A Navigation and Reservation based Smart Parking platform using IoT by Queuing Theory

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Abstract: - **With liberalization of economy number of vehicle on the road have increased leading to illegal, unorganized parking behavior in at public place, private building, educational campus, corporate campus. our main objective to avoid this unorganized parking system, for this to avoid we can provide the intelligent parking system which can solved the real time problem of organized and unorganized parking, In this study we will develop a smart parking proposal using queuing theory approach which can be model the parking system as a queue and the evaluation parameter like wait time for user in a queue or in a system can be estimated. The parking space closest to the current location can be found using multiple server multiple queue system and optimizing the existing system for better user experiences.**

Keywords: **Smart parking, Queue theory, Parking system**

I. INTRODUCTION

The idea of smart car parking systems is recently gaining attention in many countries of the world owing to need for urban renewal programs and smart city initiatives (urbanization).

1.1   Background

In last 50 years, urban population of India has exponentially grown from 17.6 percent to 34.6percent with an annual rate of 1.72 percent in 2018 [1]. This population trend has increased significantly from 45.2 million in 1960 to 182.2 million in2015. By estimation, it is expected to grow to around 38percent by 2035. As per research world is going to have 2 billion of car on the road by 2020, Added to this around 770 million of truck, from this we can get an fair idea about how our traffic system can being the near future. thus this is very challenging task to find a better and a convenient and safe parking spot.

According to global vehicle ownership and vehicle production statistics, the number of people who have vehicles is steadily increasing.(3) The huge proliferation in the number of vehicles on the road along with mismanagement of the available parking space has created parking related problems as well as increased the traffic congestion in urban areas.(4) Thus, it is required to develop an automated smart parking management system that would not only help a driver to locate a suitable parking space for his/her vehicle, but also it would reduce fuel consumption as well as air pollution.(3)According to global vehicle ownership and vehicle production statistics, the number of people who have

vehicles is steadily increasing. The number of vehicles in the world is expected to exceed 1 billion before 2020, and multilateral efforts are being made in various countries to alleviate congestion due to vehicle growth.

In parking areas such as those in shopping malls or public building like a hospital and government building, driver tends to face problem to find vacant and convenient parking IOT (5).To help users when searching for a parking lot, a smart phone application is very useful (3). The needed of sensors had been introduced and implemented into the parking lot system. These systems gave users lots of benefits while searching for parking. To help users when searching for a parking lot, a smart phone application is very useful. The needed of sensors had been introduced and implemented into the parking lot system. These systems gave users lots of benefits while searching for parking [4]. They provide users with information on the availability parking vacant towards the empty parking lot. Besides that, it is also beneficial to the parking management as they now can easily monitor the parking traffic flows and manage to provide a better parking system (5)

With this population trend, virtually all the large metropolitan cities face the same problem of obsolete commercial public road transport system (PRTS). Obviously, the PRTS is grossly insufficient to cater for the commuter demands and needs. Slow paced city expansion, and absence of parking spaces leads to time delays in searching for parking spaces and increased emissions by commercial road vehicle owners. In most locations, most people travel by their own cars (2), leading to overcrowding in major cities/roads and environmental gas emissions

1.2 Motivation:

Most of the smart parking systems (SPS) proposed in literature over the past few years provides solution to the design of parking availability information system, parking reservation system, occupancy detection and management of parking lot, real-time navigation within the parking facility etc. However, very few works have paid attention to the Real time detection of improper parking, thus the idea of of analyzing smarking parking system and improving the user experience according to user need.

The objective of this paper is to analyses and study about the existing parking system and applying the new idea of

queuing theory ,to resolve the parking problem in the urban area.

After introducing existing parking lot management researches in section 2, we present our idea of system model in section 3. We validate our approaches in section 4, and finally conclude this paper in section 5.

II. LITERATURE REVIEW

There are many studies about smart parking approaches in the literature [1-23]. These approaches have been used different information technology concepts such as internet of things, wireless sensor network, cloud systems, mobile application, geographic information systems, and artificial intelligence techniques.

In this section, we analyze the existing researches Significant number of smart parking systems based on various technologies like radio frequency identification (RFID), wireless sensor network (WSN), Bluetooth, Wi-Fi, ZigBee etc. as well as agent based technologies and image processing techniques have been proposed in the literature over the past few years. Among these, a prototype of RFID-based smart sparking application that implements automated check-in and check-out process of the vehicle from parking lot area by using RFID reader is presented in [3]. On the other hand, either the sensor node or WSNs have been utilized to design several SPSs [4]. Among these, a prototype of wireless sensor network based intelligent car parking system is presented in [4]. Smart parking (SPARK) management system proposed in [6] also uses wireless sensor networks to perform various functionalities such as remote monitoring of parking area, reservation of parking lot, automated guidance to the parking space etc. The ultrasonic sensor node based SPS presented in [6] provides various functionality that include vacant sparking space detection, detection of improper parking, display of available parking spaces, payment facilities etc. The SPS and car parking management system proposed in [7] integrate WSNs and RFID technology.

In (11) Parking Availability Prediction for Sensor-Enabled Car Parks in Smart Cities, they have done an estimation approach for the parking using three feature sets with some parameters to show the utility of these feature sets has been presented and analyzed the performances of some machine learning methods such as artificial neural network, support vector machines, and regression) in using these features for prediction using available data acquisied from two cities as Melbourne and San Francisco.

In (19) prototype of IoT based car parking management system for smart cities, here author overcome the various advantages like user can find the parking space availability, in which iot provide the data storage ,processing and collection of data ,driver can book slot, but the limitation for the same is Absence of illegal parking detection service this approach cannot be explored to open parking system i.e. only suitable in case of indoor and multilevel parking.

Basavaraju S R. in(17) proposed the Automatic Smart parking System using Internet of Things (IOT) to manage the parking system Internet of things plays a vital role in connecting the surrounding environmental things to the network and made easy to access those things from any location ,driver can find the nearest area and the available slot in that area. This system reduces the time in finding the lot and fuel consumption, but has drawback like system doesn't have the guidance approach and the availability of the space couldn't be display on the smart phone application.

In(21), A wireless smart parking system- here The user can locate an available parking space and pay for it from smartphone, also through GPS give real time location and guidance toward destination ,the limitation for the same is that the smart phone application is efficient if the user is within 2 Km of the location.

The work in (6) provided an automated SCPS aimed at eliminating the use of human to human interaction while deploying a machine to machine interaction system with the use of ultrasonic sensors into the parking slots. This aids in the detection of vehicles in and out of the slots

The author in (9) describe a indoor and outdoor parking which allows users entering a crowded parking lot to rapidly find a good parking slot here the use a smart combination of V2I and DGP in order to provide accurate and reliable localization in hybrid indoor and outdoor environments, allowing users to find the most appropriate available parking spot, with regards to their own needs

In (21) describe about a parking guidance system which consists of software and hardware to serve the purpose of easy and safe parking. They have basically integrated the hardware sensor, led display and wireless communication device, sensor mounted on the parking floor which is used to detect the status of parking field i.e. weather occupied or empty.

In (27) A Smart Parking System using Wi-Fi and Wireless Sensor Network, this research work based on the parking space detection module, the Wi-Fi indoor positioning module and a background server. they adopted the sensor to detect the parking space, the background server will used for communication and data processing. In (12) Reservation-based Multi Objective Smart Parking Approach for Smart Cities, adopted a multi objective smart parking using the simulated annealing based metaheuristic to optimize the parking location .In (4) based on fuzzy rule find the energy efficient method for estimating the free size parking using wireless sensor network, real data is obtained by sensor network for generation of fuzzy rule in the study. In(9)-discuss a smart parking guidance system based on parking lot sensor network in which they implemented a prototype for parking navigation system based on the parking sensor network using a Dijkstra optimization algorithm to obtain the optimal parking router, system approach uses the ZigBee

communication protocol for the real-time parking information of all parking sensors. In (28) a new optimal navigated reservation based approach has been proposed to find the free parking slot in smart cities. The aim of the proposed method is to find the minimum distance to the free parking slot. For this purpose, the problem is formulated as an optimization uses a genetic algorithm to find the nearest free parking space. The current position of the driver is taken from the smart phone's GPS and the nearest free parking slot is found by using genetic algorithm. But by using genetic algorithm user take more time to navigate and reach to the destination.

III. SYSTEM OVERVIEW
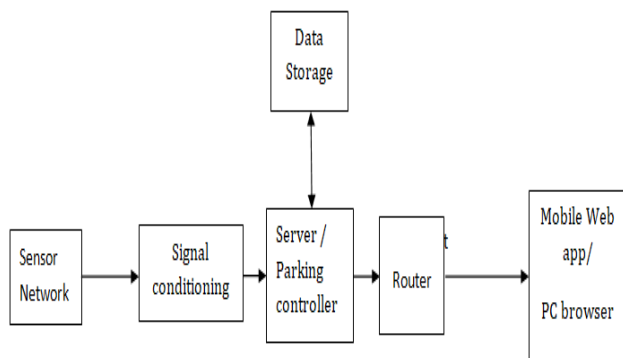
3.1   Block diagram of a system

Fig.1 Block diagram of our proposed system.

Each parking lot will be monitored with occupancy sensor (IR based) which will give us exact count of no of vehicles in queue. This data will be made available for users on internet. In short we are converting parking lots into a IOT node. To achieve this we can use as web server. Sensor data will be stored into a memory space on controller. We will be implementing a web server architecture on server which will enable users to access data on internet.
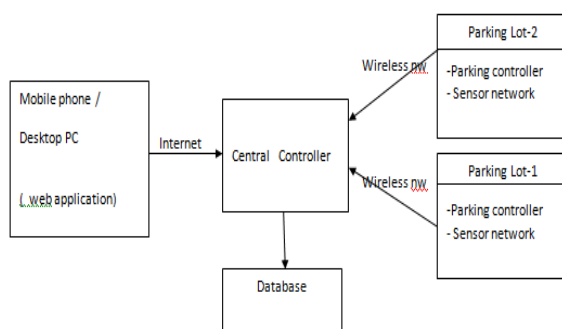
3.2   System process:

Fig.2 . university campus smart parking system of proposed model

In mobile web app., User can login through his mobile phone internet browser to fill in the user credentials, the central controller will be IOT enabled controller board which will be enabled to process sensor data, user data, and communicate with segments of physical layer. The database, basically this will be the user data

 in order to identify between categories of users. The parking controller which will communicate with central controller with real time status of occupancy. Through wireless network this data will be communicated with central controller. to achieve this scenario in a better approach we are going to use a queuing theory approach which will be integrated by IOT to optimize the system for the better user experiences .i.e. in our research work we are going to implement priority based allotment during peak hours users will be provided with login form on the system wherein they can register and login to access the parking system. Depending on peak hours or non peak hours priority based allotment will be activated. By default it will be FIFO,to integrate this with the final stage we basically analyze the Historical data will be collected of existing system. Analysis of historical data will give statistical parameters like inter-arrival rate and service rate for existing system. Based on that parking system will be modeling as multiple server multiple Queue system. Existing system will be analyzed for different parameters like total wait time, service time, total in system time. Which will be further optimized to certain constraints. Python simulation to analyze the system performance and optimize the user experience.

3.3   Sensor network:

There are two sensors at each lot one at entry and one at exit, We count number of vehicles in a parking lot using Count = Incoming – Outgoing, This real time data is sent to parking controller and stored into database, Webserver then accesses this data and displays on webpage .

3.4   Flow chart of system:

 The below flowchart shows the user interface flow diagram, where the visitor is promoted to visit the web portal, then checking if he is a visitor or campus associate, t hen accordingly visitor will fill the visitor form, the campus associate if not then they can registered into the system. If already registered then they user can sign into the portal, once logged in then user will ask to select the desired destination accordingly system will suggest the nearest parking lot, user will navigate to the location and the queue will be increment by 1. After bookling status will complete user will be prompted to logout to the portal.
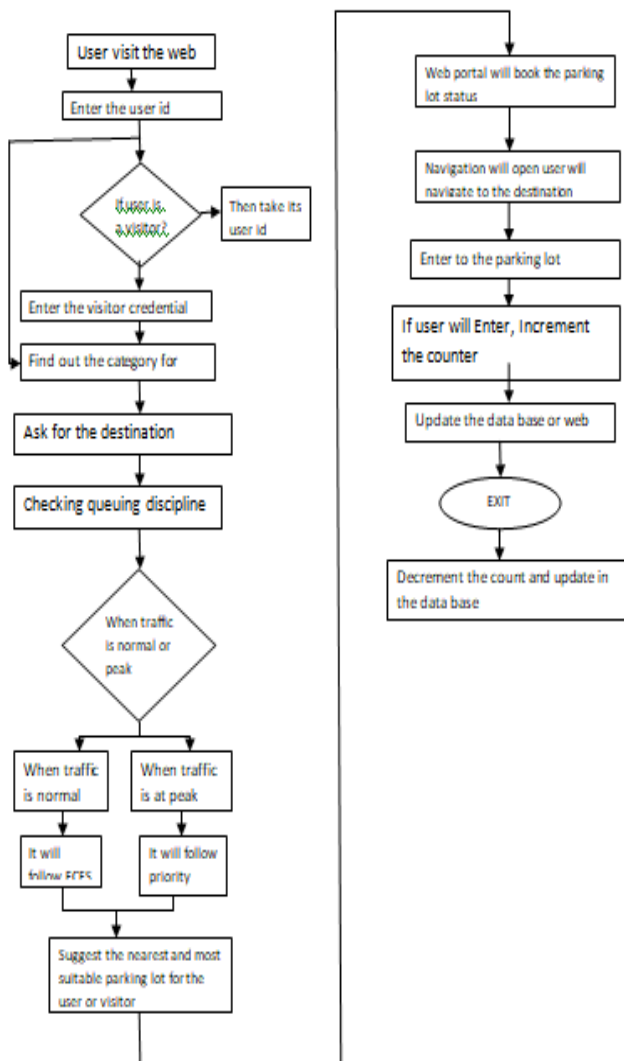
Fig.3 . Flow chart of queue based smart parking system

IV. QUEUING THEORY APPROACH

Queuing theory is the study of long waiting line done to predict the queue length and long waiting time, used in various field of operational, retail, analytics. it is the method used in operational researches studying the problem of waiting line whose task is to serve randomly arrived unit or request for a sevice. it uses a mathematical model to determine interdependences to determine the interdependence among the arrival of the unit,

their waiting to be served ,their serving and finally exit of the unit from the system.(26) the term which we used in analyzing the queue approach is the customers(service user or a client), server (performing process), queue(waiting line) .to cover the large number of simple queuing scenario there is a shorthand notation given by Kendal notation as shown below:

$$V/w/x/y/z \tag{1}$$

v - Distribution of the arrival of units into the system

w - Distribution of time of the service of units

x- Number of servers

y - Capacity of the queuing system

z - Discipline of queue

The basic parameter used for the calculation of queuing system is intensity of arrival flow (λ) and intensity of servicing (μ) these parameter can be determined based on the data obtained by statiscal observation and evaluating depend upon the respective objective depending upon the task of research.

4.1 Statistical analysis

If the arrivals of vehicles into the parking area as well as the length of parking time are random variables, it is necessary to determine the types of intensity of these variables, i.e. to verify if these variables act according to the rules of certain theoretical distributions(26). Basically in our future research work ,the data of the university campus has been taken of 2month ,based on statiscal a data the evaluations of probability distribution has been analyzed for arrival rate and service .after analyzing the empirical distribution ,the result is matched with the theoretical distribution .it means that service rate follows the exponential distribution as shown in graph and interarrival time follows the poission distribution. using This parameter we can be in a position to predict the wait time for a new user or user in a queue.

In real terms, an unlimited number of various distributions of arrivals is possible. In theory, they are described in distributions best suited to actual situation, but such distributions are after all approximations of actual processes. Distributions of arrivals are most commonly classified by type of arrivals:

a) Regularly distributed arrivals,
b) Completely random arrivals (exponential distribution of arrivals),
c) Arrivals distributed according to Erlang distribution of order k,
d) Generally independently distributed arrivals.

4.2 Queuing theory for parking system

The problem of parking in the urban area is in indiscipline manner, in order to make it in a better approach, the paper present the application of queuing theory which will be modeled in our research paper to function the optimal dimensioning of parking using the example for the university campus. Parking area represents a queuing system with the following structure: customers are vehicles forming (or not) a waiting line (depending on the current situation) in order to be served (parked) in a parking section and after the service has been completed (certain length of parking time), they exit the system.

From the point of view of the queuing theory, the following can be concluded for incoming/outgoing parking area terminals (26):

a. considering that the arrival flow of vehicles is not an integral part of the system, the parking area is an open system,

b. considering that more waiting lines are formed at the entry point into the parking area, we can talk about a multi-server queuing system,

c. arrivals of vehicles into the parking area are distributed according to certain theoretical distributions (in this paper the distribution is Poisson's),

d. service time is also distributed according to certain theoretical distributions (in this paper the distribution is exponential),

e. servicing of vehicles is done according to the FIFO method (first-come-first-served),

f. considering the fact that outside the entry ramps there is a certain number of space for vehicles waiting to enter the parking area, we can talk about a waiting line with limited length.

V. CONCLUSION & FUTURE SCOPE

Parking problem in a university campus become a major issue so in order to solve this issue, In this paper we have proposed a system model to to optimize th present exiting system for a better user experiences by using queuing theory and integrating it with IOT.

In our future scope ,we are going to implement this for the real time scenario in which the user can see the live status of parking lot in campus, user a can book a parking lot, user will be suggested the nearest and most suitable parking lot ,during the peak hours priority based allotment will be done for achieving this in our future proposed model ,we are going to model the parking system as a queue- to get the evaluation parameter like what is the wait time for the user in a system ,what is the wait time in a queue. Secondly we are implementing the web server for the same which will collect the data from the data base ,run script and facilate the user management. Thirdly, we are going to simulate the modelled parking system as a multiple server multiple queue system, evaluating its performance for the existing system and optimizing it for better making scenario of university campus.

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