CLOUD-BASED COST EFFICIENT SMART PARKING SYSTEM
BASED ON IoT TECHNOLOGY

1GOUTHAM J., 2CHAITRA B.R.
1,2Vivekananda Institute of Technology Department of CSE, Bangalore-560074
Email: 1 goutham.jagdeesh@gmail.com, 2chaitraraj1894@@gmail.com

Abstract- With the increase of economic behaviour and the upgrade of living standard, the ratio of people in India who own
Automobiles and motorcycles have recently increased giving a boost to Metropolitan Traffic. Therefore, parking issues will
be a big challenge to facilitate traffic network and ensure urban life quality. Searching for parking space in most
metropolitan areas, especially during the rush hours, is difficult for drivers. The difficulty arises from not knowing where the
available spaces may be at that time; even if known, many vehicles may pursue very limited parking spaces to cause serious
traffic congestion. In this paper, we design and implement a prototype of Smart Parking System based on Internet of Things
(IOT) that allows drivers to effectively find the vacant parking spaces. By periodically learning the parking status from the
host parking database management in parking lots.

Keywords: Internet of Things (IOT), Smart Parking System (SPS), RFID Technology, performance metrics.

I. INTRODUCTION

Internet of things was first introduced in 1999 at auto-
ID centre and first used by Kevin Ashton. As
evolving this latest burning technology, it promises to
connect all our surrounding things to a network and
communicating with each other with less human
involvement. Still internet of things is in beginning
stage and there is no common architecture exists till
today [1]. In the development of traffic management
systems, an intelligent parking system was created to
reduce the cost of hiring people and for optimal use
of resources for car-park owners. Currently, the
common method of finding a parking space is manual
where the driver usually finds a space in the street
through luck and experience. This process takes time
and effort may lead to the worst case of failing to
find any park space if the driver is driving in a city
with high vehicle density. The alternative is to find a
predefined car park with high capacity. However, this
is not an optimal solution because the car park could
usually be far away from the user destination. In
recent years, research has used vehicle-to-vehicle [2]
and vehicle-to-infrastructure [3] interaction with the
support of various wireless network technologies
such as radio frequency identification (RFID),
ZigBee, wireless mess network [4], and the Internet.
This study aimed to provide information about nearby
parking spaces for the driver using supported devices
such as smartphones or tablet PCs. However, the
current intelligent parking system does not provide an
overall optimal solution in finding an available
parking space, does not solve the problem of load
balancing, does not provide economic benefit, and
does not plan for vehicle-refusal service. To resolve
the aforementioned problems and take advantage of
the significant development in technology, the
Internet-of-Things technology (IOT) has created a
revolution in many fields in life as well as in smart-
parking system (SPS) technology [5]. The present
study proposes and develops an effective cloud-based
SPS solution based on the Internet of Things. Our
system constructs each car park as an IoT network,
and the data that include the vehicle GPS location,
distance between car parking areas and number of
free slots in car park areas will be transferred to the
data centre. The data centre serves as a cloud server
to calculate the costs of a parking request, and these
costs are frequently updated and are accessible any
time by the vehicles in the network. The SPS is based
on several innovative technologies and can automatically monitor and manage car parks.

II. LITERATURE REVIEW

In some studies, [6] [8], the authors proposed a new
algorithm for treatment planning in real-time parking.
First, they used an algorithm to schedule the online
problem of a parking system into an offline problem.
Second, they set up a mathematical model describing
the offline problem as a linear problem. Third, they
designed an algorithm to solve this linear problem.
Finally, they evaluated the proposed algorithm using
Experimental simulations of the system. The
experimental results indicated timely and efficient
performance. In another study [9], the authors
propose an SPS based on the integration of UHF
frequency, RFID and IEEE 802.15.4 wireless Sensor
Network technologies. This system can collect
information about the state of occupancy of the car
parks, and can direct drivers to the nearest vacant
parking spot by using a software application.
However, in this work, the authors have no
mathematical equations for the system architecture
and do not create a large-scale parking system. Hsu et
al. proposed an innovative system including the
parking guidance service. A parking space can be
reserved by a smartphone via Internet access. Upon
entering the car park, the reserved parking space will
be displayed on a small map using wireless
transmission for vehicles under the dedicated short-range communication protocol DSRC. An inertial navigation system (INS) is implemented to guide the vehicle to the reserved space. The system will periodically update the status of the parking space in real time to help ensure system accuracy. System performance is measured through the accuracy of the inertial navigation systems run in an indoor environment, and the system implementation is evaluated by considering the accuracy of the GPS. In this paper, the authors have not evaluated the performance of the parking services, they do not provide any mathematical model of the system, and do not consider the waiting time of each vehicle for service. Other researchers have designed architecture for parking management in smart cities [11]. They proposed intelligent parking assistant (IPA) architecture aimed at overcoming current public parking management solutions. This architecture provides drivers with information about on-street parking stall availability and allow drivers to reserve the most convenient parking stall at their destination before their departure. They use RFID technology in this system. When a car parks or leaves the IPA parking spot, the RFID reader and the magnetic loop detect the action and send this information to the unit controller to update the information on the car park status. This study uses only some simple mathematical equations for the system architecture and does not create a large-scale parking system.

In this paper, we mainly focus on designing a new smart parking system that assists drivers to find parking spaces in a specific parking district. In addition, an important goal of the system is to reduce the traffic searching for parking, hence reduce energy consumption and air pollution.

III. PROPOSED SYSTEM

The cars entering and leaving the parking slots are monitored. The information thus gathered is sent to the cloud based server. RFID sensors are employed here. The system is derived from the idea of IoT [13], [14]. The system uses the WSN [15] consisting of RFID technology to monitor car parks. An RFID reader counts the number of free parking spaces in each car park. The use of RFID facilitates implementation at low cost. The system provides a mechanism to prevent disputes in the car park and helps minimize wasted time in looking for a parking space. After logging into the system, the user can choose a suitable parking space. Information on the selected parking location will be confirmed to the user via notification. Then, the system updates the status of the parking space to “pending” during which time the system will not allow other users to reserve it. If after a certain period of pending time the system determines that no car is parked in that space, then it changes the status to “available.” The system will update the status from the WSN node (the status of car park spaces) when a new car joins in the system. Therefore, the status of the overall parking system is always updated in real time. The system will help plot the parking time for each parking space in real time and can support the business with hourly parking charges. Parking fee is directly paid through the smart phone app. Access to loading zones and residential parking zones are restricted.

IoT traffic architecture comprises of RFID, Wireless sensor technologies, Ad Hoc networking and internet based information systems. Intelligent traffic IoT is divided into three layers such as Application layer, Acquisition layer and Network layer. Application layer is responsible for intelligent traffic management, intelligent driver management, information collecting and monitoring and information services. Network layer makes use of Wi-Fi, 3G/4G and WiMAX or GPRS. Acquisition layer employs RFID, RFID reader, WSN, Intelligent terminals.
We have assumed that each parking area is a hub in a network, where each parking area is labelled as P1, P2, ..., Pn are number of parking areas; N1 is the total parking slots in P1, similarly N2 & Nn are the total parking slots in P2 & Pn. The aggregate limit of the framework is \( N = N_1 + N_2 + N_3 + \ldots + N_n \) (slots). D is the distance between two hubs in the framework. \( D_{ij} \) is the distance between hubs Pi and Pj. Each hub has a neighbour table to keep up data on the present status of the system. The neighbour table for each hub contains data on the neighbouring hubs straightforwardly connected to it. In this proposed framework, each hub will telecast a message to cloud hubs after another hub joins or leaves it. This message incorporates data on its aggregate free assets. The cloud that gets this message will update the neighbour tables.

We use a function named \( F(\alpha, \beta) \) to calculate the cost between the nodes in the network. \( F(\alpha, \beta) \) is a function that depends on the distance between two nodes and the number of free parking spaces in the destination node. If the vehicle comes into a node and that node is full, the vehicle will be forwarded to the next node, which is a neighbour of this node with the smallest value of \( F(\alpha, \beta) \) in the neighbour table. We calculate the cost function \( F(\alpha, \beta) \) from node Pi to node Pj, i.e.,

\[
F_{ij} = F_{ij}(\alpha, \beta) = \alpha \frac{d_{ij}}{D_{ij}} + \beta \frac{1}{N_{ij}}
\]

a. Reservation Process: If the user is searching for a free parking spot, he will send a message to the framework, using cell phone. The Framework will discover parking area P1 with the minimum cost [minimum estimation of \( F(\alpha, \beta) \)] and forward this message to the user. The minimum cost is the base estimation of function \( F(\alpha, \beta) \). This message incorporates the location of parking area P1 and its direction.

b. Entering Process: If a user enters parking area P1; he should be authenticated by RFID tag/smart card. In the event that approved, the entryway is opened, and the status will be updated in cloud. The framework will send a response message to the user to notify successful parking. In the event that the parking area P1 is right now full, it will send a message suggesting an alternating parking area, entails the information on new parking area P2, with the minimum cost.

IV. RESULTS ANALYSIS

To assess the execution of this system, determine the parameter for system performance as the cost in terms of user time in the system. The cost to the user is the time that user spends in the parking system for service. Cost can be reduced, by decrease alternate costs, for example, financial, fuel, and environment pollution costs. The time is average waiting time of the user and the average aggregate time of the user in the system, including the holding up, travel, and service times. A small cost leads to efficient performance of the framework. The exploratory result demonstrates the better execution in the proposed system.

CONCLUSION

This study has proposed a parking system that improves performance by reducing the number of users that fail to find a parking space and minimizes the costs of moving to the parking space. The results show that our algorithm significantly reduces the average waiting time of users for parking. Our results closely agree with those of our proposed models. Our system achieved the optimal solution when most of the vehicles successfully found a free parking space. The average waiting time of each car park for service
becomes minimal, and the total time of each vehicle in each car park is reduced. In our future study, we will consider the security aspects of our system as well as implement our proposed system in large scales in the real world.

REFERENCES


