

IoT based Smart Parking System

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Abstract - Advancement in industrialization leaves the parking management system out-dated. Traffic congestion at parking lots have become very often and people cannot even find a place to park their vehicles where first come first serve method is used. Traditional parking lots can be converted to smart ones by introducing Internet of Things (IoT) which in turn resolves the current parking issues. Problems such as, traffic congestion, limited car parking facilities and road safety can also be resolved by IoT. In this paper, the proposed Smart Parking system primarily consists of IoT module that is used to signalize the state of availability of each single parking space, the NFC technology is used to differentiate between registered and unregistered vehicles as they have separate parking areas, and a Mobile Application that provides the end users to view if the slots are occupied or empty. One of the main challenges in a college environment is students rushing to college just before the college begins. This causes a lot of congestion. Students end up parking in areas not reserved for parking or in such a way that it becomes difficult for others to remove their vehicles. Thus there is need for implementing a smart parking system in college environment which regulates all these issues using the above mentioned technologies.

Keywords— Internet of Things, IoT, Smart Parking System, NFC.

I. INTRODUCTION

The concept of Internet of Things (IoT) started with things with identity communication devices. The devices could be tracked, controlled or monitored using remote computers connected through Internet. IoT extends the use of Internet providing the communication, and thus inter-network of the devices and physical objects, or ‘Things’. The two prominent words in IoT are “internet” and “things”. Internet means a vast global network of connected servers, computers, tablets and mobiles using the internationally used protocols and connecting systems. Internet enables sending, receiving, or communicating of information. Dictionary meaning of ‘Thing’ is a term used to reference to a physical object, an action or idea, situation or activity, in case when we do not wish to be precise. IoT, in general consists of inter-network of the devices and physical objects, number of objects can gather the data at remote locations and communicate to units managing, acquiring, organizing and analyzing the data in the processes and services.

Physical Object + Controller, Sensor and Actuators + Internet = Internet of Things

The idea of creating a Smart City is now becoming possible with the emergence of the Internet of Things. One of the key issues that smart cities relate to are car parking facilities and traffic management. In present day cities finding an available parking spot is always difficult for drivers. There are many situations where a person needs to

reach a place immediately, park and rush. The difficulty he encounters at these places is finding the availability of parking space. This situation calls for the need for an automated parking system that not only regulates parking in a given area but also keeps the manual intervention to a minimum and saves time as well. The proposed system resolves problems pertaining to parking and traffic congestion in college environment by informing the users in advance about the availability of parking slot to park his/her vehicle. This proposed system being deployed in a college environment consists of three primary modules, the IoT module, Mobile application and NFC technology.

The IoT module consists of sensors that checks whether the parking slots are empty or not. The sensors used are ultrasonic sensors that measures distance by using ultrasonic waves. The collected data from sensors is transferred via internet to be stored on to database. For internet we use WeMos D1 which is an ESP8266 Wi-Fi based board that uses Arduino layout. The ultrasonic sensors used in this module sends the ultrasonic pulses at regular intervals. The time taken for the reflection of these pulses is used to detect the presence of an object. When a vehicle is parked, the time required for the reflection reduces which indicated the presence of the vehicle. This information is collected by the micro-controller which changes the slot availability from empty to occupied. The same is updated in the database. This change is shown in the mobile application by changing the colour of the slot from green to red.

The Mobile Application acts as an interface between user and the database. This application can be used by any user who has installed it to their mobiles to view if the slots are occupied or empty.

The NFC technology is used to differentiate between registered and unregistered vehicles as there are separate parking areas for the two. The admin writes the details of the user to the NFC card using a mobile phone which is enabled with NFC or a NFC writer during the registration process. The same mobile phone can be used for reading the card or a NFC reader can be used. The data from the card will be used to obtain all the details of the user and also to determine if he is already registered or not. In case of a registered user, he will be redirected to a specific slot in the registered parking area else he will have to park his vehicle in the general parking area. Each card will have a validity period beyond which the registered user will be marked as unregistered.

The main objective of this application is to address the parking issues in college. The haphazard parking and unavailability of parking lots is of great concern. The suggestion of a parking lot at the entrance eases the user from searching for one. Thus this system saves time and organizes the parking system.

II. RELATED WORK

- A. **IoT based cloud integrated smart parking system** - A mobile application is used that allows an end user to check the availability of parking space and book a parking slot accordingly. It also talks about the factors responsible for Cloud-IoT integration. Cloud is used because it can deal with real world entities in a more distributed and dynamic fashion by the use of IoT.
- B. **Smart parking solutions for urban areas** – This paper describes the technologies around parking availability monitoring, parking reservation and dynamic pricing. To assess the need for smarter parking systems, a driver survey is done like time spent searching for a vacant parking spot, Driver actions when preferred parking lot is full, Interested in reserving a parking space for a fee.
- C. **SPARK** – This Paper discusses about design and implementation of a prototype Smart parking system using wireless sensor network which provides advanced features like remote parking monitoring, automated guidance, and parking reservation

mechanism.

- D. **Parking system solution** - the proposed system collects the raw data locally and extracts features by applying data filtering and fusion techniques to reduce the transmitted data over the network. After that, the transformed data is sent to the cloud for processing and evaluating by using machine learning algorithms.
- E. **Prediction of parking availability in large areas** - The proposed system is suitable large parking area and able to send a message to vehicles about the status of parking spaces, android GPS is used and other popular wireless technologies Web services.

III. SYSTEM DESIGN

This section describes the high level architecture for the smart parking system. The parking system that we propose comprises of various actors that work in sync with one another. The system design mentioned below can be divided into five modules(where three are the primary modules):

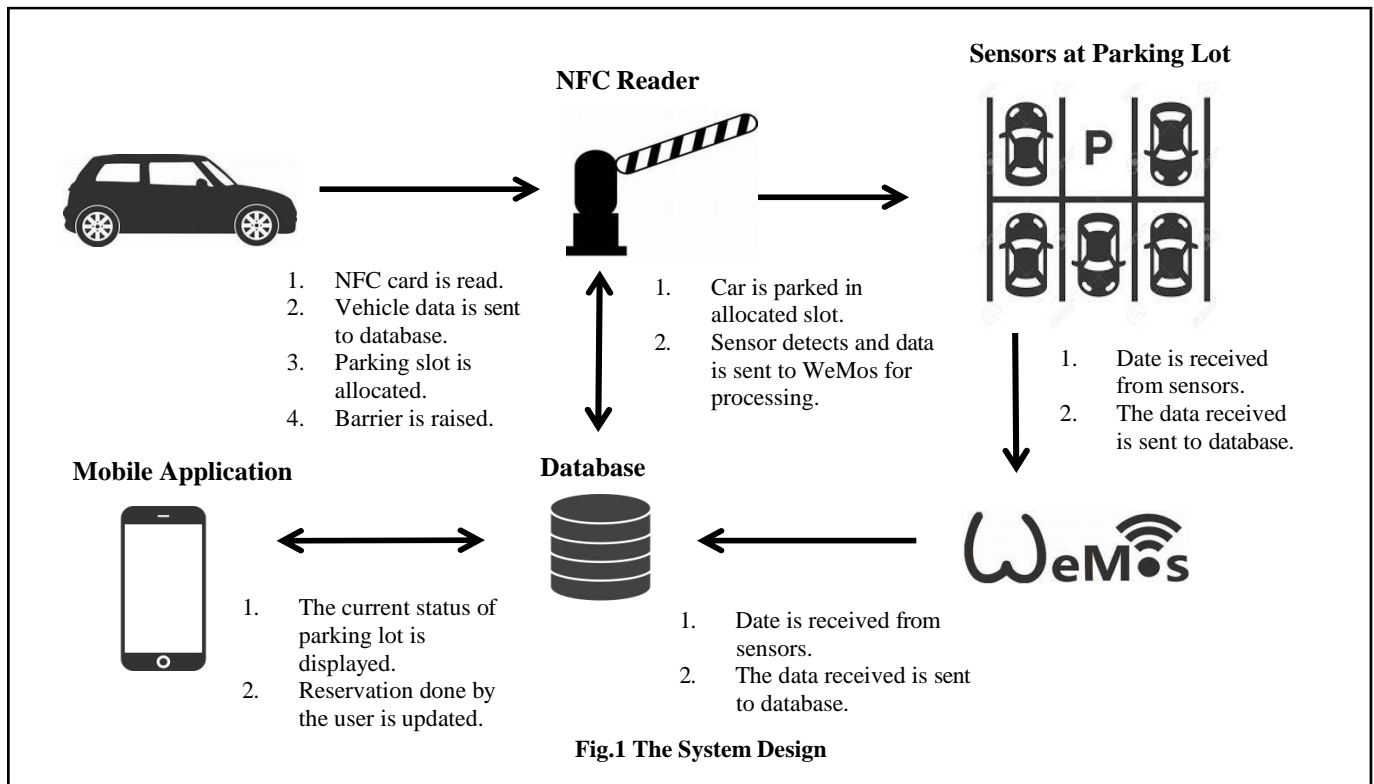
Module 1: NFC Reader/Writer

NFC card will be issued to each user. The NFC reader/writer used here is a Mobile which has NFC technology. While issuing the card, user details with their respective department names will be written on to the card using the NFC enabled mobile. A validity period of 6 months will be given. When the user wants to park, his NFC card will be read using a NFC enabled mobile. If the user satisfies all the required criteria he will be allowed to park.

Module 2: Ultra-sonic Sensor

The sensor module will be placed in each parking slot. LEDs will be placed in each parking slot to identify current status of parking slots. If the LED is red it means the slot is occupied and if it is green then slot is free. The model which we are using in this project has following features:

Model: HC-SR04 Working
Voltage: 5V DC
Range: 2cm-500cm
Resolution: 0.3cm
Frequency: 40KHz



Echo returns the signal which has to be read by GPIO input pin. When a car parks in the parking lot, ultrasonic sensor senses the data and sends it to WeMos D1 R1 telling that the parking lot is occupied. It measures distance by using ultrasonic waves. The sensor head emits an ultra-sonic wave and receives the wave reflected back from the target. It measures the distance to the target by measuring the time between emission and reception. So here in this application, it is used to determine whether a parking slot is vacant or not. The sensed data will be sent to WeMos D1 R1 and the same will be reflected in the database.

Module 3: WeMos D1 R1

The WeMos D1 is a ESP8266 WiFi based board that uses the Arduino layout with a operating voltage of 3.3V. The specification of the board:

Microcontroller: ESP-8266EX Operating
Voltage: 3V
Digital I/O
Pins: 11
Analog Input
Pins: 1
Clock Speed:
80MHz/160MHz
Flash: 4M bytes
Length:
68.6mm

Width:
53.4mm
Weight:
25g

The board is controlled by the ESP8266 chip (a 32-Bit processor) and has a larger flash memory comparatively . The Arduino IDE can be used to program the ESP8266.

Module 4: Database

The database used in this proposed system is to store all the information about the parking system and the users using it. As all the users will be issued with a NFC card, all the user details will be stored in it and a copy of that will be stored in the database with validity period of each card. Information like time of arrival, departure and slot number in which the user has parked will be maintained in this.

The data collected by the sensors at the parking lot will be updated in the database through WeMos D1 R1. It also contains current status of each parking slot. This status will be retrieved by the mobile application for the purpose of slot reservation.

Module 5: Mobile application

The mobile application is used as an interface between user and database. It is exclusively used for reservation of slots. This application shows how many slots are available

for reservation which will be shown in yellow color. The user can reserve a slot by giving their details and approximate parking time. If the allotted time is exceeded the user will be notified with a message.

IV. IMPLEMENTATION & WORKING

In the previous section we discussed about the system design related to the smart parking system. In this section we talk about the implementation and working of the system. Below are the steps that a driver needs to follow in order to park its car using our parking system:

- Step 1: Car arrives at parking lot.
- Step 2: User places NFC card on card reader. If he is a

registered user then he will be directed to available parking slot.

Step 3: When the car parks in the slot, ultrasonic sensor will detect the presence of the car and sends the data to database. Same will be updated in the UI. This updation happens with the help of WeMos device which is an ESP8266 Wi-Fi based board.

Step 4: If he is not a registered user, he will be directed to general parking slot.

Step 5: When the car leaves the parking slot, the current status will be updated to database and UI.

The complete process of parking a car in that slot and leaving the parking area is explained with the help of the following transition diagram:

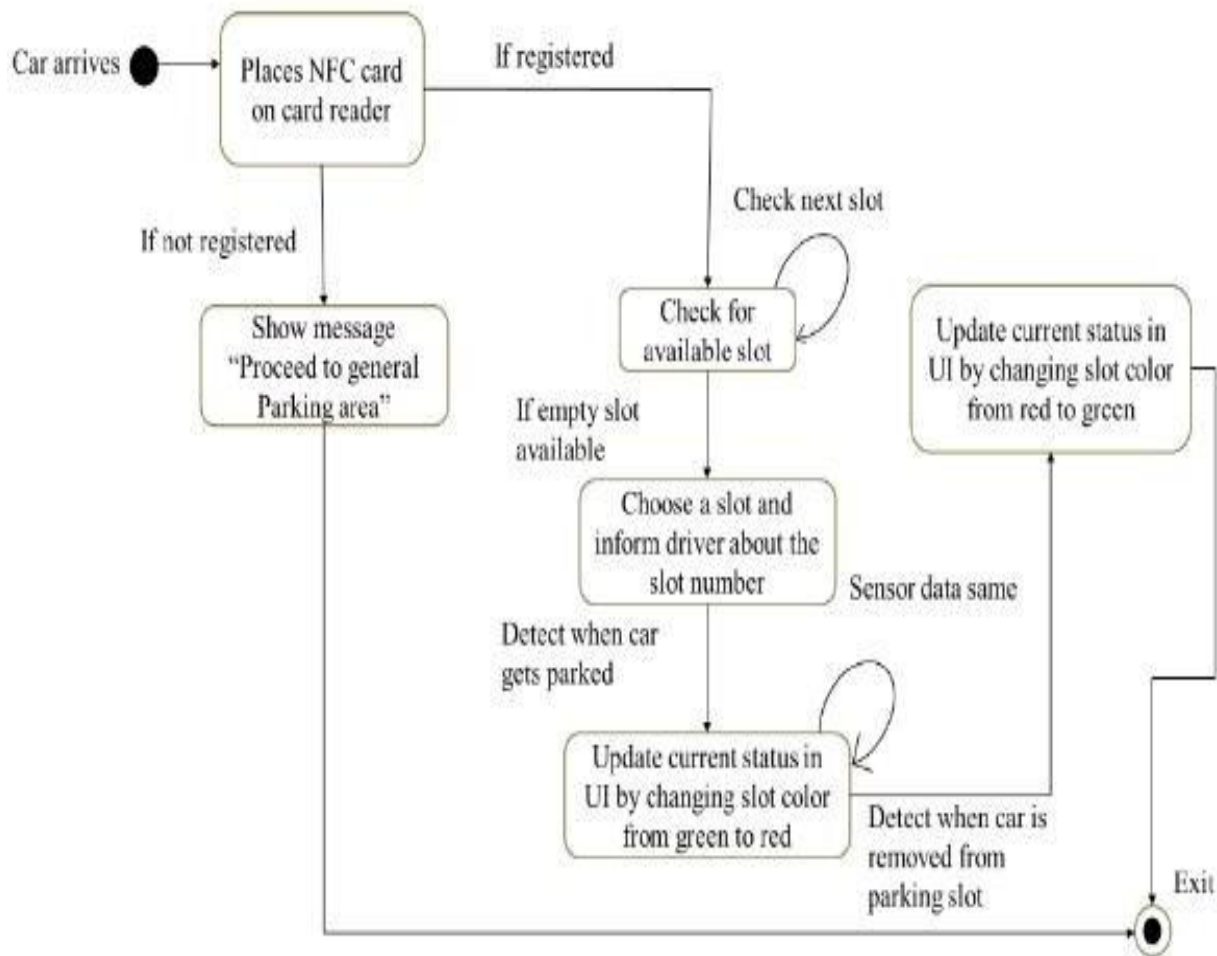


Fig.2 Transition diagram of the system

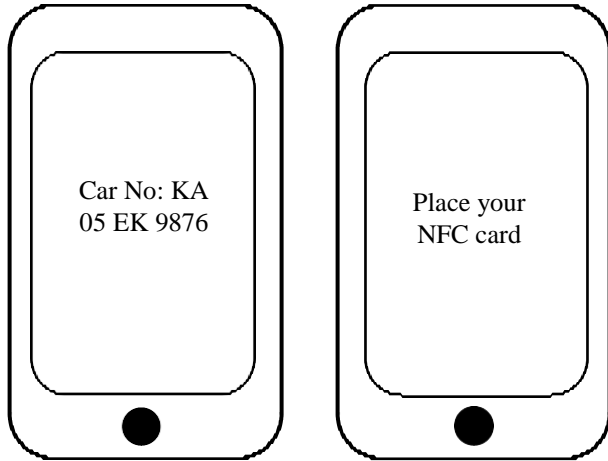


Fig.3 NFC Reader

Before issuing the card to user, car number and date of registration will be written on to the card during the registration process.

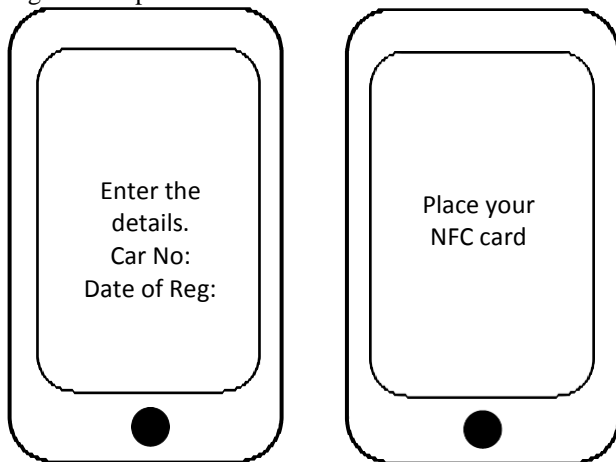


Fig.4 NFC Writer

V. CONCLUSION

Drivers in today's modern society begin to demand more intelligent services and smart parking is inevitably becoming an inherent service in urban areas. The smart parking features presented in this paper are gradually finding their way in advanced systems resulting in improved user services and increased revenues. Monitoring parking availability in real time, enables operators to gain a competitive advantage. Users utilize these services via mobile applications which enable them to access location-based information in real time and request system services. Concluding, we believe that smart parking infrastructures should be interoperable in order to scale and cover larger geographical areas. Well defined and integrated services will result in common gateways for multiple service providers within urban areas, simplifying the lives of today's citizens.

REFERENCES

- [1] Abhirup Khanna & Rishi Anand (2016, January). IoT based Smart Parking System, 2016 International Conference on Internet of Things and Applications (IOTA)(pp. 266-270). IEEE.
- [2] Rico, J., Sancho, J., Cendon, B., & Camus, M. (2013, March). Parking easier by using context information of a smart city: Enabling fast search and management of parking resources. In Advanced Information Networking and Applications Workshops (WAINA), 2013 27th International Conference on (pp. 1380-1385). IEEE.
- [3] Zheng, Y., Rajasegarar, S., & Leckie, C. (2015, April). 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 (pp. 1-6) IEEE.
- [4] FastPark System website, <http://www.fastprk.com>.
- [5] Ji, Z., Ganchev, I., O'droma, M., & Zhang, X. (2014, August). A cloud-based intelligent car parking services for smart cities. In General Assembly and Scientific Symposium (URSI GASS), 2014 XXXIth URSI (pp. 1-4). IEEE.
- [6] Dash, S. K., Mohapatra, S., & Pattnaik, P. K. (2010). A survey on applications of wireless sensor network using cloud computing. International Journal of Computer science & Engineering Technologies (E-ISSN: 2044-6004), 1(4), 50-55.
- [7] Sarkar, C., Uttama Nambi SN, A., Prasad, R., Rahim, A., Neisse, R., & Baldini, G. (2012). DIAT: A Scalable Distributed Architecture for IoT.
- [8] L. Wenghong, X. Fanghua, and L. Fasheng, "Design of inner intelligent car parking system," in International Conference on Information Management, Innovation Management and Industrial Engineering, 2008.
- [9] I. Samaras, N. Evangeliou, A. Arvanitopoulos, J. Gialelis, S. Koubias, and A. Tzes, "Kathodigos-a novel smart parking system based on wireless sensor network," in Intelligent Transportation Systems, vol. 1, 2013, pp. 140-145.
- [10] H. Wang and W. He, "A reservation-based smart parking system," in Computer Communications Workshops (INFOCOM WKSHPS), 2011 IEEE Conference on. IEEE, 2011, pp. 690-695.
- [11] J.-H. Moon and T. K. Ha, "A car parking monitoring system using wireless sensor networks," International Journal of Electrical, Robotics, Electronics and Communications Engineering, vol. 7, no. 10, pp. 830-833, 2013.
- [12] Sangwon Lee, Dukhee Yoon and Amitabha Ghosh, Intelligent Parking Lot Application Using Wireless Sensor Networks, Proceedings of IEEE conference, 978-1-4244-2249-4/08
- [13] K. Mouskos, M. Boile, and N. A. Parker, "Technical solutions to overcrowded park and ride facilities," New Jersey Department of Transportation, Tech. Rep., 2007.
- [14] L. Baroffio, L. Bondi, M. Cesana, A. E. Redondi, and M. Tagliasacchi, "A visual sensor network for parking lot occupancy detection in smart cities," in Internet of Things (WF-IoT), 2015 IEEE 2nd World Forum on. IEEE, 2015, pp. 745-750.
- [15] M. Suresh, P. S. Kumar, and T. Sundararajan, "Iot based airport parking system," in Innovations in Information, Embedded and Communication Systems (ICIECS), 2015 International Conference on. IEEE, 2015, pp. 1-5.