Smart Parking Management System using IoT for Multi Office Environment.

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***Abstract*— Parking has become a significant problem in big cities as a result of both population growth and security issues. Additionally, we've seen a marked rise in people driving their own cars to work. Consider Sri Lanka's inadequate public transportation system to be at fault. Office parking lots are significantly impacted by the inefficient management of parking spots. Using IoT as the answer, we developed a smart parking management system for business settings. Using cutting-edge technology like sensors, real-time data processing, and mobile applications, a "smart parking management system" efficiently manages parking spaces in an office environment. License plate recognition is a key AI parking management application. AI algorithms, Python OpenCV, and ESP32-CAM/CCTV enable real-time license plate reading and identification. This can improve traffic surveillance and criminal investigations. The smart parking management system employs sensors to determine when parking spaces are available and promptly alerts workers via web applications and visual displays. Employees locate parking faster since it takes less time to travel around.**

Keywords— Artificial Intelligence(AI) , OpenCV , CCTV, AI Algorithms

I. INTRODUCTION

The majority of city dwellers now drive their own automobiles, and many of them drive their cars to work every day, creating a need for parking spaces in and around commercial buildings. The bulk of the world's population now resides in urban areas and relies almost entirely on personal automobiles to go to and from work each day. The issue has caused traffic jams and congestion. Parking management is essential in a multi-office setting where scarce parking spaces need to be maximized for maximum efficiency. Our focus throughout this study was on circumstances where many businesses were housed in the same building (multi-office setups).

People today want to use intelligent solutions to society's current challenges, which is why a smart parking management system for working environments is necessary [1]. The purpose of this work is to solve parking issues in commercial buildings by applying IoT concepts. Machine learning, cloud computing, networking, embedded systems, and web development and implementation will all play roles in the creation of this smart parking management system for a multi office setting.

The majority of urban dwellers currently commute to and from their workplaces by means of personal transportation. As a consequence of this issue, there has been an increase in both traffic volume and congestion. The implementation of a well-structured parking system is of paramount importance in optimizing employee productivity within the workplace.

The implementation of a technologically advanced parking management system within office buildings is imperative in the contemporary era, wherein intricate resolutions to intricate problems are anticipated. The objective of this initiative is to implement Internet of Things principles in order to enhance and update parking management in commercial environments [2].

An intelligent parking management system for commercial buildings will be developed with the assistance of professionals specializing in machine learning, cloud computing, networking, embedded systems, web development, and deployment. The smart parking management system encompasses a device capable of accurately detecting a vehicle's registration number under varying lighting conditions. Additionally, it incorporates a web portal that enables administrators and employers to access real-time information regarding parking availability. To ensure the security of vehicles within the parking system, a closed-

circuit television (CCTV) camera system is employed. Furthermore, the system includes an analysis of parking utilization data for comprehensive evaluation [3].

II. RELATED WORKS

The "IoT based Smart Parking System" by Abhirup Khanna Rishi Anand identifies four essential features. To determine if a parking spot is free or not, ultrasonic sensors are installed. The raspberry pi serves as the brains of the operation, connecting the parking sensors to the cloud. The product bundle also includes a mobile app. Users can access the parking management system using this mobile application. All of the required servers will be housed in the cloud, and all user data will be stored in a cloud-based database. After registering for an account with this parking management system, customers may check the system's mobile app to see which parking spots are free.

In this instance, two pieces of study were considered that are analogous to the solution proposed for the issues surrounding parking at workplaces. Authors Amira A. Elsonbaty and Mahmoud Shams claim that their "THE SMART PARKING MANAGEMENT SYSTEM" employs smartphone apps, cloud services, Arduino devices, and sensors to facilitate user interaction across a parking lot's three distinct phases. However, the Smart Parking Management System for workplaces is missing the feature that would allow for character identification through image processing in different lighting situations [4].

The "Design and Module Simulation of a Smart Parking System Based On QR Code and Drone Monitoring for Open-Space Temporary Parking Lots" by Feng Yuan Hu Bo Rui Wang Hong Xin Zhang describes the functionality of the parking management system. Users must register for a mobile app before using it. The user can view available parking places in the next step.

The QR code for each parking space is different. Users must scan the correct QR code after parking their automobile in a certain location. The usage of QR codes will enable the collection of data on the vehicle that parked at a certain location. In addition, drone cameras will be used to monitor the vehicles parked in the lot [5].

Based on the paper "Parking Space Sharing System Based On Intelligent Parking Pile" by Bai Tao, Gong Shiyan, Gao Haichao, Li Pengyi, and Yang Wei, the following are some of the main features of this parking management system: Private parking lot owners not only install intelligent parking piles to perform license plate recognition, parking space positioning, pile control, parking lot monitoring, and vehicle sensing, but they also report this information to a shared parking cloud platform by saying "I have a parking space. Each intelligent parking stack acts as a parking node, relaying data collected through Lora wireless communication to a Lora gateway. Next, the gateway connects to the cloud server with its processing power, stores the information in a database, and finishes the visualization display in order to spot shifts in parking data in real time. Also The driver of a private car can utilize the vehicle's unique license plate information to make a reservation for a shared parking place by accessing the cloud platform through a mobile app.

III. METHODOLOGY

Prior to the commencement of the entire process, several issues were identified. These include traffic jams, congestion, elevated fuel costs resulting from excessive fuel consumption, environmental pollution, and time wastage due to the search for parking spaces. Additionally, there is a high demand for manpower to effectively manage vehicles within parking areas.

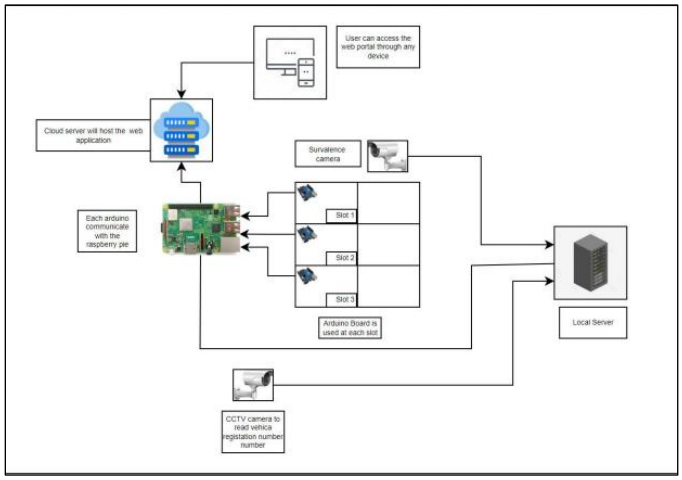

Figure 1 : Overall System Diagram

As a result, we provide a parking management system for a building with many offices that is entirely automated and has the following benefits:

- Vehicles may be identified automatically based on their license plate numbers and the sort of vehicle they are.
- A computerized system that allots parking spaces to vehicles depending on the owner's business and the kind of car. The system uses algorithms to choose the best parking spot, taking into account the owner's business and the car type.
- Real-time online hub detailing unused and vacant parking spots. The idea behind this function comes from the Internet of Things.
- Parking compliance will be monitored by an image processing system equipped with ESP32 cameras.
- The parking lot's vehicle security may be guaranteed by installing an intrusion detection system.
- Creating a web site and an algorithm to evaluate parking usage data and make recommendations for improved parking management in the future.
- Optical character recognition (OCR) is then used to read the number plate from the picture of the vehicle. This may be accomplished with the help of

convolutional neural networks (CNNs) or pre-trained OCR models.

- Implementing a method and developing an algorithm for reading license plates in low light.
- Develop a program that can identify the vehicle's make and model as it approaches a parking spot.

A. *Vehicle number plate character recognition under variable light levels*

The Smart Parking Management System, which is based on the Internet of Things (IoT), is a sophisticated solution designed to effectively manage parking within multi-level structures. The identification of vehicle number plate characters under different lighting conditions is a fundamental component of this system. This section utilizes state-of-the-art technology to accurately identify license plates, even in conditions with limited lighting.

The widespread adoption of license plate reader (LPR) technology across various domains such as law enforcement, parking management, toll collection, and traffic surveillance can be attributed to its remarkable versatility. The successful implementation of a smart parking management system is contingent upon the dependable identification of license plates.

The presence of a reliable license plate recognition system that can effectively adjust to varying lighting conditions is of utmost importance in a multi-office environment where parking spaces are shared among multiple businesses [4].

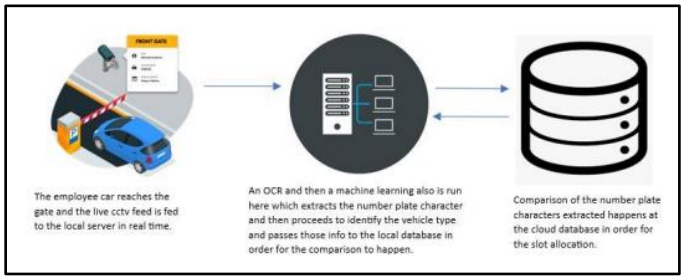

Figure 2 : Number plate and vehicle type detection.

By employing advanced image processing techniques and leveraging machine learning algorithms, we have achieved a high level of accuracy in accurately identifying license plates across various lighting conditions.

The implementation of Internet of Things (IoT) technology enables the integration of cameras, sensors, and network infrastructure to facilitate the exchange of data and enable real-time bidirectional communication with the parking management server. The utilization of Internet of Things (IoT) technology facilitates the expeditious and precise capture of license plate information by the system, enabling its transmission to a centralized server. This data can subsequently be employed for purposes such as verification, payment processing, and allocation of parking spaces, among various other applications.

B. *Design a system that distributes parking places by vehicle type and owner*.

The system employs a complex algorithm to assign parking spots to users in accordance with their car category and organizational affiliation. The capacity of parking places, vehicle size, and corporate parking preferences are only a few of the variables considered by the algorithm. The technology determines which vehicles are eligible for a certain parking spot based on real-time information collected by sensors placed across the parking lot.

The system incorporates a live-updating portal that displays the current occupancy status of parking spots, improving transparency, and facilitating access to the most recent information. Parking lot managers and workers alike may take use of the website's intuitive layout. In terms of parking spot availability, occupancy rates, and use trends, the system provides real-time information[6].

The system utilizes image processing technologies to ensure cars are parked in the most suitable spots. Vehicle entry and egress are monitored by CCTV cameras installed in the parking lot. Advanced computer vision techniques are then applied to these photographs in order to read and evaluate license plate information.

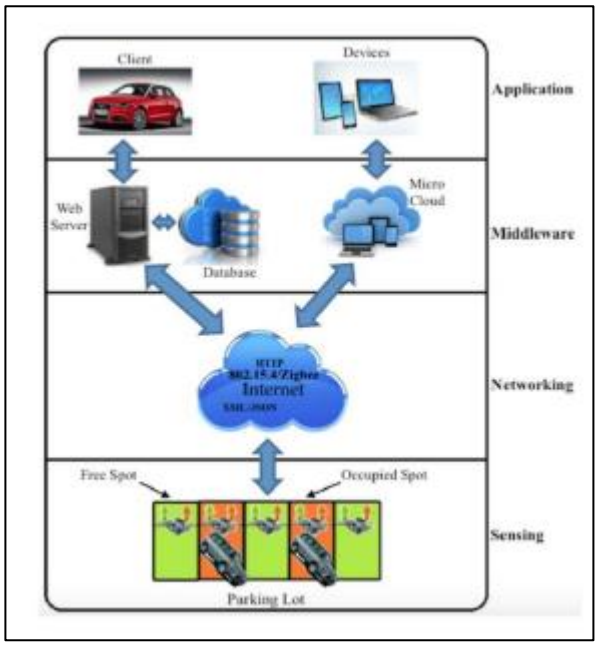

Figure 3 : Automated parking slot assignment system and real-time parking slot availability and utilization web portal architecture.

In addition, the system provides a straightforward online gateway via which parking spots may be reserved at the user's leisure. Employees can log in to the portal and reserve vehicles in accordance with their company and vehicle type. The website displays available parking spots that meet the needs of the employee's car and the company.

During the reservation process, you must choose your arrival date and time, car type, and employer. As soon as the system confirms that the requested time window is available, the reservation is considered confirmed. The employee receives a confirmation SMS that includes details on their parking space, making it simple for them to park when they arrive. The method for processing images compares the obtained license plate information to a database of allotted parking places. If a car is parked in an unauthorized location or against the rules, the system sends out an alert to the parking lot manager or the relevant authorities.

This encourages efficient parking management by ensuring that parking spots are utilized in line with the established criteria. The data that is required to update the live webpage is provided by IoT-enabled sensors placed in every parking space. These sensors inform a central server of the presence or absence of autos. The website retrieves this data, which is then shown in simple-to-read maps, graphs, and charts. Users may easily and quickly utilize the website's user-friendly design to find available parking spaces and make educated decisions about where to leave their automobiles.

C. *Analyzing parking utilization data and predicting future recommendations of the parking system for better management.*

The Smart Parking Management System collects real-time data from various sources in order to monitor parking availability. The presence of vehicles in parking spaces is detected by sensors that are enabled by the Internet of Things (IoT) technology. These sensors then transmit this information to a central server for further processing and analysis. Additionally, the system collects data from occupancy sensors, payment terminals, and points of entry/exit. The entirety of this information is consolidated within a singular location, facilitating convenient retrieval and comprehensive analysis.

The system gathers data pertaining to parking utilization and conducts a comprehensive analysis employing contemporary data analytics techniques. Pattern recognition algorithms are employed to identify and analyze trends, patterns, and anomalies related to parking activities. The technology has the capability to ascertain periods of high demand for parking, periods of low utilization, as well as both scenarios [7].

The system acquires knowledge regarding occupancy rates, typical parking hours, and preferred parking days and times through the analysis of historical data. The system utilizes predictive modelling techniques to generate recommendations for enhancing parking management in subsequent periods, drawing upon the analyzed data. The timely suggestions and alerts provided by the Smart Parking Management System can be advantageous for parking managers, workers, and customers alike. The system utilizes analytical models to anticipate user behavior and generate suggestions for convenient parking spots, available parking spots, and alternative modes of transportation.

The aforementioned recommendations have the potential to be disseminated through various channels, namely the digital signage system located in the garage, the web portal, or the mobile application. Push alerts can be utilized to provide updates regarding a user's parking status, reservation status, and current traffic conditions.

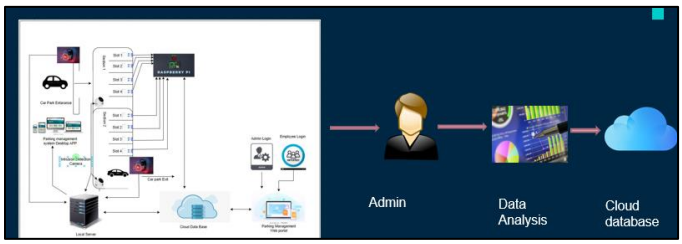

Figure 4 : Analyze parking utilization data and predict future recommendations of the parking system.

The implementation of the Smart Parking Management System within a multi-office environment leverages the capabilities of the Internet of Things (IoT) to enhance parking management and optimize the user experience by employing data analysis and predictive modelling techniques. By analyzing historical data, technology has the capability to make predictions regarding parking needs by identifying trends and patterns. The utilization of predictive modelling in the business realm offers several advantages, including enhanced traffic flow and improved convenience in parking spot reservations. Deliver users with up-to-date information by means of instantaneous suggestions and notifications.

D. *Provide improved security for the vehicles.*

The technology uses microphones placed in key locations throughout the parking lot to pick up sounds from all directions. The microphones are connected to the Internet of Things (IoT), allowing them to send audio samples to a centralized server for processing. The installation of a mic network across the parking garage ensures complete coverage of the area, cutting down on dead spots.

After processing, microphone recordings undergo advanced audio analysis. Pretreatment begins audio processing. During preprocessing, numerous methods increase sound quality. Machine learning algorithms analyze preprocessed audio samples. Audio recordings of car alarms, metal tool sounds, and glass smashing are used to train machine learning systems. Algorithms recognize patterns and distinctive properties associated with these occurrences via feature extraction and classification. Training helps the system distinguish between regular and harmful sounds. After training, the Smart Parking Management System integrates machine learning algorithms for real-time acoustic sample processing. The algorithm constantly compares recorded audio to harmful noise patterns. A suspicious noise indicates a harmful sound occurrence to the algorithm. The system's audio analysis module will detect an automobile alarm's particular sound pattern and sound an alarm. The system may also detect aural signs of break-ins or vandalism, such as metallic instruments or glass smashing. When it hears odd sounds, the system reacts quickly [8].

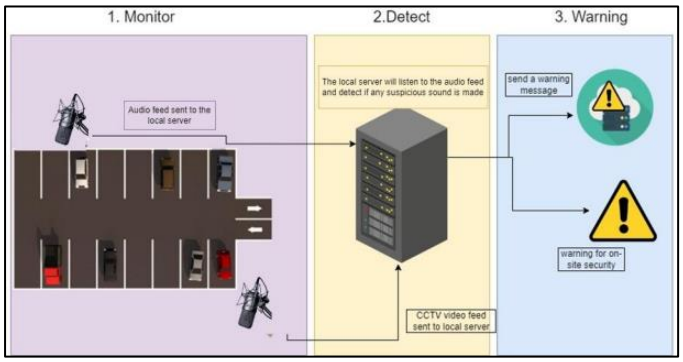

Figure 5 : Theft detection and prevention system

The identification and prevention of theft involves three successive processes. A "monitor" is any instrument or system used for keeping tabs on or measuring anything. At first, the server receives the audio feed from each microphone.

Audio analysis methods and machine learning algorithms are used to the audio for analysis. The act of spotting something. In the case that a person hears a noise that sounds like breaking glass, an alarm going off, or other suspicious noises, they should be on the lookout. This phenomena will be uncovered. Warn If theft is detected, an alert will be produced and sent to local security as well as the cloud, where the user will be informed without delay.

The Smart Parking Management System will immediately notify the car owner and police authorities of any suspicious sounds coming from the vehicle. There are a number of ways to have these warnings sent, including apps for smartphones, text messages, emails, and digital displays set up around the building itself. As a result of receiving this information quickly, the vehicle's owner can assess the situation and take any required preventative steps. Integration with other Internet of Things components, such as motion sensors or vibration detectors, is also possible with the audio analysis module.

IV. MODELS

A. *YOLO*

In a multi-office setting with a Smart Parking Management System using IoT, the ability to read licence plates in varying lighting conditions is crucial. A machine learning model called YOLO (You Only Look Once) might be utilised by the system to guarantee reliable identification. Licence plate recognition is a popular use of YOLO's object detection capabilities. When it comes to real-time object detection in multimedia streams like images and videos, the YOLO model is at the forefront of current research and development in deep learning architectures. YOLO takes a novel approach to object identification by seeing it as a single regression problem, as opposed to the standard region proposal methods employed by other algorithms [9].

A developed YOLO model may analyse real-time camera video and identify licence plates in the Smart Parking Management System. It recognises licence plate images and extracts key elements. The model reads licence plates and extracts VINs using OCR. The Smart Parking Management System optimises parking using YOLO. Real-time licence plate recognition saves time and eliminates human error. Multiple cars can enter and leave the parking lot without overcrowding it.

If many buildings share a parking garage, the Internet of Things may connect the YOLO-based licence plate recognition system to the garage's main parking management server. A server can authenticate, verify payments, and distribute parking spots using real-time licence plate data. This interface manages site-wide parking via departmental communication. In conclusion, the Smart Parking Management System with IoT for a multi-office setting uses the YOLO machine learning model to improve vehicle number plate character detection in various lighting conditions. YOLO increases OCR and licence plate recognition for faster parking and improved user experience .

B. *TensorFlow*

Deep learning is a relatively new topic within the larger field of machine learning, often known as deep structured learning. The foundational framework for deep learning approaches is the Artificial Neural Network (ANN). Deep learning is being used in many different fields, including image processing and computer vision, among others. Utilizing cutting-edge algorithms helps deep learning evolve, which advances artificial intelligence (AI) research towards its end goal. It has been demonstrated that deep learning is more accurate than other methods for detecting and identifying objects. Google's TensorFlow deep learning framework is frequently used to execute a variety of deep learning algorithms with ease [10].

In the present configuration, sensors strategically positioned within parking spaces possess the capability to detect the presence of vehicles. The installation of these detectors can be carried out either in the ground or in specifically designated parking spaces. The sensors establish communication with a gateway or server via a wireless network.

The parking sensors establish communication with the gateway by utilizing Internet of Things (IoT) protocols such as MQTT or HTTP. The sensors provide real-time updates to the server regarding the current availability of parking spaces. TensorFlow uses sensor data from the primary server. TensorFlow analyses sensor data and predicts parking spot availability using machine learning. Object detection and categorization can identify a parking spot's occupancy status. The study found that the centralized server updates a database or real-time dashboard with parking availability [11].

The system can use parking data-trained machine learning models. This lets the system forecast parking habits and improve space distribution. These algorithms can help find vacant parking spaces, forecast high demand, and increase parking management efficiency. A Smart Parking Management System may be created by integrating TensorFlow with IoT to provide real-time parking spot availability, predictive analytics, and resource allocation optimization.

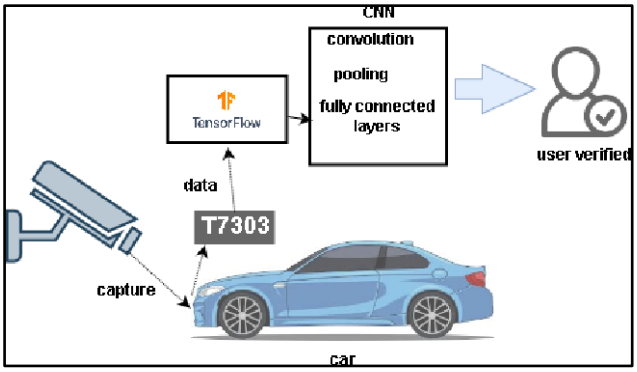

Figure 6 : TensorFlow Model

V. FUTURE POSSIBLE RESEARCH PROBLEMS

Headings, or heads, are organizational devices that guide the reader through your paper. There are two types: component heads and text heads.

Component heads identify the different components of your paper and are not topically subordinate to each other. Examples include Acknowledgments and References and, for these, the correct style to use is "Heading 5". Use "figure caption" for your Figure captions, and "table head" for your table title. Run-in heads, such as "Abstract", will require you to apply a style (in this case, italic) in addition to the style provided by the drop down menu to differentiate the head from the text.

Text heads organize the topics on a relational, hierarchical basis. For example, the paper title is the primary text head because all subsequent material relates and elaborates on this one topic. If there are two or more sub-topics, the next level head (uppercase Roman numerals) should be used and, conversely, if there are not at least two sub-topics, then no subheads should be introduced. Styles named "Heading 1", "Heading 2", "Heading 3", and "Heading 4" are prescribed.

VI. CONCLUSION

A multi-office Smart Parking Management System using IoT eliminates parking challenges and offers several benefits. Real-time monitoring, IoT, and data analysis improve parking space management, user experience, and resource allocation. IoT links parking sensors, central servers, and user interfaces. Connectivity allows real-time occupancy, availability, and historical parking data collection. Using smartphone applications or web interfaces, workers and tourists may find and book parking places.

Real-time parking spot monitoring decreases congestion. IoT occupancy data optimizes office space and parking resource utilization. Historical data and predictive analytics evaluate parking demand and assign spaces, saving time and enhancing efficiency. IoT-connected smart parking management systems provide automated payment and security. Internet and mobile apps speed up payments, reducing cash use. The system may contain security cameras and access limitations for parking safety.

IoT-enabled multi-office Smart Parking Management System revolutionizes parking management. Real-time availability information, resource optimization, and easy features simplify parking for workers, visitors, and site management. It removes parking hassles, improves traffic flow, and maximizes parking resources, enhancing multi-office productivity and satisfaction.

ACKNOWLEDGMENT

The preferred spelling of the word "acknowledgment" in America is without an "e" after the "g". Avoid the stilted expression "one of us (R. B. G.) thanks ...". Instead, try "R. B. G. thanks...". Put sponsor acknowledgments in the unnumbered footnote on the first page.

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