“Smart Parking System”

Internet of Things

Course Code: CSE3009

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March, 2018

Abstract

As the human population is increasing day by day, parking of vehicles is a great concern. In order to overcome the above problem, we are building a Smart Parking System design which will utilize the available space in an efficient manner. The main idea of our design is to reduce the time involved in searching of parking lots and avoiding unnecessary jams in the parking lots**[2]**. The increase in the use of vehicles in smart cities has demanded that traditional parking system to be more efficient. We have proposed a smart parking system for commercial cities which can be implemented using different database storage systems like Cloud, MySQL wherein the vehicle is guided to the parking lot using the data, which is sensed by sensors and image detectors.

Introduction

Now-a-days people expect their life to be easy and luxurious**[1]**. The increase in the number of vehicles on the road along with the mismanagement of limited available parking space leads to the parking related problems as well as increased traffic congestion in smart cities. So, it is highly required to develop an automated smart parking management system that would help the driver to find a suitable parking space for their vehicle conveniently. Therefore , it will reduce the fuel consumption as well as air pollution which in turn reduce the carbon in the atmosphere**[5]**. There have been instances that it takes more than 15 minutes to find the parking lot which increases the fuel consumption and air pollution. The main idea of the parking system is to reduce unnecessary frustration drivers experience as they waste priceless minutes circling parking garages looking for the optimal parking spot. To overcome the come problem**[10]** . we are developing a user-friendly and adaptable smart car parking system which can be implemented in smart cities to alleviate parking hassles.

Literature Review 1

In the paper "A novel architecture of Parking management for Smart Cities" **[1],** Tullio Giuffrè, Sabato Marco Siniscalchi, Giovanni Tesoriere Cities talked about the need for 'smart' systems, that improve the urban traffic and increase the mobility of the inhabitants. From a macro- economic cost, the society pays a very high cost for urban mobility and every user needs to adapt to make sure his costs remain low. It was summarized that the major effects that we need it take into account are difficulty in reaching the parking lot, the occupancy rate or the level of use for a particular parking lot, the impact of changes in demand (the times of the day there is maximum use of the parking lot) and the change in the provision of parking areas. In the absence of smart parking systems, the traditional urban ways including things like making sure parking spaces are only given for a few hours, adjusting the number of available stalls, differentiated parking weights and the location of the parking areas. A survey was taken, after which the proportion of the time spent by vehicles in each modal activity was recorded. It was seen that the idle time for these vehicles was directly proportionate to their average speed. The intelligent parking assistant was then introduced, which consisted of a senor that could detect the occupancy of the spot by a vehicle. This sensor could be visible or infra-red light, ultrasound etc. It would also consist of a post/barrier for each parking spot to guarantee that reservation was properly implemented and there was prevention of unauthorized drivers from

entering the parking space. A wireless transceiver allows communication with other IPA modules, and this could a ZigBee device of Wi-Fi network or a wireless LAN network. A unit controller embedded into the rollway could tell the status of the parking lot. Post the implementation of the hardware and software model, estimates of the efficiency parameters under the IPA model were discussed and compared to the traditional methods. Although IPA is still at its preliminary phase, the journal does prove that with future work it may perform better than conventional car parking mechanisms.

Secondly, in the paper "Internet of Things Approach to Cloud-Based Smart Car Parking" **[2]**, Yacine Atif, Jianguo Ding, Manfred A. Jeusfeld talk about using IoT embedded wireless sensor networks to connect physical parking space infrastructures with information and communication technologies where cloud based smart management services are provided. They stress on the concept of data- aware parking systems, that focus not on using sensors but pre-determined calculations on the basis of algorithms, that were developed by keeping a track on the publically available parking spaces and live traffic counts. Structurally, it takes the data from parking devices, and car devices and using IoT middleware, uses Sensing as a Service, which is being extensively applied today. All of the data is saved on the cloud platform, which guarantees scalability and maintenance of big amounts of data. This includes, the business modelling in which the producer and consumer are mutually benefitting, and has real time processing. Under this business model, they let intermediaries buy parking spaces and register them in the cloud space, and then these parking spaces are requested by people wishing to use them. The economy is increasingly using cloud services to design new business models. Using a similar to lift parking spaces from a purely physical business into one that becomes a computational service. The parking owners also profit from these spaces, and it creates an additional economic incentive in society.

In the paper "A Genetic Algorithm Approach to Autonomous Smart Vehicle Parking system" **[3]**, by Diya Thomas, Binsu C. Kovoor stressed on the chaos involved in the manual labour required to help find a parking spot and help with the constantly occurring deadlock positons. They think that one of the main reasons for excessive traffic on the road is the cars that get parked on the sides of the road, due to the inefficiency in parking lot systems where the cars are actually supposed to be parked. The system they propose includes an android application, for the customers to book the parking lot in advance. This customer is given and ID, and can re-use this ID. This booking specifies the amount of time they will spending, and they are alerted and overcharged for exceeding that time limit. All this information is stored in the cloud database. A core part of this system, is an autonomous trolley. This trolley, will take the vehicle to the pre-allotted space in the parking lot; when you leave your vehicle at the entrance. The image of the car, and the location is sent to the customer's phone as a conformation that their car has been successfully parked. Ultrasonic sensors, detect the parking and un-parking of the car in the slot and give updates to the system. An algorithm was then developed, keeping in mind this general working. This was done in terms of utility, using the chromosome structure and crossover, which use the concept of probability. The algorithm hence calculated was able to detect the best parking region. With this algorithm in place, the user can select and pay for their parking slot. An analysis of this service, and the traditional

method was done and we saw that the waiting time decreased significantly. Moreover, the trolley efficiency didn't too much if the number of vehicles increased, and the region utilization did increase significantly. This model is specifically helpful in shopping mall areas.

In the paper "PC vision in computerized stopping frameworks: Design, execution and difficulties" [4], by Markus Heimberger, Jonathan Horgan, Ciarán Hughes, John McDonald, Senthil Yogamani manages the plan part of the stopping frameworks. It says that it's not just the sensors that assistance in productive stopping yet additionally the markings and cameras that assistance with the expansion in effectiveness of stopping. Mechanized driving is a quickly developing region of innovation and some top of the line autos have started to make them stop highlights. This is clearly prompted the change in sensors, yet in addition more precise and hearty frameworks. This paper concentrated on the advantages of camera sensors, and how it empowers stopping utilized cases. They examined the framework usage of a computerized auto stopping framework, and different parts of the same including the inserted framework segments and the vision calculations.

Finally, in the paper "Execution Analysis of Proximity and Light Sensors for Smart Parking" [5] ,by Mamta Bachani, Umair Mujtaba Qureshi, Faisal Karim Shaikh discusses the issues of despicable stopping. When stopping openings are as of now empty, at that point stopping in them effectively and not leaving excessively space takes excessively time physically and as a rule doesn't occur and still, after all that. These issues would we be able to tended to by utilizing a keen auto stopping framework. This paper had a nitty gritty discourse on the LDR sensor, IR sensor and the Magnetic Sensor based on their choice and sending. These reasons were dependant on their cost, their necessity and nearness. Their unwavering quality and exactness likewise came into question. In the result of the relative examination, that the precision of the LDR is exceptionally influenced by the adjustment in radiance for the duration of the day. This builds the multifaceted nature of the code, and consequently makes the vehicle recognition vague on stormy and overcast days. In contrast with this, the IR sensor turns out to be a superior sensor as it has the ability of distinguishing distinctive kinds of vehicles not at all like the LDR sensor. The sole burden of this sensor is that is devours more vitality.

Survey Table 1:

Paper Name	Sensors	Common Protocols	Pro's	Con's	Year
A novel architecture of Parking management for Smart Cities	Ultrasound, infrared light, visible	Wi-Fi, IEEE 802.11	Efficient, Scalable, Accurate	Complete, still in developing phase	2012
A Genetic Algorithm Approach to Autonomous	Ultrasonic	Wi-Fi IEEE802.11,	Good Business Model,	Specific to shopping malls,	2018

Smart Vehicle Parking system		4G, Cloud	efficient utilization	complex	
Internet of Things Approach to Cloud-Based Smart Car Parking	Ultrasound, infrared light, visible	Wi-Fi, IEEE 802.11, Cloud	Good Business Model, efficient utilization	People have to buy space beforehand, Complex	2016
Computer vision in automated parking systems: Design, implementation and challenges	Camera sensors	Wi-Fi, IEEE 802.11	Increases Efficiency	Expensive	2017
Performance Analysis of Proximity and Light Sensors for Smart Parking	LDR, IR, Magnetic Sensors	Wi-Fi, IEEE 802.11	Better utilization or resources	IR consumes too much power	2016

Literature Review 2

Stresses for stopping has turned out to be extremely imperative to help. The issues that we look because of stopping can be utilized as a chance to grow new thoughts [6]. This paper discusses a work to underwrite the private spaces for stopping, additionally to lessen weight on offices, make a wellspring of cash, and present new things in showcase. The mediators, called Parking Service Providers (or PSPs) assume a vital part in commercializing these parking spots utilizing distributed computing [7]. The IoT show expands the extent of savvy stopping applications in shrewd urban areas. With applications to diminish activity based movement in urban areas. this paper exhibits new business arrangements and royal research impacts.

using keen sensors [8] will enable parts to acknowledge in time parking spot to stock control [9]. Enlistment circle, camera and attractive sensors can be introduced for this stopping worldview, \In this every approaching, active auto and the parcel inhabitance can be figured it out. What's more, ultrasonic sensor is utilized to identify if it's a stopped auto or empty spot. this it will give a proficient method for stopping.

In one of the paper the author, actualized a keen stopping framework on a shopping center in Dubai to perceive how he can diminish the clog of the bustling city. in this proposed framework, the parking garage of the shopping center was fitted with remote sensors, which detected the empty or discharge space, and afterward transfers the information to the web server, this information is shared to a versatile application which at that point illuminates the client utilizing an application that utilizations maps to indicate what space is accessible.

This paper centers around finding satisfactory stopping for cargo vehicles [10], trucks and so forth in the city of Oregon. This was finished utilizing a study in light of answers by truck drivers in various circumstances. This study centers geologically around drivers and truck action, to better get data on truck stopping in the examination region. the information is utilized to gather paired outcome(logit)to

discover how the information gathered by these drivers help to enhance the nature of finding the stopping. 11 out of 134 factors were observed to be huge and tells the issue a driver will confront while attempting to discover stopping. The outcomes demonstrated that light cargo bearers, end of the week shipments and old drivers thought that it was less demanding to discover a stopping.

This paper [11] likewise proposes a comparative technique for stopping as we have seen previously however it additionally includes the component of paying additional if hours other than indicated are surpassed. So, it utilizes a remote sensor to, which detected the empty or purge space, and after that transfers the information to the web server sense. Additionally, aside from utilizing this plan it likewise has distinctive rates for various time of stopping and diverse rates for various no of hours.

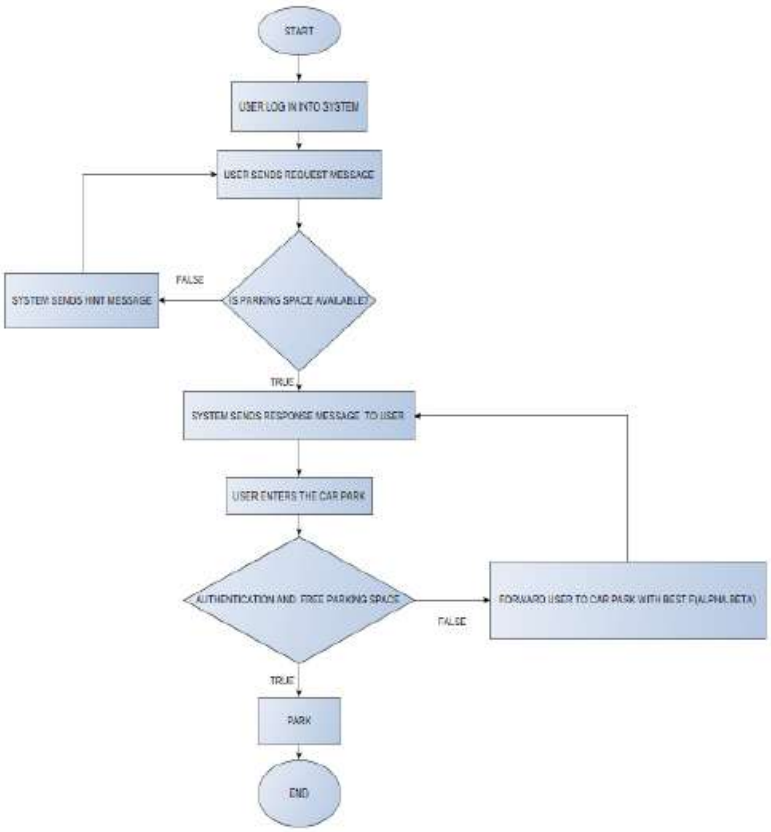
PAPER NAME	SENSORS	COMMON PROTOCOL	PRO'S	CON'S	YEAR
Internet of Things Approach to Cloud-Based Smart Car Parking	-	Wifi, IEEE 802.11, Cloud computing	EFFICIENT AND CHEAP	NEEDS AN INTER CONNECTION	2016
Parking Survey Made Efficient in Intelligent Parking Systems	Induction loop, camera and magnetic sensors, ultrasonic sensor	IEEE802.11, Wifi, 3G/4G	Reliable	Expensive	2015
Parking problems in Abu Dhabi, UAE toward an intelligent parking management system ''ADIP: Abu Dhabi Intelligent Parking"	Arduino, Wireless sensor	IEEE802.11, Wifi, 3G/4G, cloud computing/	efficient and interactive with the maps	expensive	2016
Perceived safe and adequate truck parking: A random parameters binary logit analysis of truck driver opinions in the Pacific Northwest	-	-	Easy to implement, cheap	is purely based on experience, and is volatile in nature	2017
Parking pricing for a sustainable transport system	Wireless sensor; Vehicular Tag; Arduino	Arduino protocols, IEEE802.11, 3G/4G	easy to implement, economical, generates revenue	can be unreasonable if time exceeded is really less	2014

Survey Table 2:

Proposed Methodology

First, the user logs into the system. Once you've logged in, you send a request to the system, and the system tells you if there's parking available. If there's no parking available it, it hints you a message. Otherwise the system responds, if there is space the user is able to enter the parking. Before entering, there is authentication of this user and then he's allowed to enter. If he doesn't have authentication, then the user isn't allowed to enter and the system is reset.

Otherwise, the car parks.



FLOWCHART

Algorithm

1.Initialising the various slots of the ultrasonic sensors for trigger and echo functionalities

2.Defining parameters:

2.1 MIN_DISTANCE=30

2.2 previousMillis=0

2.3 s1 parked time

2.4 s2 parked time

2.5 s3 parked time

2.6 s4 parked time

2.7 SECS = 1

2.8 RATE = 0.1

3.A loop function wherein:

3.1 Ranging(CM) for each slot is specified

3.1.1 if range[(s1,s2,s3,s4)>30], print that the parking slot is free.

3.1.2 mention the parking slot to the user for his use which is free.

3.1.3 else specify to the user that all slots are full.

3.2 If vehicle is parked covering all parameters such that of MIN_DISTANCE AND PARKED TIME

3.2.1 ParkedTime function will time the total time milliseconds and convert into seconds by converting it.

3.2.2 Final amount will to be paid will be stated according to the formula for time and rates of the parking slots and will also specify for how much time was the car parked for.

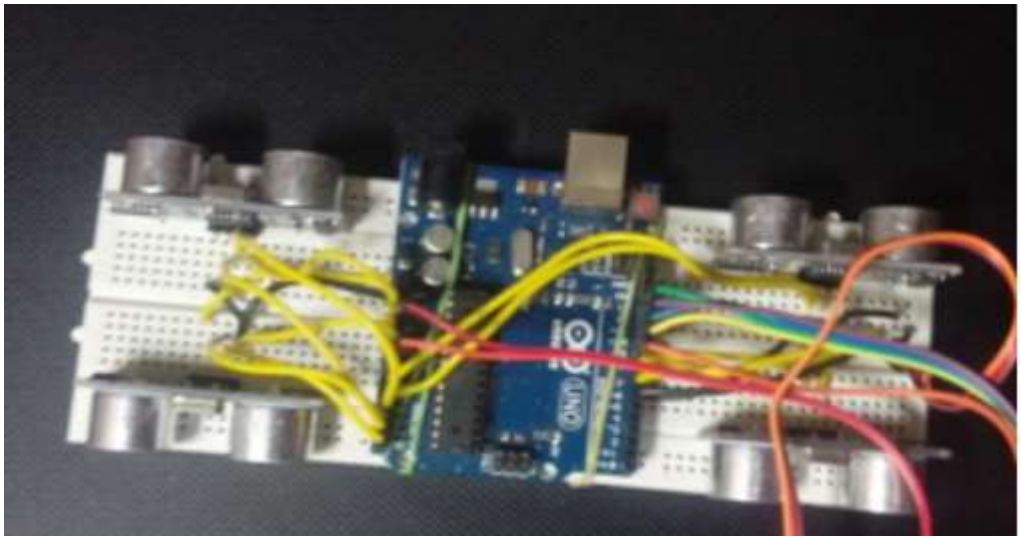
3.2.3 The process will be repeated for (s1,s2,s3,s4) if all are occupied.

4. Finally all of this data that is generated will be pushed towards the integrated cloud services for easy access and retrieval.

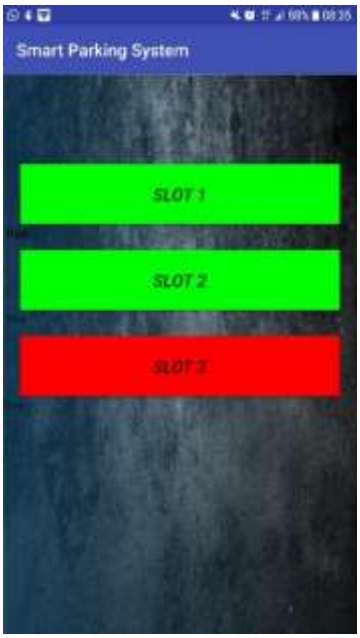
Implementation

Model Screenshot: -

Hardware:



Software:



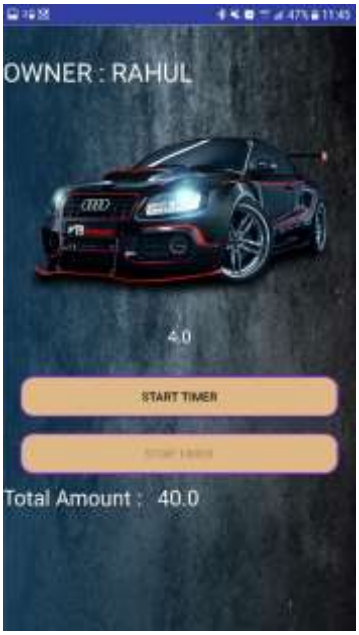


Image1 **Image 2** **Image 3**

Explanation of the Proposed Model: -

Hardware:

Component	Description
Arduino Uno	Arduino is an open-source computer hardware and software company, project, and user community that designs and manufactures single-board microcontrollers and microcontroller kits for building digital devices and interactive objects that can sense and control objects in the physical and digital world. The UNO is the best board to get started with electronics and coding. The UNO is the most used and documented board of the whole Arduino family. It has helped us in running the algorithm acting the CPU for the entire system and controlling various inputs and outputs.
HC/SR04	Ultrasonic going module HC - SR04 gives 2cm - 400cm non-contact estimation work, the extending precision can reach to 3mm. The modules incorporate ultrasonic transmitters, collector and control circuit. The essential rule of work: (1) Using IO trigger for no less than 10us abnormal state flag (2) The Module naturally sends eight 40 kHz and identify whether there is a heartbeat motion back. (3) IF the flag returns, through abnormal state, time of high yield IO length is the time from sending ultrasonic to returning. Test separate = (abnormal state time*velocity of sound (340M/S)/2,)

Software:

We have three major components of our system:

-Arduino and its IDE is used for gathering data from various sensory inputs. In our case, it's the Ultrasonic sensors and thus print results for showcasing whether the parking slot is free or not.

-Cloud based implementation is done through Google Firebase which acts as a server for running the Android Application who then relays the information to the app regarding the availability of the parking space.

-Our application runs on an Android platform

-Image1 shows that all parking spots can be used or that all slots are available for parking. Red implies that a slot is free

-Image 2 shows some slots are free while some aren't. The colour Green shows that the parking slot is engaged as of now or that it isn't free.

-Image 3 shows a timer which the time for which the parking slot was occupied for and correspondingly displays the rate of parking/ amount which has to be paid upon exiting.

Testing and Result

A process of executing a program with the explicit intention of finding errors, that is making the program fail. It is the process of detecting errors and performs a very critical - role for quality assurance, also for ensuring the reliability of software. The results of testing are used later on during maintenance also.

Unit Testing

It concentrates on each unit of the software as implemented in source code and is a white box oriented. Using the component level design description as a guide, important control paths are tested to uncover errors within the boundary of the module. In the unit testing, the steps can be conducted in parallel for multiple components in the project I tested all the modules individually related to main function codes and attacks also

Test Case	Expected Result	Result
Start Loading of the application	Display correct occupancy status messages for all the parking slots	Pass
Upon receiving occupancy status change from client for parking slot 1	Change in the parking slot 1 only, and should not affect other parking slot status messages	Pass
Upon receiving occupancy status change from client for parking slot 1	Change in the parking slot 1 only, and should not affect other parking slot status indicators	Pass
Upon receiving occupancy status change from client for parking slot 2	Change in the parking slot 2 only, and should not affect other parking slot status messages.	Pass

Upon receiving occupancy status change from client for parking slot 2	Change in the parking slot 2 only, and should not affect other parking slot status indicators	Pass
Upon receiving occupancy status change from client for parking slot 3	status change from client for parking slot 3 Change in the parking slot 3 only, and should not affect other parking slot status messages.	Pass
Upon receiving occupancy status change from client for parking slot 3	Change in the parking slot 3 only, and should not affect other parking slot status indicators.	Pass
Upon receiving Occupancy Status as 'Occupied'	Change Green indicator to Red indicator	Pass
Upon receiving Occupancy Status as 'Occupied'	Change Occupancy Message from 'Vacant' to 'Occupied'	Pass
Upon receiving Occupancy Status as 'Vacant'	Change Red indicator to Green indicator	Pass
Upon receiving Occupancy Status as 'Vacant'	Change Occupancy Message from 'Occupied' to 'Vacant'	Pass

Test Case	Expected Result	Result
Upon receiving Occupancy Status as 'Occupied'	Change Green indicator to Red indicator and change in Occupancy Message from 'Vacant' to 'Occupied'	Pass
Upon receiving Occupancy Status as 'Vacant'	Change Red indicator to Green indicator and change in Occupancy Message from 'Occupied' to 'Vacant'	Pass
Upon a vehicle occupying a vacant parking slot	Display the presence of vehicle at that particular time in the chart and also change in the occupancy status and message	Pass

Validation Testing

In this, requirements established as part of software requirement analysis are validated against the software that has been constructed i.e., validation succeeds when software functions in a manner that can reasonably expected by the customer. We made sure we have covered all the requirements that were discussed earlier at the start of the project. And also confirmed that the application works just the way it has to.

Conclusion:

The main objective of perceiving the difficulties caused by spreading transportation problems is being faced utilizing the novel framework joining the cloud and IOT innovations. Utilizing the real time applications, we are anticipating the issues of space and position. Ultrasonic Sensors are utilized both for parking slots location availability and restrict issues discovery. The Proposed engineering for the problem recognition firm will diminish restricting down empty slots and lessen occasions of single auto vehicles consuming the unnecessary parking spaces by avoiding the other number of vehicles to park in slots. Future research might inspect auto stop booking systems and streamlining of sensor uses. Accuracy and cost parameters would also be taken into considerations.

References

[1] Giuffrè, T., Siniscalchi, S. M., & Tesoriere, G. (2012). A novel architecture of parking management for smart cities. *Procedia-Social and Behavioral Sciences*, *53*, 16-28.

[2] Atif, Y., Ding, J., & Jeusfeld, M. A. (2016). Internet of things approach to cloud-based smart car parking. *Procedia Computer Science*, *98*, 193-198.

[3] Thomas, D., & Kovoor, B. C. (2018). A Genetic Algorithm Approach to Autonomous Smart Vehicle Parking system. *Procedia Computer Science*, *125*, 68-76.

[4] Heimberger, M., Horgan, J., Hughes, C., McDonald, J., & Yogamani, S. (2017). Computer vision in automated parking systems: Design, implementation and challenges. *Image and Vision Computing*, *68*, 88-101.

[5] Bachani, M., Qureshi, U. M., & Shaikh, F. K. (2016). Performance Analysis of Proximity and Light Sensors for Smart Parking. *Procedia Computer Science*, *83*, 385-392.

[6Atif, Y., Ding, J., & Jeusfeld, M. A. (2016). Internet of things approach to cloud-based smart car parking. *Procedia Computer Science*, *98*, 193-198.

[7Badidi, E. (2016). A broker-based framework for integrated SLA-aware SaaS Provisioning. *arXiv preprint arXiv:1605.02432*.,09-18.

[8] Chen, N., Wang, L., Jia, L., Dong, H., & Li, H. (2016). Parking Survey Made Efficient in Intelligent Parking Systems. *Procedia engineering*, *137*, 487-495.

[9] Teodoroviü D, Luþiü P, 2006. Intelligent parking systems. European Journal of Operational Research 175(3), 1666-1681.

[10Anderson, J. C., Hernandez, S., Jessup, E. L., & North, E. (2018). Perceived Safe and Adequate Truck Parking: A Random Parameters Binary Logit Analysis of Truck Driver Opinions in the Pacific Northwest. *International Journal of Transportation Science and Technology*.

[11] Migliore, M., Burgio, A. L., & Di Giovanna, M. (2014). Parking pricing for a sustainable transport system. *Transportation Research Procedia*, *3*, 403-412.