ISSN 2229-5518

Mobile Crowd-sensing For Smart Parking

Benjamin Bohia, Vanlalhriatzela, Ramengmawii

Abstract— In this paper, a mobile crowd-sensing smart parking android app is designed and implemented, exploiting the key elements that a mobile crowd-sensing system (MCS) should possess. The paper shows all the available parking spaces in different locations where users of the app could locate their desired parking space and park their vehicles. The crowd-based smart parking system collects relevant data from participating drivers, and then uses the data to navigate them to the right parking slots.

Keywords— parking, smart, mobile, crowdsensing, app, data , information, sensing, system.

1. Introduction

Finding a good place to park a car is a practical problem faced by many drivers daily. At personal level, it involves anxiety and uncertainty, and at the level of society, it wastes limited resources–time, road space, and fuel – when drivers circulate in search of free parking ,spaces. These problems could be alleviated if drivers had advance information of vacant parking spots. The information can be gathered with dedicated sensor systems keeping track of the reservation status of parking areas. This paper aims to solve problems of many drivers searching for a place to park using a simple smart parking app. Vacant parking spot can be easily located using the smart parking app that shows the location of vacant parking spaces over certain areas. The basic idea behind the research is to build a system that first collects the parking availability information from participating drivers around a certain area and then uses it to guide those drivers, who tries to find vacant parking spots there later. The goal of this project is to use Participatory Crowdsensing, a subset of Crowd Sensing to create a smart parking system.

The project is implemented using an app specifically created for this project. The app shows all the available parking spaces in different locations where users of the app could locate their desired parking space and park their vehicles by simply scanning a QR code. Deallocation of the parking slot can be done by simply scanning the same QR code before leaving the parking slots.
Smart parking system displays available parking spaces to drivers who are using the Smart Parking App. The crowd-based smart parking system collects relevant data from participating drivers, and then uses this data to navigate them to the right parking slots.

2. Related Works

2.1 Mobile crowdsensing of parking space using geofencing and activity recognition

Rinne, Mikko; Törmä, Seppo

This paper investigated whether a sensor-based smartphone can help a person in search for available parking space with the help of crowdsensing. Their method used the activity recognition of two devices in states, ‘in vehicle’ and ‘on foot’ combined with GPS. They used geofencing API, which allows the detailed description of geographic areas and produces enter ad exit events when a device is crossing the boundary. And Activity recognition API, which produces updated information of the activity type related to the devices whether it is moving, walking, tilting etc. It is implemented by an android application that is connected to a network server.

2.2 Crowdsourcing automobile Parking availability using Mobile Phones

Jesus Villalobos, Bereket Kifle, Derek Riley and Jesús Ubaldo Quevedo-Torrero

This paper showed a parking monitoring system which uses mobile phone sensors and crowdsourcing to determine precise and trustable information. UW-ParkAssist an android application is created which uses GPS to investigate whether a person is leaving or entering the parking lot and which particular part of the parking lot is used using vector mapping. They gathered data from each parking lot and also from parking officers or the police department to get a reliable and a real-time information of the parking spaces.

2.3 ParkJam: Crowdsourcing Parking Availability Information with Linked Data (Demo) Jacek Kopecky´ and John Domingue

In this paper, the author implement a demo of mobile Android app that uses openly available geographic data and crowd sources parking availability information, in which user can know the parking availability around this surroundings. Their application is builds on Linked Data, that can easily shows parking availability data openly as well. The app collects data from the user. It combine parking location data with business and service directories, So that the users can choose a parking lot that is near a desired business or other place of interest.

2.4 Smart Parking by Mobile Crowdsensing Xiao Chen and Nianzu Liu

In this paper, they design a crowdsensing based system that first collects the parking availability information from participant drivers around a certain area and then uses it to guide those drivers, who try to find a vacancy for parking spaces. They are using a coordinated crowdsensing by asking question and navigating the users. Information is gathered mostly form the participant users. Their main aim is to gives the drivers the information of the parking vacancy as soon and as they are close to their destination.

2.5 ParkCar: A smart roadside parking application exploiting the mobile crowdsensing paradigm Konstantina Banti, Malamati Louta, George Karetsos

In this paper, they design and implement an application of mobile crowdsensing for a smart roadside parking system, called ParkCar. ParkCar gathers data of parking vacancy information using the MCS paradigm and the users can search for their desired parking space. They showed the solutions for various MCS challenges with the application which runs on Android OS. It Involves both participatory and opportunistic crowdsensing. The ParkCar application main page have four options namely 'Account Information', 'Task Creation', 'Task Execution' and 'Parking Information'. The users can also turn off their locations.

3. METHODOLOGY

3.1 Proposed Model

The model proposed for this paper is divide into four steps:

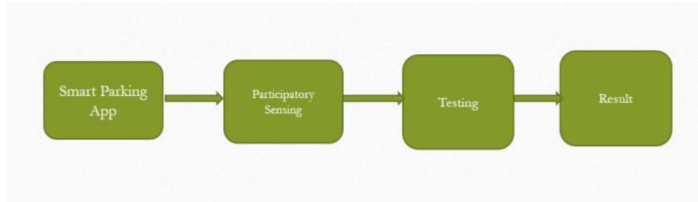

Fig. Proposed Model

1. **Smart Parking App:** A smart parking app is created specifically for the project.

2. **Participatory Sensing:** In this stage, user datas are collected using the Smart parking app and the data collected is stored inside a database. Data stored in the database is then used to inform the users about the availability of parking slots in certain parking locations.

3. **Testing:** In the testing stage, the actual crowdsensing is implemented using the smart parking app to determine whether the system is applicable and functional in real world scenarios.

4. **Results:** This stage then generate results from the experiments performed in the testing stage.

3.2 Smart Parking App:

A smart parking app is created specifically for the project. The Smart parking app is used as a tool to perform the actual crowdsensing. The app display available parking locations to which an user can select his/her desired parking location and check wheather there is a vacant parking slot in his desired parking location. The app is equipped with a QR code scanner. Parking slots are allocated and deallocated by scanning QR codes.

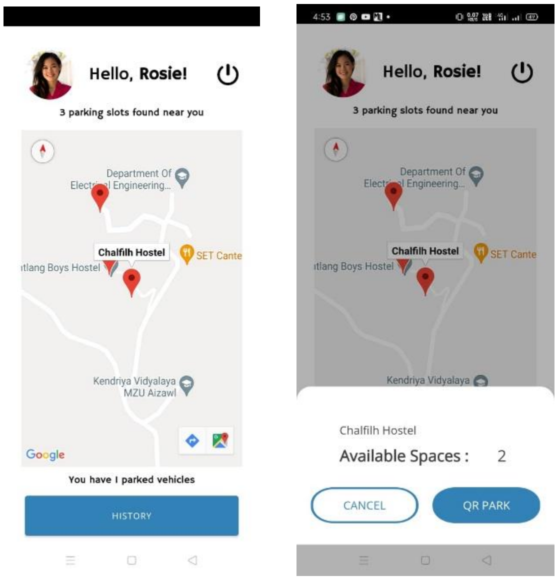

Fig 2. Smart Parking App

3.3 Participatory Crowdsensing:

Crowdsensing or Mobile Crowdsensing is a method used to collect and share datas from a crowd or a group of people using mobile devices. The datas collected are used to extract or generate meaningful informations.

Participatory Crowdsensing is a subset of Crowdsensing, where a crowd or a group of people voluntarily share datas using their devices.

In this paper, Participatory Crowdsensing is implemented using the app. By scanning a QR code for a specific parking slot using the Smart parking app, users are involved in the participatory sensing experiment.

The participating user occupies the parking slot by simply scanning the QR Code and the parking slot is de-occupied by scanning the same QR code that has been previously scanned.

3.3 Testing:

In this stage, crowdsensing using the Smart parking app is tested on real parking locations. Experiments are performed on three parking locations where three parking slots are reserved for the experiment. Participating users are requested to install the Smart Parking app on their phones.Participatory Crowdsensing is then performed on the participating users.

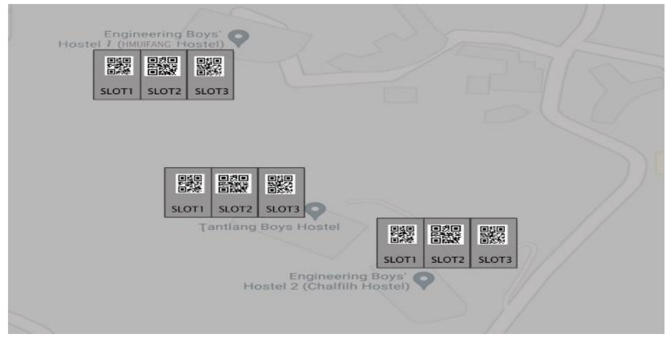

Figure 3. Parking Locations used for testing

4. Result

After the testing and experimental analysis is done for several days on real parking lots, the system is found to be operational and applicable enough to be implemented in actual parking location. The number of occupied parking slots and the available parking slots are represented in figure 4.

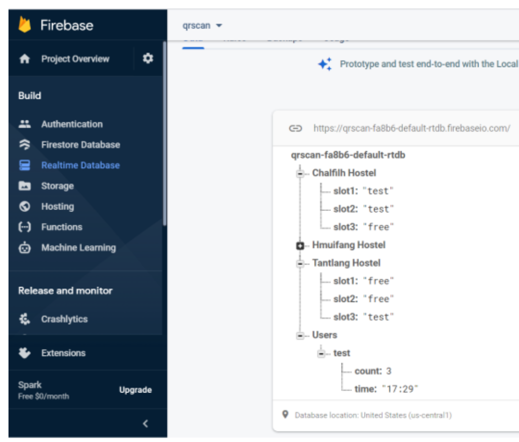

Figure 4. Database representation

5. Conclusion

In this research, the availability of parking slots in specific parking locations is remotely located using mobile crowdsensing. Participatory Crowdsensing, which is a subset of Mobile Crowdsensing, is implemented in this paper. Experiments are performed using a Smart Parking App that makes use of Participatory Crowdsensing. After several testings are carried out on different parking locations, the smart parking system is found to be functional in real world scenarios and would be of great help for drivers attempting to find free parking slots. The paper could be extended and used as a reference in other smart parking related projects.

References

[1] R. K. Ganti, F. Ye, and H. Lei, "Mobile crowdsensing: Current

state and future challenges," IEEE Commun. Mag., vol. 49, no. 11, pp. 32–39, Nov. 2011.

[2] V. Coric and M. Gruteser, "Crowdsensing maps of on-street parking spaces," in Proc. IEEE Int. Conf. Distrib. Comput. Sensor Syst., May 2013, pp. 115–122

[3] X. Chen, N. Liu, "Smart Parking by Mobile Crowdsensing", Internation Journal of Smart Home, vol.10, no.2, pp.219-234, 2016.

[4] M. Rinne, S. Törmä, "Mobile crowdsensing of parking space using geofencing and activity recognition", in 10th ITS European Congress, pp. 16-19, Helsinki, Finland, 2014.

[5] K. Banti, M. Louta, "A smart roadside parking application exploiting the mobile crowdsensing paradigm", in 8th International Conference on Information, Intelligence, Systems & Applications (IISA),2017.

[6] S. Nawaz, C. Efstratiou, C. Mascolo, "ParkSense: A smartphone based sensing system for on-street parking," in Proc. of the 19th Annual International Conference on Mobile Computing & Networking, pp. 75–86, Florida, USA, 2013.

[7] B. Guo, Z. Yu, D. Zhang, X. Zhou, "From Participatory Sensing to Mobile Crowd Sensing", in Proc. of the 12th IEEE International Conference on Pervasive Computing and Communications Workshops (PERCOM Workshop), pp. 593 - 598, Budapest, Hungary, 2014.

[8] Y. Zheng, S. Rajasegarar, and C. Leckie, "Parking availability prediction for sensor-enabled car parks in smart cities," in Intelligent Sensors, Sensor Networks and Information Processing (ISSNIP), 2015 IEEE Tenth International Conference on, April 2015.

[9] G. Cardone, A. Cirri, A. Corradi, L. Foschini, R. Ianniello, and R. Montanari,
"Crowdsensing in urban areas for city-scale mass gathering management:Geofencing and activity recognition," IEEE Sensors Journal,
vol. 14, no. 12, pp. 4185–4195, Dec 2014.

[10] Tingxin Yan, "CrowdPark:A Crowdsourcing-based Parking Reservation System for Mobile Phones." UMASS Technical Report., Tech. Rep. UM-CS-2011-001, (2011).

[11] S.S. Kanhere, "Participatory Sensing: Crowdsourcing Data from Mobile Smartphones in Urban Spaces," in Mobile Data Management (MDM), (2011).

[12] Rongxing Lu, "SPARK: A New VANET-Based Smart Parking Scheme for Large Parking Lots," in INFOCOM 2009, IEEE, (2009) , pp. 1413-1421.

[13] A. Bagula, L. Castelli, and M. Zennaro, "On the design of smart parking networks in the smart cities: An optimal sensor placement model," Sensors, vol. 15, no. 7, pp. 15443–15467, 2015.

[14] E. Moguel, M. Preciado, and J. Preciado, "Smart parking campus: An example of integrating different parking sensing solutions into a single scalable system," ERCIM News Smart Cities, no. 98, pp. 29–30, 2014.

[15] X. Sevillano, E. Màrmol, and V. Fernandez-Arguedas, "Towards smart traffic management systems: Vacant on-street parking spot detection based on video analytics," in Proc. Int. Conf. Inf. Fusion, 2014, pp. 1–8.

[16] E. Polycarpou, L. Lambrinos, and E. Protopapadakis, "Smart parking solutions for urban areas," in Proc. IEEE Int. Symp. Workshops World Wireless, Mobile Multimedia Netw., Jun. 2013, pp. 1–6.

[17] U. Männi, "Smart sensing and time of arrival based location detection in parking management services," in Proc. Baltic Electron. Conf., 2010, pp. 213–214.

[18] Z. Zhang, X. Li, H. Yuan, and F. Yu, "A street parking system using wireless sensor networks," Int. J. Distrib. Sensor Netw., vol. 9, pp. 1–10, Jun. 2013.

[19] F. J. Villanueva, D. Villa, M. J. Santofimia, J. Barba, and J. C. López, "Crowdsensing smart city parking monitoring," in Proc. IEEE World Forum Internet Things, Dec. 2015, pp. 751–756.

[20] S. Gupte and M. Younis, "Participatory-sensing-enabled efficient parking management in modern cities," in Proc. IEEE Conf. Local Comput. Netw., Oct. 2015, pp. 241–244.

[21] X. Chen, E. Santos-Neto, and M. Ripeanu, "Crowdsourcing for onstreet smart parking," in Proc. ACM Int. Symp. Design Anal. Intell. Veh. Netw. Appl., 2012, pp. 1–8.

[22] J. Kopecký and J. Domingue, "ParkJamJAM: Crowdsourcing parking
availability information with linked data (DEMO)," in Proc. Extended Semantic Web Conf., 2012, pp. 381–386.

[23] S.S. Kanhere, "Participatory Sensing: Crowdsourcing Data from Mobile Smartphones in Urban Spaces," in Mobile Data Management (MDM), (2011).

[24] S. Mathur et al., "ParkNet: Drive-by sensing of road-side parking statistics," in Proc. Int. Conf. Mobile Syst., Appl., Services, 2010, pp. 123–136.

[25] S. Mathur, S. Kaul, M. Gruteser, and W. Trappe, "ParkNet: A mobile sensor network for harvesting real time vehicular parking information," in Proc. MobiHoc S3 Wksp, 2009, pp. 25–28.

[26] S. Ma, O. Wolfson, and B. Xu, "UPDetector: Sensing parking/ unparking activities using smartphones," in Proc. ACM Int. Workshop Comput. Transp. Sci., 2014, pp. 76–85.

[27] L. Stenneth, O. Wolfson, B. Xu, and P. Yu, "PhonePark: Street parking
using mobile phones," in Proc. IEEE Int. Conf. Mobile Data Manage., Jul. 2012, pp. 278–279.

[28] Z. Suryady, G. Sinniah, S. Haseeb, M. Siddique, and M. Ezani, "Rapid
development of smart parking system with cloud-based platforms," in Proc. Int. Conf. Inf. Comun. Technol. Muslim World, 2014, pp. 1–6.

[29] J. Villalobos, B. Kifle, D. Riley, JUQ Torrero, "Crowdsourcing Automobile Parking Availability Sensing Using Mobile Phones", in UWM Undergraduate Research Symposium, pp.1-7, University of Wisconsin-Milwaukee, USA, 2015.

[30] Kopeck, J., Domingue, J.: ParkJam : crowdsourcing parking availability information with linked data (Demo). 9th Extended Semantic Web Conference (ESWC 2012). p. 5 ,Heraklion, Crete, Greece (2012).

[31] Bechini, Alessio, Francesco Marcelloni, and Armando Segatori. "A mobile application leveraging QR-codes to support efficient urban parking." Sustainable Internet and ICT for Sustainability (SustainIT), 2013. IEEE, 2013.