

INVESTIGATING DIFFERENT PARKING SYSTEMS AND ISSUES

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ABSTRACT

Availability of parking within a short period of time is a critical problem. Drivers are wasting a lot of time circling around on campus multiple times to try to find a vacant spot to park especially during the peak hours. In turn, this problem is causing another one – that of wasting a lot of fuel and thus polluting the surroundings. A literature review that investigates thoroughly existing parking systems was carried out to understand better their solution and to highlight the advantages and mechanisms which they used to tackle the parking problem. Amongst others, parking management systems as well as automated parking systems are reviewed in detail. Additionally, research was carried out on the demand for parking and also on traffic and the health issues related to it. Different payment methods together with dynamic pricing were explored rigorously too.

Keywords: parking, parking problem, point-based parking, parking management system, parking reservation system, dynamic pricing, traffic, congestion, environment, health

INTRODUCTION

Different parking systems exist namely e-parking, parking information and guidance systems and automated parking systems. These different parking systems are each composed of different sub-systems and have different mechanisms. Some solutions can work better than others but may be costlier and require constant monitoring and maintenance to ensure that they are working properly [1]. Several of these parking systems, mainly automated parking systems and e-parking systems, were investigated in order to be able to see how these types of system have evolved and also how they can be of utmost help in the daily life of a driver. They can essentially help to solve parking problems which in turn saves a lot of time, reduces congestion and traffic while also contributing towards cleaner environment.

This research work attempts to develop a parking system where one can reserve parking spaces with points. Each user would be allocated a defined amount of points upon registering and when selecting a parking spot for reservation the system deducts some points that vary according to the day of the week, time of day and location. The University on Malta campus parking is being used as an example to evaluate the proposed system. Scarcity of parking space and high demand are equally affecting students and staff at the University and a solution is urgently needed.

DIFFERENT SOLUTION PROPOSITIONS

Manni [2] suggests a parking management and payment service for vehicle drivers facilitating them advance booking of parking space would be beneficial to them and also to the environment. The requirements of such a system include ensuring genericity of requests, identification and meeting user preferences while allocating parking spaces.

The demand for parking spaces varies based on the day of the week, the time of the day and some other factors. The future demands can be estimated by analyzing the current and historical data of parking lots can be collected by availability monitoring

systems. Dynamic pricing based on demand may provide many advantages including maximizing revenue for parking operators, solving the problem of overstays. Further, higher parking fees during high demands may make people decide to choose public or shared transport as an option or else change the time/place of their activity which in turn results in reduced congestion and pollution, reduced demand and improved availability of parking spaces [3].

A reservation process seems simple enough however when one examines it in detail some important matters pop up which are mainly due to the different arrangements and policies at parking lots. Making a reservation deals with some issues namely: is the reservation request generic, is it subjects to some specific criteria like distance and cost or is it to reserve a space in some specific parking lot. It is critical to have accurate availability information available at all times since the system needs to identify and allocate the vacant parking slots. Then, when a reservation is accepted and is identified by the system, one has to determine how long it is going to remain valid. In order to minimize the number of “no shows”, meaning that the reservation is booked but for some reason the driver does not show up and results in an unoccupied parking spot that could have been used by someone else, a small reservation fee could be charged upon reservation and then perhaps refunded upon payment of the parking fee [2].

On the other hand, making your payment at time of reservation would help in covering for cancellations and this would require the duration of stay to be estimated which would be helpful for operations in order to calculate the time gaps between reservations (for the same parking spot). In order for all this to work the system must enforce reservations and guarantee that the space reserved would be available upon arrival of the driver and vehicle. Reservation verification can take place via a specified mobile application. In such a system, one need to plan for everything, including overstays meaning that the drivers leave their vehicles parked longer than the reserved time. A solution to this would be to leave some parking slots vacant to use when such a case occurs [2].

Automated Parking Systems

Another proposition [4] describes a vision system solution for detecting free parking slots. The vision system was chosen because of the rich information in images

produced as well as the fact the interference and noise do not hinder the results and can be detected. An empty parking space can be detected from the images resulting from image processing and vision computing.

The position and the orientation of the available parking are needed for the detection of the parking slot by using a camera or two cameras the car is able to detect and pinpoint its location. To obtain the necessary information from the images, the pixels need to be clustered together so that each cluster represents the empty parking space and also some necessary measurements can be carried out to find the geometric information of the clusters. Another approach other than detecting a parking slot using vision is detection using colour. This consists of determining their coordinates with regards to the ground plane after detecting the empty space. Therefore, given that the colours of the parking space's marking are basically the same and differ from its background, it is ideal to use colour to make out their pixels from the images. This method was first suggested and developed by Xu, Chen and Xie [4].

Another similar approach was mentioned by True [5] where a support vector machine was used in order to arrange the colour histograms of the parking slots into different categories. The results were then improved thoroughly when Markov Random Fields were applied and resolved conflicts of classifications. This type of system was implemented using the parking lot security cameras together with the above mentioned computer vision algorithms.

PAYMENT METHODS

A platform for PSOS (Parking Space Optimization Service) was proposed in a project by Holden and Cong [6]. They discuss the importance of creating such a system as well as pricing schemes. The system uses integrated tools and all the processes are available from a mobile phone and by the using Bluetooth, it enables interaction with the already existing payment scheme located at the entry-exists of a car park. The payment is based according to registered time stamps. The report highlights the benefits of e-Parking with regards to multiple stakeholders which include: simpler parking payment methods, improved and instantaneous information given prior to or along the trip for the end user sector and with regards to the parking sector there is

more effective management of parking operation and also the increase of parking spaces in high demand areas and the increase of revenues for other business sectors.

The paper outlines the PSOS system's functionality: the system finds a parking space that is readily available to be reserved and its information is put into the PSOS database immediately, then the PSOS can be accessed by users to get parking details or else to make a reservation and this is also recorded in the PSOS database. The user receives an acknowledgment that the reservation was successful and also receives the booking information together with the access code. In order to open the barrier, Bluetooth is used to transmit the parking information to the PSOS and allows the car to enter and exit. Finally electronic payment is made and the entire operation is recorded into the PSOS [6].

Basically this PSOS tries to find available parking spaces and tries to compare the parking spaces demands with offers made for it and deals with payment charges to the payment service providers which can either be a financial establishment or a telephone operator since it can be reached by both the car drivers via Web, SMS, WAP technologies and also can be accessed by parking space providers via Web Services to the central database of the system. By using Bluetooth technology, the driver can be acknowledged at both the entry and exits locations so that secure m-payment can be assured by transmitting his credit card information or phone bill information for the parking charges [7].

Polycarpou's paper conveys the outcome of a survey distributed among drivers to obtain more information on the needs of drivers with regards to smart parking systems. The problem of increasing cars and thus increasing demand of parking spaces raised awareness that a solution has to be found since a lot of precious time and fuel are being wasted searching for some empty parking slot. This problem also causes delays and increase in traffic, pollution and irritated drivers [8].

Polycarpou discusses about various parking availability monitoring methods, parking reservation and dynamic pricing. As opposed to the traditional method of having to navigate around searching for parking, the parking spaces are kept under systematic real time monitoring so as drivers can see what parking spaces are available immediately and with minimal effort. By implementing this strategy operators also

have the chance of increasing their revenues because of the increasing number of satisfied drivers [8].

On-street vs. Off-Street Parking Spaces

On-street spaces are the parking spaces available on the road and where drivers need to pay utmost attention to the permit parking times and special zones or otherwise they would be penalized. These on-street parking spaces have a higher demand than off street parking (i.e.: in a parking lot) and also, the number of on-street spaces are usually considerably lower than the ones found in off-street parking spaces. The result is usually signs of usage limitations and possibly higher fees to allow fair usage to the restricted number of parking spaces in these areas [8].

Current Payment Methods

Some of the current payment methods include parking meters, which accept coins and also pay and display machines. However the payment policies needed to be expanded and several other methods were introduced such as scratch cards, SMS and advanced pay and display machines that accept credit cards and prepaid cards. Barriers are used to control the cars and payment can be done either on entry or at other times when exiting the parking lot. On entry payment means that there is a fixed fee, which on exit payments, the fee is calculated according to the duration of the stay [8].

DEMAND ESTIMATION

The demand for parking spaces varies a lot and can depend on a number of different factors. During business hours, it may increase significantly in some areas and in other it may peak during weekends mostly and so on. At the same time parking spots that are located nearest to popular places of interest have a much higher demand than those further away and thus may cost more [2].

Dynamic Pricing

In order to obtain estimates for future demands, the current and historical data of parking lots can be collected by availability monitoring systems. This is why different price schemes are developed for different time periods of the day, different locations and even different customers. This is called dynamic pricing and this can be of an advantage for various reasons and the most obvious being that it can maximize revenues for parking operators. Higher fees are made during high demands i.e. peak times and lower fees are charged when the demand is not too high and also to attract drivers. If the parking prices are too high, then people may decide to choose public transport as an option or else change the time/place of their activity which in turn results in reduced traffic. If there is an uneven distribution of cars during the day this causes an uneven distribution of parking spaces also and drivers would be satisfied since they can find parking spaces whenever they want and choose which one depending on the price [2].

To inform on the rates for different parking spaces and durations, they may be published on a website or an applications. This would be of utmost help and importance especially when some event in an area is taking place and is going to attract many people. It would be helpful if the prices were defined and known before hand since they could be higher if the peak demand is known. Otherwise, the parking rates can vary in real time as a cause of the current demand and supply or else prices can be set at regular intervals according to statistical information [2].

TRAFFIC AND HEALTH

Transportation is an essential part of each person's daily activities. People travel to get to their jobs, for shopping, for pleasure, for getting access to services and amenities, to visit someone and for several other different reasons. Whether traveling near or far each time, people rely on transportation to get to their destinations. Over time, there has been quite a significant increase on the use of private vehicles as a mode of transportation. This thus led to several other problems like more traffic congestions, more fuel consumptions, which mean more emissions of air pollutants. This exposure to all these hazardous emissions in the air around us could be the cause of several severe health issues especially amongst vulnerable age groups for

instance the children and the elderly [9]. It was found that the health of the members of the community could be compromised when exposed to traffic [10].

Prevention and Solution for Health Challenges

In order to confront these health challenges, transportation needs to be improved for all because these health problems are only going to increase with more vehicles on the road producing lots of air pollutants [11]. The prevention of such health problems caused by vehicle pollutants can be reinforced by having more people deciding to make use of modes of transport that are safer for the overall wellbeing of the community and also by combining the development of transport technologies which prove to be cleaner than traditional methods, and additionally implementing and enforcing effective policies in order to meet with the increasing demands for transport. Such methods would be beneficial for the whole community both in terms of transportation and also health wise [9]. A survey took place in Germany and investigated thousands of cases and analysed thousands other tests on children aged between 9 and 11 years and came to the conclusion that high amounts of road traffic pollutants reduced forced expiratory flow and increased respiratory symptoms in these children [12]. With the increase of vehicles on the road, the risk of traffic accidents also increases, but vehicle safety measures have been enhanced and studies [13] show that a higher percentage of people are making use of these measures more often now such as wearing seatbelts, putting up child seat and having air bags in their car. Additionally, significant improvements have been made in emergency responses and trauma care together with intelligent transportation systems [13].

Health Issues and Factors Contributing to Emissions

Some, more than others, have a higher exposure to traffic pollutants and hazardous emissions such as those people whose home is situated amongst busy roads or nearby, road users like drivers of vehicles and pedestrians walking by and also those people who spend quite a lot of time on the roads for example delivery persons and driving instructors. Some of the factors that contribute most to emissions are the dense traffic congestion, internal combustion engine and conventional fuels, motorcycles emissions such as hydrocarbons, carbon monoxide and particulate matter, other vehicle components like tyres, brakes and clutch linings and

furthermore also from the road surface wear and the treatment materials it entails. A lot of individuals as much as up to tens of thousands of people in the WHO European region [14] are affected by emissions from road transport and the latter can cause mild to severe short and also long term effects. Amongst the health issues caused by air pollutants, which are generated by vehicles, are asthma and other respiratory problems, cardiac rhythm disturbances and also reduction in life expectancy [9], [12].

On a brighter note, advancement in studies, technologies and awareness of the harm that vehicle emissions have increased significantly and some hopeful solutions for these problems are in process. Some of these include technologies like particle traps that aim to lessen vehicle emissions as well as new engine and aftertreatment technologies that use fuels that do not contain any type of metals in them [12].

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