

Frameworks for Parking Systems: A Survey

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Abstract—Integration and possibilities of application of cloud based web applications in real scenarios with different embedded Internet of Things (IoT) devices are growing rapidly. The opportunities for creating more direct integration of the physical world into computer-based systems are enabled by the use of IoT, which allows objects to be sensed or controlled remotely across existing network infrastructure and resulting in improved efficiency, accuracy and economic benefit in addition to reduced human intervention. These featured technologies are used to realize a novel framework for parking system. Such a few frameworks which are developed in recent times are portrayed in this paper along with our future research work.

Index Terms—IoT-Internet of things, Smart parking system (SPS), Sensors

I. INTRODUCTION

India is having a new problem nowadays – insufficient parking space. With families getting smaller and the total number of vehicles exceeding [1] the number of heads in the family, the parking situation is falling short of the current requirements in the country. The situation is such that on any working day 40% of the roads in urban India are taken up just for parking. Therefore researchers have turned on to applying technologies for managing of parking area by designing and implementation of an novel prototype system for smart parking that allows vehicle drivers to effectively find the parking places with ease.

In the future the demand for intelligent or smart parking service are to increase because of the rapid growth in the automotive industries integrating with smart devices. An ideal solution to this service can be provided by many new different technologies. Combining of applications of Cloud and IoT there emerges a wide scope for development in parking system. Researches have been developing and implementing frameworks to minimize the parking issues all over the world.

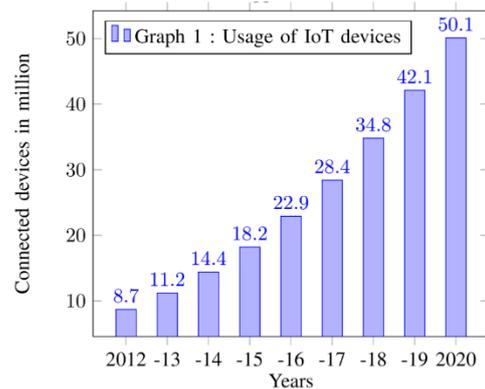
A. Applications of Cloud and IoT in Smart parking frameworks

The IoT can guide in integration of communications, control, and information processing across various transportation systems. Application of the IoT extends to all aspects of transportation systems (i.e. the vehicle, the infrastructure, and the driver or user). Interaction

between these modules of a transport system facilitates:

- Smart traffic control
- Inter and intra vehicular communication
- Smart parking
- Electronic toll payment systems
- Logistic and fleet management
- Vehicle control, and
- Safety and road assistance

Internetworking of Cloud along with IoT enables us to remotely monitor the services that are provided by the IoT devices. Research on Internet of Things with the vehicular data clouds is still in its infancy and hence there are lot of opportunities for future work.



The Graph 1 shows the estimation of number of IoT connected devices through cloud over several years. Which shows that the use of IoT devices for various requirements are rapidly increasing.

Recent research [2]-[6] deals with integration of Cloud and IoT. Which shows that use of Cloud and IoT bring out the creation of novel smart parking system with increases flexibility, availability and less human interface.

In this paper, we outline the idea of smart parking system, their categories and different frameworks for smart parking are described.

II. PARKING SYSTEM

Over the years, parking systems and the related technologies have increased and diversified. Parking systems have been around almost since the time automobiles were invented. There are parking systems, in any area where there is a significant amount of traffic. Parking systems were started to develop in the early 20th century in response to the

need for garage for vehicles. There are primarily two types of parking systems:

- Traditional parking system
- Automated parking system

On a basis of long term, automated parking systems are more cost effective when compared to the traditional parking.

A. Smart parking system

In large cities with heavy traffic, looking for parking slots is not only a waste of time and energy; the worst, it also causes more traffic. People waste away litters of fuel just for searching and trying to park, on an average 30% of drivers is looking for an available parking spot [7].

Intelligent parking system is a parking system that exploits various technologies to manage the parking of vehicles [8].

Intelligent parking is a way to help drivers find parking places resourcefully through information and communications technology, mainly for on-street parking. Smart parking can also be defined as an automated parking system that assists drivers to locate an available vacant spot using sensors that detect the presence or absence of a vehicle, and finally navigate drivers to available parking locations.

1. Categories of smart parking system

Some of the systems that can be categorized as Smart parking system are:

- Transit based information system
- Smart payment system
- Parking guidance and information system (PGIS)
- Automated parking garage

Every System uses different methodology to detect the presence of car in the slot. The automobile sensors and detector system are divided into two main categories non-intrusive and intrusive sensors [9].

Intrusive sensors:

They are the sensors which are fixed in holes on the skim of roads, by channelling under the road which results protruding procedures of installation.

Some of the intrusive sensors are as follows:

Infrared sensors, Magnetometers, Magneto resistive sensors.

Non-intrusive sensors:

It can be easily fixed and managed.

They do not affect the exterior plane in the process. Non-intrusive sensors comprise of microwave radar, passive acoustic sensors, passive infrared sensor, radio-frequency identification (RFID), ultrasonic sensors and video image capturing.

III. EXISTING PARKING FRAMEWORKS

Many systems and technologies are developed for parking by enforcing various approaches to overcome the difficulties faced at the time of parking [10].

The authors in [11] presents a methodology that could be used to manage automobiles in a parking garage by indicating drivers about the number of untaken parking slots and in which slot should they be directed and parked. The stats obtained from all sensors is processed in two way, either in distributed or centralized process. The scheme is mostly based on the modification of the original wireless sensor network (WSN), use of ZigBee and RFID technology. Other meaningful metrics such as time, availability etc.. are also validated.

The authors in [12] demonstrate design and implementation of a SPS based on WSNs, Embedded Central Web-Server, and Mobile phone. Detection of the state of parking slot using mobile devices and allow users to find the free parking places are the implementations of this paper. Each parking slot has its own sensors which helps in identifying the state of the parking slot and update to central web-server with the help of Wi-Fi. Another implementation prototype model for smart parking is based on processing of image [13] in which the image of parking lot captured and processed by the system. It produces the data of the availability car parking spot.

Paper [14] the authors intent to design an SPS with a guidance system. ARM8 microcontroller has been used along with an image processing model. ARM8 can be used to run an embedded system. Webcam is used to find the vacant parking slots. The captured slots data and time is displayed on device like LCD. A red color box is displayed if any car is present in the slot. Empty slot number is displayed on the device if no vehicle is not parked. People can book the parking area, subscribe for slot all this process are confirmed through SMS. Controller collects the slot number information through (Global system for mobile communication) GSM. After gathering the data the controller keeps the slot as occupied.

People driving in big cities waste time searching for the available parking spaces which increases the traffic and pollution. The authors in [15] have proposed a SPS based on GSM technology to resolve this problem. Their systems are divided into two modules

-Slot management and

-Reservation

With security module. In their work they use passwords to get in and out of the parking place. The physical components used in this system are Pic Microcontroller, LCD to inform the driver if the password is wrong, motor to control the password protected automated gate, GSM tech for interfacing between the driver and smart device.

[16] Presented a solution using wireless technology for secure SPS and reservation model with Bluetooth. The main disadvantage was communication is limited to short distances. Proposed model excludes driver's intervention and

use a physical technique that transports vehicles in and out of the car parks. When vehicles enters to the park bay, the vehicle is moved on a mobile platform, Bluetooth is accessed, its sensor fetches the users Bluetooth unique id and updates to database. The whole system is managed using ARM microcontroller. Another paper using wireless technologies for managing SPS is in [17]. Here authors have developed a system which has two modules: Managing modules and Master module for helping the drivers in easy parking. They use digital infrared sensors embedded with the microcontroller for sensing parking availability. The status information is received by ZigBee and managing of vacant places in parking is managed by master module.

The combination of RFID and networking sensor technologies has been used in an auto car parking management system. In [18] car parking framework (CFP) is proposed which is scalable and has low cost. The CFP has 3 modules: parking area, gate and slot manager. Driver guidance, auto payment, parking slot retrieval, security and detection of vandalism are some of their proposed implementations. Cost and energy consumption is more as they don't use mote in every spot instead used a hybrid communication tech.

Locating parking spots remotely via smartphone is proposed by authors in [19]. Automation of locating car parks and payment is proposed. Sensor nodes collect and transmits the availability info of location to servers. The details are updated to backend. Parking spot and location of most nearby site is sent to user.

Authors in [20] propose an agent based network coordination between drivers and parking area. The MaSE methodology is used to design and develop the prototype system. To bargain on parking prices and to calculate the shortest path for users, a negotiation algorithms are employed.

In other study [2] the authors suggest a SPS using IoT, enabling the drivers to view available slot in that area and to navigate to the nearest parking area. Their software and hardware components used to develop the architecture are: centralized server, image capture, Raspberry PI, and other smart devices. Status of parking slots are managed by centralized servers along with cloud services. Drivers can map the car parks, subscribe to parking slot remotely with the help of a web browser.

The authors introduced a SPS using cloud-based platforms as a service (Paas) in [3]. They promote the services essential to develop SPS. The use of Paas has led in creation of faster SPS with lots of advantages.

In [4] a prototype for IOT based parking management system for urban areas is propose using RFID and IOT. Parking area and it availability are sensed using IOT devices. The IOT also manages the database through a shared server. They different

facilities like online booking, auto entrance and exit system. Less human interaction, increased availability, flexibility and security are some of the advantages.

[5]The authors present an intelligent parking system using vehicular data cloud services. The main modules used are: Intelligent Parking Cloud Service, Communication from virtual ad-hoc networks (VNET) to cloud, Vehicular Data Mining Cloud Service. Here the use a concept of VNET to communicate to the cloud.

[6]The author presents a time-efficient vehicle parking services based on cloud services. A complete framework that resolves the urban cities vehicle parking problem has been proposed. End users can easily find nearby parking lots along with the available parking spaces with the aid of navigational directions. The system consists integration of smart phone, cloud services, sensing and communication technologies.

IV. FUTURE WORK

In the future work we will propose a novel framework for parking architecture. Our system will be based on cloud and IoT technologies. Figure 1 shows the basic architecture containing mainly 3 key entities

A. The web application domain

It provides a good graphical user interface (GUI) through which user (driver) registers himself, searches and selects the parking places available nearby and confirms the parking place for a required interval of time. It is also provides a secure connection and stores data on cloud storage system where in the storage servers are accessed virtually. The user interacts with the web application domain through the GUI provided with the help of IoT devices such as Personal computer, tablet or mobile phones via Internet.

B. IoT devices

Here we are using RFID sensors for the basic operation for detecting the occupancy and we use another RFID for automatic opening of gate while entering the parking place. Here we assume RFID tag is embedded to vehicle.

C. End Users

They use the GUI to register into the services through internet to the web application which is hosted on the cloud.

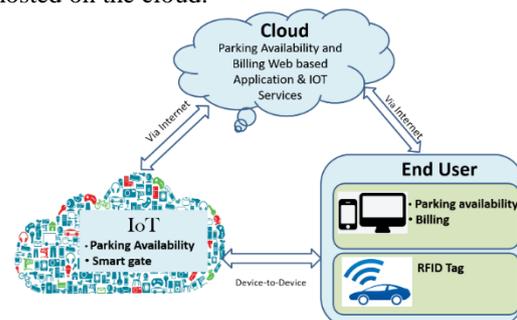


Fig. 1. Basic architecture

D. *The basic use cases are as follows*

1. FRONT END:

- User registers on to web application with unique RFID tag along with other basic details like contact, address
- The user searches for place to park by in the web application. The web application gives a dropdown menu of available places.
- The user selects the place available for parking and subscribes for a specific slot. The slot availability is indicated using colors in a map of parking layout.

2. IOT DEVICE:

- When the car enters at building the RFID sensor senses the RFID tag in the car and automatically opens the gate. The check in log details will be sent to cloud.
- As the car is parked onto the specific slot the proximity sensors detect the car and send the occupied and vacancy data to cloud where the web app changes the color of slot depending on the data.

3. CLOUD:

- As the user checks in a message is sent to user registered contact which will have the details of parking slot like, floor number and slot number.
- As the check-out is done the web application computes the overall cost for parking and generates an invoice and sends email to user registered email or contact.

Integration of different technologies are considered in order to achieve a system which is the most efficient, reliable, secure and inexpensive.

V. CONCLUSION

The concept of the smart parking system, their types, classification of different technologies and a survey of different parking systems which was implemented by many researches to resolve the growing problem of traffic congestion, wasted time, wasting money with the help of cloud and IoT technologies are described. As a future work a novel frame work for parking system will be proposed.

REFERENCES

[1] A. UDDIN, "TRAFFIC CONGESTION IN INDIAN CITIES: CHALLENGES OF A RISING POWER," KYOTO OF THE CITIES, NAPLES, 2009.

[2] S. BASAVARAJU, "AUTOMATIC SMART PARKING SYSTEM USING INTERNET OF THINGS (IOT)," INTERNATIONAL JOURNAL OF SCIENTIFIC AND RESEARCH PUBLICATIONS, VOL. 5, NO. 12, 2015.

[3] Z. SURYADY, G. R. SINNIH, S. HASEEB, M. T. SIDDIQUE, AND M. F. M. EZANI, "RAPID DEVELOPMENT OF SMART PARKING SYSTEM WITH CLOUD-BASED PLATFORMS," IN INFORMATION AND COMMUNICATION TECHNOLOGY FOR THE MUSLIM WORLD (ICT4M), 2014 THE 5TH INTERNATIONAL CONFERENCE ON. IEEE, 2014, PP. 1-6.

[4] B. M. K. GANDHI AND M. K. RAO, "A PROTOTYPE FOR IOT BASED CAR PARKING MANAGEMENT SYSTEM FOR SMART CITIES," INDIAN JOURNAL OF SCIENCE AND TECHNOLOGY, VOL. 9, NO. 17, 2016.

[5] M. HEMALATHA ET AL., "INTELLIGENT PARKING SYSTEM USING VEHICULAR DATA CLOUD SERVICES," IN INNOVATIONS IN INFORMATION, EMBEDDED AND COMMUNICATION SYSTEMS

(ICIECS), 2015 INTERNATIONAL CONFERENCE ON. IEEE, 2015, PP. 1-5.

[6] P. R. ADKI AND J. AGARKHED, "CLOUD ASSISTED TIME-EFFICIENT VEHICLE PARKING SERVICES," IN INVENTIVE COMPUTATION TECHNOLOGIES (ICICT), INTERNATIONAL CONFERENCE ON, VOL. 1. IEEE, 2016, PP. 1-7.

[7] G. MARSDEN, "THE EVIDENCE BASE FOR PARKING POLICIES A REVIEW," TRANSPORT POLICY, VOL. 13, NO. 6, PP. 447-457, 2006.

[8] J. CHINRUNGRUENG, U. SUNANTACHAIKUL, AND S. TRIAMLUMLE RD, "SMART PARKING: AN APPLICATION OF OPTICAL WIRELESS SENSOR NETWORK," IN APPLICATIONS AND THE INTERNET WORKSHOPS, 2007. SAINT WORKSHOPS 2007. INTERNATIONAL SYMPOSIUM ON. IEEE, 2007, PP. 66-66.

[9] L. E. Y. MIMBELA AND L. A. KLEIN, "SUMMARY OF VEHICLE DETECTION AND SURVEILLANCE TECHNOLOGIES USED IN INTELLIGENT TRANSPORTATION SYSTEMS," 2000.

[10] K. HASSOUNE, W. DACHRY, F. MOUTAOUAKKIL, AND H. MEDROMI, "SMART PARKING SYSTEMS: A SURVEY," IN INTELLIGENT SYSTEMS: THEORIES AND APPLICATIONS (SITA), 2016 11TH INTERNATIONAL CONFERENCE ON. IEEE, 2016, PP. 1-6.

[11] M. PATIL AND V. N. BHONGE, "WIRELESS SENSOR NETWORK AND RFID FOR SMART PARKING SYSTEM," INTERNATIONAL JOURNAL OF EMERGING TECHNOLOGY AND ADVANCED ENGINEERING, VOL. 3, NO. 4, PP. 188-192, 2013. [12] J. YANG, J. PORTILLA, AND T. RIESGO, "SMART PARKING SERVICE BASED ON WIRELESS SENSOR NETWORKS," IN IECON 2012-38TH ANNUAL CONFERENCE ON IEEE INDUSTRIAL ELECTRONICS SOCIETY. IEEE, 2012, PP. 6029-6034.

[13] H. AL-KHARUSI AND I. AL-BAHADLY, "INTELLIGENT PARKING MANAGEMENT SYSTEM BASED ON IMAGE PROCESSING," WORLD JOURNAL OF ENGINEERING AND TECHNOLOGY, VOL. 2014, 2014.

[14] P. DHARMAREDDY, A. R. RAO, AND S. M. AHMED, "AN INTELLIGENT PARKING GUIDANCE AND INFORMATION SYSTEM BY USING IMAGE PROCESSING TECHNIQUE," INTERNATIONAL JOURNAL OF ADVANCED RESEARCH IN COMPUTER AND COMMUNICATION ENGINEERING, VOL. 2, NO. 10, 2013.

[15] Y. RAHAYU AND F. N. MUSTAPA, "A SECURE PARKING RESERVATION SYSTEM USING GSM TECHNOLOGY," INTERNATIONAL JOURNAL OF COMPUTER AND COMMUNICATION ENGINEERING, VOL. 2, NO. 4, P. 518, 2013.

[16] H. SINGH, C. ANAND, V. KUMAR, AND A. SHARMA, "AUTOMATED PARKING SYSTEM WITH BLUETOOTH ACCESS," INTERNATIONAL JOURNAL OF ENGINEERING AND COMPUTER SCIENCE ISSN, PP. 2319-7242.

[17] H. C. YEE AND Y. RAHAYU, "MONITORING PARKING SPACE AVAILABILITY VIA ZIGBEE TECHNOLOGY," INTERNATIONAL JOURNAL OF FUTURE COMPUTER AND COMMUNICATION, VOL. 3, NO. 6, P. 377, 2014.

[18] E. KARBAB, D. DJENOURI, S. BOULKABOUL, AND A. BAGULA, "CAR PARK MANAGEMENT WITH NETWORKED WIRELESS SENSORS AND ACTIVE RFID," IN ELECTRO/INFORMATION TECHNOLOGY (EIT), 2015 IEEE INTERNATIONAL CONFERENCE ON. IEEE, 2015, PP. 373-378.

[19] O. ORRIE, B. SILVA, AND G. HANCKE, "A WIRELESS SMART PARKING SYSTEM," IN INDUSTRIAL ELECTRONICS SOCIETY, IECON 2015-41ST ANNUAL CONFERENCE OF THE IEEE. IEEE, 2015, PP. 004110-004114.

[20] S.-Y. CHOU, S.-W. LIN, AND C.-C. LI, "DYNAMIC PARKING NEGOTIATION AND GUIDANCE USING AN AGENT-BASED PLATFORM," EXPERT SYSTEMS WITH APPLICATIONS, VOL. 35, NO. 3, PP. 805-817, 2008.