38	356129106619221
9	Park circus	20.04.2020	11:35:12	11:35:33	11:50:35	11:50:42	868134038083612
10	Tikiapara	22.04.2020	09:35:23	09:35:41	09:50:21	09:50:35	356129106619221

Table 2 Containment zones with the time of entry and exit in the zones, the time of receiving notification alerts in the android application and the extracted IMEI number of the trespasser in the corresponding containment zones which is uploaded to the online database

Fig.4 Geofence triggering events

Conclusion And Future Scopes

The application provides an efficient way of showing the identified COVID-19 containment zones to the users in a Google map. With the alarming increase of COVID-19 affected cases throughout the world, this developed application can be employed as a tool for creating further social awareness among the people. This application further tracks the user's location and checks whether it is present in the list of identified containment zones. It sends separate notification alerts to the user on entering and exiting the containment areas. The developed android application further extracts the IMEI Number of the trespasser in the containment zones which can be useful to the local police to track and identify people who are frequently trespassing the containment zones. Thereby this application identifies the containment zones and highlights the need for taking further precautionary measures for combating COVID-19. The application has been tested in various locations and has been found to yield accurate results.

The application can be further used for many purposes like maritime and forest safety to prevent users from entering restricted areas.

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Declarations

Funding

Not Applicable

Conflicts of interest

There are no conflicts of interest

Availability of data and material

Data and material available

Code availability

The Java code of the app is available

Authors’ contribution

All the authors have contributed in their respective parts.

Figures

Figure 1

Methodology of the app

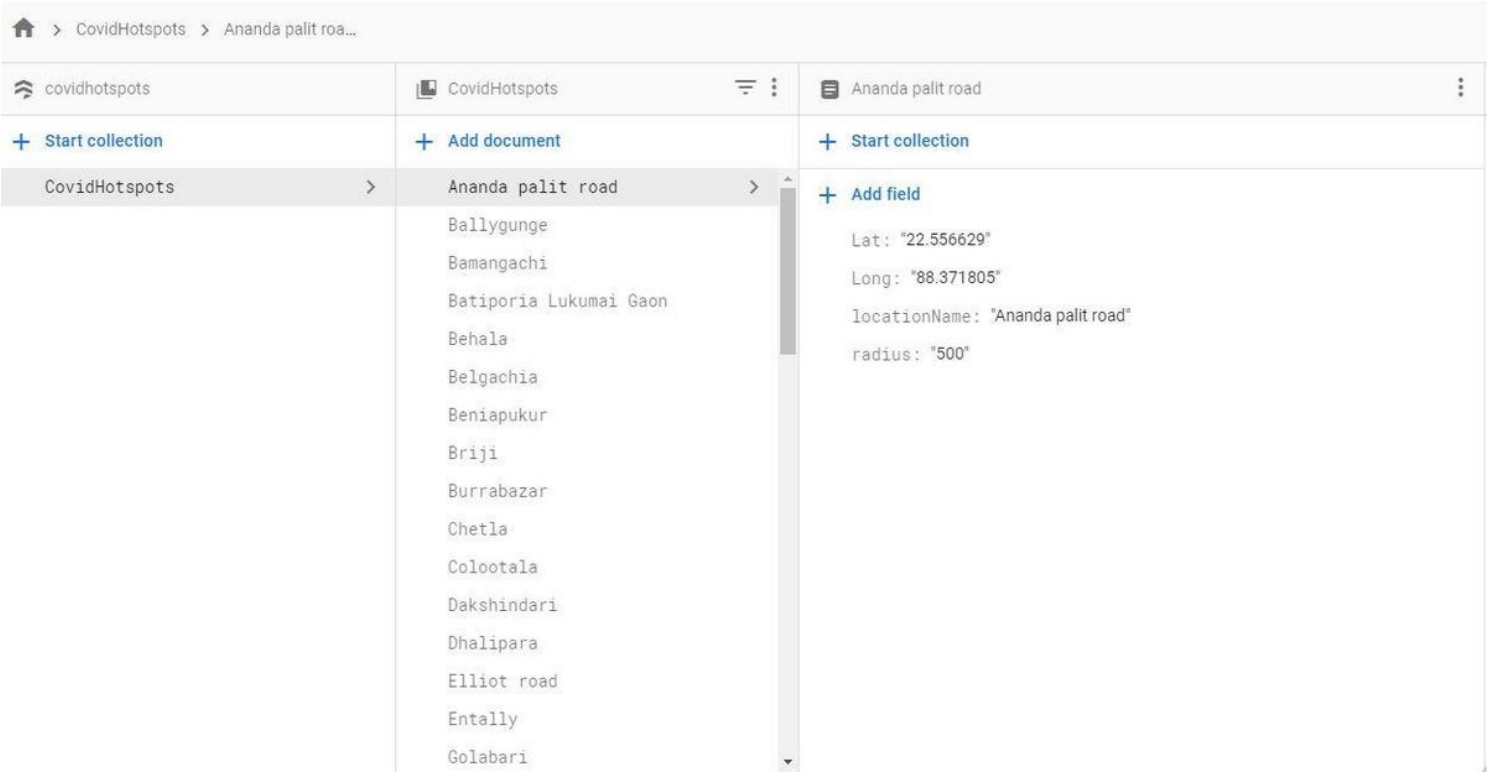

Figure 2

Cloud Firestore database with location data of containment zones

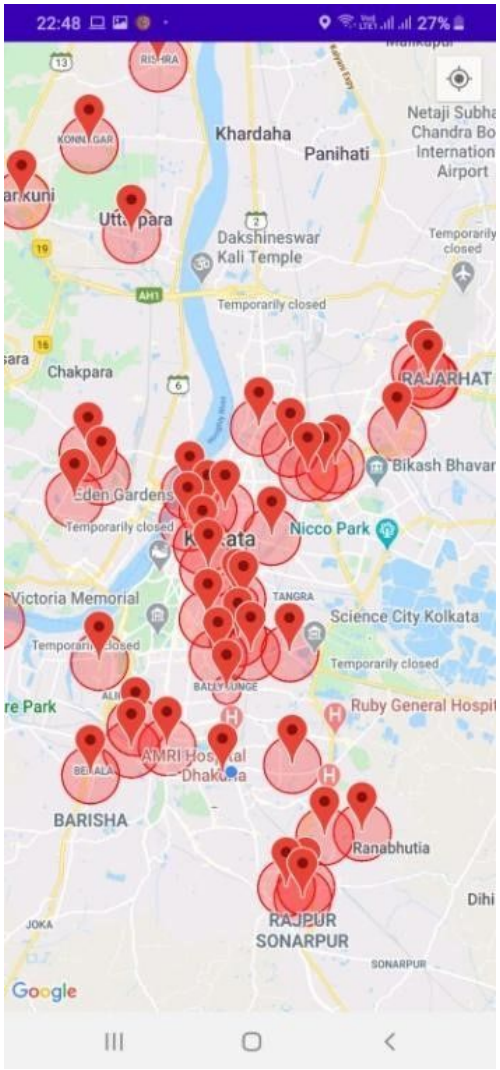

Figure 3

Covid-19 Containment zones in Kolkata

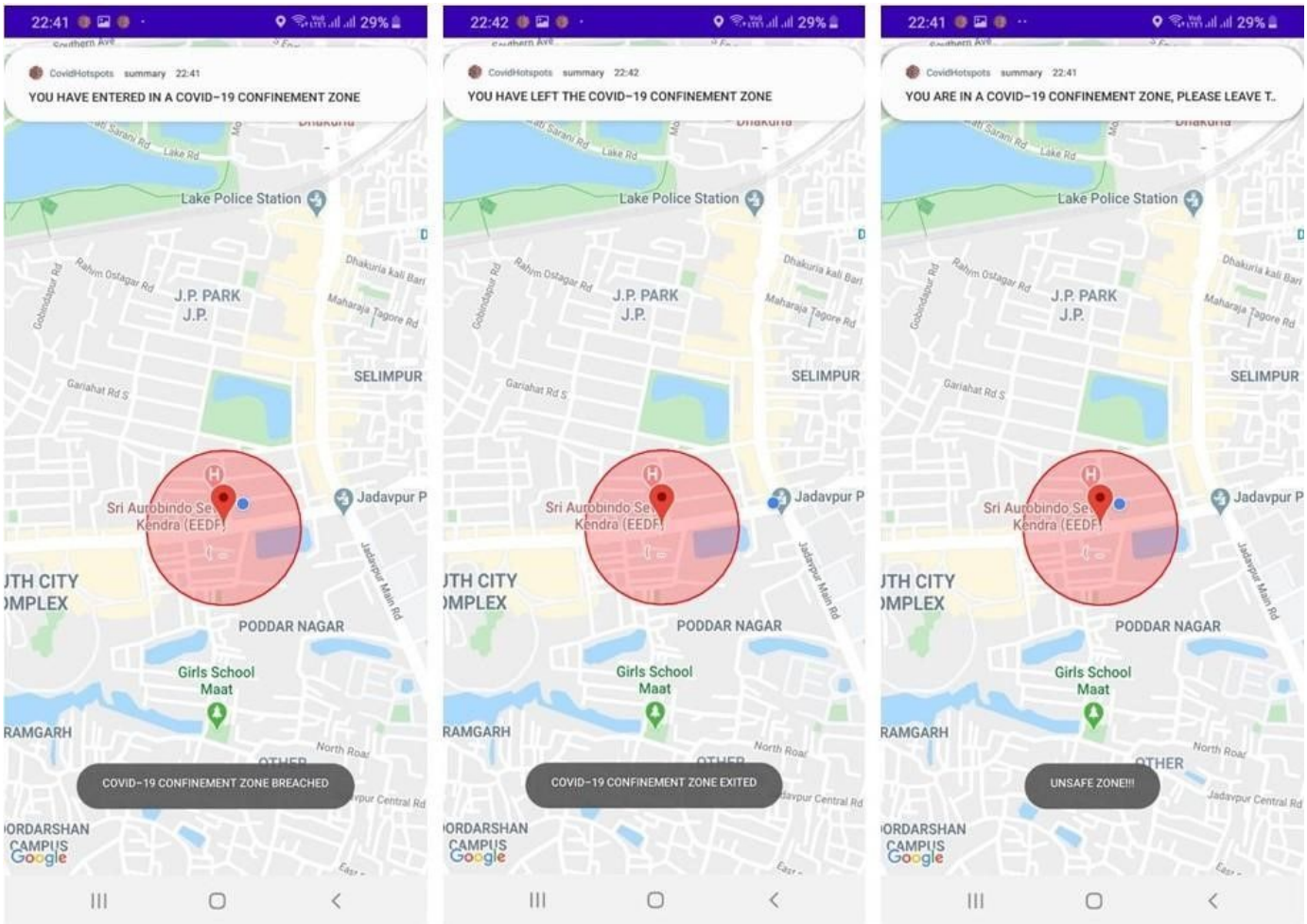

Figure 4

Geofence triggering events giving notifications

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- CovidHotspotsV3.apk