Intelligent Parking for ADAS

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Abstract—Urban centres and dense populations are expanding, hence, there may be a developing call for novel packages to resource in making plans and optimization. Normally drivers hold looking for suitable parking slot, which ends up in growth in visitor volume, which in-flip booms the vehicular exhaust that creates a bad effect at the environment. The main motivation behind the smart parking system is to assist the drivers to locate parking slot easily. In this work, a smart parking device that operates each indoor and outdoor is introduced. The device is primarily based totally on Bluetooth Low Energy (BLE) beacons and makes use of Multilateration approach to enhance accuracy. Multilateration is an approach for figuring out vicinity with known vicinity records and device distance to each access point. Through easy BLE connectivity with smartphones, an intuitive parking system is designed and deployed. This approach makes use of BLE beacons which consumes much less power than WIFI and GPS and suggests accurate vicinity each Indoor and outside. Beacons are positioned in every nook providing customers steering to the available parking slots. An android app changed into advanced which may be used to Digitally book your slots and it suggests vicinity of the parking slot withinside the app.

Index Terms: Bluetooth Low Energy(BLE) Beacons, Multilateration, Internet of Things(IOT), parking estimation, smart parking,

I. Introduction

In the olden days, there was no tremendous increase in population and people mostly use the common modes of transport. Automobiles were not much popular in the olden days. Modernization and rapid urbanization is the main reason for the population explosion. To cater to the needs of an exponentially increasing population, more automobile firms are releasing vehicles frequently. The main goal of automobile manufacturers is to reduce the time of travel. Nowadays everyone owns a vehicle. The rapid increase of automobiles on highways and urban roads as also increased vehicle collisions and accidents tremendously. Due to these reasons, congestion and accidents are increasing day by day.

Road accidents are the most unwanted issue which happens to a road user, though they happen quite often. Most of the road users are quite aware of general rules and safety measures but the major reason for accidents and crashes is due to the laxity of road users and human errors. One of the main reasons for the accidents and vehicle crashes is the driver cannot concentrate on all the four sides simultaneously in parking areas and in congestion areas during heavy traffic. To avoid this kind of situation in the technological world we can either move towards autonomous vehicles or we can use semi-autonomous systems i.e., ADAS. Autonomous vehicles cannot be used in all situations and also the

price of an autonomous vehicle is too high and people will not afford that much money. To assist a driver in parking areas or heavy congestion areas, a driving assistance system can be used.

Advanced Driver Assistance System (ADAS) is a popular technology that is used to make motor vehicle travel safer by automating, improving, or adapting some tasks involved in operating a vehicle. Driver assistance serves to make travel comfortable and easier and also increase car and road safety. Driver assistance not only helps in-vehicle control but also in location finding and obstacle detection. Driver assistance involves both simple and complex systems. Complex systems are done with the help of deep learning or machine learning.

Bluetooth Low Energy also called Bluetooth Smart, has been introduced to enable small battery-run devices to utilize. Bluetooth whilst still being able to support very long battery lifetimes. BLE is a form of Bluetooth technology that has been developed to provide effective connectivity for many forms of small devices, particularly those associated with the Internet of Things, IoT.
Bluetooth Smart is aimed at use in devices that may need to run off small batteries for long periods of time, while also being able to communicate with larger devices like smartphones or tablets. Bluetooth Smart has the advantage that it is easy for developers and OEMs to develop products that will work with the Bluetooth enabled products that are already in existence today.

Many IoT style devices like sports & fitness devices, health care devices, keyboards and mice, beacons, wearables, along with small sensors and actuators that may need to be able to operate for a year or more on a single battery charge. Along with previous versions of the specification, the Bluetooth Smart can be optimized according to the application, enabling the battery usage to be minimized when long ranges are not needed.

RSSI (Received Signal Strength Indicator) is the strength of the beacon's (transmitter's) signal then will be seen on receiving the device, (on a smartphone). The strength of the signal depends on Broadcasting Power and distance value. The RSSI ranges from -26 (a few inches) to -100 (40-50 m distance) at maximum Broadcasting Power (+4 dBm). It is used to estimate the distance between the beacon and). RSSI tends to fluctuate due to some external factors affecting radio waves like interference, absorption, or diffraction. The RSSI becomes more unstable if the device moves further away from the beacon.

The following formula is the log-distance path loss model and it tries to describe the fading that a signal encounters when traveling through a building or densely populated area.

$$\mathrm{RSSI} = -20 * \log(d) + A \qquad \ldots (1.1)$$

where A is a reference received signal strength in dBm (measured RSSI value when 1 meter separates sender and receiver). The d in this formula is the distance between the sender and the receiver. By solving this formula for d, a distance estimation can be calculated which is mentioned below

$$d = 10^{\frac{A-\mathrm{RSSI}}{20}} \qquad \ldots (1.2)$$

Trilateration is a technique accustomed to verify the position of objects, as an example, beacons, via distance measuring. Triangulation, in addition, takes the angle into consideration. Since GPS isn't out there in buildings, trilateration and triangulation are used for measuring, positioning, and navigation there. For viewing objects in 2D, three beacons are necessary, for 3D it's four.

In geometry, trilateration is that the method of decisive absolute or relative locations of points by measuring of distances, victimization the geometry of circles, spheres or triangles. In addition to its interest as a geometrical downside, trilateration will have sensible applications in measure and navigation, as well as international positioning systems (GPS). In distinction to triangulation, it doesn't involve the measuring of angles.

Triangulation is the method of deciding the placement of some extent by forming triangles thereto from known points. Specifically, in measuring, triangulation in and of itself involves solely angle measurements, instead of measure distances to the purpose directly as in trilateration; the employment of each angle and distance measurements is noted as triangulateration.

II. *Literature Survey*

The research for Integrity Monitoring for Bluetooth Low Energy Beacons RSSI Based Indoor Positioning: RSSI is an estimated measure of power level that an RF client device is receiving from an access point or router. At larger distances, the signal gets weaker and the wireless data rates get slower, leading to a lower overall data throughput. A Review was carried out by HAIYUN YAO , HONG SHU ,XINLIAN LIANG(Senior Member, IEEE), HONGJI YAN , AND HONGXING SUN (2020) published on IEEE Access on RSSI value of Bluetooth beacon is calculated at different lengths. Geometry of Network affects performance.

The research for Smart Parking System Based on Bluetooth Low Energy Beacons with Particle filtering: BLE beacons is a form of wireless communication designed especially for short-range communication. BLE is very similar to Wi-Fi in the sense that it allows devices to communicate with each other. However, BLE is meant for situations where battery life is preferred over high data transfer speeds. It was carried out by Andrew Mackey, Student Member, IEEE, Petros Spachos , Senior Member, IEEE, and Konstantinos N. Plataniotis, Fellow, IEEE (2020) published on the IEEE Systems Journal which provides information about the Individual BLE beacons used in each slot for parking management.

The research for Performance Evaluation of Beacons for Indoor Localization in Smart Buildings was carried out by A. Mackey and P. Spachos (2017) published in the IEEE Global Conference on Signal and Information Processing (GlobalSIP) which provides performance of Different Bluetooth beacons is evaluated. Metals and concrete might block beacon signals.

The research for Comparison of energy consumption in Wi-Fi and Bluetooth communication in a Smart Building was carried out by G. D. Putra, A. R. Pratama, A. Lazovik, and M. Aiello (2017) published on IEEE 7th Annual Computing and Communication Workshop and Conference (CCWC) which proposed Bluetooth is 30% more energy efficient than Wi-Fi. Interference may disturb the connection if multiple Bluetooth devices are running simultaneously.

The research for Development of Mobile Indoor Positioning System Application Using Android and Bluetooth Low Energy with Trilateration Method: The system is to increase the efficiency in the emergency room, the goal of this research is to implement a mobile-based indoor positioning system using mobile applications (APP) with the iBeacon solution based on the Bluetooth Low Energy (BLE) technology. **It** was carried out by Agustinus Noertjahyana, Ignatius Alex Wijayanto, Justinus Andjarwirawan (2017) published on the International Conference on Soft Computing, Intelligent System and

Information Technology (ICSIIT) which proposed by Location is calculated by trilateration method. Therefore, hidden node problem may occur.

III. Proposed System

In this section, a brief overview introduces the system, followed by a detailed description of each technology, along with its functionality and performance enhancements within the system
environment.

A. System Overview

The proposed smart parking system relies on four main components that use different wireless technologies

1) NoSQL Database

NoSQL databases (aka "not only SQL") are non-tabular, and store data differently than relational tables. NoSQL databases come in a variety of types based on their data model. The main types are document, key-value, wide-column, and graph. They provide flexible schemas and scale easily with large amounts of data and high user loads.

2) User Profile

For the user profile, the application supports the ability to save vehicle and payment information unique to the user. At the same time, the application keeps track of useful statistics for the user, such as preferable parking spots, and provides a recommendation, such as available parking spots close to events the user plan to attend.

The second necessary component is BLE connectivity. The majority of smartphones in today's market have the required hardware and capabilities to listen to and interact with BLE devices, specifically BLE beacons. However, in case BLE is not available, the users are able to enter the unique spot ID of each beacon, which is a letter to identify the lot, followed by a unique
number to identify the spot.

The application will act as a receiver to the BLE transmitters, it will take the signals as input then process them with the help of Multilateration technique, and that will let application to locate user's position.

3) Hardware

Internet of Things is the concept of connecting any device (so long as it has an on/off switch) to the Internet and to other connected devices. The IoT is a giant network of connected things and people – all of which collect and share data about the way they are used and about the environment around them.

The NodeMCU (**N**ode **M**icro**C**ontroller **U**nit) is an open-source software and hardware development environment built around an inexpensive System-on-a-Chip (SoC) called the ESP8266. The ESP8266, designed and manufactured by Espressif Systems, contains the crucial elements of a computer: CPU, RAM, networking (Wi-Fi), and even a modern operating system and SDK.

4) Beacons

BLE beacons use the BLE standard, but they only use broadcasting packets without allowing the connection of other devices. The reason for this is, that if a device would establish a connection to the beacon, advertisements would have to stop and therefore no other device would be able to find the beacon or receive the signals of it. Also, establishing a connection is more energy consuming for the Beacon itself. BLE beacons are very attractive to retailers because they promise a long battery life (of a few years) and they have low maintenance requirements. Once deployed to a wall or an object of choice, they do not need any maintenance until the coin battery needs to be replaced. It is important to keep in mind, that a long battery life requires low power output and/or low advertisement rates and that may affect the beacon's usefulness, depending on the scenario they are used in. Manufacturers, which produce BLE beacons, are Gimbal, Estimote, Kontakt and some others. A Beacon consists of a power supply (a coin battery most of the time), a Bluetooth module and a processor. Most currently available

Bluetooth modules are manufactured by Texas Instruments, Bluegiga, Qualcomm and Nordic Semiconductor.

Category	Bluetooth LE	Bluetooth Classic
Optimized for	Short Bust of data	Data Stream
Frequency	2400 to 2483.5MHZ	2400 to 2483.5MHZ
Data Channels	37	79
Advertising Channels	3	32
Encryption	AES – 128 bit	AES – 64/128 bit
Throughput	<300 kb/s	<3 Mb/s
Setup Time	6 ms	>100ms
Energy Consumption	0.01x to 0.05x	1(ref)
Supported Topologies	Point to point, Broadcast, Mesh	Point to Point

FIG 1: Bluetooth LE vs Bluetooth Classic

Fig 1 shows the difference between the standard Bluetooth and Bluetooth Classic.

The format of the advertisement packets depends on the BLE communication standard which is used. The most common ones are iBeacon and Eddystone.

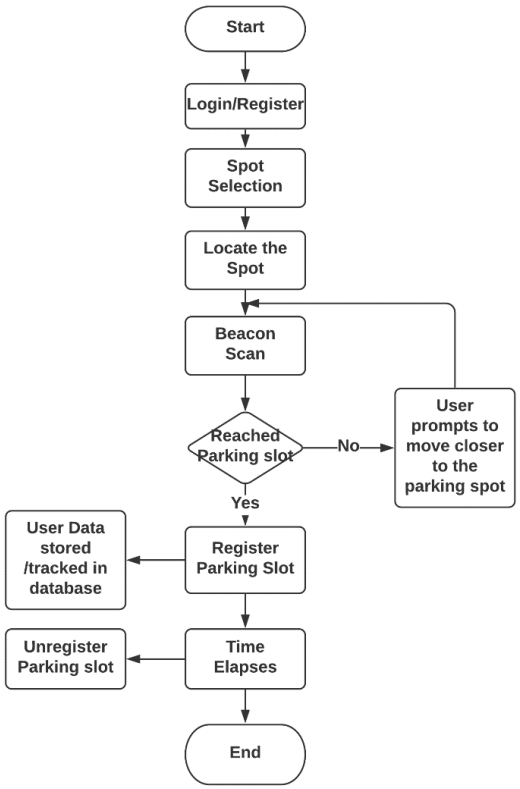

FIG 2: Flow Diagram of Introduced System

B. System Implementation

1) Firebase Database

The Firebase Realtime Database is a cloud-hosted NoSQL database that lets you store and sync data between your users in real-time. Data is stored as JSON and synchronized in real- time to every connected client. When you build cross-platform apps with our iOS, Android, and JavaScript SDKs, all of your clients share one Realtime Database instance and automatically receive updates with the newest data.

2) Mobile Application

Mobile Application is a second major element of an indoor navigation system. A mobile application that retrieves and interprets signals, is a basic need of the system that anyone can get familiar with. The application is comprised of the following four main activities:

- profiling user and vehicle information
- parking registration capabilities
- live view of slots
- Retrieving RSSI Values of nearby BLE Beacons.

3) Hardware

IR sensor collects data about the slots and send the data to NodeMCU. NodeMCU sends the data to the mobile application developed. The mobile application displays the live view about the slots.

IV. Results and Analysis

Mobile Application is developed which shows the location of the available parking slots to the user. BLE Beacons are placed in corners of the Parking area which covers range of 10m. Parking system is demonstrated in an area of 10mx10m. Mobile application captures the RSSI value of each beacons and finds the distance of the user from each beacon and predicts the exact location. The Android

Application screenshots are attached below.

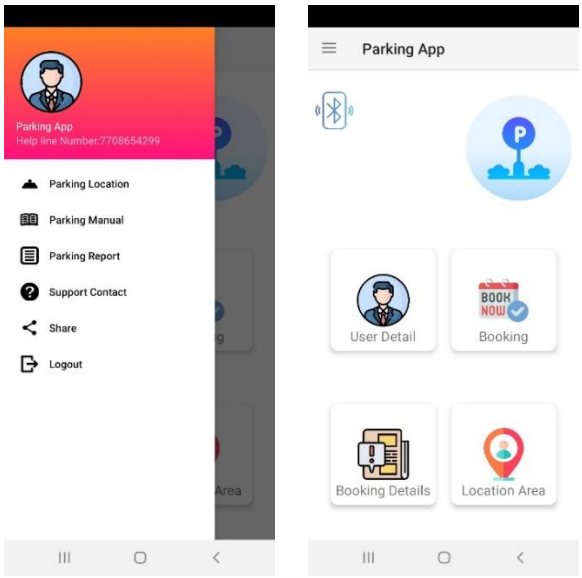

FIG 3: PARKING APPLICATION MAIN PAGE

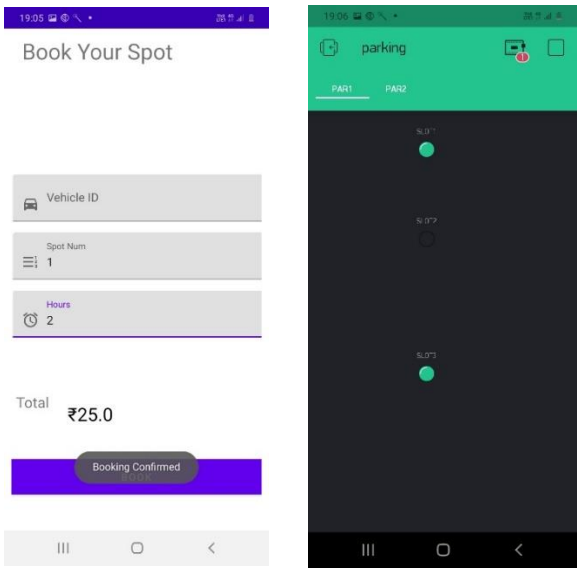

FIG 4: BOOKING PAGE AND AVAILABLE SLOT PAGE

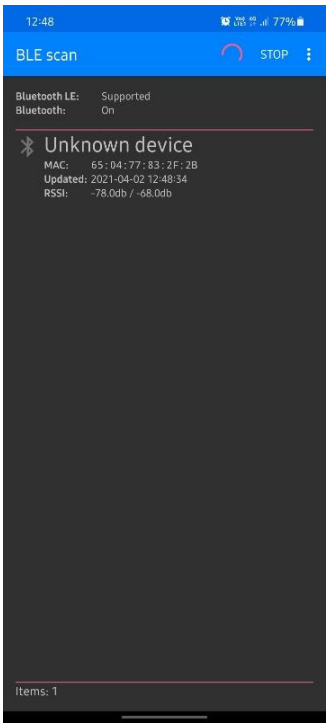

FIG 5: Bluetooth scanner with RSSI value

V. Conclusion

This article presented a novel framework for a Intelligent parking for ADAS using BLE beacon devices. The goal was to develop a smartphone application that people can utilize to securely and easily find and pay for parking, while also providing management capabilities for the parking facility owners.

The result is obtained in Android Application and the results obtained shows that BLE beacons are accurate both Indoor and Outdoor than Wi-Fi and GPS and consumes less power than both Wi-Fi and GPS. The system has sufficient accuracy in terms of parking availability estimation.

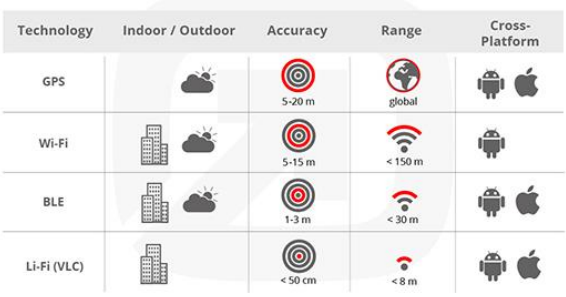

FIG 6: Difference between GPS, Wi-Fi and BLE

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