

# Survey on IoT Base Smart Parking and Traffic Flow Control

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**Abstract:** One of the biggest issues of the any city is car parking facilities and traffic management systems as an increase in population, there is high vehicle density on roads. Internet of Things (IoT) is very useful in the connectivity between surrounding environmental things to internet and makes easy to access those things from any remote location. IoT base parking Management can sense data from things involved in parking management and provide intelligent view of city or big organization in order to efficiently provide suggestions to driver about free parking slots. Smart parking systems mainly focus on reducing the time in finding the parking lots and also it avoids the unnecessary travelling through filled parking lots in a parking area. Thus it reduces the fuel consumption which in turn reduces carbon footprints in an atmosphere

**Index Terms – Internet of Thing, Cloud, esp8266, sensors, analytics, parking**

## I. INTRODUCTION

Internet of Things (IoT) incorporates concepts from the pervasive computing and enables interconnections of everyday objects equipped with ubiquitous intelligence, which becomes an integral part of the Internet. With rapid advances in underlying technologies, IoT is opening tremendous opportunities for novel applications that promise to improve the quality of our lives. IoT has spawned a wide variety of smart automated systems, such as smart buildings, smart homes, smart factories, Smart Parking and so on [3].

In metropolitan cities along with an increase in population, there is high vehicle density on roads. One of the important problem to be addressed for these cities is traffic and parking management. Parking and transportation are both essential in the movement of people and goods. Parking is a very annoying issue for the drivers to park their vehicles as it is very difficult to find a parking slot. The drivers usually waste time and effort and end up parking their vehicles finding a space on streets through luck. In the worst case, people fail to find any parking space especially during peak hours and festive seasons. Also in large campus or organizations parking is a really measured problem, employees and visitors find it very difficult to find free parking slot in various parking areas on campus [2].

Over half of humankind, about 4.000 million people, lives nowadays in cities. On 2030 this figure will raise to 60%. Cities have a big mobility, energetic and pollution problem that lowers live quality. A 35% travel during rush hours looking for free parking spots that are hard to find. That's why parking is very important to regulate vehicle's flow and reduce atmospheric pollution. New autonomous, connected and electric vehicle will show up as intruders in parking that will have to adapt to this new reality. Cities must turn into gentle, smart and efficient places and evolve to become Smart Cities. Availability of dynamic systems to guide the traffic towards its final destination, the parking is very import. The use of autonomous, connected, electric, smart and non-polluting vehicles to reduce traffic, noise and pollution is very necessary. Get a more effective and ecological parking that allows the driver to find the free parking space quickly, safely and with the minimal energetic consumption [9].

Now day cities have parking places with parking meter, but this solution will not cope up to above mention problem. Smart parking system should have global view of all parking space available in city or campus and it should provide intelligence to drivers even before entering the city or campus. Previously there are few attempts for parking automation using electronics technologies like RFID, but these automated system will can only manage one particular parking area but will not cope up to manage whole parking spaces in city, traffic routing and providing intelligence [12]. Latest IoT technology can help us to connect all objects or things involve in parking and provide intelligence and help to control parking and traffic flow. Internet of Things (IoT) is also new advancement which helps in detection of vehicle occupancy and congestion by intelligence and computational capability to make a smart parking system. The main motivation of using IoT for parking is to collect the data easily for free parking slots. IoT-based Real Time Smart Street Parking System (IoT-based RTSSPS) with accessibility of data to make it simpler for residents and drivers to locate a parking slot at the streets and also help to control traffic flow in city [4].

Among all the IoT-enabling technologies, Ultra High Frequency (UHF) Radio Frequency Identification (RFID), and Wireless Sensor Network (WSN) represent two of the most promising candidates for the development of an innovative parking system. RFID is a low-cost, low-power technology, mainly consisting of passive devices, named tags, which are able to transmit data when powered by the electromagnetic field generated by a reader. Although the long lifetime of tags makes this technology highly suitable for the development of a variety of application scenarios, however, their reduced operating range (i.e. up to 10 m) limits the use of RFID solutions to object identification and tracking within quite small areas . On the contrary, WSNs are self-organizing networks of small, low-cost devices that communicate in a multi-hop manner to provide monitor and control functionalities. WSN motes usually integrate an IEEE 802.15.4 radio enabling up to 100-m outdoor communication range (single hop). Such considerations allow asserting that RFID and WSN represent two complementary technologies, whose physical integration might give new perspectives to a broad range of innovative applications [8].

The propose system will use WIFI, ZigBee and sensor base approach for parking management, so whenever any vehicle enter into city/Campus ,driver can find free parking slot and place in the city. WIFI Base approaches help use to monitor parking space and monitor the vehicle from remote area as now day's vehicles are coming with Wi-Fi modules. Sensor base approach help to monitor each parking slot in parking space with accuracy. As we have combine WIFI and Sensor approach even one or two

sensors damage or stop working we will get status. As we have combines these approaches it is easy to provide other facilities also like automated billing. All these data can be gather and analyse to provide intelligence to driver.

Taking into account these considerations, it could be possible to design and develop a smart parking system able to reduce the traffic congestion and improve the citizens' quality of life. The system should be capable not only to drive users toward the vacant parking lots, but also to allow traffic authorities to adequately monitor the state of reserved parking spaces. The ability for a user to automatically pay for the occupied parking spot could represent an important feature, as it would allow the user to deal with a single application and, at the same time, it would enable traffic authorities to perform real time checks of paid parking fees. Finally, the designed system should be easily scalable and seamless interoperable with a complete Smart City infrastructure.

## II. RELATED WORK

Several works addressing the aforementioned issues have been already presented in the literature, but each of them have some pro and cons. IoT base smart parking should provide a flexible and scalable solution.

In the paper named Survey paper on Smart Parking System based on Internet of Things by Vishwanath and Ashwarya [6], proposes a Smart Parking system which provides an optimal solution for parking problem in metropolitan cities. Due to rapid increase in vehicle density especially during the peak hours of the day, it is a difficult task for the drivers to find a parking space to park their vehicles. The aim is to resolve the above mentioned issue which provides the Smart Parking system. Drawbacks of their approaches are User need to take RFID cards, manual swapping of RFID card is required, there system only shows empty spaces. Users can only get parking space but not exact parking empty slot in parking space. Monitoring of the vehicle is not possible.

In the paper named APPARKING: Smart Parking System based on Cloud Computing using Android and IoT [1], author have proposed Cloud computing and Internet of things can be united and functional for solving real-time difficulties. This research work, we have combined the Internet of Things technology and an Android application using cloud computing to design an enhanced intelligent parking system. This system will be manageable through an Android app or through the web portal provided. In this research work, Wi-Fi base IOT parking management is proposed. At each parking space Wi-Fi module will be setup with Raspberry pi. Raspberry pi will help to process and store at local level also before uploading to cloud. Each car owner will have android app installed in their mobile or Wi-Fi module in car. As soon as user or Wi-Fi module setup in car come in range of Central Wi-Fi server system will automatically detect the presence of the vehicle and exit of the vehicle. The raspberry Pi will collect all status data and upload to the cloud, so user can check the status of the parking space. Drawbacks of their approach are User can only check the status of parking space, Accuracy of the system is 80-90% because of only Wi-Fi module, and Users can only get parking space but not exact parking empty slot in parking space.

In the paper title Automatic Smart Parking System using Internet of Things (IOT) [3], author have proposed Internet of Things (IOT) plays a vital role in connecting the surrounding environmental things to the network and made easy to access those un-internet things from any remote location. It's inevitable for the people to update with the growing technology. And generally people are facing problems on parking vehicles in parking slots in a city. In this study we design a Smart Parking System (SPS) which enables the user to find the nearest parking area and gives availability of parking slots in that respective parking area. The city will have different parking space. Each parking space will have different parking slot equipped with sensors. And each parking space will have central raspberry pi. As User Park car in any parking slot sensor will sense the car and update slot status to cloud via raspberry pi. This System will assist the user to find parking space and slot with minimum effort. Drawback of this approach is Monitoring of the vehicle is not possible in case of Theft and If any parking slot fails we cannot get status for that slot.

In this paper named A Smart Parking System Based on NB-IoT and Third-party Payment Platform[13], the author proposed system, the data of the sensor node is transmitted by Narrowband Internet of Things (NB-IoT) module, which is a new cellular technology introduced for Low-Power Wide-Area (LPWA) applications. Basic information management, charge management, sensor node surveillance, task management and business intelligence modules are implemented on the cloud server. With integrated third party payment platform and parking guide service.

In the paper titled A Cloud Based Smart Parking System Based on Internet of Things Technologies [2], author states that structure that helps user automatically finds out a free parking space at the smallest amount of cost based on new routine performance metrics for calculating the customer parking charges by bearing in mind the distance and the total no. of free places in every car park. In this system, the result shows that the algorithm helps to get better probability of victorious parking and reduces the driver waiting time.

There is another work titled as A New "Smart Parking" System Based on Optimal Resource Allocation and Reservations [7]. This system assigns and reserves a parking space for a user (driver) based on the users distance from the parking area and parking cost and also ensures that the overall parking capacity is effectively utilized. Their approach solves a Mixed Integer Linear Program (MILP) problem at each decision point in a time-driven sequence. For each MILP there is a solution which gives an optimal allocation based on user's current state information and also supports random events such as new user requests and parking space availability. The allocation is updated at the next decision point which ensures that there is no parking slot reservation conflict and that no user is ever assigned a parking slot with higher than the current cost function value.

In the paper titled Poster: Exploring the Need for Sensor Learning and Collaboration in IoT-based Parking Systems [14], the author proposed BlueParking architecture for efficient reservation of parking slots based a smart IoT solution. In the system, with high precision the reservation algorithm can be applied from a start point by using a traffic estimator service on the top of IoT basic services. Traffic estimator service automatically presents the road status by analyzing the congestion of location nodes and ways reported by the connected cars of the system. The scheme is developed and demonstrated on BlueMix IoT platform. Generation of online traffic map, suggestion of suitable routing paths and online estimation of transportation time are facilities proposed.

In the work titled "A Prototype of IoT-Based Real Time Smart Street Parking System for Smart Cities [16], Author proposed that, there is need to implement the IOT based congestion of the traffic of all cities. Author Suggest that collect data of free slot of parking system to enable the driver free slots of parking. Then it has implemented RTSSPS its architecture and algorithm and it has

divided into 3 parts i.e. IOT based WSN centric smart street parking module, IOT-based data centric smart street parking module and IOT-based cloud centric smart street parking module with street parking algorithm, evaluation and future directions.

There is another work IOT based Parking System using Google[15], Author proposed that, there are many problems not Only in India but also in rest of the world because of unplanned parking. Hence author are trying to introduce a parking system based on IOT to make the travelling comfortable. The android applications are very user Friendly interfaces can give better results for parking places although the Google maps are the key element of this system. From these maps not only user can locate the available spaces but also can find the direction for it. This system will show the efficient place for parking and it will also direct to reach there. This can reduce accidents as well as pollution.

In the paper titled Swarm Intelligence and IoT-Based Smart Cities: A Review, Author proposed that, Smart cities are complex and large distributed systems characterized by their heterogeneity, security, and reliability challenges. In addition, they are required to take into account several scalability, efficiency, safety, real-time responses, and smartness issues. Author proposed Swarm Intelligence is a very promising paradigm to deal with such complex and dynamic systems. Swarm intelligence based algorithms and existing swarm intelligence-based smart city solutions will be analyzed. Moreover, a swarm-based framework for smart cities will be presented. Then, a set of trends on how to use swarm intelligence in smart cities, in order to make them flexible and scalable, will be investigated.

### III. TERMINOLOGIES

The traditional parking system is unable to provide some real help to the residents and drivers in the streets. Parking congestion in cities is a major problem mainly in developing countries; to encounter this, many models of parking system have been proposed by different scholars. Different ways have been proposed to make the parking system smarter, reliable, and robust. IoT base smart parking system can provide better solution for aforementioned issue, here are some building block for IoT base smart parking system.

#### 3.1 Internet of Things

The internet of things, or IoT, is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction.

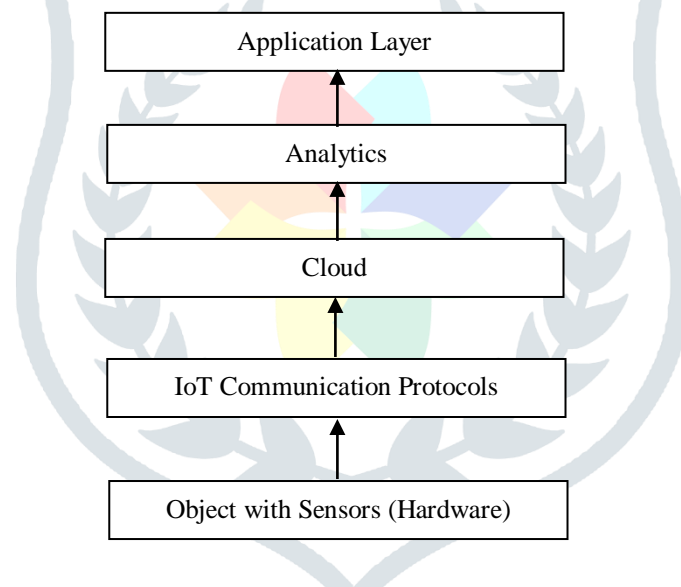


Fig. 1. Building Blocks of IoT

#### 3.2 Sensors & Hardware Layer

In order to monitor parking space and upload data to server various sensors and hardware is involved .

##### 3.2.1 Ultrasonic sensor

A basic ultrasonic sensor consists of a transmitter, a receiver, and a control circuit. The transmitter emits a high-frequency ultrasonic sound, which bounces off any nearest solid objects. The ultrasonic sound has detected the obstacle which is within the range and reflects the signal to the sensor. That reflected signal is then processed by the control circuit to calculate the time interval between the signal transmitted and received. Ultrasonic sensors are designed to sense range using ultrasound reflection, like the radar system, which calculates the time interval between the sensor and a solid object by passing ultrasonic waves. Ultrasonic sound is mainly used since it is inaudible to the human ear and it gives almost accurate results within short distances.

### 3.2.2. ESP8266 NodeMCU

An ESP8266 chip is the Wi-Fi chip, which is low in cost. It is a small module which allows microcontrollers to connect to the Wi-Fi network.

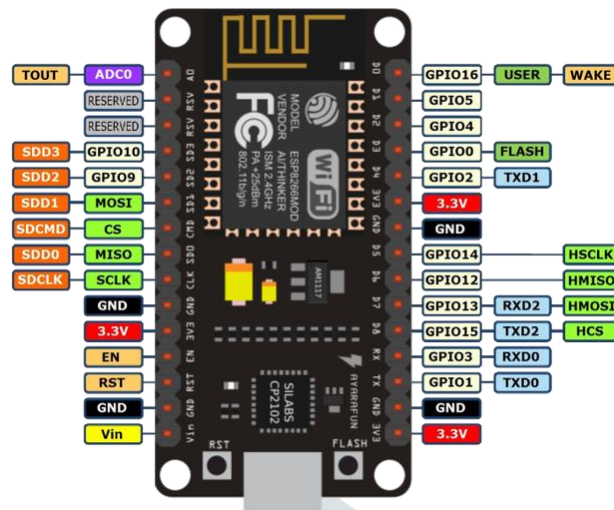


Fig. 2. ESP 8266 NODE MCU

### 3.3.3 PIR Motion Sensor

PIRs are basically made of a pyroelectric sensor (which you can see below as the round metal can with a rectangular crystal in the center), which can detect levels of infrared radiation. Everything emits some low level radiation, and the hotter something is, the more radiation is emitted. The sensor in a motion detector is actually split in two halves. The reason for that is that we are looking to detect motion (change) not average IR levels. The two halves are wired up so that they cancel each other out. If one half sees more or less IR radiation than the other, the output will swing high or low.

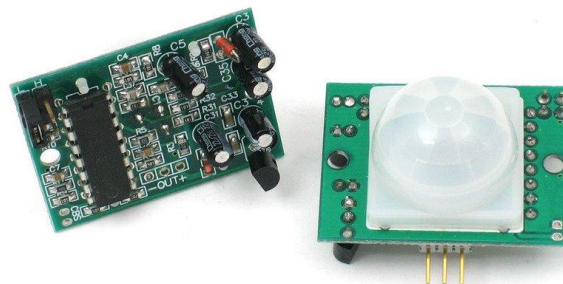


Fig. 3. PIR Sensor

### 3.3 IoT Communication Protocol

MQTT (MQ Telemetry Transport) is a lightweight messaging protocol that provides resource-constrained network clients with a simple way to distribute telemetry information. The protocol, which uses a publish/subscribe communication pattern, is used for machine-to-machine (M2M) communication and plays an important role in the internet of things (IoT). MQTT enables resource-constrained IoT devices to send, or publish, information about a given topic to a server that functions as an MQTT message broker. The broker then pushes the information out to those clients that have previously subscribed to the client's topic. To a human, a topic looks like a hierarchical file path. Clients can subscribe to a specific level of a topic's hierarchy or use a wild-card character to subscribe to multiple levels.

The MQTT protocol is a good choice for wireless networks that experience varying levels of latency due to occasional bandwidth constraints or unreliable connections. Should the connection from a subscribing client to a broker get broken, the broker will buffer messages and push them out to the subscriber when it is back online. Should the connection from the publishing client to the broker be disconnected without notice, the broker can close the connection and send subscribers a cached message with instructions from the publisher.

### 3.4 Cloud Platform

Cloud computing is a general term for anything that involves delivering hosted services over the Internet. These services are broadly divided into three categories: Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS) and Software-as-a-Service (SaaS).

### 3.5 Data Analytics

A big amount of data will be collected and generated through data-centric IoT which emphasizes on data collection, processing, storage and visualization. Data analytics (DA) is the process of examining data sets in order to draw conclusions about the information they contain, increasingly with the aid of specialized systems and software. Data analytics technologies and techniques are widely used in commercial industries to enable organizations to make more-informed business decisions and by scientists and researchers to verify or disprove scientific models, theories and hypotheses.

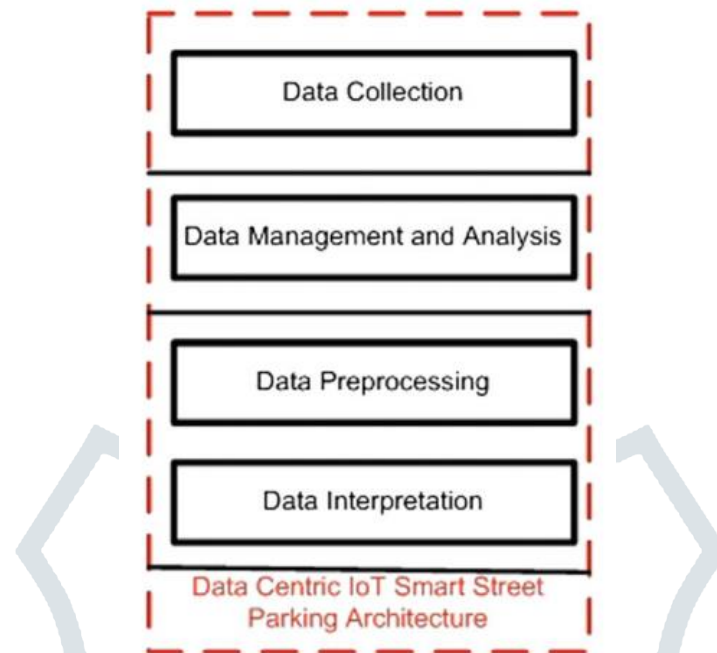


Fig. 4. Data Analytics

The data models that are run of the mill of conventional data analytics are often static and of restricted use in tending to quick changing and unstructured information. With regards to IoT, it's frequently important to distinguish connections between many sensor sources of info and outside components that are quickly creating a great many data points.

### IV. Smart Parking Application of IoT

As Internet of Things technology and data mining research help us simply the system at greater depth for convenience of people and help to make smart cities smarter. IoT base smart parking can overcome the drawbacks in previous systems. IoT base smart parking can combine WIFI base and Sensor base approach. WIFI Base approach help use to monitor parking space and monitor the vehicle from remote area. Sensor base approach help to monitor each parking slot in parking space with accuracy. As IoT base smart parking can combine WIFI and Sensor approach even one or two sensors damage or stop working we will get status. The IoT base smart parking can give auto billing by tracking vehicle. IoT base smart parking provide the user with shortest path. IoT base smart parking can give predictive analysis to driver about possible empty slot in particular area. IoT base smart parking will predict the empty parking space by analysing daily data so user can take appropriate route in city to save time.

### V. Conclusion

Thus we have detailed survey about Application of Internet of Things technology for smart parking. In the literature various approaches has been adopted like RFID base system, some research have use parking automation by using the sensor, and by using WIFI. Each approach have some pro and cons. These solution can help to manage single parking area without providing intelligence to visitors. IoT base parking management can help to solve parking problem in city and traffic flow management. IoT base parking Management can sense data from things involved in parking management and provide intelligent view of city or big organization in order to efficiently provide suggestions to driver about free parking slots. IoT base parking management will also help to route the traffic in right direction by providing suggestions to drivers.

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