Mobile Crowd Sensing (MCS)

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***Abstract*—Mobile crowd sensing (MSC) is a technique which uses these powerful devices – smartphones, tablet, computers, wearables devices to collect required data and extract information to measure, analyze, estimate or infer any processes of common interest. By using Participatory crown sensing technique, we are going to design an android application for parking system. In this application the user can input the data of parking. So, the other user can check the parking status and can decide to go in that parking or not. We set four parking status: occupied, unknown, unknown occupied, available. It user themselves booked any parking spot then it will show only to that user with green car color and other occupied spots with red color where as unknown occupied spots are colored dark blue gray. On the other hand, the parking space is initially all unknown spots. With the time, user's input will improve the system and feed it with actual real time data. We are also preventing user to enter false data by checking user's location. Thus, only user who is present on the parking space location can cenobite data. Moreover, to increase the number of our app user, we will create some kind of incentive mechanism system in future. So, for ease of the parking information and rewards system can bound the user to use the app.**

I. Introduction

In recent years, MOBILE Crowd Sense (MCS) has become an appealing data sensing and processing model. Mobile users have become important sources of sensing data in a global wireless sensor network by advancing and increasing the use of mobile devices with growing computing, communications and sensing capability. The term mobile crowdsensing was first introduced by Ganti et al. to indicate a more general paradigm [1] than mobile phone sensing. Guo et al. in [2] give a definition that clearly highlights this difference: "MCS is a new sensing paradigm that empowers ordinary citizens to contribute data sensed or generated from their mobile devices, aggregates and fuses the data in the cloud for crowd intelligence extraction and people-centric service delivery". MCS represents an approach for a new sensing and geo-crowdsourcing paradigm that leverages the power of various mobile devices, such as smartphones, tablets, wearable devices and smart sensors.

MCS systems rely on sensors and communication interfaces embedded in commonly used mobile devices. the number of worldwide smartphones sales in 2018 was 1.55 billion units, and the number of wearable devices shipped in 2018 was 178.91 million, which is projected to reach 453.19 million in 2022. Furthermore, the crowd analytics market is predicted to reach USD 1 142.5 million by 2021 raising from USD 385.1 million of 2016 at a compound annual growth rate of 24.3%. MCS can significantly improve citizens everyday life and provide new perspectives to urban societies. The world population makes more than 64% of all travel kilometers within urban environ¬ments, which is expected to triple by 2050. Thus, MCS is an essential solution for building smart cities of the future. The use of mobile crowd-sensing attracts considerable interest in academia and in industry, which began to explore the commercial usage of mobile crowd-sensing. However, the adoption of mobile crowdsensing approach in business context requires the guarantee of the quality-of service (QOS). We review the mobile crowdsensing techniques, challenges and applications. In this paper, we discuss the different mobile crowd sensing technology and developed an android application for smart parking based on MCS[3].

II. Related Work

We review the paper Smart Parking by Mobile Crowdsensing by Xiao Chen and Nianzu Liu along with some other parking systems which are currently available. As far as smart parking is concerned, most existing studies either assume the availability of special devices installed at the parking lots or heavily depend on the accurate data produced by such devices. Systems like SPARK [16] employ wireless sensors or VANET (Vehicular Ad-hoc Network) devices to collect and disseminate information about parking availability to help drivers find vacant parking spaces. CrowdPark [4] assumes a seller-buyer relationship between drivers, who are going to leave or parking at the lots, to deal with the parking reservation problem. A relevant study [5] tries to realize smart parking by solving an optimal resource allocation problem according to driver's various parking requirements. Although these solutions could be applicable to large off-road parking garage, they are not suitable for sparsely located on-street parking lots that are not owned by a single entity. Some remarkable initiatives that realize smart-parking by the infrastructure-based approach include the SFPark[6] project in San Francisco and the CBD in-ground sensors [7] in Melbourne. Although the effect is instant, few cities worldwide can afford the high initial investment and the maintenance cost. Alternatively, some naïve apps like Open Spot just mark what users report on the map but failed to recruit enough contributors.

The proposed method in paper improves existing approaches in several ways. First, by integrating crowdsensing and a road navigation system. The data collecting tasks much easier for drivers to accomplish as they only ask drivers for their

manual input at the beginning and the end of their trips. Second, as Open spot failed to recruit enough contributors, they have introduced a money reward which can help to increase the number of contributors. Some existing approaches that only share information about parking vacancies, but this system also tries to identify occupied areas through user 's sensor data so as to help drivers avoid unnecessary cruising. In this paper their contributions are twofold. On the one hand, the mobile crowdsensing is a feasible and cost-effective approach to deploy a smart parking system. On the other hand, they regard this application as a case study to demystify some rumors that have influenced the design of mobile crowdsensing-based applications for a long time. They also concluded that recruiting more participants may not necessarily lead to a better performance if the crowd sources fails to coordinate participant's behavior in the context of these applications. In addition, people can provide valuable information by answering very simple questions in a dynamic mobile environment if they are coordinated[8]

III. Background

A. Crowd Sourcing

The term "crowdsourcing" was coined in 2005 by Jeff Howe and Mark Robinson, editors at Wired to describe how businesses were using the Internet to "outsource work to the crowd ". First published a definition for the term crowdsourcing in a companion blog post to his June 2006 Wired article, "The Rise of Crowdsourcing "[9]. Crowdsourcing represents the act of a company or institution breaking up a project into a collection of smaller pieces and providing those pieces to a larger group of workers expedites the completion of projects

B. Mobile Crowd Sensing (MCS)

Guo et al. coin the term Mobile Crowd Sensing and Computing (MCSC), which investigates the complementary nature of the machine and human intelligence in sensing and computing processes. Mobile crowdsensing (MSC) is a technique which uses these powerful devices – smartphones, tablet, computers, wearables devices to collect required data and extract information to measure, map, analyze, estimate or infer any processes of common interest. Citizens contribute data with their mobile devices to the cloud which enforces crowd intelligence. The basic mobile crowdsensing procedure includes three steps: data collection, data storage and data upload. Data collection is the first phase of the mobile crowdsensing. The strategies for data collection usually can be divided into three categories.

- All the data is collected by the user manually by controlling the sensing devices, such as smartphone with specific application. This approach is attention-consuming and inefficient.
- Data collection is partially controlled by the user and by sampling, which is performed periodically. Sometimes, the data can be collected opportunistically, i.e., when the user opens some applications
- Context-aware data sensing is triggered by predefined context, such as a location or time slot. This method releases the user from focusing on the crowdsensing tasks and makes it practical

C. Types of MCS

Based on the type of involvement from the users, mobile crowdsensing can be classified into two types

1) Participatory Crowdsensing
2) Opportunistic Crowdsensing

1) Participatory Crowdsensing: In the participatory crowdsensing, users participate for contributing information either voluntarily or for getting rewards. It increases the amount of data we had, and gathering more localized and accurate knowledge. For example, MCS is using by many governments to maintain the government services such as road conditions, water drainage lines, etc. So, user can take a picture of related issue and by using smart phone GPS sensor they can pin that location. So, The MCS approaches such issues with more feasible solutions. The google crowdsource application is another example of participatory crowdsensing. Which involves users' inputs to improve the google services. Such as user as to proved data ask for and they will earn rewards for that and on the same time google gets the right data from the user.

2) Opportunistic Crowdsensing: Opportunistic crowdsensing uses the devices like smartphones which are equipped with various sensors to collect data from the surrounding environment. For example, when our fitness band connects to the mobile device, it sends all the statics of our body moments, heart rates, sleeping data and many more important information. Those data will be share on the companies/host server and the data is analyzed among the all users. So, we can compare our score with the community uses the same fitness band. So, MSC is improving the health conditions, road traffic situations, and many more areas. For Example, the fitness band collects data continuously and those data will be analyzed by the fitness band's company and sends back the comparison, health tips according to that data.

D. Importance of MCS

The influence of MCS can have direct impact on applications affect our physical world. These days smartphones are constantly connected to the wireless network and thus everyone is able to collect real-time data about the physical world either through their observation and manual input or by the sensors in the device. Therefore, mobile crowdsourcing enables data collection through millions of such devices and collects data from the surroundings of people's everyday life. Such collaborative data collection enables the design and implementation of services that are helpful to each individual in our society. One of the most efficient examples is the smart parking

E. Parking System

The parking problem has existed in since long. Studies show that an average of 30% of the traffic in busy areas is caused

by vehicles cruising for vacant parking spots. The extra traffic causes a series of problems such as traffic congestions and accidents, air pollution and waste of fuel. Therefore, some local governments try to mitigate these issues by means of smart parking. so that drivers can spot the right parking place quickly. For example, the city of San Francisco installed thousands of sensors to on-street parking spaces in its busy areas for parking management. There are huge initial investment and maintenance cost but the effect of such a centralized approach is immediate and efficient.

IV. Proposed Method

The basic idea behind our design is to build a parking system based on Participatory Crowdsensing for small parking area. The main aim of this design is to show the mobile crowdsensing is a feasible and cost-effective approach to deploy a smart parking system. As we are using participatory crowdsensing our design is totally based on the user's input. First the user location will be detected by application using GPS (global positioning system) of user's mobile phone. As soon as user will reach near the parking area the application will show which parking slots are available or free so user can easily find the free parking spot. After parked his/her vehicle, user will be asked with some question with which parking slots are available and user will give his input for which parking slot is available. This input will be useful to decide which parking slot is empty and which one is occupied.

A. Type of users

In our system there are two types of user

1) Smart users
2) Ordinary users

1) Smart users: Smart parkers are the drivers who have access to the service through their client devices. A smart parker will input their destination before they start driving. Then they will receive recommendations from the system about potential parking vacancy when she approaches his/her destination. At the beginning and the end of a trip the smart parker is expected to answer a question about parking availability in the area by manually operating the client device.

2) Ordinary users: Ordinary users are the users which are not connected with the application or the users who have access of the parking location but not using the application. To manage the ordinary users are very challenging task. Unlike smart parkers, ordinary drivers do not provide data when they arrive at or leave from a parking space. In this case the central server cannot notice the change of status in those parking lots. Thus, for all parking spots, we automatically change the status to unknown when a timer expires. The timer length can be derived by statistics or by occupancy prediction and can be adjusted through the observation of the crowdsourced data

B. Incentive mechanism

A reasonable incentive design is a key factor to develop any sustainable application by crowdsensing. As we have discussed that many applications like Open spot failed to recruit enough contributors. To overcome this issue, we have developed an incentive design to reward the Smart parkers. As every smart user must answer some questions at the end of the trip so after every 10 correct answer the user will be rewarded with a free parking.

C. Preventing from false data

The main difficult task of crowdsensing is to deal with the false data. In our case user may give false data like they are at home but still providing the inputs for parking slot. This type of noisy data can decrease the system performance. To restrict the user from giving the false input we check their location by using GPS and if user in the parking than only he will be able to provide information.

V. Development Environment

Android Studio is the official integrated development environment for Google's Android operating system, built on JetBrains IntelliJ IDEA software and designed specifically for Android development.

1) Application Flow: An Android activity is one screen of the Android app's user interface. An Android app may contain one or more activities, meaning one or more screens. In our application, we have 8 activities for different purpose as described below.

1) SplashActivity.java: This is the first screen pop up when the application starts. It will show basic logo or name of the application. Then the app will redirect to the UserGuideActivity.
2) UserGuideActivity: In user guide, it will show briefly the features and guide the user for the gui of application. After this activity it will redirect to the location activity if the permission is not granted else it will jump to the loginWithGmailActivity.
3) LocationActivity: The location activity will ask user for location permission as we require to authenticate the data. The user can be input the data from any location so we are considering that data as false and will not update the parking status. Thus, we check the user's location is nearby with the parking spot or not? Now, It will redirect to loginWithGmailActivity.
4) LoginWithGamilActivity: The use does not need to create a new id for login to the application. We are using google authentication services so the user can login with google id password, which is way more secure and ease for user to does not remember the credentials. It will move to the user profile activity to show user their details.
5) UserProfileActivity: The user profile activity shows the data of user's google profile that is First Name, Last Name, Email id, and id. Then user can sign out or move to the parking screen.
6) ParkingActivity: In the parking screen, we try to design the screen same as parking. There are total 10 parking spot, from p1 to p10. On any parking spot user can touch and give the input. If user has already occupied

one parking spot then it will not allow to reserve another one but it will still allow them to contribute for other parking spot data that is, is the parking spot is free or not. The data will be updated in real-time firebase database. There are mainly 4 status of parking, occupied, available, unknown occupied, unknown and will describe in later topic.

7) BookActivity: In the booking activity the selected parking spot will be booked or free. In this activity, the data will be uploaded to the database. Then it will move to success activity
8) SuccessActivity: The success activity will show the final result of the booking or freeing the spot.

A. Parking status managed by application

From the server 's perspective, each road segment could have one of the four statuses for its parking availability. We have also used one counter which shows user about how many free parking available or occupied

1) Unknown: At the beginning of the application all the parking status are "Unknown" as the server don't have any information about those parking slot as they are available or free.
2) Available: The status "available" will show that this parking slot is free and if any user wants to occupy the spot, he can occupy it. The status available is derived from the smart parkers input as if someone can see that the parking spot is free, and he will inform to server by using application. So, it will be changed from unknown to Available.
3) Occupied: If any smart parker has already occupied the parking spot than the system will show the status "occupied" to all users but for the particular user it will show "self-occupied". At the end of the trip user will free the parking slot so it will be again available for other users.
4) Unknown occupied: If any ordinary user has occupied the parking spot than the system will show the "Unknown occupied". As any smart user reports the spot is occupied then system can identify that the spot is not occupied by any smart parkers and it will change the status to Unknown occupied.

B. database

For storing the user's data, we have used firebase database. Firebase is a comprehensive mobile development platform offered by Google backed by Google Cloud platform. Firebase is a suite of services ideally required when writing a mobile app, for instance, running analytics, integrating messaging into the app, having access to a fast-real-time database for storage, gaining an insight into crash reporting. Firebase supports many platforms, for instance, IOS, Android, Web, Unity for the mobile apps to run on. The integration is easy smooth with these platforms.

VI. Conclusion

Mobile crowdsensing is an increasingly popular mechanism to realize applications that harness a large volume of real-time data to improve daily life efficiency. Crowdsensing, however, brings several new issues that arise only in the context of participatory, peer-to-peer systems. In this paper, we take the different smart parking application as a use-case and tried to develop an android application based on mobile crowd sensing. We achieved our main goal by developing our smart parking application which is totally based on participatory crowdsensing which can help the users to find the free or available parking slot without any help of physical parking sensors. We have also developed incentive design which can helpful to increase the user participation so we can encourage more users to participate and we can get more accurate data. We have also identified some loopholes of the system as the system can not detect the immediate changes in the reservation of the parking slots. Apart from that to handle the ordinary users is difficult task. To remove the ordinary drivers, we can assume that only smart parkers can park in the particular area but for now we want to make a generalize system, so we have considered them.

VII. FUTURE WORK

We have developed the application which can be used for only small parking area but in future we can also use this application for large platforms. We have also designed the incentive mechanism but currently we have not implemented it in our application but in future we can add this module to our application.

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