

# Advance Prediction of Parking Space Availability and other facilities for Car parks in Smart Cities

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**Abstract** - *In order to manage the critical infrastructure and services of a city efficiently, there is need to formulate concept of smart city. Searching an available parking spot in the city is always troublesome for drivers, and it tends to become harder and tedious with the increasing number of private car users. Finding a free parking space is not only a hectic job but also a challenge to mobility, since up to 30% of traffic in urban scenarios is generated by vehicles looking for vacant parking spaces. So there is a need to solve this problem of parking space availability, traffic congestion and air pollution problem. A smart parking exchange system will solve these problems and reduce the wastage of fuel while finding space for parking. Moreover, traffic and pollution update can also be obtained.*

**Key Words:** Prediction model , Internet of things, Smart city, Prediction, Framework

## 1. INTRODUCTION

In today's world Parking space, traffic congestion and Air traffic pollution are a major headache. In most of the metropolitan cities the daily commuter has to face many problems such as pollution, traffic congestion, traffic jams, road closed etc. An information exchange system to update about routes so that the user can take an informed decision regarding the route selection which will take him to his destination with least amount of obstacles which saves time. It is predicted that about 70 percent of the world's population will start living in cities and surrounding regions by 2050. In order to efficiently manage the critical infrastructure and services of a city, these need to evolve into a smart city [1]. A smart city according to Forrester, is one that uses information and communications technologies (ICT) to make the critical infrastructure and services of a city, such as public safety, transportation and utilities, more aware, interactive and efficient.

The realization of the Smart City is now becoming possible with the emergence of the Internet of Things (IoT), which radically evolves the current Internet into a network of interconnected objects, such as sensors, parking meters, energy measuring devices and actuators [2]. These

networked devices have the ability to compute, sense and interact with their surroundings in fine spatial and temporal detail, and generate a vast amount of data.

## 1.1 Need of the Smart Parking System

One of the key services that cities need to manage is car parking facilities and traffic. Finding an available parking spot in the city is always troublesome for drivers, and it tends to become harder with the increasing number of private car users. Searching for a free parking space is not only a tedious task, but also a challenge to mobility, since up to 30% of traffic in urban scenarios is generated by vehicles looking for parking spaces [4].

## 2. SURVEY OF WORK DONE

M. Caliskan, A. Barthels, B. Scheuermann in 2007 [3] addresses the issue of automation and modernization of car parking management by proposing a Car Parking Framework (CPF), and assessing its relevance with respect to the engineering and economic efficiency. The proposed framework is based on the integration of WSN and RFID technologies and builds around a modular approach to enable a variety of services. These include driver guidance, automatic payment, parking lot retrieval, security and vandalism detection. Its partial implementation as a lab prototype is also described in this paper, where some modules have been tested and evaluated by real experiments. Smart parking solutions that are closely related to the one proposed in this paper have been presented. These solutions use a single wireless mote per parking lot, which is outfitted with a sensor for vehicle detection. The sensor can be a magnetic sensor, an ultrasonic sensor, an optical sensor, etc. When a car is in sensing field of some sensor (a parking spot), the sensor status will change and a signal will be transmitted to the connecting mote. The latter processes the incoming signal to decide about possible detection [3].

Felix Richter, Sergio Di Martino, Dirk C. Mattfeld in 2014 [4] proposed Temporal and spatial clustering for a parking prediction service. An approach to learn models of parking availability from historic data on a back-end, in order to save these models within in-vehicle navigators, to predict future parking availability. In particular, investigation was focused on getting a better insight on what is the most suitable spatio-temporal representation of parking availability

trends, with the goal to minimize the storage requirements while maximizing the accuracy of future availability predictions. The baseline solution is to learn one prediction model per each road segment (i.e. the segment of a street between two intersections) of a digital map and each day of the week. However, this idea cannot be effectively implemented in vehicles having excessive space requisites. To solve this problem, they proposed and compared five different clustering strategies, both on temporal and spatial dimensions of the historic parking data[4].

S.Pullola,P.K Attrey and A.El Saddik in 2007[5] demonstrated GPS based vehicle navigation system for finding parking lot. The prediction is based on the information about different historic contents and actual information about parking availability is given by sensors.These approaches are based on the finest granularity of parking data, because each parking lot is described by a prediction model. This approach models the probability of parking spaces to be free at a given instant of time[5].

Zhanlin Ji, Ivan Ganchev , Martin O'Droma and Xueji Zhang in 2014 [6] presented the generic concept of using cloud-based intelligent car parking services in smart cities, as an important application deployed on the Internet of Things (IoT) paradigm. The corresponding IoT sub-system includes sensor layer, communication layer, and application layer. A high-level view of the system architecture is outlined. To demonstrate the provision of car parking services with the proposed platform, a cloud-based intelligent car parking system for use within a University campus is described along with details of its design and implementation[6].

J. Froehlich, J. Neumann and N. Oliver in 2009 [7] proposed Sensing and predicting the pulse of the city through shared bicycling which has model which uses Bayesian networks for short and medium term predictions of availability of bicycle in Barcelona.Short term prediction is of 5 minutes and medium term prediction is of 2 hours.This model incorporate the day time but it does not consider weather effects[7].

Bei Chen, Fabio Pinelli , Mathieu Sinn, Adi Botea and Francesco Calabrese in Oct 2013[8] a class of algorithms which use Generalized Additive Models (GAMs) for demand and availability prediction on various time scales. It states that in contrast to existing methods, exogenous effects can be explicitly factored into the models, resulting in significant gains in terms of prediction accuracy. Another advantage of this approach is that it estimates the distribution of the waiting time for the next available bike/parking lot if the current availability is zero. It also showcase how this additional information can be used as part of personal uncertainty-aware journey planners which allow users to choose from multiple routes according to their time constraints[8].

Tooraj Rajabioun, Brandon Foster, Petros Ioannou developed new parking guiding and information system [9] in 2013 .The system assists the user to find the most suitable parking space based on his/her preferences and learned behavior. The system takes into time, destination, type preference, cost preference, driving time, and walking distance as well as time-varying parking rules and pricing. Moreover, a prediction algorithm is proposed to forecast the parking availability for different parking locations for different times of the day based on the real-time parking information, and previous parking availability/occupancy data. A novel server structure is used to implement the system. Intelligent parking assist system reduces the searching time for parking spots in urban environments, and consequently leads to a reduction in air pollutions and traffic congestion. On-street parking meters, off-street parking garages, as well as free parking spaces are considered in our system[9].

Evangelia Kokolaki, Merkouris Karaliopoulos in 2013[10] systematically explored the impact of the information. This systems make available on the efficiency of the parking search process and resource utilization when the parking resource allocation is not controlled by a centralized entity, e.g., through a reservation mechanism. The drivers choose independently to either compete for the inexpensive but scarce on-street parking spots or head for the more expensive parking lot(s). In the first case, they run the risk of failing to get a spot and having to a posteriori take the more expensive alternative, suffering the additional cruising cost in terms of time and fuel consumption (and stress) of the failed attempt. Drivers make their decisions by drawing on various levels of information about the parking demand (number of drivers), and perfect knowledge of the parking supply(capacity) and the applied fees on the parking facilities.[10]

### 3. COMPARISON OF DIFFERENT METHODOLOGIES

**Table -1:** Comparison of different methodology used for parking scheme.

Sr.No	Name of the paper	Methodology used	Limitations
1.	M.Caliskan,A.Barthels, B. Scheuermann, and M.Mauve,“Predicting parking lot occupancy in vehicular ad hoc networks,” in Vehicular Technology Conference,2007.VTC 2007-Spring. IEEE 65th. IEEE, 2007, pp.277-281[3]	Markov Chain approach	1.Devices used in this system has limitations in terms of connectivity and storage.  2. It requires special technique for handling mobile data.  3.It does not use historic data for analysis
2	Felix Richter ,Sergio Di Martino ,Dirk C. Mattfeld, “Temporal and spatial clustering for a parking prediction service”26th IEEE Conference on tools with Artificial Intelligence,2014[4]	Hierarchical clustering with complete linkage and dynamic wrapping	Prediction is not as good as seven day prediction model
3	S. Pullola, P. K. Atrey, and A. El Saddik, “Towards an intelligent gps based vehicle navigation system for finding street parking lots,” in Proc. IEEE Int. Conf. Signal Process. and Communication pp. 1251-1254,2007[5]	GPS based vehicle navigation system	It is efficient for short term scope only and it models only at instant of time
4	Zhanlin Ji, Ivan Ganchev , Martin O’Droma and Xueji Zhang “A Cloud-Based Intelligent Car Parking Services for Smart Cities”, IEEE,2014[6]	Cloud based parking system	Area of coverage is very less like University campus
5	J. Froehlich, J. Neumann and N. Oliver, Sensing and predicting the pulse of the city through shared bicycling, IJCAI’09 Proceedings of the 21 <sup>st</sup> International Joint Conference on Artificial Intelligence, pp. 1420-1426, 2009[7]	Prediction via sensing methodology	Weather conditions are not considered
6	Bei Chen, Fabio Pinelli , Mathieu Sinn, Adi Botea and Francesco Calabrese, “Uncertainty in urban mobility: Predicting waiting times for shared bicycles and parking lots” Proceedings of 16th International IEEE Annual Conference on Intelligent Transport systems, Netherland, October 2013[8]	Generalized Adaptive method	There is no provision of reserving parking slot
7	Tooraj Rajabioun, Brandon Foster, Petros Ioannou “Intelligent Parking Assist” 21st Mediterranean Conference on Control and Automation, Greece,June 2013[9]	Prediction Algorithm	Error in predicting available parking slot is 2.8 %

8	Evangelia Kokolaki, Merkouris Karaliopoulos "Leveraging Information in Parking Assistance Systems" IEEE Transactions on Vehicular Technology, Vol. 62, No. 9, November 2013	Game theoretic approach	There is uncertainty in human decisions so it is not reliable
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**4. CONCLUSIONS**

Lot of research is carried out in formulating parking space prediction system .Detailed comparison of various methodologies is illustrated with its limitations. In future, additional factors can be added into the model that may affect the parking availability predictions, such as events (e.g. social and economic) and the effect of nearby parking slots

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