**ADVANCED INTELLIGENT PARKING MANAGEMENT SYSTEM LEVERAGING IOT INTEGRATION AND AI-DRIVEN ALGORITHM**

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**ABSTRACT**

The Intelligent Parking System using IOT and AI aims to revolutionize the way parking spaces are managed, enhancing efficiency and reducing congestion in urban areas. By integrating IOT sensors such as infrared sensors the system provides real-time data on parking space availability which is transmitted to a cloud based platform for remote monitoring. AI algorithm analyse parking patterns, predict space occupancy and optimise parking management by dynamically guiding drivers to the nearest available spot/ The system is accessible through a allowing users to check availability, reserve parking and make payments and provide alerts. The integration of IOT ensures seamless communication between devices, while AI improves decision-making through continuous learning and pattern recognition. This smart system reduces traffic congestion, saves time, and optimise space utilisation, providing a sustainable solution for urban parking challenges. The Intelligent parking system is a step toward smart city development where efficient parking management plays a crucial role in improving overall urban mobility and reducing environmental impact.

**INTRODUCTION**

The fast growth of urbanisation, combined with the growing number of vehicles on the road, has created significant issues in parking management. Traffic congestion, inadequate space utilisation and environmental problems are all common in highly populated places. Traditional parking systems frequently fail to react to changing conditions, resulting in user annoyance, higher fuel usage and operational inefficiencies. To address these difficulties the combination of artificial intelligence and the Internet of Things has emerged as a game-changing approach to modern parking solutions. An advanced Intelligent Parking Management System makes use of IoT-enabled sensors, real-time data analytics and AI-driven decision making to increase parking efficiency, improve user convenience and reduce environmental impact. An AIPMS maximises parking spot utilisation, decrease traffic congestion, and improves the entire urban mobility experience by leveraging smart monitoring, predictive analytics and automated control mechanism. The system has significant feature like real-time parking availability updates, flexible pricing schemes and energy efficient operations. This project demonstrates the design and implementation of an AIPMS, with a focus on its ability to improve decision making streamline parking operations, and adapt to changing urban settings. The suggested system promises to change urban parking infrastructure by combining cutting-edge AI algorithms with IoT connectivity, making it more efficient user-friendly, and environmentally sustainable.

**REVIEWS**

(Jaafar Ahmed AbdulSaheb., 2024)examines the real time updates online, an Internet of Things based smart parking system can help users find parking spots in congested area. The entire car parking process from vehicle entry to payment and eventual departure is streamlined by this technology.

(Hardik Tanti, Pratik Kasodariya., 2023) regenerate the expansion of transmit services into suburban regions, and the overall trend toward more mobility in our society, many metropolitan areas have experienced dramatic rise in the number of the clients and tourists in recent years.

(Amara Aditya, Sri Krishna Vamsi.,2022) uses a IOT Based technology to address the problem of parking spaces locating in smart cities. An internet of things architecture makes up the suggested intelligent parking system, which gathers data in real time, sends it to the cloud, and then recommends to the users a good spots to park nearby.

(Muhammad Ifran.,2021) one of the most prominent issues with urban transportation is traffic congestion, which contributes to both air pollution and excessive energy use. One of the main causes of traffic bottlenecks is the lack of available parking spaces. Parking and congestion are related since looking for a free parking space increase local circulation and causes more delays.

(Nishant Doshi., 2019) to connect different physical objects and automate them to make people’s lives easier the internet of things essential. This eliminates the need to locate parking and allows users to reserve a spot using a mobile device.

**Table: Existing Methods of Smart Parking System**

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| --- | --- | --- | --- |
| Authors | Methodology | Inference | Pros and Cons |
| Jaafar Ahmed Abdul Saheb | Parking space optimization | Reduce parking search time | Pros: Reduced parking time.  Cons: High implementation cost. |
| Hardik Tanti, Pratik Kasodariya | Traffic management | Real-time parking availability updates | Pros: Traffic decongestion.  Cons: Cybersecurity risk |
| Amara Aditya, Sri Krishna Vamsi | Sustainable urban mobility | Automated payment, slot reservation, and vehicle tracking | Pros: Automated payment and booking.  Cons: Scalability challenges |
| Muhammad Ifran | Carbon footprint reduction | Fuel consumption, and carbon emission | Pros: Environmental benefits.  Cons: Reliability issues. |
| Nishant Doshi | Smart sensors | High infrastructure costs, security risks and scalability concerns | Pros: Data driven decision making.  Cons: User adaptability. |

**Application of Smart Parking System using IOT and AI:**

1. Urban Parking Management: Helps city administrations monitor and optimise parking spaces, reducing congestion in metro areas.

2. Commercial Parking Lots: Used in malls, office building, airports and railways stations for efficient space utilization and automated ticketing.

3. Residential complexes and societies: Enhances security and convenience by providing automated parking solutions for residents.

4. Smart city initiatives: Supports government project focused on digital transformation and sustainable urban mobility.

5. EV charging station management: Integrated with electric vehicles charging stations to facilitate seamless parking and charging solutions.

6. Automated Toll and parking system: Used in highways and transport hubs to enable cashless transaction and license plate recognition for automated entry and exit.

7. Event and stadium parking: Manages large crowds by providing real time parking availability and automated slot booking during events.

8. University and campus parking: Helps students, faculty and visitors find parking spots easily within large educational institutions.

9. Shopping centres and retail outlets: Enhances customers experience by providing real-time parking availability and reducing wait times.

10. Tourist attractions and hotels: Assists travellers by offerings automated reservation and guided parking, improving accessibility at popular destination.

**CONCLUSION**

The IoT and AI-based smart parking system successfully integrates hardware components such as Arduino, RFID, IR sensors, Node MCU and a web camera with software technologies like embedded c, Python, and cloud-based IoT platform. The system efficiently automates vehicles entry and exit tracks real-time parking availability and enhances security using AI-driven license plate recognition and RFID authentication. Extensive unit and integration testing confirm the system’s ability to effectively manage parking spaces. Minimise human involvement and enhance user convenience. IoT connectivity enables real-time data monitoring, improving traffic control and space optimization. This project offers a scalable and cost-effectiveness solutions for smart cities, cooperate offices, and commercial spaces, helping reduce congestion and streamline parking operations. Future enhancements could include AI-driven predictive for parking demand forecasting and mobile app integration for an improved user experience.