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Research Article

Crowdsensing using Geofencing for Smart Parking

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Abstract: Finding a parking spot for a car is a practical problem faced by millions of drivers daily. Most of the times it involves anxiety and uncertainty, also considering a threat to environment, it wastes limited resources which includes time, road space, and fuel. Also drivers roam around in search of free parking spaces. These problems could be minimized if drivers had advance information of vacant parking spots. This information can be gathered with dedicated sensor systems keeping track of the reservation status of parking areas. New devices such as mobile phones come with a variable number of sensors and thus can interact with many things in environment. Recently mobile operating systems have started to incorporate means to offer contextual information derived from measurements of multiple sensors, i.e. by interacting with open sources it can get information about the surrounding. The idea is to investigate how these interacting capabilities could be used to derive information about available parking places in addition to parking sensor of the infrastructure or by smart parking using geofencing by which the model aims to reduce the traffic in the surrounding.

Keywords: Geofencing, GPS, Location Services

1. Introduction

"Geofencing is defined as a location-based service which uses GPS, RFID, Wi-Fi or cellular data via an application or various other software in order to trigger an already programmed action when an object tries to enter or exit a virtual boundary which is set up around a geographical location, known as a geofence." Depending on the configuration of the geofencing techniques, the model can prompt mobile push notifications, trigger text messages or alerts, send targeted advertisements on social media, or deliver location-based marketing data. The model can also allow tracking on vehicle fleets as well as disable certain technology. Smart Parking is a parking strategy that includes smart IoT device and creative human ideas, in an effort to make parking of vehicles much faster, simpler and less time consuming in a crowded area. Many countries has starting implementing smart parking system or facilities but there are many instances where users book parking slot in smart parking facilities but they never show up or they come very late, by that time there are many users who are finding the parking slot but they might not find any and end up wasting consumable energies. Thus by implementing geofencing in smart parking facilities, the average time of user in finding parking slot is minimized and also reduces the consumption of non-renewable resources. The geofencing API is used to define perimeters or geofences, which are used to surround the areas of interest within a defined area of pre-determined radius. The application gets a notification when the device crosses a geofence. For example, a smart parking app can define a geofence around a parking facility when a vehicle is near parking facility in order to book a parking slot. When the device passes through the geofence, the app creates s trigger which sends a notification that takes users to an activity that allows the users to get the parking slot booking page. The Geofence API uses mobile sensors to acquire the location of the device or an object in an efficient way.

To create a list of geofencing objects, the model needs to set the longitude, latitude, radius, and time and trigger action types for each geofence. The trigger action shows all the events that could triggers the geofence, for example when users enters or exits a geofence. Once the list of geofence is created, you can add it to a geofencing request. The Geofencing API Transfers the information about the events to an Intent Service in the application, which eliminates the need of having an application running in background solely for geofencing purpose. The service is only requested or called upon when there is true relevant information provided. The service obtains all the geofencing events from the Intent, including the record of all the triggered geofence. With that the model decides what should be done after the geofence is triggered.

2. Related works

G. Yamanaka et al. (2019) [1] has made a camera based geofencing system using wireless local area networks. It shows geo-location which is based on wireless access control in order to manage area where the wireless LANs are available. A.S.Binti Amir Boktar et al (2018) [2] has used a geofencing mechanism that configures remote

monitoring of a teenager by predefining area which is engulfed by a virtual boundary. If the teenager moves out of the geofence or the location then the geofence system will trigger an alert to avoid any unwanted activity which can lead to possible dangerous happenings. Abbas et al. (2019) [3] created a system which provides a high-security mechanism that prevents vehicles from being stolen. The model issues an alert to the user whenever the vehicle leaves the geofenced area by using Internet of Things. In this study, "the system was able to easily monitor and track location of the vehicle and was able to issue an alert when the vehicle exited the geofence area." Sachin W. Rahate et al. (2016) [4] shows a new approach to offload mobile gps resource for monitoring the user's geographic coordinates in the infrastructure. The cell phone is thereby considered to be a client that is primarily responsible for locating itself by the continuous comparison of the mobile phone's position with an enormous set of geofences which is implemented within an environment with inferior resource constraints. With this model Sachin W. Rahate et al. tries to deal geo notifications according to the location specific information.

Zhanlin & Ganchev et al(2014) [5] presents the generic concept of using cloud-based intelligent car parking services in smart cities, as an important application deployed on the Internet of Things (IoT) paradigm into which this model is tried to be implemented. F. Zhou and Q. Li et al. (2014) [6] created an "intelligent parking guidance system based on Zig Bee network using geomagnetic sensors which was designed to find real-time vehicle position and related traffic information." The data was collected using geomagnetic sensors around parking facilities and then were updated to central server. However, outdoor LCD screens were controlled by central server which displays information of empty parking slots. A. Ampuni et al. (2019) [7] proposed the model regarding "IoT smart parking system based on cloud computing using several smart devices, and also smart automatic machine." The model is projected to provide services regarding car parking spot searching and car parking spot allocation. This is done by the mobile application in which whenever the user is on his way out, the bill is automatically processed from the automatic cashier machine. M. Praveen and V. Harini (2019) [8] has proposed a "NB-IOT based smart parking system" in which they have tried to minimize the human contact in parking assistance using the 3GPP standard. This was made possible by adding geofencing techniques in smart parking system. With the combination of two models i.e. smart parking and geofencing, the time and non – renewable resources can be saved in much higher amount and also helps in finding a nearby parking spot easily.

3. Proposed methodology

The following section describes explicate the proposed work. In this methodology, geofencing is implemented in addition to smart parking facility. With the implementation of geofencing, the model reduces the no – show users.

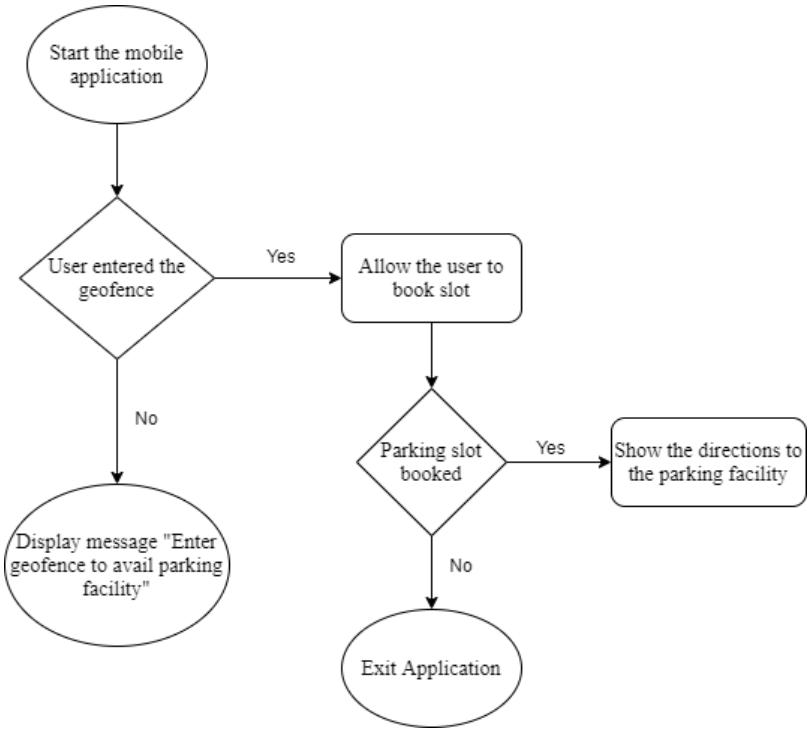

Figure 1. Geofencing Flowchart

1. Geofence Formation

A perimeter is created around the parking facility within a radius of 1.5 – 2 km. Now with this geofence, whenever any vehicle is inside this area of 1.5km radius, the user can avail the parking facility.

1.1. Creating Geofence

Set the latitude and longitude of the parking facility and add marker on it. Then, with that marker, create a circular area of 1.5km radius and add that circle in database.

1.2. Working of Geofence

Geofence comprises of local points on map with which virtual fence is set up. Thus, whenever any vehicle enters this geofence, the user can book a slot in the parking facility.

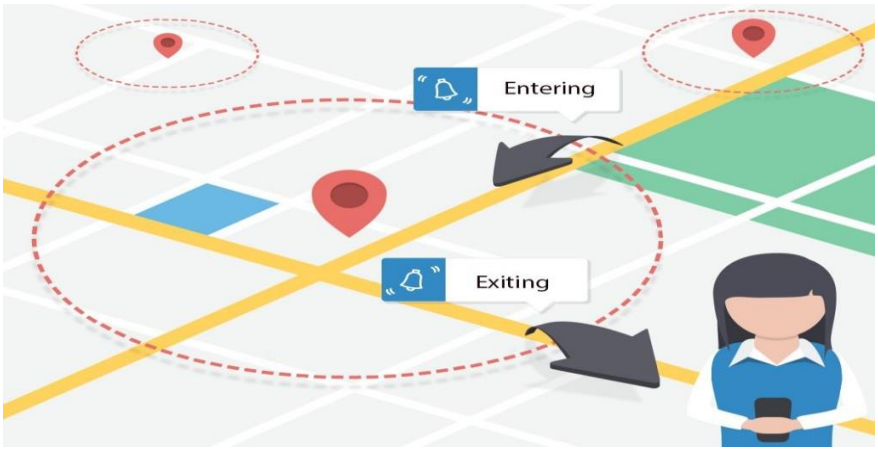

Figure 2. Geofence

2. Vehicle Registration

After downloading the mobile application, the user has to accept various permissions following which a vehicle registration page will pop up wherein the user has to input the vehicle details and personal details like license number, etc. When the user is inside the geofence and wants to avail the parking facility, the users can quick login into the application in which already has the vehicle information, and then book a parking slot. After the parking slot is booked, the application shows the direction to the facility. In this application, all the details like name, email, phone number, license number, and RC book details will be collected at the start so at the time of booking, the time consumption is reduced. When the parking slot is booked, a QR code is generated which will be displayed on the mobile phone when will be used to get entry into the parking facility.

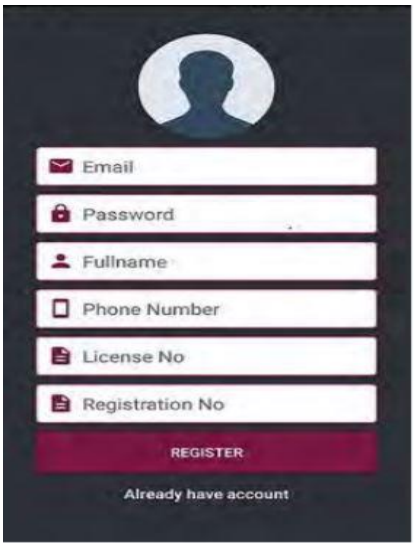

Figure 3. Registration Details

3. Parking Direction Assistance

There are various smart parking facilities available where users are already booking parking slots for their vehicles. This module's directive is to target those smart parking facilities and integrate the geofencing techniques in those smart parking facilities. By integrating this geofencing technique, user will be able to book a parking slot only when inside the geofence which reduces no – show users and saves time searching for parking area. The user books a parking slot through the mobile application. After the parking slot is successfully booked, the application then shows direction to the parking facility which the user can follow and on arrival to the entry gate of the parking facility, the QR code will be scanned following which entry to the parking facility will be made available. The user can park anywhere in the available space in the parking facility and a bill is generated when the user exits the parking facility according to the time availed for parking services.

Figure 4. Parking Facility

4. Results and discussion

With the implementation of geofencing in smart parking system facilities, the number of no show users will decrease in enormous amounts because with implementation of this methodology, the users can only book a parking slot when inside a particular range of parking facility. Also with the implementation of geofencing in parking, the time taken to find a parking slot also reduces significantly which in turn decreases the wastage of non-renewable resources and a mental pressure of finding a parking spot in case of hurry.

Also since this model is based on geofencing, it can also be extended to various streams of work like school bus, in which a regulated path is defined for the school bus and if the bus has gone off route, then an alarm is triggered alerting the management of the school.

This model can also be extended to animals monitoring system, in which a gps tracker can be mounted on wild animals in forest and if the animals try to move out their territory or they seem to move towards nearby residential places, then the forest officers are alerted.

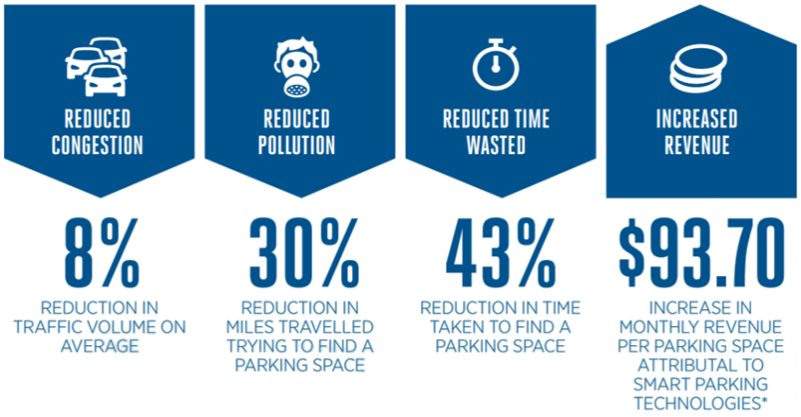

Figure 5. Benefits of using Smart Parking

According to studies carried out by GSMA Intelligence with Machina Research, "The research shows that where smart parking systems have been installed, the time taken find a parking space can be reduced by up to 43%, vehicle miles travelled can be reduced by 30% and traffic volume decreased by 8%."

5. Conclusion

There are various smart parking system facilities which are already in use to which geofencing techniques can be applied and implemented which in turn decreases time for searching available parking slots along with an assurance to the parking facility owner that the parking slot booked will be occupied by the user and also there will be decrease in no – show users. Thus, the implementation of geofencing techniques in smart parking facility is a win – win situation for both the parking facility seekers and parking area providers. Both the parties have assurance of availability and usage of parking facilities along with the tremendous decrease in time needed in searching for parking space. The model also helps in decreasing the wastage of limited resources or fuel used in searching for available parking spaces in nearby places.

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