IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

ISO 3297:2007 Certified ⁜ Impact Factor 8.102 ⁜ Vol. 12, Issue 4, April 2023

DOI: 10.17148/IJARCCE.2023.12468

Smart Parking for Urban Cities Using IoT and Edge AI

Anika[1], M N Shreyas[2], Aditi R Patil[3], Chirag S[4], Dr. Mamatha T[5]

Student, BE, Department of CSE, Atria Institute of Technology, Bangalore, India [1-4]

Professor, Department of CSE, Atria Institute of Technology, Bangalore, India [5]

Abstract: A With increase in economic growth more and more people are able to afford vehicles to commute. Especially in metropolitan cities like Bengaluru where the number of people using two-wheelers and cars are high. The number of cars and vehicles in cities have increased by two folds which has created the non-availability of parking slots which in turn leads to traffic jams, congestions etc. Using information and Communication technology with sensors/ embedded systems and IoT the problem of parking can be addressed. Along with that the vehicles can be classified on the basis of their size for a better parking experience. We aim to address the parking availability at malls or different parking complexes in the city. The customer who wishes to find slot in a particular mall/ parking area would check list of availability of free slots using Self Interactive KIOSK machines. The machine is implemented with features to freeze parking slot, cancel the slot and view the list of free slots. Sensors are used to detect if a slot is free or blocked. Edge based AI in the smart parking area/mall parking area is used to give a consolidated report on slots available to reduce the latency to display the free slots. We propose to implement Smart Parking System based on IoT and Edge -AI to predict the possibility of getting the slot based on conditions such as weekdays, weekends, festive days, offer days.

Keywords: Automation, Image processing, Internet of Things, Edge-AI, KIOSK Machines, servo motors and mechanical structures, identify and sort various objects, Object Recognition algorithms, properties, and embedded systems.

I.INTRODUCTION

In the present world trend parking of vehicles in metropolitan city is a hassle, finding the exact and the appropriate parking feasible for a specific vehicle is difficult and time consuming. With extensive growth in the number of vehicles there is a drastic increase in the parking requirements; also the addition in number of vehicles has led to the increase in pollution and traffic congestion. As per recent studies in October 2022 Bengaluru traffic police registered 83,42,692 cases of traffic violations out of which total of 10,06,606 cases were for illegal parking. Even when we do find a parking slot it's a tedious procedure and sometimes there is not enough space to open the car doors which is stuck between two huge cars. There is no proper system without the involvement of humans that solve all these issues. All this sums up to a huge amount of time loss which is a big thing in today's fast-moving world. In recent days modern technologies are being used to accompany human activities completely or partially. A big part of that is IoT, Internet of Things (IoT) has changed a lot of human behavior by providing them with numerous amenities. Recent study conducted on the usage of IoT has shown an exponential growth in the usage of various IoT devices to make daily life easier. Web enabled smart devices which uses embedded system comes under IoT, it is one such platform which allows easy and effective implementation of projects like smart parking system with the help of sensors, hardware communication, processors to collect process and act on data. IoT devices are connected either to an IoT gateway or an edge device through which the IoT devices share the data collected from various sensors which is either transmitted to the cloud to be analyzed or can be locally analyzed. The exponential growth of IoT and cloud-based smart systems along with the concept of developing smart cities has led us to a new dimension and led to various implementations and methodologies in not only smart parking system but in various other ventures. One more technology which plays a great role now-a-days to make day to day tasks easier by introducing the concept of algorithms and machine intelligence is Artificial Intelligence and Machine Learning. Artificial Intelligence in now being used in many fields and even in everyday life. Artificial Intelligence plays an important role when it comes to Smart Parking System as it can help to keep a count of the number of vehicles inside the parking lot and it also helps in the classification of vehicles on the basis of their respective sizes which makes the car parking process smoother and more efficient. Here, the authors have mentioned the various smart parking sensors, tools as well as different approaches to develop Smart Parking System along with their own implementation part. This paper consists of appropriate prospects for parking complexes along with open parking lots and has further discussed about their strengths and drawbacks as well as a

IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

ISO 3297:2007 Certified ⁜ Impact Factor 8.102 ⁜ Vol. 12, Issue 4, April 2023

DOI: 10.17148/IJARCCE.2023.12468

comparison between the entire existing project and what the authors implemented. It is seen that Smart Parking System depends on functionality; certain Smart Parking Systems are fruitful only in certain cases. Thus, it is important to compare different Smart Parking System based on sensors, networking techniques, methods, services and computational approaches, and services, so as to come up with a feasible and accurate solution.

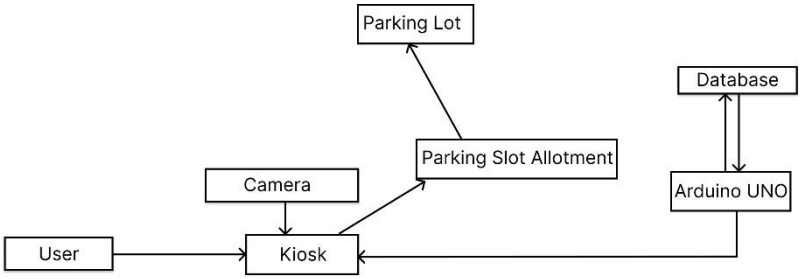

Figure 1 shows the block diagram of our project

II. RELATED WORK

As seen, that during peak hours there is lot of traffic congestion, and no proper space is being allotted for the citizens to park their vehicles. Hence individuals end up spending a significant time looking for a parking slots or waiting in lines to find a parking spot which leads to traffic as well as wastage of resources such as fuels which in turn leads to pollution. This section contains the survey from various reputed publishing sites were referred such as IEEE, IJERT, ICCAIS and so on, dating back to different years. The overall data collected from different research paper ranging over different years is being illustrated in Figure 2.

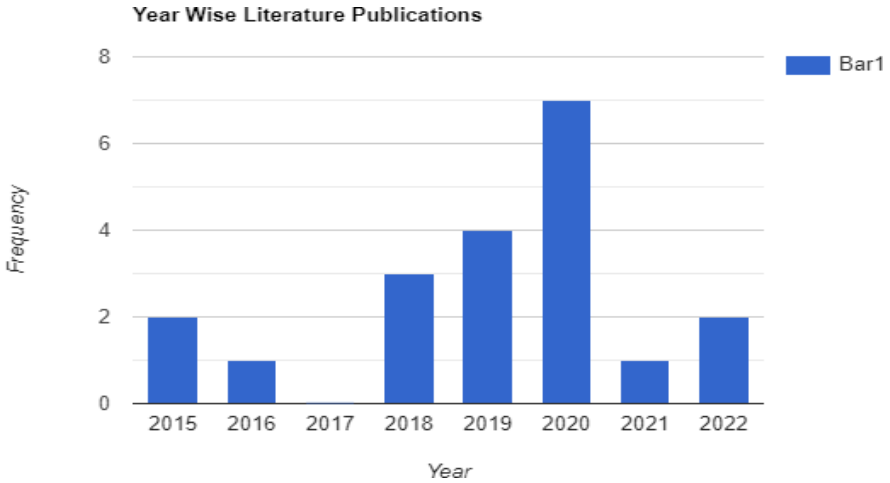

Figure 2 shows a graph of year wise literature publications

There are suggestions from authors [6] for the adaptation of a real time cloud-based system which detects and updates the information about the parking lots, reservations etc. Something similar was also noted down by the authors in [1] where IoT-based parking system is being made with the use of various sensors and in order to connect the parking infrastructure to the backend of an application via cloud-based management services all this is being shown to the user using a mobile application which shows the real-time updates of the parking slots. The user can also reserve or book slots priorly. Whereas in [6], we can see the use of WSN (Wireless Sensors Network) this model consists of four different layers to detect and determine parking lot status. The different layers in [6] consists of network layer which collects all the data, the middleware layer and application layer which gives the user the real-time status of the parking lots.

A similar division can be seen in [3] where the Smart Parking System concept has been divided into three parts namely parking element which includes sensor nodes in indoor and on-street parking, as well as microcontroller devices. The cloud functions as a go-between for the automobile parking and the user application and the user application is a mobile application. The system uses sensors to collect data on indoor and on-street parking, which is then analyzed and processed by IoT devices. To analyze and assess the data, machine learning techniques are applied. This technique aids in the alleviation of traffic congestion. With the aid of the Google API, the application uses a map to display the user the number of parking spaces that are available as well as the routes that are closest to and least trafficked from their current position.

International Journal of Advanced Research in Computer and Communication Engineering
ISO 3297:2007 Certified ⁜ Impact Factor 8.102 ⁜ Vol. 12, Issue 4, April 2023
DOI: 10.17148/IJARCCE.2023.12468

The use of RFID and Arduino technology is seen in [2]. Here the RFID is being used as a tag-based wireless sensor network to keep an eye on parking lots. Parking places are counted using RFID tags. The Arduino module authenticates as a car draws near, sending user data to the cloud server where it is kept in a database. This system links various parking lots; each lot is referred to as a node, and when one lot is full, the user is alerted to the neighbouring lot. The use of moving and fixed Arduino can be seen in [8] where, the moving Arduino analyses the signal which is further converted into a code which is sent to the fixed Arduino. But unlike other research papers [8] does not consists a real time website or mobile application rather it makes use of a Nextion display touch screen which shows the results of the parking lot. In [7] we can see the use of surveillance cameras and IoT sensors to count vehicles in the parking. All this is connected to a website which provides real-time parking space availability, floor-level capacity estimation and parking occupancy prediction. The proposed model in [9] also makes use of CCTV or surveillance cameras which situated 2.5 meters above the ground near the parking area. This system makes use of Haar Cascade Classifier and YOLOv3 Detection which is used to detect object in real-time.

Research paper [4] makes use of automatic number-plate recognition to identify the vehicle's number plates. The system assigns the best and closest available slot, ensures that another vehicle does not receive that slot, and directs the car to the slot using LED boards, which are turned off as the system passes the node.

In [5], we can see raspberry pi-based parking sensor equipped with a pi-camera, and the data is delivered to a server where it is stored and accessible to users. The availability of parking and the number of slots filled are updated on a regular basis in the servers and can be accessed by users over the internet. A single user can obtain information about multiple car parking places and select the best one for them. The proposed model in [10] is an application based which makes use of Mobius server for the driver's information. The Arduino receives the information, which acts as a display. The RFID and the three beacons at the bottom of every corner are recognized by the application which then calculates the current driver's position. The Mobius Server then receives the current driver's position via the Raspberry pi, which acts as a gateway. The number of automobiles has significantly increased over the last couple of decades. Therefore, it is critical to effectively deploy technology to provide convenient parking at both public and private places. The authors of the publication [16] suggest a smart parking system built on IoT and machine learning methods to address real-time parking management and uncertainty, it throws light on a completely autonomous parking system which makes use of various sensors like IR Sensors, Magnetometer Sensor, RFID Sensors [19], [16], GSM module [19] and IoT based cameras; which will help in detecting the empty slots in a parking bay and directing the user to the specific parking. To predict the best and most suitable parking slot for a vehicles various methods and algorithms are being discussed; which includes object detection [17] using AI cameras and Open ALPR technology [20] to detect the number plates and size of various vehicles and using image processing methods [16],[17] to convert the image into binary format by implementing pixel image to binary conversions [11] for the machine learning system to process the received data and predict the parking slot. In order to increase the efficiency and the speed of prediction of the suitable slot, various algorithms have been touched upon like YOLO [17], Haar Cascade [13], KNN [14]; which allows detection of slots based of the visibility of the reference lines drawn for each parking slot, and updates the same to the back-end storage of the application which is either a cloud-based storage [19] or a local storage.

Interconnection methods of all the hardware components and the sensors are also achieved using techniques like ZigBee [12], Artificial Bee Colony & Artificial Neural Network [15] which acts as a platform for interconnections of various components and can be integrated onto an Arduino board.

Integration of IoT and cloud [18] is also being discussed which will allow the developers the feasibility to present the data regarding the empty, non-empty slots of a parking using services like Fire based cloud applications [14]; this will also add an extra feature allowing the users to pre-book an empty slot in a parking bay, all this put together as an application or a website will allow for a completely autonomous parking experience serving as a mean of saving money, saving time, reducing pollution and allowing for a completely organized parking bay using classifiers algorithm which classifies the vehicles in a certain parking bay and organizing them in such way that there are no disturbances between two or more parking slots.

III. METHODOLOGY

Using low-cost sensors, real-time data, and applications that show users which parking spaces are accessible and unavailable are all part of smart parking. The goal is to automate and reduce time spent manually looking for the best parking floor, spot, or even lot. Some systems will provide a full package of services such as online payments, parking time notifications, and even automobile finding capabilities for huge lots. A parking solution can benefit both the lot owner and the user. Users find the best available parking spot, saving time, resources, and effort. The parking lot fills quickly, and commercial and corporate companies can make good use of the available space. Our idea was to make an IoT based smart parking system with the help of artificial intelligence and machine learning. The model will be in such a way that when a car enters the parking lot there will be an automatic toll collecting system which will keep the count of cars present in the lot. The below given subparts explains the workflow and idea of the model.

IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

ISO 3297:2007 Certified ⁜ Impact Factor 8.102 ⁜ Vol. 12, Issue 4, April 2023

DOI: 10.17148/IJARCCE.2023.12468

The Smart Parking System's System Architecture is shown in Fig. 3. The different stages in which the model works is as follows:

Stage 1 represents the entry of the vehicle at the toll gate where the gates are automatically opened after detecting the vehicle and keeps a count of the vehicles according to the parking slots available, once all the slots are full the gates won't open.

Stage 2 involves the detection of vehicle's number plate. Using the display which has attached cameras.

Stage 3 user can use kiosk for user interaction.

Stage 4 is the parking slot allotment.

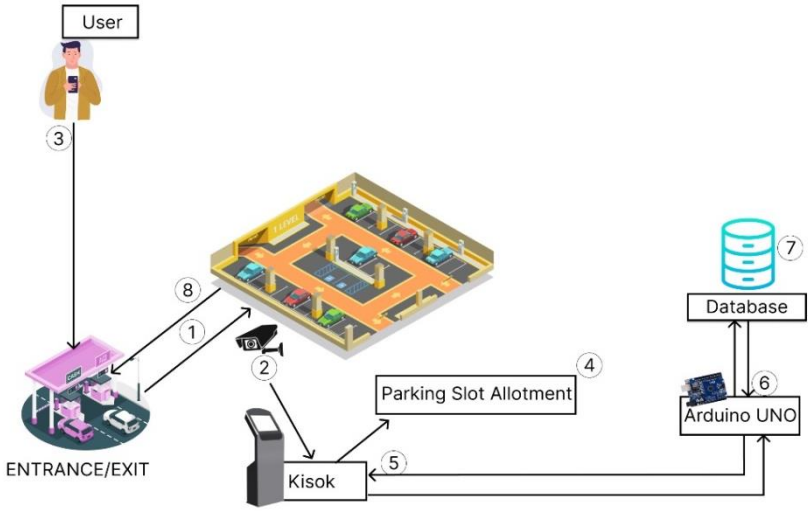

Figure 3 shows the System Architecture.

Stage 5 in this stage the allotted parking slot details are updated.

Stage 6 involves updating the number of empty slots to the Arduino.

Stage 7 it involves pushing the data into the database.

Stage 8 consists of the exit, once the payment is done through kiosk.

IV. SYSTEM DESIGN

The system works in such a way that if the parking lot can accommodate "n" number of cars, then the toll collecting booth will keep a count of the cars entering so that if the lot is full the car can be sent to a different place. The parking lot assigned to the respective vehicles is also on the basis of their sizes. If the parking space is not occupied the rays emitted will not bounce back which leads to the conclusion that no object was detected. This indicates green LED color which shows the availability of a parking lot. If the vehicle height is within the threshold distance, the IR rays that are emitted by the emitter are reflected when the parking space is occupied. When they strike the receiver, the waves are transformed into an electrical signal that results in a potential difference. The Red LED turns on as a result of this feedback, signalling to the motorist that the parking space is occupied. Since IR photons are constantly being released, the feedback is immediate. The Yellow LED comes back on as soon as the car pulls out of parking space because the light beams do not return. The increment and decrement of slots also take place simultaneous the , that is when a parking slot is occupied and the led turns red the number of available slots are decremented, similarly when the vehicle leaves a particular slot then the number of available slots are incremented. Thus, with this information the motor gate

IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

ISO 3297:2007 Certified ⁜ Impact Factor 8.102 ⁜ Vol. 12, Issue 4, April 2023

DOI: 10.17148/IJARCCE.2023.12468

won't give access to any further vehicles if all the parking lots are occupied. Moreover, this whole system will be connected to either an app which will help the user to locate the free parking space easily. The App will contain the map of the parking lot it will indicate with either yellow or red colour whether the parking space is occupied or not. Fig 4, Fig 5 represents Circuit design, Schematic representation respectively.

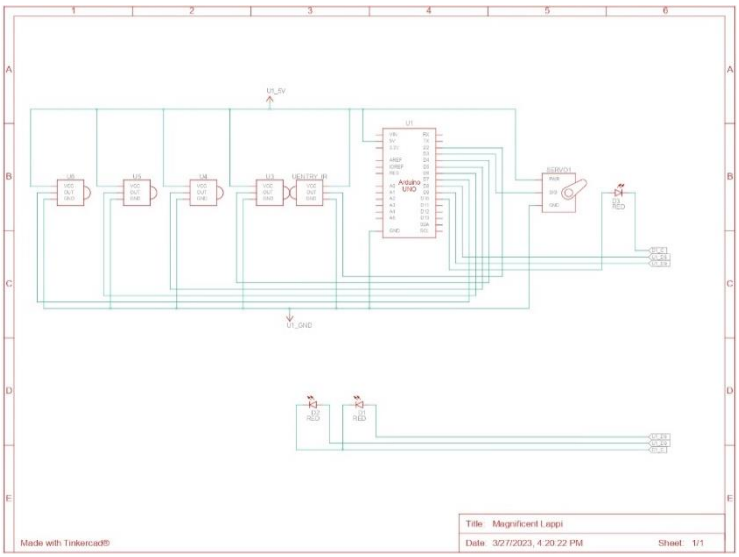

Figure 4 shows the circuit design of smart parking system

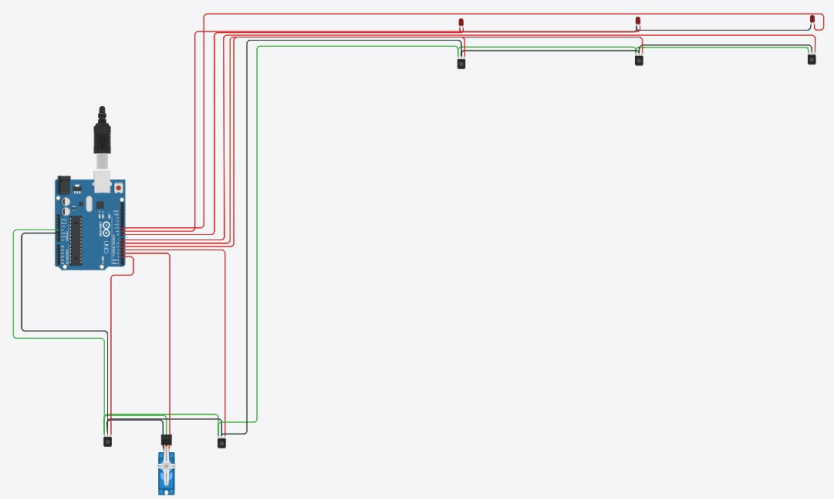

Figure 5 shows the schematic representation of smart parking system

V. EDGE AI

Edge AI enables to react quickly to incoming inputs as compared to the cloud. The processing time is reduced by using edge device closer to the Smart Parking System. We propose to use the Edge AI for classification of vehicles/cars according to their size and model. The Incoming cars are directed to different sections of policy according to their size and models. The model is trained using convolution neural networks at the edge device.

VI. BENEFITS TO THE SOCIETY

Reduced traffic- As fewer automobiles are required to travel about looking for an open parking space, traffic flow improves.

Reduced pollution- Looking for parking consumes approximately one million barrels of oil every day. An efficient parking solution will greatly save driving time, minimizing daily car emissions and, ultimately, the global environmental impact.

International Journal of Advanced Research in Computer and Communication Engineering
ISO 3297:2007 Certified ⁜ Impact Factor 8.102 ⁜ Vol. 12, Issue 4, April 2023
DOI: 10.17148/IJARCCE.2023.12468

Increased Safety- Security guards and parking lot staff have access to real-time lot data that can help stop parking violations and suspicious activities. Cameras that can read license plates can collect relevant data. Also, fewer people hunting for parking spots on the streets can lessen accidents brought on by the distraction of parking.
Reduced Management Costs- Less manual work and more automation reduce labor costs and resource exhaustion.
Enhanced User Experience- A smart parking system will combine all aspects of the user experience into a single activity. The driver's payment, location search, time notifications, and spot recognition all effortlessly integrate into the destination arrival procedure.

VII. RESULTS

Figure 6 shows the vehicle identification on our android application

Figure 7 shows the vehicle identification on our android application

IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

ISO 3297:2007 Certified ⁜ Impact Factor 8.102 ⁜ Vol. 12, Issue 4, April 2023

DOI: 10.17148/IJARCCE.2023.12468

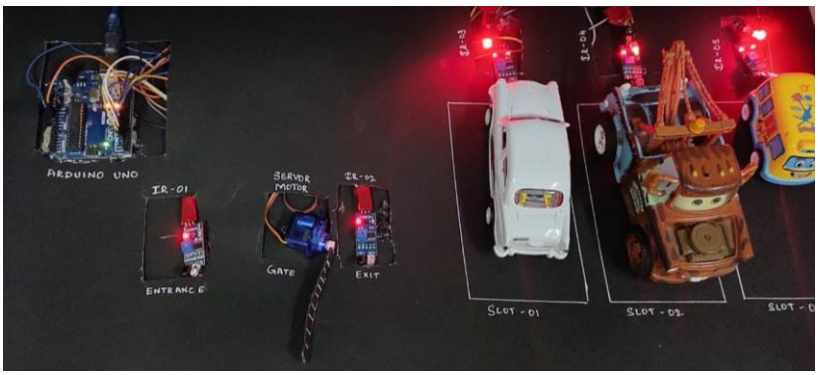

Figure 8 shows our prototype

Figure 6 and 7 shows the identification of vehicles using our android application. Figure 8 shows the prototype of our smart parking system. Our model is capable of identifying any vehicle and allotting space or slots in realtime. If parking is full vehicles won't be allowed. It is a robust system of parking with AI capability. Payment gateway can also be added to the project so that time duration of parking shown in the app can be charged accordingly. According to their size and model, we suggest categorising automobiles and cars using Edge AI. According to the size and model of the incoming cars, certain sections of the policy are tailored to them. The model is educated at the edge device using convolution neural networks.

VIII. CONCLUSIONS

A reduction in parking spaces and an increase in traffic congestion are both results of urban population growth and unplanned urbanization. Because of this, experts and urban planners are interested in smart parking. The smart parking technologies deployed by several researchers are described in this study in general terms. The article contrasts cutting-edge platforms or methods used in different smart parking systems. It also describes the various sensors and microcontrollers that may be employed in an IoT- based system. In addition, the research gives an overview of cloud computing and the connectivity of cloud computing and other wireless networks with IoT in order to store the various kinds of parking system data. There has also been a user interface classification of the Smart Parking System. computing, networking, and service technologies. These categories offer a comprehensive overview of the Smart Parking System from a variety of angles and methodologies. Furthermore, the paper provides a thorough assessment of the benefits and drawbacks of various types of Smart Parking Systems in addressing a variety of difficulties placed upon the systems. The conclusion drawn from the thorough evaluation and analysis conducted in this study is that future smart cities built on the Internet of Things would mostly use multi-approach based Smart Parking Systems. Common features of the Smart Parking System's user interface, which will be based on either a smart phone app or a web-based application, include parking supervision, online payment, parking reservation, and vehicle direction. Depending on the conditions inside and outside, the Smart Parking System uses different sensors. The ease of installation, privacy, sensing technique, and sensor coverage area will, however, be the most crucial factors to take into account when choosing a sensor. In upcoming SPS, data transmission protocol security will likewise be a major source of worry.

REFERENCES

[1] "Smart Parking System based on IOT", Hardik Tanti; Pratik Kasodariya; Shikha Patel; Dhaval H. Rangrej, (IJERT)
[2] "A Cloud-Based Smart-Parking System Based on Internet-of-Things Technologies", THANH NAMPHAM; MING-FONG TSAI; DUC BINH NGUYEN; CHYI-REN DOW; DER-JIUNN DENG, (IEEE)
[3] "Smart Car Parking System Solution for the Internet of Things in Smart Cities", Wael Alsafery; Badraddin Alturki; Stephan Reiff-Marganiec; Kamal Jambi, (ICCAIS)
[4] "Automatic Smart Car Parking System Using IoT and Python", A.Durga Praveen Kumar; Harika Matta; Pravallika Saka; Poojitha Reddy Erusu; Dinesh Chandra Koyyalmudi, (JSES)
[5] "Automatic Smart Parking System using Internet of Things (IOT)", Mr. Basavaraju S R, (IJSRP)
[6] "A novel and Secure Smart Parking Management System (SPMS) based on integration of WSN, RFID, and IoT", Omar Abdulkader; Alwi M. Bamhdi; Vijey Thayananthan; Kamal Jambi; (IEEE)
[7] "Demo Abstract: Building a Smart Parking System on College Campus", Yunfei Hou; Yan Zhang; Kimberly Collins; Mihaela Popescu, (IEEE)
[8] "Smart Parking System for Monitoring Cars and Wrong Parking", Faris Alshehri; A. H. M. Almawgani; Ayed Alqahtani; Abdurahman Alqahtani, (IEEE)

International Journal of Advanced Research in Computer and Communication Engineering

ISO 3297:2007 Certified ⁜ Impact Factor 8.102 ⁜ Vol. 12, Issue 4, April 2023

DOI: 10.17148/IJARCCE.2023.12468

[9] "Car Detection in Roadside Parking for Smart Parking System Based on Image Processing", Deni Kristin Manase; Zahir Zainuddin; Syafruddin Syarif; Arsan Kumala Jaya, (IEEE)
[10] "IoT Platform Based Smart Parking Navigation System with Shortest Route and Anti-Collision ", Dae- hyun Kim; Sung- hyun Park; Seungwoon Lee; Byeong-hee Roh, (IEEE)
[11] "Implementation of Smart Parking using Artificial Intelligence", Jaspreet Kaur, (IJSDR)
[12] "Advanced Parking Slot Management System Using Machine Learning", Leobin Joseph1, Ajay Krishna2, Maschio Berty3, Pramod P4, Velusamy A5, (IJARSCT)
[13] "SMART CAR PARKING SYSTEM", Rani Astya1, Soni Jain2, Sukriti Sachan3, Aish Aggarwal 4, (IJME)
[14] "VALET BASED CAR PARKING SYSTEM USING MACHINE LEARNING", Shraddha Thorve ,Swapnali Satpute, Pranjali Salunke , Sayali Kedar, (IJCRT)
[15] "AN OPTIMIZED VEHICLE PARKING MECHANISM USING ARTIFICIAL NEURAL NETWORK", Ruby Singh, Dr. Niraj Singhal, (IJCET)
[16] "Machine Learning and IoT based Real Time Parking System: Challenges and Implementation", Ravi Kumar Gupta & Geeta Rani, (SSRN)
[17] "Machine Vision Smart Parking Using Internet of Things (IoTs) In A Smart University", Noah Sieck, Cameron Calpin & Mohammad Almalag", (IEEE)
[18] "IoT based Smart Parking System", Abhirup Khanna & Rishi Anand, (IOTA)
[19] "Smart Parking System using IoT", ElakyaR,Juhi Seth, Pola Ashritha, R Namith, (IJEAT)
[20] "A Truly Smart Airport Parking Solution", Vinh Bui, Minh Bui, (IEEE)