Smart Parking Technologies

Milja Simeunović[1], Zoran Papić[2], Pavle Pitka[3], Dejan Radivojev[4], Nenad Saulić[5]

*Abstract –***The Smart city concept involves the use of smart technologies to improve the quality of life of all residents. Traffic, as an important functioning component of all human activities, has an important role in smart city planning. Within this paper will be introduce some of the smart technologies used in the parking system.**

*Keywords – **parking, smart technologies, sensors**.*

I. INTRODUCTION

Solving existing parking problems has been a major challenge for decades. The level of motorization is constantly growing in the world and causing increasing problems of organizing parking. There is less and less space available for organizing parking, especially in urban areas. Drivers spend a lot of time searching for a parking space, so finding a free parking space is often a frustrating activity for many people in cities around the world. In the last few decades, there has been an explosive growth of information and communication technologies. The use of these technologies in cities for various activities has led to increased efficiency of functioning in cities and such cities are labeled as smart cities. In smart cities, digital technologies are used in public services for residents and for better use of resources with less impact on the environment. Creating smart cities is a natural strategy to mitigate the negative effects of urbanization. They can reduce energy consumption, water consumption, carbon emissions, transportation requirements and municipal waste, despite the high cost of deployment. Traffic has a very important role in the concept of a smart city. Smart technologies have found their role in different fields of traffic. Therefore, the use of modern technologies in solving parking problems has become a constant practice.

II. SMART PARKING TECHNOLOGIES

Creating smart cities also involves the application of modern smart technologies in the field of transport. The old automated technologies meant the availability of information about the available number of free places in certain parking spaces, however, this information did not inform the drivers about the location of the free parking space within the parking lot, the shortest route to the free parking place, the possibility of remote reservation of the parking space, and etc. The use of smart technologies is increasingly prevalent as these technologies are able to advance and solve deficiencies of older information technologies. The most important benefits of smart technologies are reducing fuel consumption, reducing time spent searching for a free parking space, reducing harmful emissions, reducing noise, etc. According to a report, Smart Parking could result in 2,20,000 gallons of fuels saving till 2030 and approx. 3,00,000 gallons of fuels saved by 2050 , if implemented successfully [1]. The researches also shows that every car driver wastes on average about 100 hours a year looking for a parking space, which accounts for one third of city center traffic [2]. Consequently, the importance of smart parking and smart traffic management is increasingly important today and is becoming a mandatory part of the smart city planning process.

There are different developing technologies of smart parking. Some of these technologies are used independently in some situations, while multiple technologies are combined in other certain situations. There are different categories and classifications of smart parking which vary from source to source.

According to one source, numerous technological methods are grouped into the following classification [3]:

– Smart parking systems based on agent model
– Wireless sensor networks-based systems
– Smart parking systems based on Vehicular to infrastructure communication
– Smart parking systems based on Global Positioning Systems (GPS)
– Smart parking systems based on Computer vison
– Smart parking systems based on RFID technology, etc.

Smart parking systems based on agent model

These types of system can be any entity capable of observing facts via sensors, as the system is acting upon the changes of the environment through exchanging information and interaction upon that act. Essentially, a multiagent system is a modelling method developed to represent systems with entities, autonomy, and interaction.

Wireless sensor network-based systems

This type of system, which utilizes sensors to monitor environmental conditions, is widely used, due to the ease of installation and configuration, and the reasonable price.

[1]Faculty of Technical Science, Trg Dositeja Obradovića 6, Novi Sad, Serbia, mlekovic@uns.ac.rs

[2]Faculty of Technical Science, Trg Dositeja Obradovića 6, Novi Sad, Serbia, njele@uns.ac.rs:

[3]Faculty of Technical Science, Trg Dositeja Obradovića 6, Novi Sad, Serbia, pitka@uns.ac.rs

[4]Faculty of Technical Science, Trg Dositeja Obradovića 6, Novi Sad, Serbia, pitka@uns.ac.rs

[5]Faculty of Technical Science, Trg Dositeja Obradovića 6, Novi Sad, Serbia, pitka@uns.ac.rs

Smart parking systems based on Vehicular to infrastructure communication

This promising technology emerged recently. It proposes a new smart parking technique that depends on developing a new smart parking to be used for smart steering and smart parking. It refers to Vehicular Communication Systems, in which vehicles and roadside units communicate and exchange information with each other, such as safety warnings or supplying the traffic congestion information and even for finding vacant parking spaces.

Smart parking systems based on GPS

Global Positioning Systems (GPS) technology is used to offer information about the location and availability of parking spaces at the destination.

Smart parking systems based on Computer vision

This field of study includes methods for acquiring, processing, and analysing images. It uses computers to emulate human vision, including learning and being able to make inferences and take actions based on visual inputs. The goal of computer vision is to make computers efficiently perceive and process visual data, such as images and videos, and act upon changes in these images. Usually, the technique involves analysing a few frames per second and then sending the data to a central database, after which, the user can retrieve information about the changes at the parking lot.

Smart parking systems based on RFID technology

The main mechanism of RFID technology depends on an electromagnetic field to identify and track tags attached to objects automatically.

The following will describe one of the existing smart parking systems developed by Simens – Intelligent City Parking Solutions.

III. INTELLIGENT CITY PARKING SOLUTIONS

Siemens has developed a sensor-controller parking management system (Intelligent Parking Solutions) that helps optimize the use of urban parking facilities and substantially reduce the congestion caused by drivers searching for a parking space (Fig. 1) [4]. A first pilot project was installed at the Berliner Bundesallee in September 2015 for test and demonstration purposes [5]. This parking management system use of the full potential of digitalization: smart sensors, intelligent software and clever analysis of the available data.
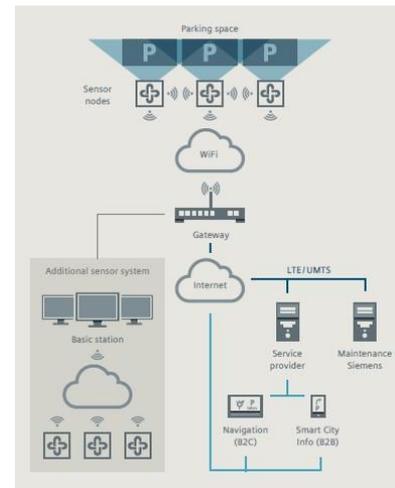

Fig. 1. Schematic diagram of the Simens smart parking system

The Siemens parking bay sensor (Fig. 2) is an ultra-low-power microwave-radar detector. It is used for detecting parked vehicles as well as recording parking start and end times. Sensors can be installed in pavement or as overhead (e.g. mounted in street lights). If installed at a height of 10 m, the sensor can monitor five to seven cars parking slots plus the surrounding area, for instance cycle paths or lanes reserved for buses or emergency vehicles. This allows the fast and cost-effective recording of parking data as well as the detection of parking violations. Sensors can detect a free parking space also what is very important for users of parking lot. They can detect the flow of cars or the flow of pedestrian and can measure their speed and traffic conditions[6].

Detection accuracy is not affected by lighting conditions or dirt, dust or oil on the sensor and they are not impared by light or weather conditions.

Fig. 2. An example of the installation of sensors on street lights

The sensor readings are sent over the mobile network to the softwer in control center where they are analyzed, current parking space occupancy is calculated, and the information is prepared for services such as a parking space aplication (Fig.3) [7]. The softwer recognizes recurring patterns in parking space occupancy. On this basis it calculates prognoses and recommendations for the users, such as the expected parking space situation at their destination or alternative routes through

areas with lower volumes of traffic. By using adaptive systems, the software can answer to specific users' questions, for instance: How likely is it that a parking slot will be available in front of my favorite restaurant in 30 minutes [4]?

Informations can be used by different uses [6]:

- traffic info centres to enhance their own traffic information services.
- driver assistance system (smartphone aplications, sat navigations or parking guidance signs) to help drivers find out in real-time where they can park.
- multimodal trip planning tools to help citizens plan their trips considering the parking situation or to propose public transport alternatives when no parking is available

Drivers can use the collected data to find out about currently available parking spaces. Route planning aplications and integrated navigation systems minimize the time spent in search for a parking space and thus help reduce urban traffic volumes. As the solutions predicts the time needed to secure a parking space as well as the walking distance to the final destination, it even helps the road users make informed decisions about which means of transportation to use.
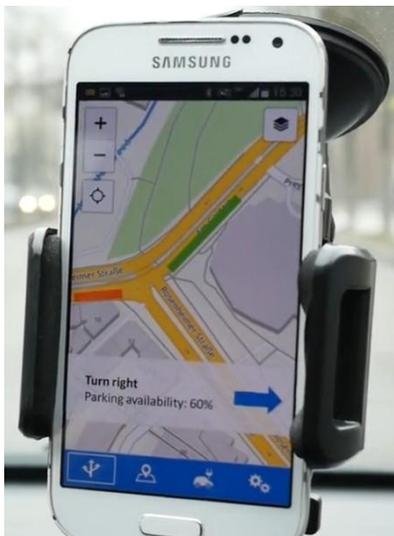

Fig. 3. The user application to use the Intelligent Parking Solutions

Benefits parking management system (intelligent Parking Solutions)

Benefits of implementing the smart parking system can be viewed from various aspects. There are several stakeholders involved in improving parking performance, such as drivers, parking operators, cities and their citizens.
The use of smart parking systems enables drivers to find the free parking space in the shortest possible time by different applications, to drive to free parking space in the shortest possible route, to plan their trips, save on fuel, etc. When users search the free parking space by aplications they can also get information about the walking distance from a potentially free parking space to the place he wants to go. At the same time drivers also receives information about the nearest P + R

parking lot with the corresponding urban transport service. This can motivate people to use urban transport and ensure a balanced utilization of the overall available urban parking capacity.

Parking operator using smart parking systems has real-time statistic about parking parameters, better utilization of parking spaces which has the effect of increasing revenue, prediction capabilities with real-time data, and generally better service to customer.

Each city aspires for efficient organization of traffic and traffic areas, with the reduction of congestion, pollution, noise, improper parking, etc. The implementation of smart parking systems has a positive effect on all of the above and also contributes to increasing accessibility to visitors in high-attraction areas.

An analysis of the operation of the developed the Intelligent Parking Solutions shows that 43% less time is spent searching for parking, 30 % less parking-related vehicle miles is traveled, 8% less traffic volume when increasing parking availability and CO_2 reduce greenhouse gas emissions accordingly [6].

IV. CONCLUSION

The benefits of using smart parking systems are multiple. Getting information about free parking spaces in the real time and routing drivers to that location allows drivers to easily plan their trip while saving travel time and travel costs. In addition, with a strategic approach to parking system control, it is possible to minimize the influx of cars in areas with a lack of parking spaces, routing them to other locations. Obtained data by the use of smart parking systems can be used for planning purposes, enabling strategies to be created as part of the system in such a way that it can increase customer satisfaction, increase revenue, reduce irregular parking, etc. Smart parking solutions can uses the Internet of Things platform from the U.S. firm Intel for communication between the sensors and the control center, forming the basis for a sensor and communications network that is suitable for future smart city concepts.

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