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Real-Time Vehicle Tracking Through Mobile Device

Junia O*, Anitha D**

*(Department of Computer Science and Engineering, Government College of Engineering, Tirunelveli.)

** (Department of Computer Science and Engineering, Government College of Engineering, Tirunelveli.)

Abstract

IoT has evolved due to the convergence of multiple technologies, real-time analytics, machine learning, and embedded systems. Nowadays, many companies from different sectors are adopting IoT technology to simplify, improve, automate, and control different processes that optimize the different operations that increase productivity and efficiency. IoT applications are expected to equip billions of everyday objects with connectivity and intelligence. It is already being deployed extensively in various domains, namely: Wearable's, Smart Home Applications, Smart Cities, and Industrial Automation. This paper proposes a vehicle tracking system by using a Mobile device that acts as a GPS device which collects the location coordinates like latitude, longitude, based on a timestamp from the mobile phone and gives live updates to the firebase realtime database and retrieve data from the database and display it on a Google map. IoT vehicle tracking solutions provide advanced mobile data connectivity to resolve the issues of traditional vehicle tracking. The internet of things may provide satisfactory and good results by relying on a mixture of software and hardware, which is in the overall interest of the project. The aim of using IoT for tracking and monitoring is the great advantages that provide when working with its components.

Keywords — **Vehicle Tracking, Mobile Device, Vehicle Detection, IoT.**

I. INTRODUCTION

IoT is already being deployed extensively in various domains, namely: Wearable's, Smart Home Applications, Smart Cities, and Industrial Automation. Vehicle tracking system is the system that allows detecting and tracking of vehicles via an online computer, Smart Phone, tablet, etc. Buses are the most popular means of transportation, but the main problem is difficulty in waiting for the particular bus has always affected the bus ride experience. Microchips and radio-frequency identification (RFID tags) provide location information when close to the reader. We have witnessed an exponential increase in the use of smartphones due to all the embedded sensors in it, such as GPS, gyroscope, Accelerometer, etc. With the development of the Internet of things, new technical support is provided for the intelligent bus system.

Internet of Things is an emerging field, as a result of the information industry developing into the 21st century. It is expected to give the third wave of the information industry revolution. In recent years, researches on the IoT and the related technologies have continued to flourish. Mobile technologies have significantly influenced the emergence of many applications and real-time systems for tracking's, such as navigation systems, autonomous vehicle systems, mobility analysis, and targeted marketing. Real-time tracking of vehicles has been of interest in many industrial products and research applications related to parking systems. Therefore, the expectations behind this type of realtime systems are the quick response and the quality of the positioning estimation and its parameters.

Mostly, location is tracked via the mobile application, internet service provider, RFID tags, GPS and microchips. Microchips and RFID tags provide location information when close to the reader.

GPS is a global navigation satellite system that provides location, time synchronization, and speed. The satellite system consists of 24 satellites in six Earth-centered orbital planes, each has four satellites, orbiting at 13,000 miles (20,000 km) above Earth and traveling at a velocity of 8,700 mph (14,000 km/h). But only three satellites are used to produce a location on earth's surface, a fourth satellite is used to validate the information from the other three satellites [1].

GPS is made up of three components, called segments, that work together to provide location information. The three segments of GPS are:

- Space (Satellites)
- Ground Control
- User Equipment

In the Space segment, the satellites circling the Earth, transmitting signals to users on geographical position and time of day. In Ground control, it is made up of Earth-based monitor stations, master control stations, and ground antenna.

Control activities include operating the satellites in space, tracking, and monitoring transmissions. In the user-equipment segment, the GPS transmitters and receivers including items like smartphones, watches, and other devices.

The global positioning system is based on 'trilateration' mathematical principle. For calculating location, velocity, and elevation, trilateration collects signals from satellites to output location information. Each satellite within the network circles the earth twice a day, and each satellite sends a unique signal, orbital parameters, and time.

A single satellite broadcasts a microwave signal which is picked up by a GPS device and calculate the distance from the GPS device to the satellite. When a satellite send the signal, it creates a circle with a radius measured from the GPS device to the satellite. When we add a second satellite, it creates a second circle, and therefore the location is narrowed down to one of two points where the circles intersect.

With a third satellite, the device's location can finally be determined, as the device is at the intersection of all three circles. So it is called a three-dimensional world, which means that each satellite produces a sphere, not a circle. The intersection of three spheres produces two points of intersection, therefore the point nearest Earth is chosen.

The location coordinates like latitude and longitude are collected from the GPS device by using both application and services. But when using the application, the application must be interacted every time. But when using the service, don't need to open the application every time.

A Service is an app component which will perform long-running operations in the background. It does not provide a user interface. Once started, a service might continue running for some time, even after the user switches to another application. Additionally, a component can bind to a service to interact with it and even perform interprocess communication (IPC). For example, a service can handle network transactions, play music, perform file I/O, or interact with a content provider, all from the background [2].

There are two types of services performing background tasks. They are:

- Background service
- Foreground service

A background service performs long-running operations in the background. It does not provide a user interface and also it does not send any notification to the user. Whenever an app runs in the background, it consumes limited resources, like RAM. This can give result in an impaired user experience, especially if the user is using a resource-intensive app, such as playing a game or watching a video. So the app targets API level 26 or higher, the system imposes restrictions on running background services [3].

A foreground service performs some operation that's noticeable to the user. For example, an audio app would use a foreground service to play an audio track. Foreground services must display a notification so that users are actively aware that the service is running. Foreground services continue running even when the user isn't interacting with the app.

Firebase is a Backend-as-service. The services offered by firebase are firebase Authentication, Firebase Analytics, Real-time Database, Firebase Storage, Firebase Test Lab for Android, etc.

In the Firebase Realtime Database, the data store and sync with the NoSQL cloud database [4]. Data is synced across all clients in realtime and remains available when apps go offline. The Firebase Realtime Database is a cloud-hosted database. Data is stored as JSON and synchronized in realtime to each connected client.

All Firebase Realtime Database data is stored as JSON objects, when data added to the JSON tree, it becomes a node in the existing JSON structure with an associated key. Unlike a SQL database, there are no tables or records [5]. Own keys are also provided such as user IDs or semantic names, or they can be provided for you using childByAutoId.

Firebase data is written to a Firebase Database reference and retrieved by attaching an asynchronous listener to the reference. The listener is triggered once for the initial state of data and again anytime the data changes.

Firebase performs CRUD operation which can do creating the data, reading the data from the database, updating and deleting the data in the Firebase Realtime Database.

II. Literature Survey

Anis Koubaa et al. [6] proposed Drone Track, a real-time object tracking system involving a drone that follows a moving object over the Internet. The system provides remote computation in the cloud. Various computationally intensive algorithms using libraries for image processing and data analysis are provided.

Drone Track uses the Dronemap Planner cloud-based system to control, Manage, and communicate with drones over the Internet. The main contributions of this work consist of the deployment and development of Drone Track, a real-time object tracking application using the Dronemap Planner cloud platform, and a comprehensive experimental evaluation of its real-time performance. Drone Track relies on the exchange of GPS locations through the cloud. Tracking accuracy of 3.5 meters on average is achieved by Drone Track with slow-speed moving targets. But it impacts the communication latency on tracking the object.

Anandhali and V.P. Baligar [7] uses a recursive algorithm for detecting the vehicles accurately. Detections of the moving vehicles are identified and the density of the vehicles traveling in the sight of the camera is determined. Vehicle detection results in this system are based on the basic appearance of the vehicles. None of the vehicles have left without detecting. Still, the system should improve by making use of color extraction, corner detection, and edge detection of the vehicles.

J.Xiong, L. Shu et al. [8] use the Kalman filter method, the time alignment method, the coordinate transformation method, and the optimal fusion criterion method, the core algorithm of our framework employs the track correlation as the performance index of the optimal fusion. The maximum error between the real location and the estimated location is only 1.32 cm which meets the standard for engineering applications. It has a large computations burden due to large data in the memory.

From the above study, it reveals that many different systems have been developed to detect and track the vehicle, which is of high cost and hence limits the number of systems to be used at different locations, difficult to classify the vehicle, difficult to estimate the correct location, have high computation burden due to large data memory.

In contrast to the previous literature, this proposed work presents the architecture and design to make use of the smart phone to perform tracking and detecting the vehicle. Furthermore, this describes the process of good management of the synchronization data between the mobile device and also the Firebase Real-Time database.

III. PROPOSED SYSTEM

For a smart transportation system, the performance and accuracy of tracking the vehicle are more important. A new system introduces the Mobile device which works as a GPS device. Android has an in-build GPS for tracking each move of the mobile device. For accessing GPS, the new system uses Google play services. Google provides the Fused Location Provider API.

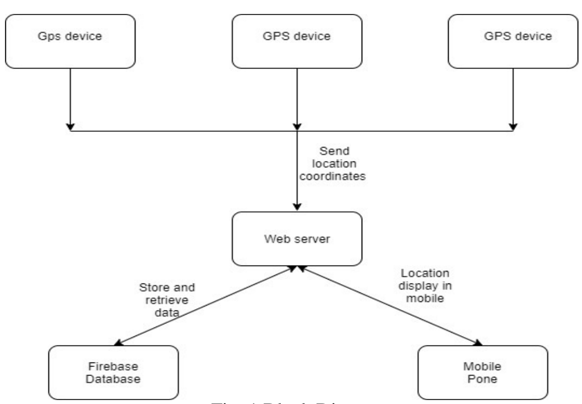

Fig. 1 Block Diagram

Fused Location Provider API helps to collect the location information from the location provider inside the mobile phone. The location provider is mobile data and also GPS. Fused Location Provider API track mobile devices with the help of mobile data and GPS. For accessing the Fused Location Provider API, the application requests location permission initially. For running the application, the proposed system uses the foreground service. Because the user doesn't want to open the application always, the application runs the background task which tracks the location information. When the user chooses the request location update, then it starts running the service. Once the user starts the service, the system display notification on the screen bar. The notification contains the coordinates like latitude and longitude. When the user migrates to another app, the notification display on the notification bar. But when the user opens the service app, the notification doesn't display. The collected location information like latitude and longitude is stored in the Firebase Real-Time database. The latitude, longitude, timestamp are updated to the firebase database based on the reference.

When the data add to the JSON tree it becomes a node in the existing JSON structure with an associated key. Retrieve the location information from the firebase database and show that information in the Android Application with the map. Using the Mac address, the mobile device is differentiated. Mac address is unique for all mobile devices. The location information is stored based on the Mac address. Querying the latest location information like latitude and longitude based on the timestamp taken from the database and display it in the android Google map.

A. Modules

Based on our proposed method described in the previous section, the methods integrated into our Real-Time system's modules are structured as follows:

- Application Layer
- Data Access Layer

1) ***Application Layer*:** To get accurate and continuous location information from mobile devices, the new system going to use GPS. A Google Play service is kind of a "service provider" which connects apps to other Google services, like

Google Sign In and Google Maps. Google Play Service isn't the same as the Google Play Store app and is included with Android, Google Play Services doesn't make the battery drain faster. The location services are integrated into Google Play. Google has a set of APIs, including location-based API which is used to track the device.

The exact location for Google Play services data is the unique package namely, com.google.android.gms. Android provides Foreground service and Background service. Background service gives some limitations to Android 8.0 and above. So we are choosing a Foreground service. Foreground service performs the background task and it is directly notified to the user so that the users are actively aware that the service is running.

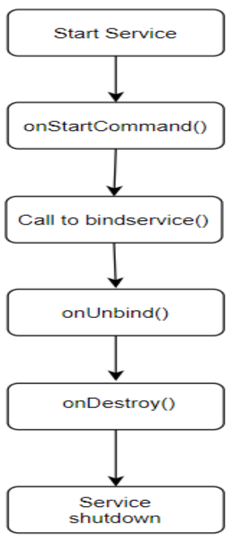

Fig. 2 Application Layer

Initially, check the location permission of the mobiledevice for tracking. ACCESS_FINE_LOCATION is more accurate than ACCESS_COARSE_LOCATION.ACCESS_FINE_LOCATION allows the API to determine as precise a location as possible from the available location providers, including the GPS as well as Wi-Fi and mobile cellular data. After the system allows the location permission, the application activity visible to the user. When the user chooses the Request Location update then the activities enter into the started state by using the onStart() function. It starts service and running as a background task.Bound service offers a client-server interface that allows a component to interact with service, send requests, receive results with Inter-Process Communication. IPC allows the process to communicate with each other and synchronize their actions.

The local Broadcast Manager notifies any other Broadcast Listener about location. If service is running in the foreground it notifies the location to the Broadcast Receiver. Notification Compat API is used to access features in notification settings. By using Notification Compat API, the location information like latitude and longitude are displayed in the notification bar when the user migrates to another application.

If the user doesn't want to send the location information then they choose the remove location update button, it calls the unbind() function which unbinds the service. After unbinding the service, the user can rebind() the service. If they don't want that application then they remove it from the background then the service enters into the end state. Once the user of the GPS device starts the service, the location information is display in the notification bar.

2) Data Access Layer: The location coordinates like latitude, longitude is collected by performing the foreground service and also with the help of Google play service.

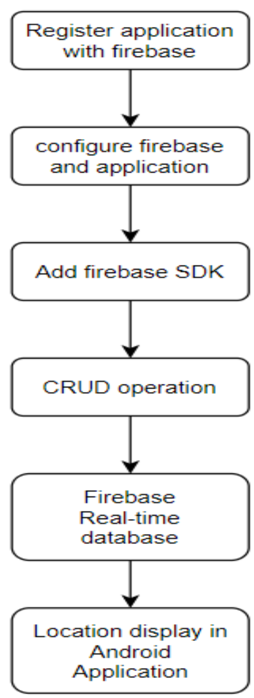

Fig. 3 Data Access Layer

. The collected information is sent to the firebase Real-time database. Initially, creating the Firebase project. When creating the project, they give us a unique identifier.

It is helpful when we add another app to that same project. Once the project is created, then register the android application by application package name. Configure firebase and android using the google-service.JSON file which contains a bunch of constants that the firebase SDK needs to configure itself correctly. Add the dependencies based on BOM. BOM is a Bill of Materials that has a list of libraries that work together.

Firebase Real-Time database performs CRUD (Create, Read, Update, Delete) operation for creating the data, reading the data, updating the data, and also deleting the data. Firebase data is written to a firebase database reference and retrieve by attaching an asynchronous listener to the reference. To read, write data from the database you need an instance of database reference. And also read data at a path and listen for changes, use addValueEvenListener() method for adding ValueEventListener to Database Reference. Initially, the data collected from the GPS device is updated to the firebase database based on Mac Address. Because Mac Address is a u

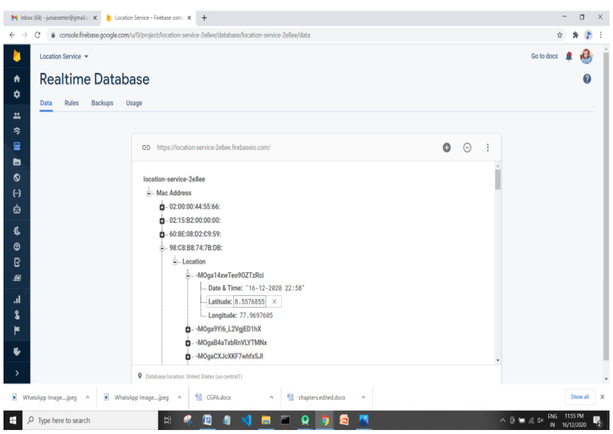

Fig: 4 Firebase Database

Mac address support only 48 bits long address, it does not support 64 bits long address. The length of the mac address is a maximum of 17 characters, it is composed of 0-9,a-f, A-f,:. Coordinates like latitude, longitude, and timestamp are added to the Mac Address as a child node. For every 30 seconds, the location information is added to the firebase database. Each time a new location id is generated.

Firebase real-time database has some security rules for reading and writing the data to the firebase database. Only the authenticated user can read and write the data to the firebase database. Firebase database also has some basic structure. Based on that, the location information is updated to the database.

The coordinates are collected from one mobile device and it shows the location in another mobile device with the help of an android application. Using Google Maps, we will display the current location of the mobile device. Google provides Google Map API which generates a key for a specific application, using that key we can use the Google Map. In a mobile application, it displays the location of each GPS device by using the Mac Address.

The location coordinates are sorted based on the timestamp and retrieve the latest timestamp which is the current location of the GPS device. For displaying the live location, the marker must be updated. When the user opens the application, it shows the live location of the GPS device based on the mac address.

IV. IMPLEMENTATION AND RESULTS

If the app needs to access the user's location, requesting permission is more important by adding the relevant Android location permission to the app. The ACCESS_FINE_LOCATION permission determines the accuracy of the location returned by the API. After the permission is granted, the application activity is visible to the user. When the user clicks the Request Location update button, it starts operating. The services are bound to the component to send requests, receive results. If the service is running, the broadcast listener notifies the location to the broadcast receiver.

If the user switches to another application, then the notification is display in the notification bar. Therefore, the foreground service performs the background task and it is directly notified to the user so that the users are actively aware that the service is running.

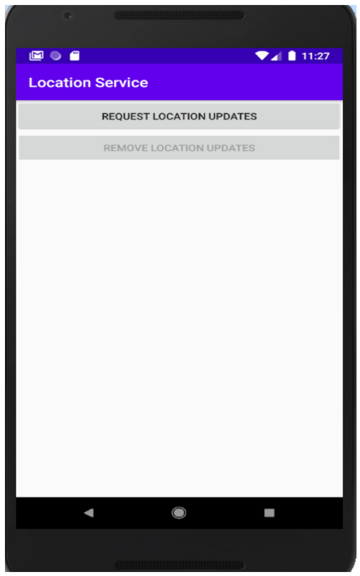

Fig: 5 Activity visible to the user

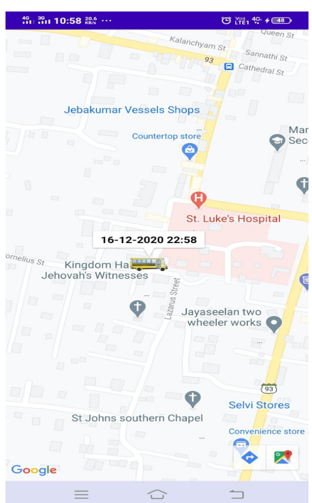

Fig: 6 Shows the location of the Bus

Using the Google Map API, the live location of the mobile device is displayed in the android application. In this application, list the number of mac addresses where a GPS device is used to update the location data to the firebase database. Each mac address is access via the buses in the list. If the user chooses the bus No:1, it displays the live location of the particular bus with the date and time display in the marker title. Likewise, if the user chooses the bus no:2, it displays the live location of that bus.

B. Performance Analysis

On evaluation, when tracking the mobile device using GPS only, the performance accuracy is low which is 65% only.

The proposed system using both GPS and mobile data for tracking the mobile device which gives a more accurate location than the previous one, the overall performance accuracy of the proposed system is 95%.

TABLE I
Performance Analysis

Location Technology	**Accuracy**
GPS	65%
GPS and mobile data	95%

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V. CONCLUSION

The design scheme of an intelligent bus system based on the Internet of Things is proposed. It integrates Google play service for accessing the GPS. Traditional location tracking is implemented in Whatsapp. In the Whatsapp application, the location is tracked based on one-time activity. When the user shares the location it shows the location to another user. But the proposed system is based on scheduling activity. Every 30 seconds the locations are sent to the database automatically and view it in the Google map and also this location is tracked using a service that doesn't want any user interface. The main functional modules of the intelligent bus system are discussed from the aspects of vehicle detecting and tracking the vehicle from the mobile device that acts as a GPS device. The system can locate and monitor the bus running status in real-time, provide the bus running information to the user, and improve the quality, efficiency, and satisfaction of the bus service.

This project shows only the vehicle location at the user end. In the future, the vehicle location is displayed at the administration level. At the admin level, the overall bus information is displayed. Only an authorized person can view the location of the bus in the admin panel.

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