

# IoT based smart parking model using Arduino UNO with FCFS priority scheduling

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## ABSTRACT

Develop a suitable method to handle parking problem in the crowded big city, as per the demand and number of parking slots available, by giving priority to the users with help of smart parking system. This study proposed Internet of Things(IoT) based smart parking model using the Arduino UNO model in implementation. This proposed model helps users to allocate booking users vehicles parking free available slot as per time to time availability in college campuses during technical fest in different parking slots and locations. In this working model, Passive Infrared, with ultrasonic Sensors are used which helps to deducting the available parking location and allow us to find out for giving priority based First Come First Serve based(FCFS) scheduling of parking allotments as per slot is vacant count. This model examine the way of the proposed system with utilizing scenarios of various possible ways with FCFS which show the significance of the parking model using IoT platform. The parking availability detection is capable to find solutions for an empty vehicle parking area for monitoring and reduces users search time as per an automated smart parking model using the internet of things, sensing devices and Arduino UNO("Uno" means one in Italian languages) in giving priority to users with scheduling model is actual findings with Smart systems. This study proposed an automated parking system to function on a real-time basis to detect all empty parking places based on the internet of things platform, with help of sensors. Arduino UNO platform brings automation to this system on per priority basis to all the users with scheduling techniques. The priority given to users with an automation system is a novelty compared with an existing system. This smart parking is working on real-time basis inputs based on that user demands priority is varying to book parking slots with first come first serve preference.

## 1. Introduction

In digital era, nearly everybody owns their vehicle which is basic needs of transportation in day-to-day life. Such scenario the usage and high demand of vehicles parking which is increasing rapidly so its is very critical scenario helps to figure out user vehicle parking slots in highly populated cities, particularly in peak timing of more vehicle's parking usage. Vehicles users if they are able to find their parking slot space before reaching that particular location is very much useful in handling parking issues easily. For this we need system which brings users and

parking space service provider together in common platform that able to address the issues of non-availability of parking space.

IoT is connected multiple nodes together by using the Internet which enables communication among the peers of people, computers and anything as an object. IoT is beneficial in terms of development and network advancements of technology for connecting things which can be monitored and computed, sharing signals among peers and controlling administrators. Nodes are much more intelligent based on the recognition of devices, tracking, and observance of anything part of the connected network. IoT relates to 3 important key things like a sensor

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network, radio frequency like RFID, and terminal computing systems are very important for achieving the functionalities of IoT [1].

Smart parking system can be build using IoT platform, where all stakeholders can part of the smart system. The problem much focused on parking slot allocation based on user given priority with IoT platform to make parking location smart system operated with help of automation explained flow of different layers in figure-1 [2], The mobile application helps users to access available parking slot booking FCFS.

This article also describes importance of Erlangian distribution for priority queuing technique for use case to give best outcome of the proposed model. As demands of parking increase every part of the college campus during festive time and smart parking helps to work out easily. Mettupally et al. (2019) [3], and [4] In Digital platform automation are increased due to industry 4.0. everywhere with users customization. When compared with western countries, in India struggle is more for parking space location finding and also more dominant due to the massive population in all the major cites. Therefore in developing country nowadays taking smart model to implement as per smart city projects, examples of such project is smart traffic system, monitoring of traffic as per work by Refs. [5–7].

In the existing condition, Internet of Things is an emergent subject as per including, computing and sensing device systems, with sensing devices, immense data collections and generating to apply in that with AI model is to give complete entrenched system for application usage. Hence IoT model are highly flexible, trustworthy, effectual and simple to use and handle, in the way deep utilization in various applications. With help of IoT information can be gathered more efficaciously, system operations can be finished in highly precise with connectivity. Internet of things platform used in wide range of application to automat model with edge computing [8,9]. The sensors and actuators are useful to collect data from real time inputs. The networking model based on NFD (NDN Forwarding Daemon (NFD) is a network forwarder which is used to implements the Named Data Networking working protocol), Wi-Fi, Bluetooth and Zigbee the sensing device are utilized with network for communicating purpose. These sensing device connecting with wide range of network models like GSM, GPRS, 3G and LTE, [10].

Due to commercial, unsuitable control of empty parking slots vicinity end in problems applicable to parking. Mohamed A. et al. (2020) [11, 12] It is especially important to discover a comfortable and safe, automated, sturdy, and impartial device to be able to assist to pick out unoccupied empty slot locations, directs away closer to the parking area, choice of appropriate parking charges and suitable employer of the parking available system [12,13]. The gift advanced device is plenty

beneficial for vehicle parking workers, parking service providers and beneficial in surrounding locations. As per the data gathered the use of a smart parking model, it'll be used to forecast new patterns in the smart system. Solic, P. et al. (2021) [14,15], Let us focus on how its implemented using IoT platform what is advantage of smart parking and the same way its lagging in terms of giving priority to end users based on preference to the users using some logical way of handling issue like scheduling of given preference to end users as per Table 1.

## 2. Proposed methodology

The proposed system working with automated platform IoT with help of sensors data analysis. Data sets used to understand the demand and allotment of parking IoT is based on data collection like object\_id, Parking\_lot id, Created by, Modified by, Creation\_date, Creator, Edit\_date, Location, Latitude, Longitude. Geographical area used to test this prototype system during annual festival function of TechFest 2021 in the locality of Visakhapatnam area college Campus.

A sensor-based IoT smart parking model aids in the construction of buildings based on their location, data gathering from office locations, and processing and data manipulating on IoT edge with smart devices. Based on the studies and evaluation of various models, as well as our reading of publications, we have begun to collaborate on a viable model that would gather and apply current traffic and vehicles related traffic information to a specific site during periods of high demand for parking spaces. In figure:1-Three layers of the working model of the system are explained the application of the smart parking model topmost layer, the transmission layer for communication among peers with connected networking channels, IoT Sensor layer for signal data collection from working environments.

System working with three different parking sensors like Ultrasonic sensors, Electromagnetic and Rear-facing cameras sensors as given in Fig. 2. In this working model, Passive Infrared, with ultrasonic sensing device are used which helps to deduct the available parking slot and allow us to find for giving priority based First Come First Basis scheduling of parking allotments as per slot is vacant count. To find out the presence parked vehicle we can use ultrasonic model sensors in this smart parking systems.

This is simplest and popular logical algorithm called as First Come First Served (FCFS). This helps us to considers booking tasks in the order of sequence of their inputs request arrival in the smart platform IoT system. And this schedules for each booking task until there is enough required available free slots for that not enough resources available to book it. Then FCFS algorithm with priority queuing model awaits for enough available free slots to be freed by the completing of the previously incomplete scheduled (Booked parking to be free until) booking tasks. Lionel [21] Erlangian distribution applied for priority queuing is explained with two inputs queue how they get their services completed with function(t) and k.

Priority queuing model with two types of customers priority. This method allowing the customers of different priority waiting in queue. Priority based on two listed categories of given preferred rules like, preemptive and non-preemptive priority models as per equation (1). In many complex queuing models, Erlangian distribution which provides a very good initial point for the systems with different phases or different stages and levels.

$$f(x; k, \mu) = xk - 1e^{-x/\mu} / \mu k(k-1)! - \quad 1$$

K is used as a shape parameter. This always positive number,  $\mu$  is used as a scale parameter which is a positive real number. Scale value metric is the reciprocal of rate metric value,  $\lambda$ , i.e.  $\mu = 1/\lambda$ . Mean calculation using:  $k/\lambda$ , Mode value using:  $(k-1)/\lambda$ , Variance is based on  $k/\lambda^2$  [22]. A process which is sequential level giving rise to an Erlangian distribution depending upon whether or not those such phases have identical distribution as described using equation-1 as shown in Fig. 3.

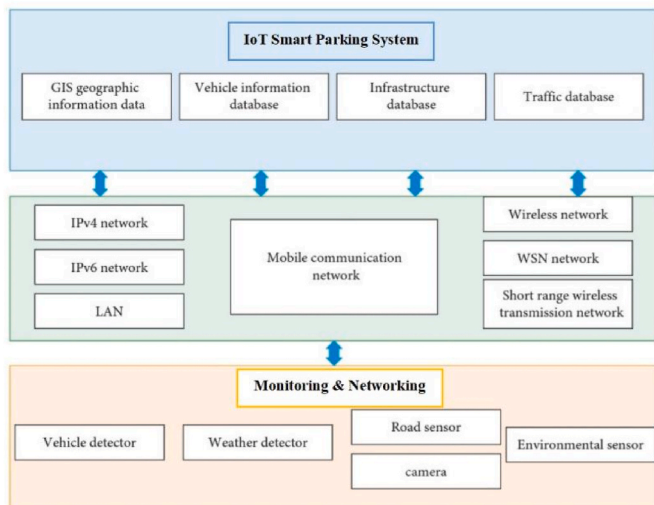
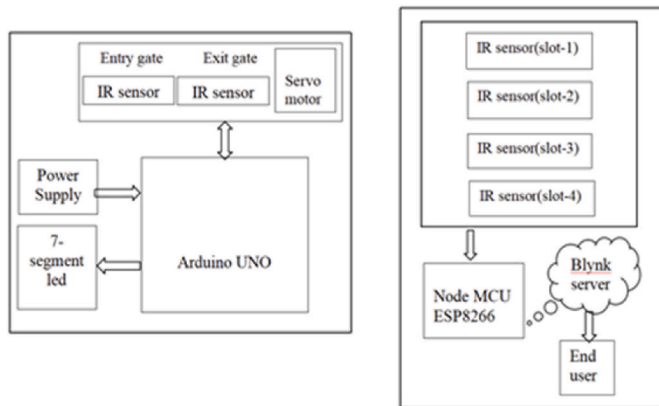
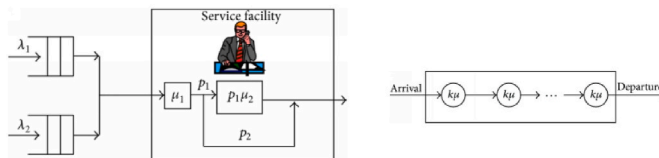


Fig. 1. IoT based Smart Parking System Operational and Communication Framework.

**Table 1**

Related smart parking system with different methodologies of implementation.

S. No:	Reference number	Year of publication	Methodology	Advantage	Limitations
1	Mettupally, S. N. R. and Menon, V., "A Smart Eco-System for Parking Detection Using Deep Learning and Big Data Analytics," 2019 SoutheastCon, 2019, pp. 1–4.	2019	Deep Learning and Big Data, CNNs with Supervised learning system.	CNN-learning models-smart system detection and classification framework.	High-end Camera Classification of objects and detection model
2	[4]. Ali, G., Ali, T., Irfan, and et al., "IoT Based Smart Parking System Using Deep Long Short Memory Network", Electronics 2020.	2020	IoT over Wi-Fi with Arduino Uno in Android applications	Android Platform, Algorithm proposed	No priority based booking slots
3	[16]. Urooj, S. Alrowais, F., Teekarafman, Y., Manoharan, H., Kuppusamy, R. "IoT Based Electric Vehicle Application Using Boosting Algorithm for Smart Cities", Energies 2021, 14, 1072.	2021	IoT, Boosting Algorithm	IoT Platform	No booking priority
4	[17]. An IoT Based Smart Parking System. Journal of Physics: Conference Series, 1339, 012044.	2019	Sensor with RFID Tag are utilized	IoT Platform with RFID tags	Expensive for setup and also time consuming for working model
5	[18]. Roja T V, Sandhya N, Ashwini, Harshitha Bedre, "Smart parking system using IoT", IJARIT, 2018.	2018	Number Plate Recognition, OCR algorithm is used to recognize the input character with certain condition	This system is designed specifically for Malaysian license plates design models, it can be extensible to other license plates other countries	OCR reading must used high-end camera devices
6	[19]. Implementation of an Image Processing Based Smart Parking System Using Haar-Cascade Method. In 2019 (ISCAIE), (pp. 222–227).	2019	Haar Cascade, AdaBoost Algorithm (Raspberry Pi, Cloud, IoT)	The car can be detected from any angle of view.	In multiple-car detection, the accuracy is affected by the car and shadow, which results in detecting two cars as one object.
7	[20]. Khanna, A and Anand, R., "IoT based Smart Parking System", 2016 ICIOT, India 22 Jan - 24 Jan.	2016	Mobile Application model with Cloud platform	low level security for identify the theft as well as the vehicle related information	NA

**Fig. 2.** Block diagram of the proposed system.**Fig. 3.** FCFS based Priority Queuing system for Smart Parking and Erlangian service facility-k phases. Lionel [21].

### 2.1. The important elements of the working principle

The first foremost is electricity input given to entire system, as per the Thermal infrared-TR Sensing device, we will collect required data signal for park slot data available and getting connected with node-mcu. This model facilitates to locating looking with inside the free vehicle park area with usage of Blynk. The IR Sensor related with NODE MCU then reveals a free area from the automated parking model. The LED flash primarily based totally at the range of parking to be had empty slots. The various stage of working model explained in the following

points.

- Initiate working model by switch on the electricity input for complete system as per designed model.
- NODEMCU as IR Sensor able to connect with fully functioning parking slots deductions to know availability of unused parking space.
- Blynk application useful in finding free parking lot as per given data for better performance of booking slots availability with help of TR and IR Sensors.
- NODEMCU can able to find the available free & non-utilized park area for smart system and take preference of FCFS technique to book vehicle park. Priority scheduling given importance for early booking parking lots with smart application.
- As per utilized park slot and free slot area details data are stored on Blynk cloud by collecting and updating the database system storage. And with help of NODE-MCU able to access in any particular time and anywhere for vehicle advanced booking lots space.
- This working model can able to display the number of free space using LED based on booked slots from smart application.
- Blynk terminal are used to display as per free park slot information to users. It helps users and administrator to know that all slots current status information as per booked and available slots.
- As per flow else go to step e repeat again from previous procedure e
- System display its free area using Blynk Cloud information which enables users to book their parking free area space with help of online platform based on FCFS preference.
- Applying First Come First Serve based scheduling to allocate booking slots with combining free slots together this helps users to know who is given prior preference for advance booking slots as per early booking.
- Whenever its booked in that particular moment display of LED indicate as off state as its booked slot to know other user to aware of booking status
- NODEMCU using IR helps us to open parking lots based on user advance booking lots to utilize that automatized smart system.

Here entire working model system flow completed for proposed model on the basis of IoT smart system and Priority Scheduling.

## 2.2. Micro-controller

The purpose of Micro-controller is to do signal processing as per its functioning model. The remaining components are memory utilization and receiver information and sender of information signal are part of this working function. The important part of microprocessor is similar to heart of the complete computing model as displayed in Fig. 4. No required extra more components for working model the reason is necessary all main peripherals are built within system.

## 2.3. Working model-hardware components

### 2.3.1. Arduino ATmega 328P micro-controller for proposed model

This is very important component of the Arduino micro-controller board for working. Some of the listed features are: 8-bit micro-controller shown in Fig. 5 as [5,23,24]:

- flash memory with 32 KB, SRAM with 2 KB for micro controller.
- 1MIPS per MHz for measuring computing speed of controller.
- SPI serial port with 20 GPIO pins are equipped for input and output of controller board.

### 2.3.2. IR sensor for object deduction

Infrared Sensor as IR. It able to detects any obstacle in opposite of it which have three pins like VCC., GND & OUT. Two LED's one for IR transmission and another one IR receiver with LED for displaying information to the end users in parking lots.

### 2.3.3. Servo motor with angular positioning

This is useful as rotatory sensing actuator which helps to perfect control over in angular positioning, with capable of velocity and corresponding speed of acceleration. Adoptable motor are coupled with sensing to collect their feedback signals. Hence specific motor class are called servomotor for in close-looping controlling model Mettupally, S. et al. (2019).

### 2.3.4. MCU ESP8266-Open source board design

Prototype designing board are available Open-source firmware software. "Node MCU" named as micro-controller unit to referring firmware which are not associate with development kit are shown in Fig. 6, [10].



Fig. 5. Arduino UNO and node MCU

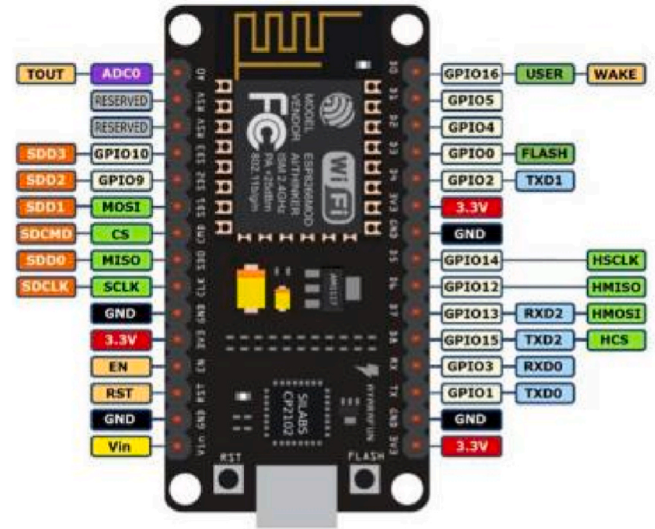


Fig. 6. Node MCU pin configuration.

### 2.3.5. LED display with seven segment

Its used to show numerals display of numbers using electronic board device basically used as an alternative for dot matrix display model board. Digital clocks also part of this comprehensively by other application.

## 2.4. BLYNK with cloud access

IoT system model are controlled remotely with using hardware and Blynk is useful in displaying all information like sensing data, and storing in cloud, helps us to visualize that information. There are three components part of this IoT platform they are:

### 2.4.1. BLYNK application & server usage

This help is to create awful interfaces system of our IoT projects with help of different widgets are provided as part of inputs model. This will perform all communication with computing hardware part of complete system. This storing information either using Blynk cloud or with execute as per local data memory repository, which are open-source anyone can handle it such huge number of device. Also helpful for launching Raspberry pi system too. This one popular platforms for hardware and server communication to serve with end process in possible input and output associated commands.

## 3. Results

This model producing various scenario of parking slot pattern as per users demand, which all are listed here based on that results analysis as per booked and availability parking slots are displayed from Figs. 8–11. These implementation prototype of real smart system to understand how exactly it works for data collection and booking of parking slots places etc. To support such importance of market impact on smart parking system explained below from source of IoT Analytics website about growth of market business from 2018 to 2022.

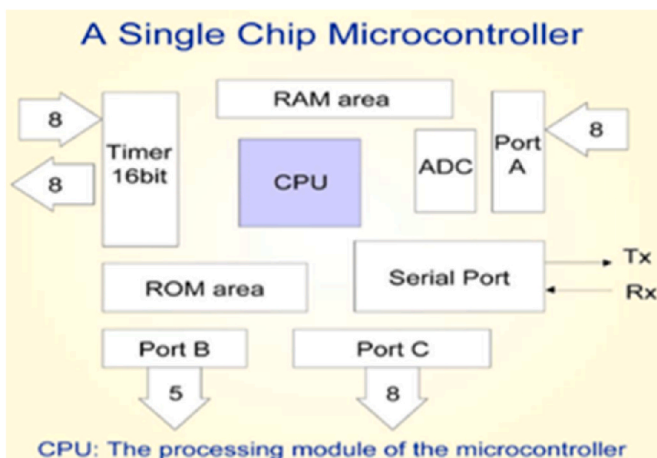


Fig. 4. Micro-controller device and its different functionality of sub-units.



The factual figure about the importance of IoT innovation application products lies in how much business impact created globally from 2018 till date listed its market values. The actual figures lie on the basis of smart parking data generation, whenever it's combined with many other stakeholders' roles and contributions like agents, locality business people, delivery smart applications.etc, with sensors data, processing devices and networking channels systems which takings innovative application to the next level for all smart cities. In Fig. 7 shows Market values disbursement for such smart parking applications and services functionalities is expected to grow from \$3.8B to a CAGR of 14% by 2023 surpassing 2022 business values [25],

Case-1 scenario: If every parking area are empty then display it: The given below Fig. 8 is displaying the number of free available area space.

Case-2 scenario: In this analysis three parking lots are free and available and only one lot-space is utilized. And Fig. 9 is displaying Blynk outputs as well with prototype output with free available and filled lot-space.

Case-3 scenario: In this analysis two parking lots are free and two-space is utilized. And Fig. 10 is displaying Blynk outputs as well with prototype output with free two available and filled two lot 1 & 2-space.

Case-4 scenario: In this analysis no parking lots are free and all lot-space is utilized. And Fig. 11 is displaying Blynk outputs with zero free lot-space available and everything is filled parking lot-space.

It is effective model of automated parking lot-space for all user to get their possible booking earlier slot as per availability in this huge crowded city environment, this optimize in n number of ways like saving their searching and booking lot time, as per available listed location. And foremost important objectives is usage of modern digital platform like mobile application to access it. This system widely useful in case of implementing with all possible places like in the covered parks spaces, open lot-space and as well with road-side parking too. This system ability to identifying the demand and need of all user by giving priority options functioning model to check all free lot-space and also helps users to figure out booking slots based on FCFS priority given to them for parking vehicles within crowded college campus in festive time. All the data collection related to book parking is useful for analysis part for different scenario. Almost 180 different scenarios come across while advance booking with this automated system during peak hours of evening 5pm to night 11.30pm in festive campus annual event 24 [19].

So, when compare this study results with other related works as per Table 1 like, Android Platform is used to implement with proposed algorithm [26] but not used any priority preference for users booking, another study suggested that as usage of boosting algorithm with IoT platform of parking system with given importance of user FCFS priority [16,27] one more parking system are discussed with RFID Sensor tags its actually complex model based on time consumption [28]. In next model OCR algorithm is used in this study [18] but not given priority preference to end users only its designed to recognize vehicles. Next work studied the importance of car detected model but not utilized in terms of parking model [19,29,30].

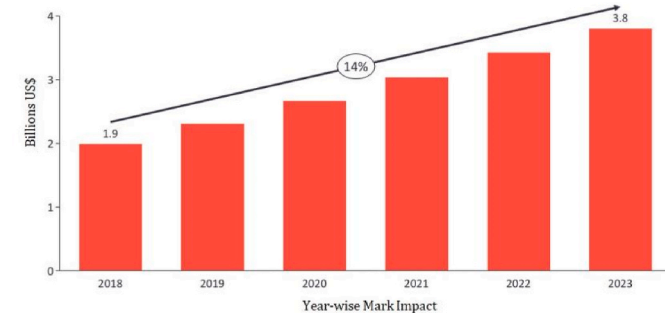


Fig. 7. Global-level Smart Parking Market Values impact [Source iot-analytics.com] [25].

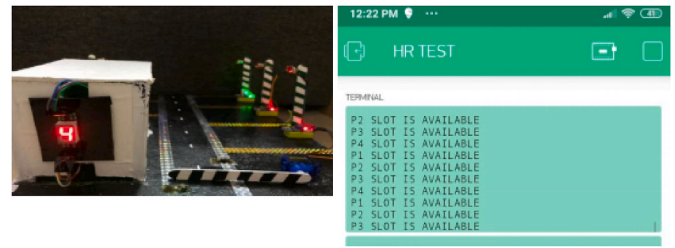


Fig. 8. All lot-space are free listed in output.

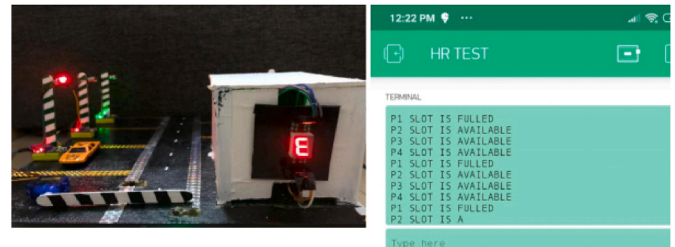


Fig. 9. Three lot-space are free listed with one slot is filled in output.



Fig. 10. Two lot-space are free listed with two slot – 1 & 2 is filled in output.

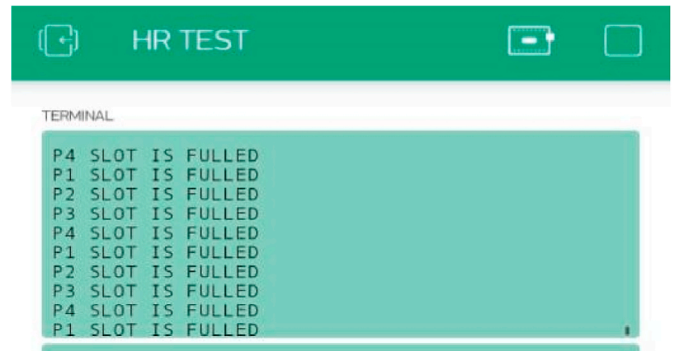


Fig. 11. Zero lot-space are free listed with all slot are filled in output.

In many related research studies suggest only either modern way of vehicles recognition with parking or they utilized IoT platform for smart parking model without usage of user's preference technique like in this work [31]. and Joseph LMI Leo et al. (2021) conducted research using machine learning and deep learning approaches [32]. discussed CNN research for Alzheimer's disease. Mall [33] and Shelke Nilesh et al. (2022) [34,35], shows the use of machine learning for disease detection etc.

Modernization of many projects with smart sensing application devices helps to optimize all possible effective outputs in good computing accuracy level. This system reduce the level of complexity and efforts are taken by all user within perfect networking model of device in IoT technology. Entire system is monitored for free parking lot-space and

allow to book required number of parking area with FCFS priority are mostly the effective services model offered to all vehicle usage and travelers using widely used Android mobile application.

#### 4. Conclusion

This study found importance of priority scheduling with parking automation system with IoT platform. The working model with ultrasonic Sensors are helpful to sense all the available empty parking slots. This information is given understanding of priority selection analyses based on First Come First Serve scheduling model. As per study almost 180 different scenarios are analyzed for parking allotments various users during peak festive time. The user information collected during booking priority are correlated with empty slots availability to give preference to the end users based FCFS model booking automated system. This smart parking is working on real case study with prototype model basis inputs based on that user demands priority is varying to book parking slots. In future study can be correlated to different booking location to coordinate among all parking systems. In Global Market values spending amount for these kind of smart parking working model and services are prediction of growth from \$3.8B to a Compound annual growth rate of fourteenth percent by 2023 surpassing its current financial year of 2022. Such smart system is evident as that allow to book parking slots-based locality available free slots on FCFS scheduling in Internet of Things platform smart parking automated systems.

Future Work: The proposed IOT model & scheduling as an optimization problem can be studied and implemented using the recent evolutionary operators and hybrid recommender systems [36–40].

#### CRediT authorship contribution statement

**M.R.M. Veeramanickam:** Conceptualization, Methodology. **B. Venkatesh:** Data curation. **Laxmi A. Bewoor:** Supervision, &, Writing – review & editing. **Yogesh W. Bhowte:** Writing – review & editing. **Kavita Moholkar:** Writing – original draft. **Jyoti L. Bangare:** Validation.

#### Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

#### Data availability

The data that has been used is confidential.

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