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A Deep Learning-Powered Smart Parking System Based On Facial Recognition and License Plate Analysis with IOT

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ABSTRACT: In today's urban landscapes, parking congestion has become a pervasive challenge,leading to wasted time, increased emissions, and driver frustration. The ever-growing urban population, coupled with the increasing number of vehicles, has led to a severe shortage of parking spaces in metropolitan areas. This scarcity has not only made finding a parking spot a time-consuming and frustrating experience but has also contributed to traffic congestion and environmental pollution. Traditional parking management systems, which often rely on manual ticketing or physical barriers, are becoming inadequate in addressing these challenges. To address this issue, innovative solutions that combine technology and automation are on the rise. Traditional parking management systems often rely on physical infrastructure and human intervention, resulting in inefficiencies and limited scalability. In contrast, the integration of deep learning techniques and advanced computer vision technology into parking management opens up new possibilities for a smarter, more efficient, and user-friendly experience. This system leverages two key components: facial recognition technology to identify vehicle occupants and automatic recognition of license plate numbers for vehicle identification. By seamlessly integrating these technologies, the system not only facilitates effortless parking but also enhances security and optimizes parking space utilization. In this project, we will explore the fundamental components, benefits, and potential impact of the Face and Number Plate-Based Smart Parking System. Experimental results shows that improved efficiency in smart parking system using face and number plate verification system.

KEYWORDS: License Plate Recognition, Face Recognition, Multi-task learning, Traditional parking management, Automatic recognition

I. INTRODUCTION

In our increasingly urbanized world, the efficient management of parking spaces has become a critical aspect of urban planning and daily life. Parking is not only a matter of convenience for drivers but also an essential component of traffic management, environmental sustainability, and revenue generation for municipalities and businesses. To address the challenges of parking in crowded urban areas and streamline the parking experience, advanced parking systems have emerged. These systems leverage technology, data, and automation to optimize the use of available parking spaces, enhance user convenience, and improve the overall management of parking facilities. This introduction provides an overview of parking systems, outlining their significance, components, and the benefits they offer to both drivers and parking operators. As urban centres continue to grow, the role of parking systems in creating more efficient and sustainable cities becomes increasingly crucial. Security is a paramount consideration in parking systems, ensuring the safety of vehicles, individuals, and the overall operation of the facility. Here are key aspects of security in a parking system

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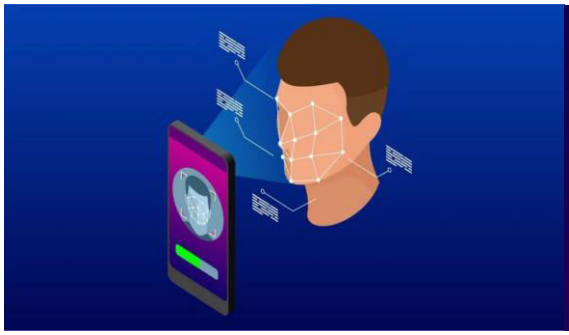

Figure 1

Figure 2

II. RELATED WORKS

As the demand for smart parking continues to grow, many studies and projects have emerged to explore solutions using Internet of Things (IoT) technology. In this section, we examine some related projects in the field of smart parking. The famous study by Li et al. (2018) focused on developing smart parking systems that use IoT sensors and cloud computing to improve parking efficiency. The system can identify the parking area in real time and provide information to parking area users via the mobile application. The results show that parking efficiency in the area has increased significantly and traffic congestion has also decreased. Another interesting project by Kumar et al. (2019) proposed a smart parking system that integrates IoT devices with machine learning algorithms to predict parking availability based on historical data. The system can analyze parking behavior patterns and accurately predict parking needs, allowing users to better plan their trips. This study demonstrates the potential of using predictive analytics to optimize parking management and reduce parking time. Additionally, Zhang et al. (2020) investigates the use of technology in smart parking to improve the processing time of IoT sensor data. By deploying edge servers between stations, the system can improve response time and reduce delays in detecting available stations. This study highlights the importance of edge computing in making faster decisions and improving overall performance. In addition to academic research, many companies are developing smart parking solutions using IoT technology. ParkiFi, for example, offers a smart parking system that uses IoT sensors and analytics to provide real-time parking information to drivers and parking attendants. This system makes parking more convenient and convenient by helping users find parking and reserve parking in advance. Similarly, companies like Streetline and ParkMobile are using IoT-based parking systems in cities around the world to improve parking management and reduce traffic congestion. These solutions use technology and a cloud-based platform to monitor parking, simplify the payment process, and improve parking management. Overall, research and commercial development of smart parking systems using IoT technology demonstrate the potential to improve urban mobility and improve user experience. Leveraging real-time data analytics, predictive modeling, and edge computing capabilities, these systems have the power to change the way we solve parking and urban congestion problems.

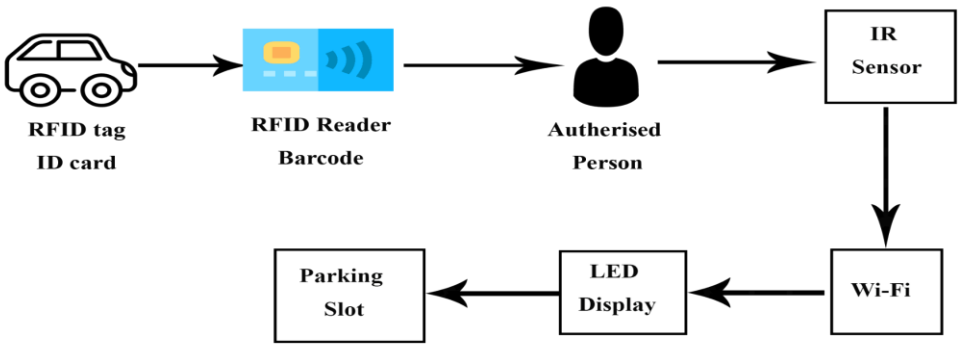

Figure 2

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III. METHODOLOGY

1. Design process The first step in creating a smart parking system is to create a complete design of the system. This includes identifying elements of the system such as sensors, communications, data processing, and user interfaces. The scalability, reliability and security of the system should be taken into account in the design.
2. Sensor deployment The basis of smart parking is a sensor network used to check whether there are cars in the parking lot. Sensors can be sent to various locations such as a parking lot, road or garage. The type of sensor used (magnetic, ultrasonic or infrared) depends on the specific requirements of the station.
3. Data Collection Once deployed, the sensors start collecting data about the station's location. This information is sent to the central server using methods such as Wi-Fi, Bluetooth or LoRaWAN. The server processes the data and updates the station's status in real time.
4. Data processing: Analyze the collected data to determine the best station allocation. Machine learning algorithms can be used to predict parking needs based on historical data, weather, conditions and more. The processed data is then displayed in relevant user interfaces such as mobile applications, websites or electronic signatures.
5. User Interface User interface plays an important role in providing a good experience to drivers looking for parking. Mobile apps can display the nearest parking lot, direct users to the car park, and offer payment options. The portal can view parking status in real time and allow users to reserve parking in advance.
6. Integration with payment system Integration with payment system is important to benefit from the advantages of smart parking. Drivers can pay the parking fee using a mobile wallet, credit card or prepaid account. Automated payment systems reduce the need for physical parking and simplify the payment process for users.
7. Communication and notifications In addition to showing parking space, smart parking systems can also send users notifications about special promotions, discounts or options. Notifications can be sent via SMS, email or push notifications to keep users informed and engaged.
8. Maintenance and monitoring Regular maintenance of sensors, communication equipment and server equipment is essential to ensure proper functioning of the site.Smart parking. Real-time monitoring tools can identify anomalies, predict failures, and trigger timely intervention alerts. Conclusion Implementing a smart parking system using IoT requires a way to create, distribute, and manage many physical things.

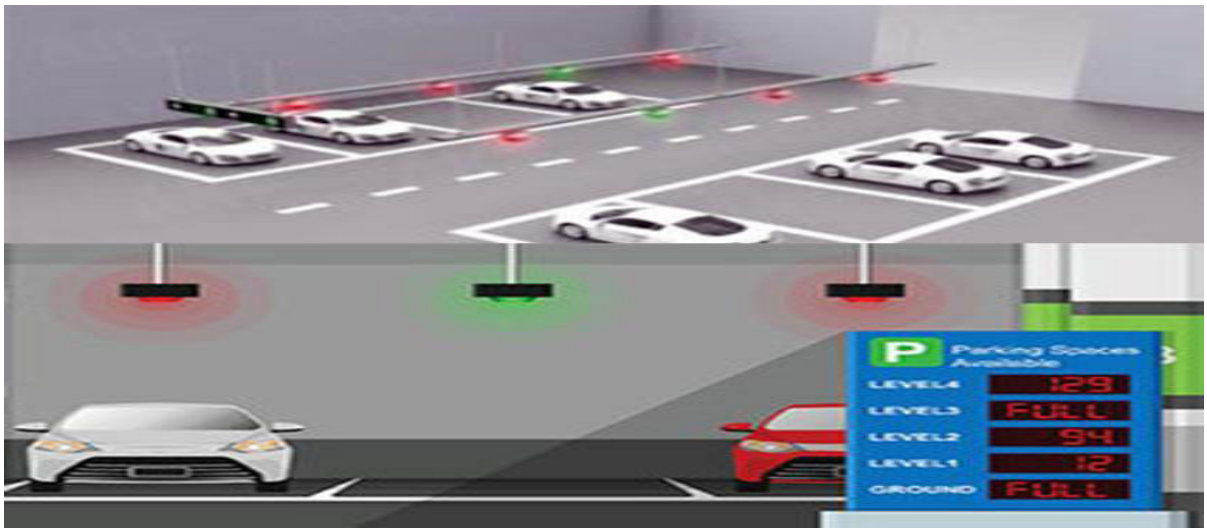

Figure 3

IV. PROPOSED ARCHITECTURE

A smart parking system using number plate and face recognition integrates cutting-edge technologies to enhance parking management and user experience. High-definition cameras capture vehicle images for number plate recognition, while face recognition software identifies individuals. A centralized database stores vehicle details and owner information, enabling automated access control and parking allocation. IoT-enabled parking gates regulate entry and exit based on authorized vehicles and individuals. Real-time occupancy monitoring optimizes parking space utilization, while touchless entry, exit, and payment facilitate a seamless user experience. Automated operations and

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centralized management reduce labour costs and administrative overhead. Data-driven insights from parking usage patterns inform parking rate optimization and strategic management decisions. This comprehensive system revolutionizes parking management, offering enhanced security, efficiency, convenience, and cost-effectiveness. A proposed system for face and number plate recognition in the context of smart parking would encompass a range of integrated technologies designed to enhance security, streamline access control, and provide an effortless user experience. At the core of this system, high-resolution cameras equipped with dual functionalities—facial recognition and license plate recognition (LPR)—would be strategically positioned at the entrance and exit points of the parking facility. These cameras would serve as the initial points of interaction, capturing crucial data from both drivers and vehicles. A sophisticated facial recognition software component would be deployed to capture and authenticate the identity of drivers and passengers as they approach these points using deep learning algorithm. Then recognize the number plate with corresponding faces using Optical character Recognition with OTP verification.

❖ **Key features of smart parking:**

1. Instant parking: Smart parking will use sensors placed in the parking lot to identify the vehicle. This information will be sent to the central system, which will provide drivers with real-time information on parking via mobile phones or electronic signals.
2. Automatic payment: This system will allow drivers to pay parking fees electronically from their mobile phones, eliminating the need for parking tickets and payment machines. This will speed up the parking process and reduce the risk of human error
3. Reservation system: Drivers can select a parking space in advance via mobile phone. This is especially true in busy areas where parking is not available, ensuring drivers have a guaranteed parking space when they arrive.
4. Data analysis: The system will collect and analyze data on parking usage, maximum parking time and other parameters. City planners can use this information to make decisions about parking improvements and traffic management strategies.

❖ **Usage of the concept:**

1. Access Control: Implement robust access control mechanisms to prevent unauthorized entry. This can include barriers, gates, turnstiles, RFID card readers, license plate recognition systems, or mobile app-based access.
2. Surveillance Cameras: Install surveillance cameras strategically to monitor the entire parking area. High-resolution cameras help deter criminal activity and provide valuable evidence in case of incidents.
3. Lighting: Adequate lighting is crucial to enhance visibility and discourage illicit activities. Well-lit parking areas create a safer environment for both vehicles and pedestrians.
4. Data Security: Safeguard data collected by the system, including user information and payment data, by implementing encryption and following data protection regulations.
5. Environmental Monitoring: In addition to security, some systems monitor environmental conditions, such as fire alarms and carbon monoxide levels, to protect against potential hazards.
6. Security in parking systems is not only about protecting vehicles but also about creating a safe and welcoming environment for users. By integrating robust security measures and staying up-to-date with the latest security technologies, parking facility operators can mitigate risks and provide a sense of safety for both patrons and their vehicles.

❖ **Advantages of smart parking:**

1. Reduce traffic congestion: Smart parking helps reduce the time required to find a parking space by providing parking information to drivers, thus reducing traffic congestion in the city.
2. Improve user experience: The convenience of advance parking and electronic payment will improve the driver's overall parking experience, thus enabling people to satisfy the pressure on customers.
3. Environmental impact: Smart parking will help reduce vehicle emissions and promote environmental sustainability by reducing driving time to find parking.

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Details:

Smart parking using IoT technology has the potential to transform urban parking, thereby improving traffic flow, improving user experience and providing environmental benefits. Using real-time data and technology, cities can improve parking and create a smarter, better city experience for residents and visitors.

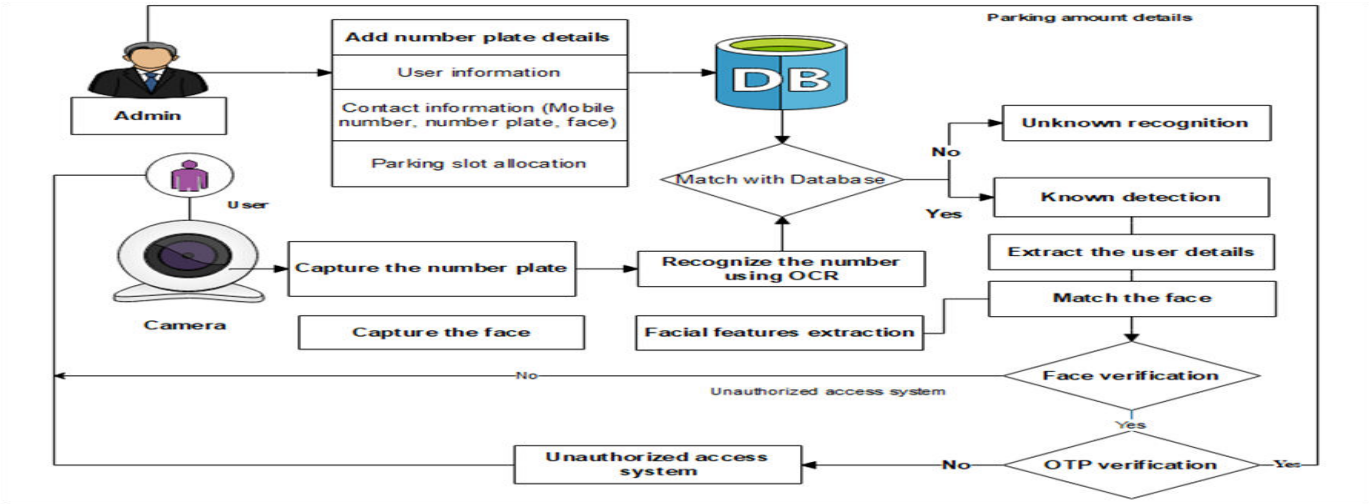

Figure 4

V. ALGORITHM

1. Optical Character Recognition Algorithm:

Optical Character Recognition (OCR) has been a topic of interest for many years. It is defined as the process of digitizing a document image into its constituent characters. Despite decades of intense research, developing OCR with capabilities comparable to that of human still remains an open challenge. Due to this challenging nature, researchers from industry and academic circles have directed their attentions towards Optical Character Recognition. Over the last few years, the number of academic laboratories and companies involved in research on Character Recognition has increased dramatically. This research aims at summarizing the research so far done in the field of OCR. Optical Character Recognition (OCR) is a piece of software that converts printed text and images into digitized form such that it can be manipulated by machine. Unlike human brain which has the capability to very easily recognize the text/ characters from an image, machines are not intelligent enough to perceive the information available in image.

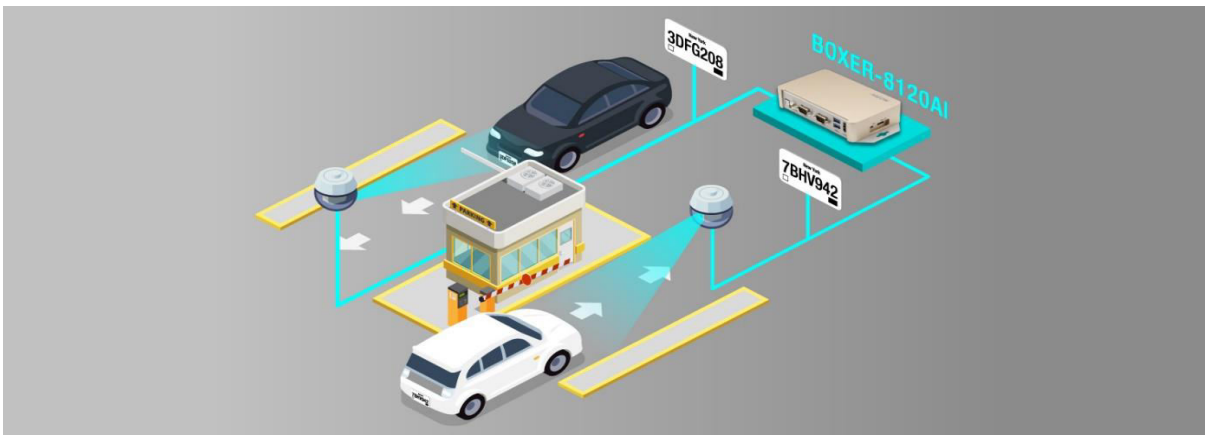

Figure 5

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2. Grassman Algorithm:

For each frame in a video sequence, we first detect and crop the face regions. We then partition all the cropped face images into K different partitions. We partition the cropped faces by a Grassman algorithm type of algorithm that is inspired by video face matching algorithm. Sampling and characterizing a registration manifold is the key step in our proposed approach. The proposed algorithm presents a novel perspective towards frame selection by utilizing feature richness as the criteria. It is our assertion that quantifying the feature richness of an image helps in extracting the frames that have higher possibility of containing discriminatory features. In order to compute feature-richness, first the input (detected face) image I is preprocessed to a standard size and converted to grayscale. By performing face detection first and considering only the facial region, we ensure that other non-face content of the frame does not interfere with the proposed algorithm. Given a pair of face coordinates, we determine a set of affine parameters for geometric normalization. The affine transformation maps the (x, y) coordinate from a source image to the (u,v) coordinate of a normalized image.

VI. .CONCLUSION

In conclusion, a smart parking system that integrates face and number plate recognition technologies offers a promising solution to address the growing challenges of urban parking management. By harnessing deep learning algorithms, these systems can efficiently monitor and manage parking facilities, enhancing the overall experience for both users and operators. The use of facial recognition in such systems not only simplifies access control but also adds an extra layer of security, ensuring that only authorized individuals gain entry. Simultaneously, number plate recognition technology provides a convenient means for users to enter and exit the facility without the need for physical tokens or access cards. The synergy between these technologies, when supported by robust data processing and management, can provide valuable insights into parking patterns, usage statistics, and real-time space availability. This data-driven approach not only optimizes parking space utilization but also contributes to reduced traffic congestion and environmental benefits.

VII. FUTURE ENHANCEMENT

Expand the payment options available to users by integrating mobile payment solutions such as mobile wallets, contactless payments, and in-app payments. This provides users with greater flexibility and convenience in paying for parking, reducing the reliance on cash or physical payment methods. In future we can extend the framework to analyse the multiple features in token-based parking system and embed with mobile applications.

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