Smart Parking System: A Brief Overview of the Last Decade

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ABSTRACT—This paper is based on literature review of different Smart Parking framework that explain the issues of metropolitan area and suggest the idea for stopping these issues. The unpredictability of free parking slots is actually not known on random times, regardless of whether this is known; numerous vehicles might pursue few parking spots which thus prompts sticking in rush hour causing road lock. The calculation will control drivers to discover and guide them to their individual parking spot at the passage level. This paper examines various techniques using different innovation like Zigbee, GSM based, Microcontroller, image processing, wireless Sensor network, number plate acknowledgment, automated stopping framework with sensor Fusion based, Bluetooth vitality proficient and solid shrewd stopping framework. This paper will help the new researchers for learning different methods of smart parking system.

Keywords—Smart parking system, automation parking, intelligent park system, real time parking.

I.INTRODUCTION

In the daily routine it is observed that drivers are facing parking problems in the urban areas. Wrong parking may cause the congestion of space and create more problems. For finding a parking slot driver require 5 to 7 min [1] for searching the slot and this may waste his time. In the ongoing examination of metropolitan areas, the increment in population produces bulk vehicle on roads. Consequently, this prompts irritating issue for the drivers to find the leaving space for their vehicles. The drivers generally sit around idly and exertion and wind up leaving their vehicles find a space on lanes through karma. In most pessimistic scenario, individuals neglect to discover any parking spot particularly during top hours and happy seasons. There are some controlled techniques that guide the driver for finding the parking without the wastage of time. Although some techniques and algorithms produce a good result for finding a parking slot but it contains shortcomings as well. Some mobile applications may help the drivers in real time scenario to park the car on available slots, somehow this is dangerous to use mobile at the driving time. Using mobile apps driver can find a parking place at any possible parking slot but it may sometime reduce the miss of the best parking slot as well. Some apps and systems are specially designed for the

static parking slot for malls, cinemas and parks etc. they all are using different algorithms, techniques and devices for producing the best result of parking system. Different authors use different names for this like automation, real time processing, smart systems etc.

In this paper there is a brief overview of last decade's different techniques. Smart Parking system uses communication of data and technologies to increase the efficiency of system for the general public and reduce their wastage of time for finding parking. Wireless sensors, Automation, Machine learning and Internet of Things (IOT)are the emerging technologies which drive towards Smart Parking system adoption. City can be considered as "Smart City" by using system like Smart Parking System that include mobile applications and web applications to help and guide drivers. Drivers can find parking slots easily and this may reduce blocking on roads, in this way traffic can be track and control by Smart traffic management. Smart traffic management share information electronically and monitor the changes of environment including sanitations, blocking etc. Different methods and frameworks are designed to resolve this issue. Stopping Guidance and Information (PGI) frameworks will give the drivers successful data on stopping

inside controlled territories and lead them to exhaust stopping spaces[1]. Furthermore, stopping the board framework is likewise accessible which is utilizing ZigBee innovation [2] and other devices as well. Before the discussion of different author's techniques, here is a brief introduction of the devices that are using to detect a vehicle in the parking system.
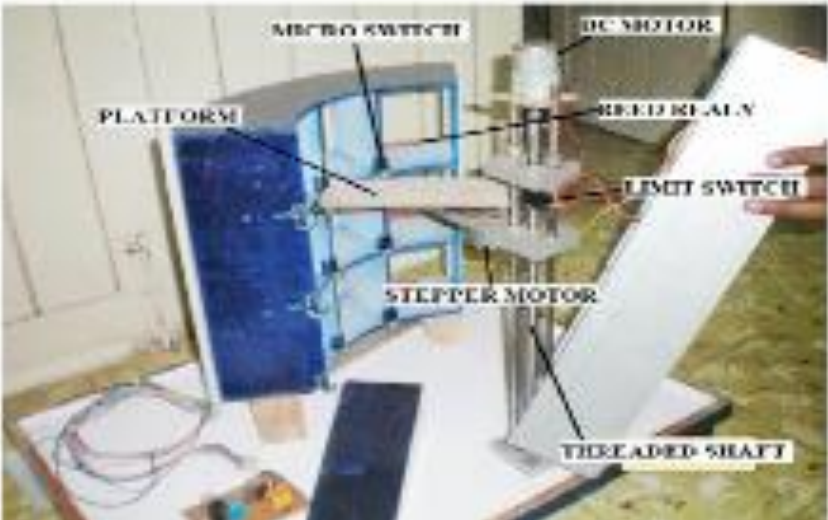
Table 1: DEVICES USED IN CAR PARKING

Device	Working
Microcontroller	Microcontroller is used for monitoring a product's behaviour and functions. It is also known as embedded controller. It runs at specific program and dedicate a single task. These are low-power machines with fragile input instruments and limited output LCD or LED display. Microcontroller take inputs by transmitting signals to various parts of device. It controls and maintain the transmission of signals. TV is the most common example microcontroller device. It takes input signal from a TV remote control and provides its output on the television screen. It includes features like memory, input and output devices for transmitting signals.
Active infrared sensor	Active infrared (IR) sensors detect and emit radiations using infrared rays. Active IR sensors have two components: Receiver and Light Emitting Diode (LED). When sensor detects any object, the LED reflects infrared rays upon the target and receiver detects this light. Active IR sensors are also called proximity sensors because they are commonly used in obstacle detection system, for example robots.
ZigBee	ZigBee uses frequencies for transmission, it transmits data at the rate of 250kbps. It includes frequency ranges, 868 MHz, 902 – 968 MHz, and 2,4 GHz. It uses low power fan unit and prolongs the battery timings. Sensors and actuators use high data rate for communication standard this require low power and latency for effective working. System designer usually consider ZigBee as compared to Bluetooth due to transmission speed and time. ZigBee is ideally suited for IoT devices like embedded systems, industrial automation and home automation, etc.
Weight in motion	Weight in Motion Equipment tests the per-axle weight and gross weight of vehicles for the drive at highway speed when quartz piezo sensors are mounted. This system senses axle-spacing in order to distinguish the vehicles by gender.
GSM	GSM incorporates FDMA (Frequency Division Multiple Access), TDMA (Time Division Multiple Access) and Frequency hopping. Initially, GSM uses two 25 MHz frequency bands: 890 to 915 MHz for uplink and 935 to 960 MHz for downlink. Two 75 MHz bands were later introduced. GSM combine FDMA and TDMA method to involve the division of frequency and each carrier frequencies divided in time which form logical channel of many devices.
RFID	Automatic Recognition and Data Capture (AIDC) provide the technology known as RFID.RFID have antenna and integrated circuit used to transmit data to the reader of RDID known as "interrogator". These radio waves transform into more accessible data form by the reader.
Bluetooth	Bluetooth is a wireless technology that uses spread spectrum of frequency hopping. Frequency-hopping spread spectrum (FHSS) transmit radio signals to several frequency channel that is known by transmitter and receiver. These signals can be modified by the transmitter for different frequency channels.

Video Image sensor	Video image sensor senses the image to transfer information. It translates light waves variable attenuation (passing and bouncing from object) into signals that convey information. It creates image that give brief current bursts to the information.
Arduino	The Arduino is actually just an 8-bit AVR microcontroller, with some additional hardware to get up and running faster. There is additional hardware includes: a USB-to-serial board to program the microcontroller and track computer's serial port. Power management-this means moving 6 + volts down to 5v for most Arduinos to power the microcontroller and anything attached to it, although there are also 3.3v models. A (usually) 16mhz crystal-most of AVR's 8-bit microcontrollers have an internal clock running up to 8mhz, but need an external crystal to run faster. Some handy headers to link external hardware easily to the pins of microcontrollers. Beside from hardware, the Arduino also comes with a custom "bootloader" loaded in AVR to make "sketches" easier to load. The Arduino IDE also includes a whole host of program libraries, so you don't have to write too much low-level code to turn on and off the registers.
Acoustic Sensor	Acoustic wave sensors are so called mechanical, or acoustic because wave is their detection mechanism. Piezoelectric acoustic wave sensors use an oscillating electrical field to generate a mechanical wave that propagates through the substratum and is then transformed back to a measuring electrical field.
PGIS	Participatory Geographic Information Systems (PGIS) is a spatial information technology that includes Global Positioning Systems (GPS) and Geographic Information Systems (GIS), Remote Sensing Software (RIS), and open access spatial data and imagery that empower the given command. Differential access will provide the benefits to the detriment of neighbourhoods and local people for influential individuals and interests, and marginalizing already oppressed. The publication 'Participatory 3-Dimensional Modelling (P3DM)[3]describes how local people were educated to use the technology to create their own 3D models and maps and study these maps and models in their own way.

II.METHODOLOGY AND DRAWBACKS OF LAST DECADE

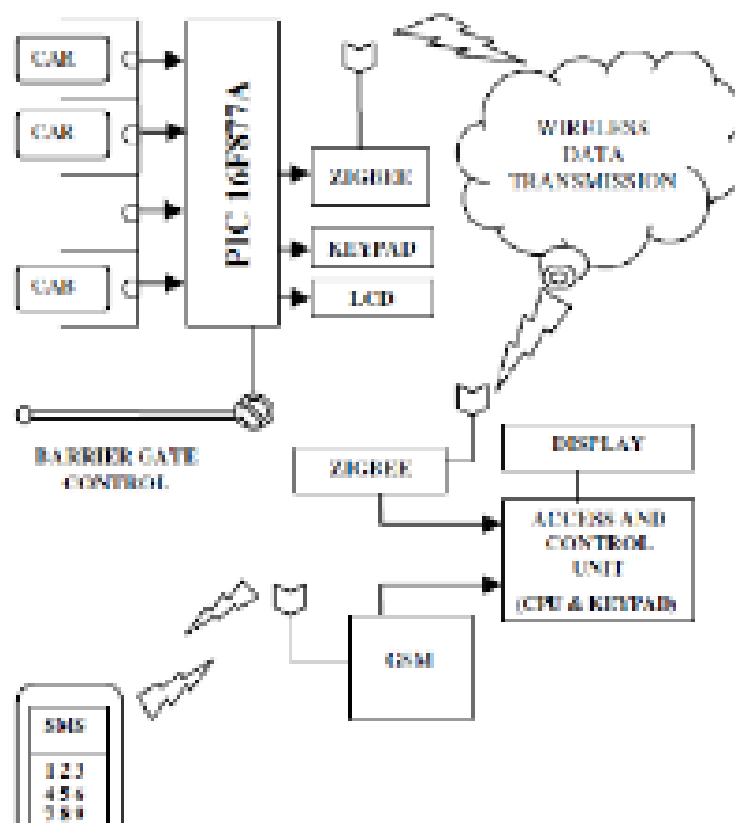**Table 2: METHODOLOGY AND DRAWBACKS OF LAST DECADE**

Authors	Paper Name	Methodology	Drawbacks
Mehta. C, Soni. J, Patel. C, 2011.	Microcontroller based multi-story parking[4]	In this paper, proposed methodology uses 8051 microcontrollers. There is an obstacle sensor used to detect the incoming car, outgoing car is sensed by headlight sensor and stepper motor used to lift the car movement. These sensors are used to sense the movement of car on the floor. There are two motors used in the proposed model. First one is stepper motor for horizontal movement detection and second is DC motor for vertical carrying movement. Current location of car is displayed by the seven segments and operator can display entered location by him using other segments. Empty spaces are indicated by the operator for parking. Fig 1: System Overview Paper 1 	The drawback of the proposed methodology is that vehicles have to configured in given mention spaces and required lot of maintenance issues.

| Ashwin Sayeeraman, P.S.Rameshs, 2012.	Zigbee and GSM based secure vehicle parking management and reservation system[5]	In this paper, proposed methodology uses Global System for Mobile Communication (GSM). Proposed system of the paper consists of three modules: Monitor, Security Reservation and SMS. Monitoring module is used to monitor the space or status of parking in the area. Security Reservation module is used to provide reservation for parking by sending SMS from user. SMS module is used by the user to send and receive the confirmations of parking.	The drawback of the system is actually advantage considered in the system that is SMS Module. It is expensive and breaks down if network congestion is occurred. Since SMS module contains entry/exit password for reservation this may lead the system to halt state in most of the times.

Fig 2: System Overview Paper 2

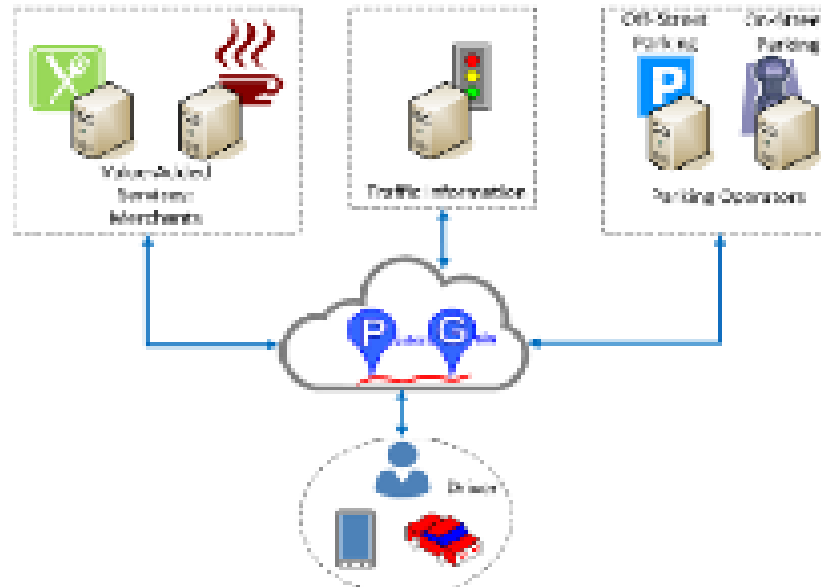| Sanaa Alfatihi, SoukainaChihab and Yassine Salih Alj, 2013. | Intelligent Parking System for Car Parking Guidance and Damage Notification[6] | In this paper, proposed methodology is known as intelligent parking system (IPS) having two modules: Car parking guidance and car damage notification. Car parking module assist the driver for parking without any damage. It assists the parking details in less time and provide suitable spot details, notify about damage or scratching of car in the absence of driver through sounds or visuals. Proposed system in the paper is based on algorithmic control system that provide parking details and notification about damage in a systematic way. The IPS system indicates the direction of wheels on the on-board computer screen by providing path planning image. When driver is not in the car, vehicle damage is recorded by the damage notification module which consists of car-camera shock sensors placed in the front and rear of the vehicle.

Fig 3: System Overview Paper 3
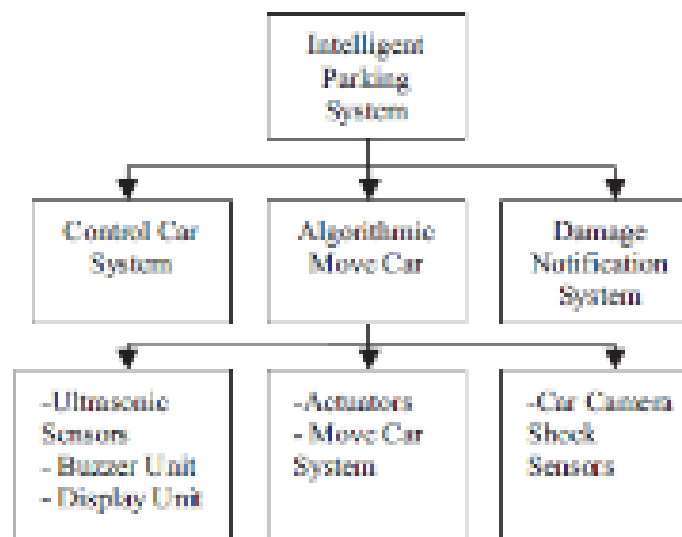
 | The drawback of the system is that, this system not guide the driver about free parking slots, it only uses the modules for save parking and notification about damage. But it is not useful on gates or area where driver need to know where car have to park. |

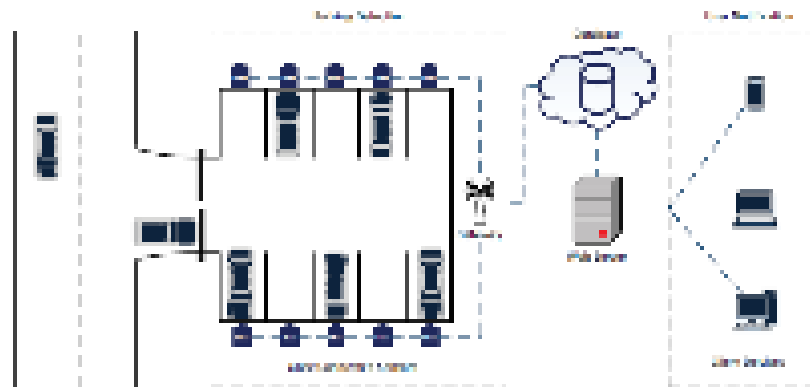|			
Pablo Sauras-Perez, Andrea Gil, Joachim Taiber, 2014.	Parking Gain: Toward a Smart Parking Application with Value-Added Services Integration[7]	In this paper, proposed methodology is based on an application that is used to help the drivers for parking and reduce the burden of environment. Proposed application simultaneously provides the advance reservation for parking before the starting of the trip. Proposed methodology named as "ParkinGain" helps the drive to find out the parking in a congested city. Additionally, this system provides digital coupons and merchant's information close to the parking areas. The application can be used by car HMI or installed on mobiles of drivers. Driver can extend their parking times if needed using the application. This smart parking system provide benefits to merchant and add the services to the system subside the cost of system.	The drawback of the system is that it is costly than other systems and benefits to merchant-based parking for special not publicly used areas.

Fig 4: System Overview Paper 4

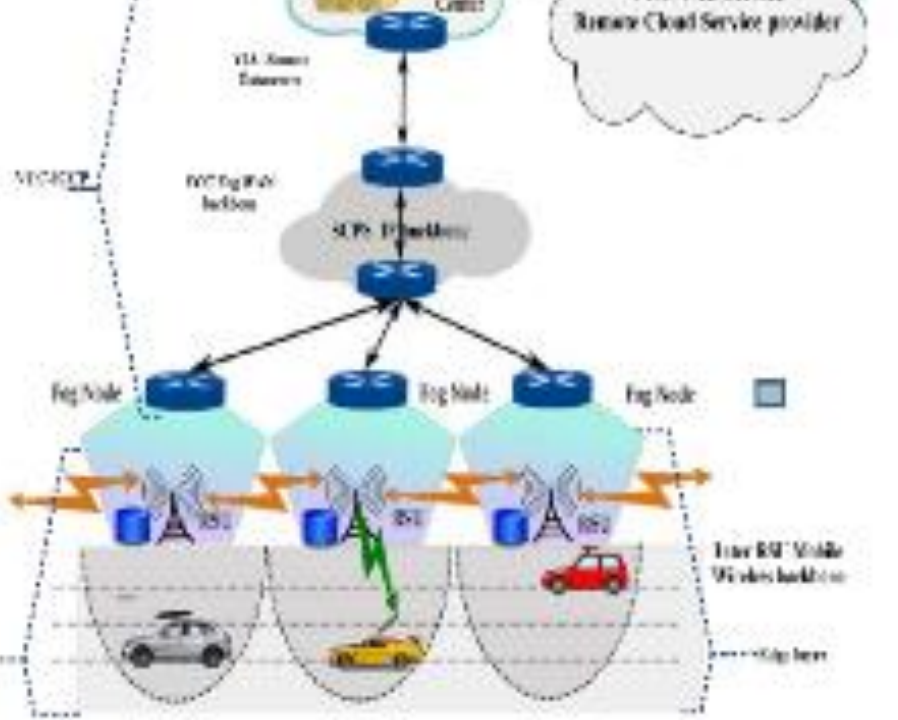| Xuejian Zhao, Kui Zhao, Feng Hai, IEEE, 2015. | An Algorithm of Parking Planning for Smart Parking System[8] | In this paper, proposed methodology presents the parking algorithm for better usage of resources. Paper proposed methodology consider the parking problem as a linear assignment problem and presents algorithm for this problem. They consider vehicles as job and parking spaces as agent, the costs of the agent are calculated by the distance between parking space and the vehicle. They solve the parking planning problem by designing the algorithm after this assignment of agents. In the real time smart parking system, this system gives efficient guide information to the vehicles timely. They also simulate the parking planning to the world by performing experiments on different data and shows the effectiveness. | The drawback of the system is that it is complex due to assignment algorithms and costly in the implementation. This system cannot deal with the adaptive number of vehicles in the queue. |

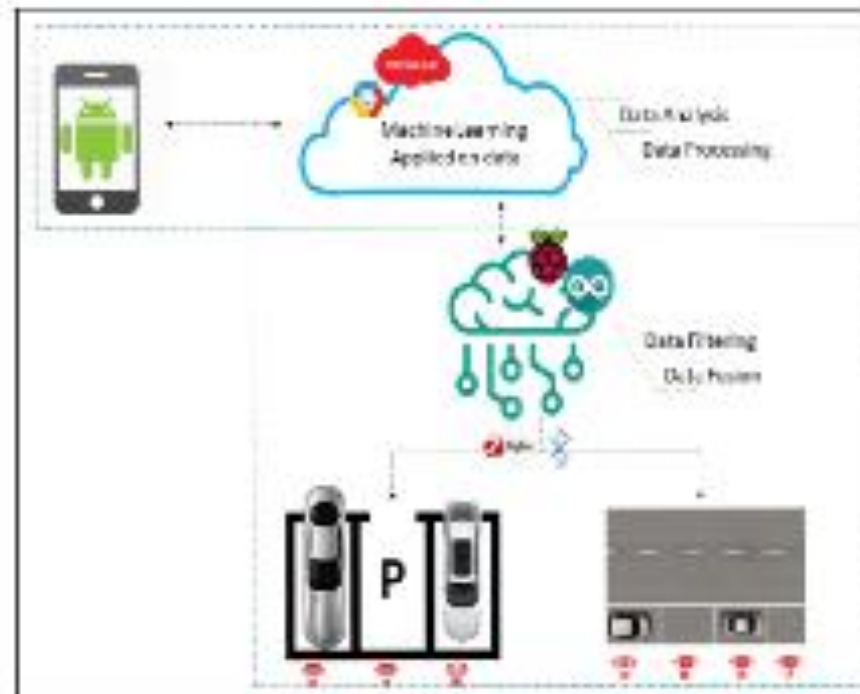|			
		planning in the real world.	
Robin Grodi, Danda B. Rawat, Fernando Rios-Gutierrez. IEEE, 2016.	Smart Parking: Parking Occupancy Monitoring and Visualization System for Smart Cities[9]	In this paper, proposed methodology is based on the Wireless Sensor Network (WSN) used to detect the ideal parking spot and transmit this information to database, User can view this information by using mobile application or by website for the parking updates. This system provides real time detection for the user to find the nearest parking place. WSN allows flexible placement of sensors, using this system waiting time of vehicle may reduce and this led to the reduction of vehicle fuel consumption in waiting time and traffic jams on the road. This system provides efficient way of parking using sensors. Fig 6: System Overview Paper 6	The drawback of the system is that it only deals with the parking lots parking, not with complete parking scenario. Also, if the network goes down the system will shut down for the parking.

| Anderson, E. C., Okafor, K. C., Nkwachukwu, O., & Dike, D. O..2017. | Real time car parking system: A novel taxonomy for integrated vehicular computing[10] | In this paper, proposed methodology embedded the design coding for the edge VCs, Network Fog centres control the input of vehicular traffic of data stream admission for SPCS; admitted – minimum-energy of data stream is dispatched; At the Fog layer, Networked Fog Centres hosted Virtual Machines (VMs) for the adaptive consolidation and reconfiguration; and injected traffic adaptive control into mobile connections of TCP/IP. The characteristics of the proposed methodology VCC scheduler is that: (a) it allows dynamic and distributed and scalable VCs; and, (b) this system is capable of providing composite QoS satisfaction up to the maximum instantaneous rates of the data stream traffic transferred to the clients of vehicle. Proposed system VCC SCPS real performances includes (a) Fog Layer consolidation and reconfiguration (b) wireless attenuation (c) client mobility. This system can be implemented in real-time at shopping malls, supermarkets, restaurants, schools etc. anywhere. This system studies a novel cognitive computing inspired VCC that has effective resource management and scheduling optimization.

 Fig 7: System Overview Paper 7 | The drawback of the system is that it is only used in Nigerian context and the usage of devices like LCD, LED, sensors etc. makes the system costly. This system also uses complex architecture and cloud services which makes its implementation complex. |

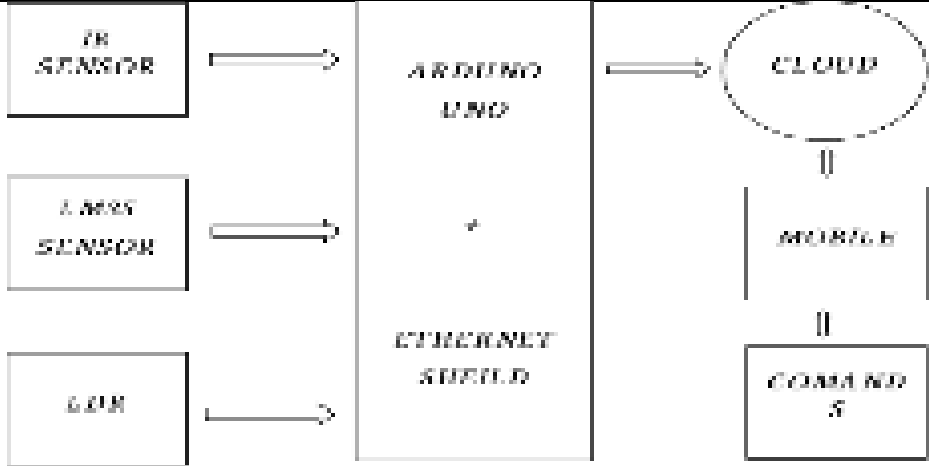| Wael Alsafery, BadraddinAlturki, Stephan Reiff-Marganiec, Kamal Jambi, 2018.	Smart Car Parking System Solution for the Internet of Things in Smart Cities[11]	In this paper, proposed methodology is based on machine learning algorithm and transmit the data on cloud by using filtration techniques and fusion methods to reduce the noise in extracted raw data. This system provides nearest parking information with the road traffic and congestions information. This will help the user to find the accurate place for parking and minimize the critical issues. The main objective of the	The drawback of the system is that, this method is collecting raw data prompted from different sensors for the filtration from the cloud and sent back after processing. This technique considered as

system is a) an approach to filter sensor data to detect the presence of vehicles in parking spaces through the use of wireless sensor network by localized storage, b) a middle-ware framework that can handle sensor generated data to support the method, c) Present a new multi-Edge-Fog parking network to reduce traffic congestion by showing available empty spaces, ensure that the closest parking spaces are advertised to drivers, and also to prevent as much traffic congestion as possible.

an expensive in terms of the data transmission as well as the consumption and energy cost.

Fig 8: System Overview Paper 8

| Shruthi Mudaliar, Shreya Agali, Sujay Mudhol ,Chaitanya K Jambotkar, 2019. | IoT Based Smart Car Parking System[12] | In this paper, the proposed methodology is a complete unit mix of hardware and software. CLOUD is responsible for the exchange of all information or data between mobile and sensor circuits. The algorithm determining the allocation of the parking slot is as follows: the initial collection and testing of car parking is made from a cloud-based smartphone or device. Checks the number of S1, S2, S3, S4 parking spaces. If the parking slot is available, Green will be the same slot on the HTML site. If all the parking spaces are full, all the slots on the HTML page are RED and a "Parking Full" pop-up is created. The block diagram describes the hardware component for the implementation of the device. It includes an Arduino microcontroller as the key processing unit and it collects outputs from the IR sensors that direct the consumer to recognize the vacant parking space, LDR is a light-dependent resistor which gives a pop-up alert when the darkness rises, i.e., temperature detector. LM35 tracks the temperature of the parking areas. The information from these sensors is sent to the microcontroller. The microcontroller is designed in such a way that if any of the sensors detects the vehicle then the subsequent information is transmitted to the cloud via the protocol and various layers of the OSI system that we can access the data on our phone through an app or a JavaScript site on the computer and view the parking lot of any place to get the empty parking slot.

Fig 9: System Overview Paper 9 | The drawback of the system is that if the internet connect is lost the web page will not upload and all information about parking is not visible. This system is costly due to combination of costly sensors and cloud-based method. |

| Mackey, A., Spachos, P., &Plataniotis, K. N, 2020. | Smart Parking System Based on Bluetooth Low Energy Beacons with Particle Filtering[13] | In this paper, proposed methodology works on indoor and outdoor parking for citizens. To improve the accuracy of the system, particle filtration is used on Bluetooth low energy (BLE) beacons. This system is designed and deployed through BLE connectivity with smartphones. Proposed methodology is based on real time automated paid parking system that find parking spaces for the users using unique BLE beacon. Different sets of experiment examine aspects of the system. These extensive experiments on indoor and outdoor was able to find the correct parking space for the user, and also calculate the distance of user from the beacon. The system has three components that uses wireless technology:

 (a) Cloud Server (b) Smartphone (c) BLE connectivity

 In this system a framework is presented for smart parking using BLE beacon devices. They develop an application that people can use to find the parking spot easily and securely. Application also integrated with the cloud services. The application is also integrated with cloud-based management services.

 Fig 10: System Overview Paper 10 | The drawback of the system is that the main component is the cloud server, if the server goes down the application will not work properly. Bluetooth connectivity demands small distance as well that will cause complication for the user. |
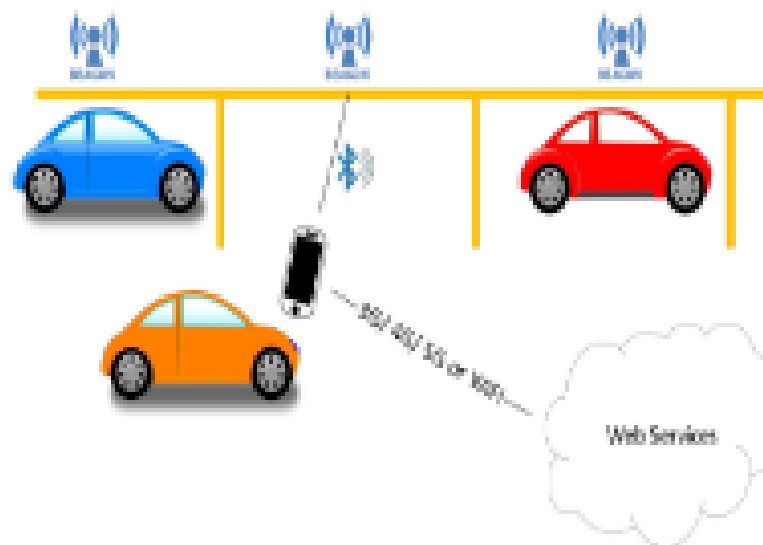
III. CONCLUSION

Technology advancement required smart city with smart parking system for drivers. Drivers are demanding easy and secure parking. In this paper different methodologies have been discussed to provide the authors to manage new system with better methodologies and advantages. In the above discussed methodologies, many solutions are successful in real time environment and others are analysing for better solutions. Advance parking and reservation system is used to allocate the suitable parking area. The real time environments are used to monitor the parking by using different notification systems like SMS etc. After analysing the different systems and solutions, it is been observed that many systems have drawbacks like expensive modules, failure in data transmission module, Bluetooth functionality for minimum distance, cloud-based services for databases lead to unauthorized access and server-based management for different areas. These drawbacks need to be eliminated for the enhancement of the systems and increase overall performance.

ACKNOWLEDGMENT

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BIOGRAPHY

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