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Smart parking with face recognition

[1].Prathipa C, [2].Dhinakaran J, [3].Dinesh A, [4].Jayaraj J, [5].Manoj S

EXCEL ENGINEERING COLLEGE
(Autonomous)
Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai
Accredited by NBA (AERO, CSE, ECE, MECH) , NAAC with "A+" and Recognised by UGC (2f &12B)
KOMARAPALAYAM – 637303
Department of Computer Science and Engineering

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 survey, 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: Smart Parking system, Face Recognition, License plate-based verification, Features extraction, Character recognition

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:

- 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.
- 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.
- 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.
- Data Security: Safeguard data collected by the system, including user information and payment data, by implementing encryption and following data protection regulations.
- Environmental Monitoring: In addition to security, some systems monitor environmental conditions, such as fire alarms and carbon monoxide levels, to protect against potential hazards.

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. Fig 1 shows the smart parking system using IOT technology

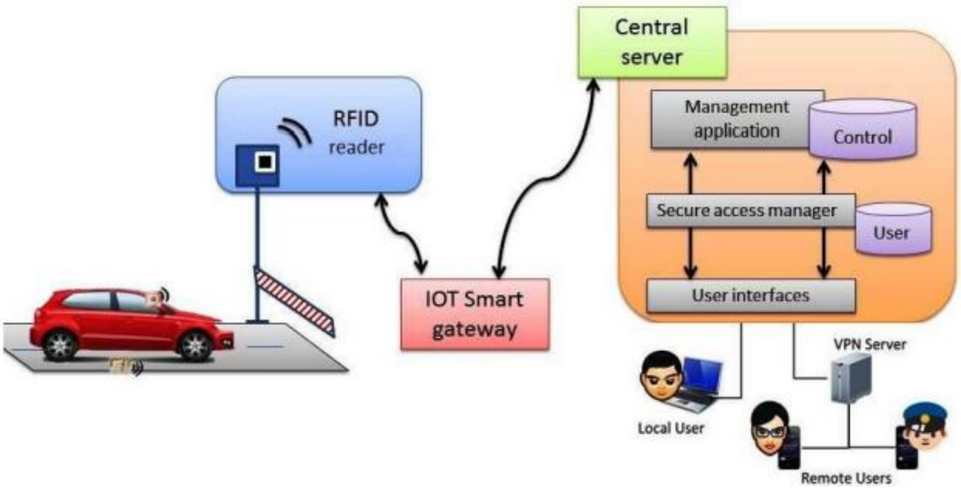

Figure 1: IOT BASED SMART PARKING SYSTEM

RELATED WORK :

Yasir Saleem, et.al,…[1] presented the development, implementation and evaluation of an IoT Recommender (IoTRec) for a smart parking system. The main purpose of this system is to provide a better experience to both users and managers in terms of vehicular mobility in a city by relying on IoT technologies. The IoTRec mainly provided the GDPR-compliant recommendations of a parking spot (nearest or nearest trusted parking spot) and a route (least congested or shortest route) leading to the recommended parking spot, as well as the real-time provision of the expected occupancy of parking areas based on the historical IoT data. Finally, the proposed system was evaluated through a prototype, called Rich Parking, which was utilized and tested by the citizens of Santander, Spain.

Jingxiao Zheng, et.al,…[2] proposed an automatic face recognition system for unconstrained video-based face recognition tasks. The proposed system consists of modules for face detection and alignment, face association and tracking, face representation, subspace learning and subspace-to-subspace similarity-based matching. We evaluated our system on four video datasets. The experimental results demonstrate the superior performance of the proposed system. Face recognition is one of the most actively studied problems in computer vision and biometrics. Nowadays, videobased face recognition is an active research topic because of a wide range of applications including visual surveillance, access control, video content analysis, etc. Compared to still image-based face recognition, video-based face recognition is more challenging due to a much larger amount of data to be processed and significant intra/inter-class variations caused by motion blur, low video quality, occlusion, frequent scene changes, and unconstrained acquisition conditions

LI MAO, et.al,…[3] focused on developing a real-time occluded face detection method. Different from the most existing face detection algorithms aiming at detecting a normal and unshaded faces, we have constructed an effective occluded face detection mechanism which has better accuracy in the detection based on the reduced computational complexity. The background of this paper is surveillance of IoT, which is mainly applied in target detection and recognizing at ATM intelligent surveillance system. In this paper, we proposed a novel face occlusion recognition framework. It provides three stages, i.e., face detection, face tracking and face verification. A novel energy with Gaussian curve is proposed, and then novel face tracking algorithm with deep CNN feature we applied, finally, we design a novel dictionary learning scheme for verification task.

H. CANLI, et.al,…[4] implemented a new architecture and a new application based on deep learning have been developed for detection of parking occupancy in IoT-based smart cities. b) With the ''LSTM-based deep learning approach'' and multivariate and multi-time series parking data set, more dominant results were obtained in determining the car park occupancy than could be determined with Support Vector Machine (SVM), Random Forest (RF) and ARIMA. c) A large data set that can be used and inspired by other studies in the literature was created by collecting parking space data with different parameters for a year. The insufficient amount of data obtained in the prediction models collected so far has affected the success of the models designed. Before starting the studies conducted, about 4.5 million data of various features were collected and the collection continues. The fact that the success of deep learning models is parallel to the increase in data has been the source of motivation in this study

AWAIS ABDUL KHALIQ, et.al,…[5] proposes a secure and privacy-preserved parking recommender scheme based on IOTA DLT, local differential privacy, and elliptic curve cryptography. Privacy of parking data is a major concern in data sharing systems as various parking service providers are sharing the historical data with third-party recommender systems for better user experience and personalized parking recommendations that may lead to unauthorized access to individual's data and the user can be uniquely identified by using background knowledge attack by the attacker. We have developed the anonymous security protocol for authentication and registration using ECC and HMAC that authenticates the user to prevent unauthorized access to data and provide anonymity and integrity during the communication. In addition to LDP anonymization techniques, we have presented a model that utilizes the IOTA DLT to provide a new level of security that ensures immutability, scalability, and quantum secrecy throughout the database and protects against a single point of failure issue.

SENSOR BASED SMART PARKING SYSTEM :

A sensor-based smart parking system is a cutting-edge solution for optimizing parking management and improving the parking experience for both users and operators. These systems employ a network of sensors, including ultrasonic, magnetic, infrared, and video-based sensors, to continuously monitor the occupancy of parking spaces. The data collected is then relayed to a central server or cloud-based platform for real-time analysis, enabling users to access up-to-the-minute information about available parking spaces. This real-time data is delivered through mobile apps, websites, electronic displays, or on-site signage, allowing drivers to locate parking spaces quickly and minimize the often-frustrating search for an open spot. Some systems even offer reservation and pre-booking options, ensuring a convenient parking experience. Navigation and guidance features further streamline the process, reducing traffic congestion. Integration with payment processing simplifies the payment process, while security measures such as surveillance cameras enhance safety. Data analytics empower parking operators to make data-driven decisions, and some systems promote environmental sustainability through EV charging stations. The scalability of these systems makes them adaptable to various parking facility sizes, offering an efficient and user-friendly solution for modern urban parking challenges.

- Ultrasonic Sensors: Ultrasonic sensors use sound waves to detect the presence of vehicles. They emit ultrasonic pulses and measure the time it takes for the pulses to bounce back. When a vehicle occupies a space, the sensor detects the reflected sound waves and registers the space as occupied.
- Magnetic Sensors: Magnetic sensors rely on changes in the Earth's magnetic field caused by the presence of a vehicle. When a vehicle parks over a magnetic field, the sensor detects the disruption and registers the space as occupied. These sensors are often embedded in the pavement.
- Infrared Sensors: Infrared sensors use infrared light to detect the presence of a vehicle. They emit an infrared beam, and when a vehicle interrupts this beam, the sensor registers the space as occupied. Infrared sensors are commonly used in automated barrier systems.
- Ground-Loop Sensors: Ground-loop sensors are electromagnetic sensors that create a loop in the pavement. When a vehicle drives over the loop, it disrupts the electromagnetic field, signaling that the space is occupied.
- Acoustic Sensors: Acoustic sensors use sound-based technology to detect vehicle presence. They listen for the sounds generated by vehicle movement and engine noise to determine space occupancy.
- Wireless Sensors: Wireless sensors are compact and easy to install. They communicate wirelessly with a central system, providing real-time data on parking space occupancy. These sensors often use technologies like Wi-Fi, LoRa, or Bluetooth for communication.
- Laser-Based Sensors: Laser sensors project laser beams to monitor parking spaces. When a vehicle interrupts the laser beam, the sensor registers the space as occupied.
- RFID Sensors: Radio-frequency identification (RFID) sensors use RFID tags on vehicles to identify and track parking space occupancy. These sensors require RFID readers at entry and exit points.
- Ultraviolet Sensors: Ultraviolet sensors use ultraviolet light to detect vehicle presence. They are particularly effective for indoor parking facilities.

These various sensor technologies can be used individually or in combination to monitor parking space occupancy, and the choice of sensor depends on factors such as the type of parking facility, cost considerations, and the level of accuracy required. Sensor-based parking systems are integral to optimizing parking management, reducing congestion, and enhancing the overall parking experience for users. Fig 2 shows the components for smart parking system.

COMPONENT NAME	IMAGE	DESCRIPTION
ULTRA SONIC SENSORS		An ultrasonic sensor is an instrument that measures the distance to an object using ultrasonic sound waves.
ZIGBEE		*ZigBee Modules* are devices that are used to transmit and receive radio signals.
ARDUINO UNO		Arduino UNO is a microcontroller board based on the *ATmega328P*. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header and a reset button.

LED DISPLAY		A *LED display* is a flat panel *display* that uses an array of light-emitting diodes as pixels for a video *display*.

Fig 2: Components for smart parking system using Sensor

PROPOSED METHODOLOGIES :

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.

Fig 3 shows the proposed framework in parking system.

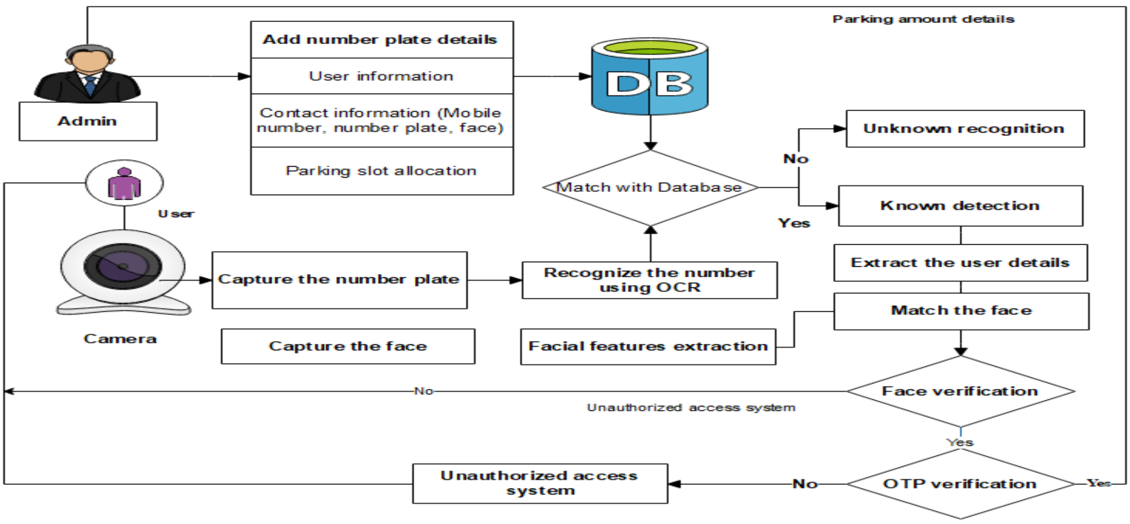

Fig 3: Proposed architecture

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.

Input: A set of P points on manifold
$\{X_i\}_{i=1}^{P} \in G(d, D)$
Output: Karcher meanμK
1. Set an initial estimate of Karcher mean $\mu_K = X_i$ by randomly picking one point in $X_i\}_{i=1}^{P}$
2. Compute the average tangent vector
A $=\frac{1}{P}\sum_{i=1}^{P} \log_{\mu K}(X_i)$
3. If $||A|| < \varepsilon$ then return μK stop, else go to Step 4

4. Move μK in average tangent direction $\mu K = \exp_{\mu K}(\alpha A)$, where$\alpha > 0$ is a parameter of step size. Go to Step 2, until μK meets the termination conditions (reaching the max iterations, or other convergence conditions

Thus, the video is transformed on a trajectory that links different points on Grassmann manifold. The projection on Grassmann manifold requires decomposition. The main advantages of this projection are being reversible and have no loss of information. The next step consists on similarity computing between human skeletal joint trajectories in order to identify the identity of a given skeleton sequence.

OPTICAL CHARACTER RECOGNITION :

Optical Character Recognition (OCR) is a technology that enables the conversion of scanned or photographed text documents into machine-readable text. OCR algorithms typically involve a series of image processing, pattern recognition, and machine learning techniques to recognize characters and words. Below are some key details on the components and processes involved in OCR algorithms:

Image Preprocessing:

- Noise Reduction: The algorithm begins by removing noise and unwanted artifacts from the image, such as dust, scratches, or background interference. Common techniques include median filtering, Gaussian smoothing, and edge detection.
- Image Enhancement: The image may be enhanced to improve contrast, brightness, and sharpness. Histogram equalization and contrast stretching are commonly used methods.

Text Detection:

- Localization: OCR algorithms locate areas in the image that potentially contain text using techniques like edge detection, contour analysis, and connected component analysis.
- Text Region Segmentation: Once potential text regions are identified, the algorithm segments these regions into individual lines or words. This is important for character recognition.

Character Recognition:

- Feature Extraction: For each character or symbol within a segmented text region, features like the shape, size, and relative positions of individual components (strokes, loops, dots, etc.) are extracted.
- Pattern Matching: OCR algorithms compare the extracted features to predefined templates or models of characters in a reference database.
- Machine Learning: Many modern OCR systems use machine learning techniques, including neural networks, to improve character recognition accuracy. Deep learning models, such as Convolutional Neural Networks (CNNs), have shown significant success in OCR.

Post-Processing:

- Contextual Analysis: Some OCR algorithms perform contextual analysis by considering the surrounding characters to improve character recognition. For instance, recognizing "i" next to "j" or "u" next to "v" can be contextually corrected.
- Dictionary Look-Up: In cases where words or phrases are recognized, the OCR system may consult a dictionary to correct or verify the recognized text.

Output Formatting:

- The recognized text is formatted and structured according to the desired output, such as plain text, searchable PDFs, or structured data.
  From the above definitions, face recognized based on features and number plate can be recognized, then automatically convert into text format. Finally OTP based verification can be done for improve the security in parking.

EXPERIMENTAL RESULTS :

In this chapter used real time datasets. This framework used the face detection and recognition techniques. Then can evaluate the performance using accuracy metrics. The accuracy metric is evaluated as

$$\text{Accuracy} = \frac{TP+TN}{TP+TN+FP+FN} * 100$$

The proposed algorithm provide improved accuracy rate than the machine learning algorithms.

Accuracy table shown in table 1.

Algorithm	Accuracy (%)
Adaboost classifier	50
Viola jones classifier	70
Grassmann algorithm	90

Table (1) Accuracy table

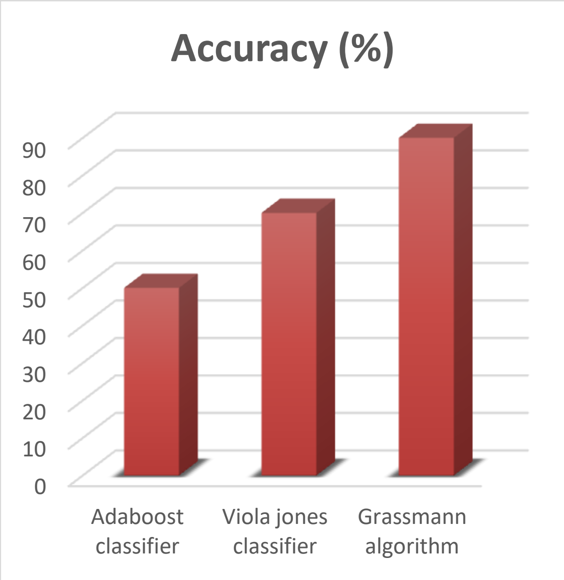

Fig 4: Performance report

From the performance chart in fig 4, Grassmann algorithm provide high level accuracy than the existing machine learning algorithms. The proposed system provides reduce number false positive rate.

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.

REFERENCES :

[1] Y. Saleem, P. Sotres, S. Fricker, C. L. de la Torre, N. Crespi, G. M. Lee, R. Minerva, and L. SÁnchez, ‘‘IoTRec: The IoT recommender for smart parking system,’’ IEEE Trans. Emerg. Topics Comput., vol. 10, no. 1, pp. 280–296, Jan. 2022.

[2] J. Zheng, R. Ranjan, C.-H. Chen, J.-C. Chen, C. D. Castillo, and R. Chellappa, ‘‘An automatic system for unconstrained video-based face recognition,’’ IEEE Trans. Biometrics, Behav., Identity Sci., vol. 2, no. 3, pp. 194–209, Jul. 2020

[3] L. Mao, F. Sheng, and T. Zhang, ‘‘Face occlusion recognition with deep learning in security framework for the IoT,’’ IEEE Access, vol. 7, pp. 174531–174540, 2019.

[4] H. Canli and S. Toklu, ‘‘Deep learning-based mobile application design for smart parking,’’ IEEE Access, vol. 9, pp. 61171–61183, 2021

[5] Khaliq, Awais Abdul, et al. "A secure and privacy preserved parking recommender system using elliptic curve cryptography and local differential privacy." IEEE Access 10 (2022): 56410-56426.

[6] Chen, CL Philip, and Bingshu Wang. "Random-positioned license plate recognition using hybrid broad learning system and convolutional networks." IEEE Transactions on Intelligent Transportation Systems 23.1 (2022): 444-456.

[7] Shashirangana, Jithmi, et al. "Automated license plate recognition: a survey on methods and techniques." IEEE Access 9 (2020): 11203-11225.

[8] Weihong, Wang, and Tu Jiaoyang. "Research on license plate recognition algorithms based on deep learning in complex environment." IEEE Access 8 (2020): 91661-91675.

[9] Zou, Yongjie, et al. "A robust license plate recognition model based on bi-lstm." IEEE Access 8 (2020): 211630-211641.

[10] Henry, Chris, Sung Yoon Ahn, and Sang-Woong Lee. "Multinational license plate recognition using generalized character sequence detection." IEEEAccess 8(2020):35185-3519