Web App for Smart Parking System based on IoT

Tarachand Verma[1], Krishna Mishra[2], Mritunjay Mishra[3]
[1,2,3] *School of Computer Science and Engineering, Galgotias University, Greater Noida, India*

***Abstract*—In Today's cities, the number of vehicles is increasing very fast. Because of this, traffic and parking problems are very common. Many drivers waste their important time and fuel searching for finding free parking spaces. Current parking systems are expensive, complex to use, or do not show free spaces in real time. They also do not provide Online booking feature and did not accept online payments. This project will provide the solution for these issues by making a Smart Parking Web App. That app will allow users to see free spaces, book them Online, and pay digitally. The system will use real-time data (from sensors or manual updates) to show which slots are available and free to use. It will also guide the user to the nearest parking space. For managers, the app will provide tools to add or remove slots, check usage, and make reports. This project is important because it saves time, reduces fuel use, and lower pollution. It will also help reduce traffic problems and support smart city growth. The system will be low-cost, simple, and easy to expand. It will directly help people by solving one of the biggest problems in cities finding a free parking space.**

***Index Terms*—Car park system, intelligent transportation system, parking technology, smart parking system**

I. INTRODUCTION

The fact that new registered vehicles in India have increased exponentially depicts a clear indication of the pressure on the current infrastructure. By the financial year 2024- 25, the auto industry in India was able to manufacture more than 3.10 crore (31 million) vehicles. The domestic sales of Passenger Vehicles alone stood at 43.02 lakh (4.3 million) units in the current year, FY 2024-25, compared to that of the last year. This massive and unremitting influx as underscored by the estimates that gather that all the registered vehicles in India will exceed 40 crores (400 million) by 2025 is a big challenge. Based on these figures provided by Society of Indian Automobile manufacturers (SIAM) and market projections, it is generally accepted that the existing transportation infrastructure and car park systems in India are too little to support the current car population. As a result, the issues such as debilitating traffic jams and severe lack of parking space are primarily widespread in large urban areas. Although a multi-pronged approach is required, the proposed paper will dwell upon the implementation of advanced car park management systems, ie the smart parking system. This technology-based solution has real- time parking space which minimizes the frustrating process of locating parking space which occupies a significant share of the urban traffic. The paper will hence review the history of vehicle detection technologies and the attendant detection systems that have been developed over the years as the source of powering such smart parking solutions in India.

II. SMART PARKING SYSTEM

Smart Parking System, which was first introduced in such regions as the United States, Europe, and Japan, is actively rolled out in India. This implementation is a tactical measure towards controlling extreme traffic congestion which is made easy through the national Smart Cities Mission.

Advantages of smart parking system implementation:
The Smart Parking System is proving to be very helpful for car park operators, patrons, and the environment in Indian cities For operators, the data collected through IoT sensors and ANPR technology can be used to predict future parking demand. This allows for flexible pricing strategies and better use of slots, which can majorly increase the revenue. This data based approach is important as the market is increasing quickly, with a estimated CAGR of over 21%. The system greatly break down on pollution. By taking drivers to available spots, the time spend

on looking for the parking space is reduced almost 30% urban traffic issues in cities like Bengaluru decreased. This decresed in vehicle travel reduces fuel consumption and air pollution, helping India to fight against air pollution. Finally, patrons gain a lot from these effective systems. Features like real-time availability, mobile booking, and automated entry and exit ensure that parking spaces are fully in use. This led to a safer and quicker experience, as the time spend in searching for the vehicle is suddenly decreased. This system manages vehicles that would normally park illegally on the roadsides, which is a leading cause of urban traffic issues. For example, illegal parking created nearly 15% of traffic jams slowdowns in Delhi's central districts.

Categories of smart parking system: Driven by Smart City missions, India's 2025 smart parking is evolving and provide solutions how we manage traffic control Systems fall into three categories: Real-Time Guidance (IoT/LPR) for finding available spots, Digital Payments (UPI/FASTag) for easy online transactions, and Automated Systems (vertical stackers) for using slots and spaces more effeciently. It is essential for building effective and sustainable urban mobility network system.

Parking Guidance and Information System (PGIS): Based on the accelerating path for Smart City development, the deployment of PGIS in India in 2025 is follows two distinct models. Functionally, a PGIS needs to operated either at a wide city level to manage the total movement of vehicles within a parking facility for proper control. The city level implementation witnessed in metro cities like New Delhi with its new Optimal Parking Space Allocation Models (OPSAM) uses real-time occupancy data from car parks, guiding drivers to the nearest available facility through integrated mobile apps and reducing urban cruising time by up to 40% On the other hand, facility-centric PGIS- common in Indian malls and tech parks-employs technologies like ultrasonic sensors and AI- enabled cameras within a multi-level structure to route a driver to a specific vacant slot inside that structure through indicator lights and dedicated wayfinding, thus ensuring immediate parking and optimizing the car park's internal throughput. Both types of systems are vital to maximizing the use of India's strained parking infrastructure and are increasingly being integrated for a seamless, end-to-end driver experience. The components of PGIS today can be identified as a mechanism for disseminating information, a mechanism for gathering information, a centralized control centre, and a telecommunications network-a structure similar to that proposed by Mouskos et al. (2007). In the recent Indian context (2025), this framework has been implemented by deploying dynamic LED-based Variable Message Signs (VMS) and other intelligent infrastructure under national and city-level programmes on traffic. On roads including expressways, VMS and integrated systems are now being used by the authorities to provide drivers with real-time guidance and advisories. For instance, on Dwarka Expressway (along with a stretch of National Highways Authority of India-managed NH-48), an Advanced Traffic Management System (ATMS) has been deployed which includes traffic-monitoring cameras, dynamic VMS, speed displays, a control room, and telecommunication links for data and enforcement. By such implementations, modern Indian PGIS directs drivers towards destinations or attractions but also conveys dynamically the traffic flow, speed limits, hazards, and enforcement alerts-realising roles of information dissemination, gathering, control, and communication under the same architectural outline. India's 2025 parking systems allow drivers to see real-time locations and nearby slot availability through GPS-enabled mobile apps. Live parking and traffic updates are possible through Web-GIS platforms, while the presence of RFID-tagged tickets ensures easy location and access to assigned spaces by the user. These integrated tools will guarantee seamless navigation, reduce the time spent searching for a parking spot, and make overall parking more efficient for the driver. Vehicle detection sensors are installed in India for smart parking, normally at entries and exits, or within individual bays, to monitor real-time vehicle occupancy, which is usually tracked per space or overall lot counts for guiding systems. Modern Indian facilities are also more likely to have integrated indicator lights at each bay. These traffic and occupancy data are managed and processed by a central command center with the aid of advanced technologies like Artificial Intelligence, Machine Learning, and Field-Programmable Gate Arrays for fast, data- driven optimization and information

display. More significantly, the telecommunications network now runs on long-range, low-power wireless technologies like IoT and LoRaWAN instead of traditional wiring. In turn, this enables smooth communication. Researchers and companies throughout India are actively deploying mobile-first smart parking systems on these wireless networks to make reservations, track real-time availability, and make digital payments on the back of nationwide smart city initiatives to help reduce urban congestion. Ultrasonic and camera-based sensors enabled by IoT, 5G connectivity, and cloud platforms further enhance accuracy and speed in India's 2025 smart-parking projects for seamless integration with citywide traffic systems and real-time user mobile applications.

Smart Payment System: The complex landscape of urban mobilities in India is record a sea change with the implementation of Smart Payment Systems in the parking systems across most metropolitan centers by 2025. This digital shift is a well observed and created response to chronic inefficiencies, delays, and substantial patron inconvenience that caused by old cash based parking transactions. The move away from cash handling and complex payment processes significantly decrease the operational loads, lowers the labour staff requirements, and critically contribute directly in improving traffic flow and reducing traffic issues in urban areas like Delhi, Mumbai, and Bengaluru. The backbone of India's improving SPS architecture is based on advance contactless and mobile based methods, progressively moving beyond the restricted scope of conventional contact based smart cards, debit cards, or credit cards, aiming for improving user convenience and system rigidity. This payment domain is affiliated by two nationally interoperable platforms: the National Common Mobility Card (NCMC) and the ubiquitous FASTag (RFID Technology). At initial stage it is mandated for electronic toll collections, the ubiquitous FASTag stickers is now being integrated into municipal and commercial parking systems. It allows for Automated Vehicle Identification (AVI), allows vehicles to pay for parking automatically upon entry and exit without the driver to interact physically or either digitally with a physical machine or attendant, hence drastically decreasing the transaction time and vehicular queuing. While old smart parking meters that abled of accepting several bank cards are being installed, the true momentum in the Indian market is based on the indigenous digital payment innovations. The mobile based payment infrastructure systems forms the crucial accelerator for digital parking systems in India, based on the combination of the Unified Payments Interface system, which allows users for encrypted and secure transaction via QR codes or virtual payment contacts, which making it the more preferred method for non-contactless terminal payment at parking faccilities. Metropolitan authorities and private operators are also using these same sophisticated mobile applications, with proper rollouts seen in cities like Kochi, Mumbai, and Hyderabad. These applications provide a wide range of sophisticated features, including real-time spot availability, pre booking and the ability for remote duration extension. the system used a mobile connectivity to send Short Message or notifications on app to the patrons whenever their paid parking duration is on the edge of expiration so that user can seamlessly increase the time and make the extra payment from a distance digitally without having to go back to the vehicles or to the payment machines. But there is also one big limitation and that is its universal acceptance and public trust in SPS: the critical concern raised from data privacy and security lags, since these systems deals with a huge amount of confidential data such as personal identification data, vehicle movement patterns, and associated bank details. The recent expansion of RFID-based FASTag into the parking area, while providing greater convenience, carries certain technological vulnerabilities, and there are public and professional fears regarding the possibility of exploits like sniffing, spoofing, replay attacks, and even denial-of-service (DoS) attacks. To ensure a safe digital parking environment and address such valid concerns, continuous security enhancement is a major priority in research and implementation in India's tech hubs, including the use of stronger, constantly updated encryption via advanced cryptography and AI-driven IDS to analyze transaction patterns and system logs in real-time to detect and handle suspicious or malicious activities on the fly, thus avoiding conventional and purely reactive approaches to security.

E-parking: In India, smart parking and e- reservation systems have made a high-tech solution available to all who wish to check real- time availability dynamically and get a parking space at a favorite

place. They are sure that a vacant slot will be there when they come. These advanced systems are mainly used through the dedicated mobile apps and the integrated Smart City portals, thus marking a giant step in technology from the old methods like SMS or the now-defunct Wireless Application Protocol (WAP) enabled devices. The infrastructure is powered by a distributed network of IoT sensors (mostly ultrasonic or magnetic) all over the parking area which send the real-time occupancy data to a cloud server. This is the reason for the dynamic data display and remote reservation that is referred to as modern E-parking.

Apart from the core benefits that are derived from smart parking infrastructure, which relies on real- time sensors and automated surveillance, the major advantage is the seamless, contactless payment integration. Now transactions are smooth and easy; local technologies do the work. The Unified Payments Interface (UPI) offers instant, secure, and mobile app-based bank-to- bank transfer which actually makes cash payments almost unnecessary. In addition, the national FASTag system is being extended to parking facilities strategically; it is mainly used for toll collection on highways. This integration allows the boom barriers to lift automatically when the vehicle is identified and the fee deducted when it exits, thus achieving an unmatched level of automation and speed in processing vehicles. The recent implementations in the major metropolitan areas such as the ParKochi initiative and the projects going on under the New Delhi Municipal Council (NDMC) have already shown how the mobile e- confirmation reservation system works. One major technical challenge at the point of access is the concurrent application of Automatic Number Plate Recognition (ANPR) and FASTag systems. This is due to the fact that ANPR works on identifying the vehicle by its number plate, while FASTag operates through the use of an RFID chip placed on the windshield. The different working protocols of the two systems are a major source of the problem. One of the biggest challenges is synchronization of data and conflict resolution the systems ought to be properly configured to smartly prioritize the faster, prepaid FASTag transaction on the one hand using ANPR mainly for verification or as a necessary fallback in the event of the tag read failure. Inadequate integration can very quickly give rise to technical glitches like erroneous double-billing, where payment via the FASTag is simultaneously processed while entry/exit is being recorded by the ANPR camera, or it can cause delayed opening of the gate, which thereby directly annoys the drivers and, hence, defeats the very purpose of high-speed automation. Also, the all-embracing aspect of these platforms brings about a lot of data, which consists of detailed vehicle movement records, occupancy heatmaps and coupled financial transaction records, to mention a few. It is extremely important to maintain strong cybersecurity and patron data privacy, particularly with regard to sensitive personal vehicle and payment information, as a crucial operational mandate for 2025 in India, which applies to all municipal and private parking providers. This rapid technological advancement has also developed a corresponding need for a single national standard for smart parking data exchange, which will be the main focus for the future of this technology At present, there are discrepancies between private operators and municipal Smart City projects leading to interoperability problems and thus, creating situations where drivers are required to download several apps for different cities. The future scope of smart parking is linked to the integration of these features into the broader V2X communication system. This dream allows the car to pre negotiate and automatically book and then pay for spaces according to internal navigation and real time reccomendations of city data, thus, going beyond with the current reservation models that is mobile-based by creating a fully automated parking experience.

III. CAR PARK OCCUPANCY DETECTION

In the smart parking system of India, the real time car park occupancy data has a very important role in making driver assistance and city management protocols more effective. There are many IoT sensor systems like the magnetic and vision- based cameras that can give this vital information. But accuracy of detection can be influenced by conditions like local weather, high price, and parking design.

Vehicle detection technology: The vehicle sensors deployed for detection and tracking are mainly classified into intrusive and non-intrusive systems. Intrusive sensors like inductive loops and

magnetometers are generally installed through cutting the pavement trenches or tunneling beneath the road surface. This method is not only quite inconvenient but also reduces the life of the pavement significantly. Furthermore, it requires a complete lane closure during installation and maintenance, which leads to discomfort and the inevitable traffic jams for the Indian commuters. The Indian traffic is very non-homogenous and consists of two-wheelers, cars, and buses that often do not observe lane discipline strictly. Hence, the traditional loop- based intrusive sensors used in such areas have often been providing less than optimum accuracy thus, limiting their use in Smart City applications. Non-intrusive sensors such as video image processing (VIPS), microwave radar, and passive infrared devices, are preferred as they can be easily mounted on the side poles or ceilings and still have no impact on the performance of the road surface. The installation and maintenance can be carried out with non-invasive methods and without interrupting the heavy traffic flow of the urban areas. Even though cost, system design, and the influence of monsoonal weather conditions must be taken into account very carefully in the selection process, still the non- intrusive VIPS and radar's flexibility is crucial for continuously monitoring and data collection in different Indian car parks with various types and layouts. There are two types of vehicle sensors: non-intrusive (pavement damage, traffic disruption) and intrusive. Vehicle sensor types in India are predominantly non-intrusive since the diverse mix of vehicle types on Indian roads, as well as harsh weather conditions, favour the use of non-invasive types for smart parking systems, such as VIPS and Radar. Unfortunately, both have limitations due to the effects of monsoon season on VIPS accuracy and the difficulty distinguishing between motorcycles and cars. For VIPS and Radar technology, cost and calibration represent major challenges for the Smart Cities Mission.

Weight-in-Motion (WIM) sensors: The use of Weight-in-Motion (WIM) technology helps provide accurate information about a vehicle's weight, which is an important part of planning, designing, and enforcing the use of overweight trucks on Indian highways. There are four main types of WIM systems: Load Cell, Bending Plate, Piezoelectric, and Capacitance Mat. The Load Cell system is the most accurate, but because of the high price associated with them, they are only installed at very few critical checkpoints. Although the Piezoelectric system is the most commonly used and cheapest option for mass screening along the vast National Highway network, it is also the least accurate type of intrusive system because of its sensitivity to changes in speed and temperature. In contrast, the Bending Plate WIM system provides a balance between accuracy and expense. Finally, the Capacitance Mat is the least accurate and is often used in a portable manner. All WIM systems suffer from very high usage and are a logistical challenge to the block authorities within India due to the mandatory replacement/ refurbishment cycle of once every 3 to 5 years.

Microwave radar: Microwave radar sensors use antennas to broadcast energy (ranging from 1 to 30 GHz) and detect vehicles by monitoring energy that bounces back to them from the vehicles. Two types of microwave radar include Continuous Wave (CW) and Frequency Modulated Continuous Wave (FMCW). They work unaffected by rain, fog, snow, or any inclement weather and can collect data on multilane traffic flows and vehicle speeds simultaneously. New regulations issued by India in July 2025 state that all Doppler sensors must be verified through strict metrology procedures. The main disadvantage of this type of sensor is that it requires an artificial intelligence (AI) fusion system to positively identify stationary vehicles; for example, the National Highways Authority of India (NHAI) offers such a solution through its Vehicle Intelligent Detection and Electronic System (VIDES).

RFID: RFID technology is secure and efficient for vehicle identification, and FASTag is India's centrally-banned form of electronic toll collection using RFID technology. The system has three components, including the transceiver (which sends and receives coded data), transponder, and antenna. Using passive transponders takes away the need for to-and-from contact or direct visual contact, and the passive transponder uses radio waves to communicate through any object, even if the object blocks visibility RFID systems can be installed at a low cost and maintained inexpensively and are able to identify vehicles at high speeds. The biggest challenge now with RFID technology in India will be KYC linkage to the vehicle identification number and

the increased concerns regarding privacy that arise from the use of the GPS/ANPR system, as these systems are expected to be implemented at the end of the year 2025.

Ultrasonic sensors: The ultrasonic sensor (25- 50kH) uses reflected energy to determine whether someone is present in the room (occupancy sensors). Ultrasonic Sensors can be incorporated into smart parkings and toll plaza over-height detection in India, as they are easy to set up. When vehicles pass through the system at high speeds, the performance starts to degrade and is heavily affected by ambient temperature.

*Video image processor***:** Vehicle image processing systems globally rely on AI-enabled cameras powered by advanced software and edge-computing microprocessors to perform real- time digitisation and analysis. When we talk about India, the procedure of monitoring continuous frames for vehicle detection employing CNNs to detect the differences between them is used to improve traffic and parking management. This method provides a service which is easy to maintain and simple to modify the detection zones, thus it is highly adaptable for coverage optimisation in various Indian urban parking facilities. Besides that, the effortless linking of information from different cameras enables wide-area, multi-lane detection, thus the overall number of cameras can be reduced and both real-time verification as well as offline scrutiny can be performed without any delay. Nevertheless, the technology's cost- effectiveness is still confined to a situation where there are numerous detection zones within the camera's view which is requiring good quality lighting consistently. There performance problems are caused by sudden changes in weather, besides that also it might be the shadow of vehicles fall on the road which is giving poor road-to-vehicle contrast situation and the accumulation of dirt and grime on the lenses. Although the camera shake from the wind is being minimized by digital stabilization, it is still contributing to the factor. Importantly, the low ceiling heights of a significant number of modern Indian basement car parks are major obstacles, as the best camera mounting height for precise presence and speed detection may cause occlusion at certain spots, however, the cameras are not affected by the construction of the facility.

IV. IMPLEMENTATION OF VEHICLE DETECTION TECHNOLOGIES IN SMART PARKING SYSTEM

A detailed comparison of smart parking solutions nationally deployed in India and commercially available worldwide highlights significant differences in types of IoT sensors and system architecture. The 2025 marketplace is heavily invested in AI-powered ANPR cameras along with a combination of ultrasonic, magnetic, and in-ground vehicle detection sensors for real-time occupancy. Although the main goal is still user guidance, the methods of deployment differ significantly as app-based reservations with FASTag integration are utilized in metro cities like Mumbai and Delhi while sensor-puck installations are carried out in Tier 2 cities under the Smart Cities Mission.

PGIS: In 2025, the Indian smart parking sector is changing fast, and ground-level technologies such as ultrasonic and magnetic sensors, which were once widely used in international hubs like Baltimore-Washington and European facilities, are now being selectively implemented. Most large commercial systems and Smart City projects in India opt for a hybrid strategy. It consists of multi-level mall and airport bay-level detection with ceiling-mounted ultrasonic sensors that provide real-time occupancy status through overhead LED indicators (red/green). Meanwhile, AI-enabled Computer Vision (CCTV cameras) is extensively employed in India for direct occupancy detection, License Plate Recognition (LPR) for automated vehicle entry/exit counting, and even indoor navigation, thus, simple inductive loops at main access points are being replaced. Top Indian commercial companies like Parkomate and Park+ are adopting an IoT-driven sensor fusion model to integrate magnetic, ultrasonic, and camera data for accuracy in guiding users through Variable Message Signs (VMS) and mobile apps. This makes the availability of individual parking spaces the central point of the guidance system.

Transit based information system: Modern Indian transit-based information systems in major metros like Delhi and Mumbai are primarily focused on using AI-powered Automatic Number Plate Recognition (ANPR) and IoT sensor fusion for city-wide

monitoring, thereby phasing out less advanced technologies such as ultrasonic detectors or inductive loops. These all-inclusive setups employ expansive Variable Message Signs (VMS) and integrated mobile applications to lead the users to the available Multi-Level Car Parking (MLCP) facilities. As a result of adopting the best global practices, the smart city corridors' guidance is becoming an increasingly end-to-end process where, at first, the user is directed to the general MLCP area via VMS and then provided with bay-level, turn-by-turn navigation inside the car park through the use of overhead Video-based Parking Guidance Systems and mobile routing to reduce the time of search and city traffic.

Smart payment system via RFID: The parking payment systems have been revolved by the FASTag concept in India in 2025. FASTag can be compared to EZPass, as both use RFID stickers on a vehicle's windscreen. Nevertheless, while Mobipower needs manual activation for a transaction and monthly billing, parking with FASTag (which is now prevalent in airports, malls, and corporate parks) is a transaction process similar to that of EZPass. The system automatically reads the tag at the entrance and exit, thereby instantaneously taking the equivalent parking fee from the prepaid wallet or bank account linked to the user without requiring any manual intervention. The system accomplishes the transaction in real-time and thus, the SMS interface is used to confirm the transaction that is performed immediately. This means that it is no longer necessary to send bills periodically. Besides, this system brings about a conveniently smooth transaction that does not require the use of tokens, and it is also UPI and ANPR compatible.

V. IMPLEMENTATION OF VARIOUS VEHICLE DETECTION TECHNOLOGIES IN COMMERCIAL SYSTEMS AND RESEARCH

This conversation moves around the Indian 2025 Smart Parking systems, mainly revolves into the different embedded methods and the IoT hardwares used for vehicle detection both on running roads and in parking system facilities. Since the core sensors are essentially the same, different placement strategies and any edge- computing or networking devices that might be used in conjunction with them are highlighted. We look at how AI-enabled ANPR cameras, magnetic ground-pucks, and overhead ultrasonic sensors are being positioned to achieve maximum accuracy in India's high-density environments. This comparative review of methods and necessary auxiliary systems that go beyond the work of researchers like Mimbela and Klein (2007) is intended to help the next generation of Indian urban mobility solutions become more robust.

Magnetic sensor: The Indian 2025 Smart Parking scenario sees the usage of magnetic sensors mainly Anisotropic Magnetoresistive (AMR) and Giant Magnetoresistance (GMR) types that are progressively getting merged into Wireless Sensor Networks (WSN) for the purpose of vehicle detection. In some of the Indian top-tier city parking basements, the present-day Indian deployments have abandoned the communication via RS485 bus which was common in the old system. They are, instead, making use of low- power Microcontrollers (MCUs) integrated with LoRaWAN or NB-IoT connectivity. These sensors are placed in waterproof, rugged ground- pucks that are battery-powered with a long life and thus are free of the complication that may arise if wiring were to be done on the floor or a wall. This WSN method is very important for the determination of the state of occupation at each bay which is the data sent to the central cloud platform for processing and later displaying on Variable Message Signs (VMS). Although the technology foundation remains the same as that of older projects (like D-Systems), the present Indian projects are concentrating on functionalities that are beyond mere occupancy such as real-time traffic monitoring, vehicle classification (car, two-wheeler), and re-identification that is uninterrupted across parking zones. Moreover, the use of edge AI for data processing without the need to be heavily dependent on bulky, stackable hardware like FPGAs is also prevailing in most of the projects.

Optical sensor: The Indian smart parking ecosystem (2025) is fundamentally based on AI- powered ANPR cameras for identifying vehicles and FASTag integration for automatic payment. Occupancy at the bay level is detected by magnetic/ultrasonic IoT sensors linked via NB- IoT/LoRaWAN. This hybrid system supplies up- to-the-minute information to VMS and mobile app users, thus enabling the highly

efficient and contactless urban mobility solutions typical of the Indian metropolises that are expanding rapidly.

RFID: The Indian 2025 parking landscape uses the NETC FASTag for smooth, automated entry/exit at ingress/egress points, thus a direct replacement of the older systems. In contrast to a proprietary RFID that needs manual operations, FASTag connects the vehicle registration with automated ANPR checks. The arrangement very quickly confirms registration and enough balance and thus removes the barriers for non-stop transit. The payments are made on the spot from the linked account, thus there is no physical ticket and the system ensures a fast, transparent, and contactless urban mobility.

Inductive loop and RFID: The parking scenario in Indian 2025 has mostly moved beyond systems that depend solely on inductive loops installed at every single bay for occupancy. Although such loops are still employed in a few high-security or industrial situations, the present standard combines them with AI-enabled ANPR cameras and the unified NETC FASTag (UHF RFID) system. In modern Indian installations, the occupancy of individual parking spaces is mainly determined by overhead ultrasonic or magnetic ground sensors in a high-speed IoT-based WSN using protocols like NB-IoT, thus the older Zigbee communications have been phased out. The FASTag sticker is read by a long-range reader at the time of vehicle entry/egress thus, no manual verification is needed while ANPR reads the vehicle's plate for the confirmation that everything is in order, thereby ensuring that access control and transaction recording are carried out in a seamless, non-stop, ticketless, and automated manner.

Sensor board with multiple sensors: Modern Indian smart parking systems (2025) have a sophisticated, multi-layered architecture that extends the concept of old three-layer frameworks and acoustic/light sensors in a rudimentary way. Present-day solutions, which are frequently designed around low-cost ESP32/NodeMCU microcontrollers, concentrate on the use of overhead ultrasonic sensors or magnetic ground-pucks for every single parking space so as to accomplish accurate occupancy detection. In this case, nodes which are light or sound may have temperature sensors to provide live monitoring of the environment of the basement. The architecture features an event- driven design in which events such as 'car-in', 'car-out', or 'sensor-fault' result in immediate action. The data is collected by powerful fog/ edge computing nodes and then sent via low-power LoRaWAN or NB-IoT (which are the replacements for older WSNs) to a centralized cloud server. This sturdy installation not only achieves real-time guidance through VMS and mobile apps but also opens up the possibility of AI-driven analytics for the pricing that is dynamic and the management of system health.

VI. CONCLUSION

Smart parking systems (SPS) are being utilized in many different types of ways to alleviate congestion caused by lack of parking availability and increasing demand for parking spaces. It is expected that these systems will promote efficient driving habits, provide instructions to users on where to park, and facilitate the use of existing facilities. The evaluation of all vehicle detection technologies, which are essential elements of any SPS, discusses a variety of options, including ultrasonic sensors (traditional), magnetic sensors, inductive loop sensors, and previous video-based vehicle detection systems. Each method has its own advantages and disadvantages in terms of cost, installation flexibility, and durability against environmental challenges, but in most cases, the advantages of using both video surveillance sensors and video-based vehicle detection systems will generally outweigh the disadvantages. Particularly in areas that require extensive coverage and ease of management, fundamental image-processing algorithms can detect changes in the frame of reference from basic video visual images to identify if an area is occupied or not. The most reliable conclusion from this research paper is that, in order to effeciently create a better, less overhead, less costly, and workable Parking Management systems as a Solutions, continuing to assess and integrate it with multiple, and comprehensive, vehicle detection technologies remains important.

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