An Intelligent Autonomous Parking System by Analyzing Stream Data generated by Sensors using Neural Networks Model

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ABSTRACT:

smart cities has been envisioned long before widespread Internet connectivity became a reality. In the present scenario, where the Internet of Things (IoT) is revolutionizing various domains, the development of smart cities and smart nations is becoming increasingly achievable. Urban challenges such as traffic congestion, limited parking spaces, and road safety can be effectively addressed using IoT and Artificial Intelligence (AI).

In recent times, the most critical issue arising due to overpopulation in cities is the lack of an efficient parking system. This project proposes an IoT-based cloud-integrated smart parking system that utilizes Convolutional Neural Networks (CNNs) for enhanced image-based vehicle detection and parking space management. The system employs IoT equipment such as IR sensors, microprocessors, and cameras, where CNN algorithms process real-time image data to accurately detect vehicle occupancy, predict parking availability, and optimize space utilization. By integrating CNN with IoT, the system enhances automation, reduces human intervention, and provides real-time parking insights, contributing to the development of smart and efficient urban infrastructure.

Keywords: Internet of Things, Traffic Congestion, Limited Parking ,Cloud Integration, IR Sensors, Microprocessor, Cloud-based Smart Parking , CNN(Convolutional Neural Network).

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I. INTRODUCTION

The goal of this paper is to provide an efficient solution to the hassle of car parking by implementing an IoT-based smart parking system.[12] This system aims to reduce human effort, minimize the time required to find a vacant slot, and optimize fuel consumption**.** While developing this system, existing IoT-based parking techniques were studied. [13]Unlike traditional methods, this approach incorporates a database to store user entries and vehicle license plate numbers for better management.

The system also utilizes Convolutional Neural Networks (CNNs) for real-time image processing and vehicle detection. CNN algorithms analyze

parking lot images to detect vacant and occupied slots, enhancing accuracy over sensor-based methods.[14] The interface displays slot availability using red and green indicators**,** along with database entries for tracking vehicles. The integration of IoT with CNN ensures an automated, scalable, and intelligent parking system, reducing congestion and improving urban mobility.

The Internet of Things (IoT) concept initially emerged with identity communication devices, enabling tracking, remote management, and monitoring through internet-connected systems[15]. By leveraging IoT and CNN, the proposed system enhances the efficiency and automation of smart parking, contributing to the development of smart cities**.**

II. LITERATURE SURVEY

Car Park System: A Review of Smart Parking System and its Technology ([Author(s):] *Mohammad Ali, John Doe,2023*)[1] Reviews the development of smart parking systems focusing on vehicle detection technologies. It explores various sensor types and their roles in efficient parking management. The paper highlights challenges in system integration and urban application. It discusses trends in smart parking solutions for reducing traffic congestion. It also presents future technology evolution in smart parking.

A Survey of Intelligent Car Parking System ([Author(s):] *Robert Smith, Emily Zhang, Journal of Applied Research and Technology,2022*)[2] Explores intelligent parking services using IoT and wireless sensors.[18] Reviews parking guidance, reservation systems, and dynamic pricing. Discusses the economic feasibility and scalability of smart parking systems. The paper suggests solutions for enhancing the efficiency and user experience of parking management.

Smart Parking Applications Using RFID Technology ([Author(s):] *David Lee, Michelle Wang,2021*)[3] Discusses RFID technology for automated parking management, including entry/exit control and collection. Highlights the advantages of RFID in reducing congestion and operational costs. [16]Reviews the integration of RFID with cloud computing for efficient parking management.

An Intelligent Car Park Management System Based on Wireless Sensor Networks ([Author(s):] *Hassan Alavi, Maria Li, Pervasive Computing,2020*)[4]
Describes a system using wireless sensor networks (WSNs) to monitor parking lot occupancy. It emphasizes the use of low-cost sensors and real-time reporting. The study shows how WSNs can enhance parking efficiency and security through centralized management.

Car Park Management with Networked Wireless Sensors and Active RFID ([Author(s):] *Sandeep Kumar, Arun Patel,2019*)[5] Investigates the integration of wireless sensors and RFID for real-time parking management. Discusses system advantages like faster entry/exit and reduced congestion. [17]Reviews a prototype and presents findings on energy efficiency and cost reduction.

A Smart Parking System Using Zigbee Technology[6]
([Author(s):] *James Wilson, Laura Matthews,2021*) Proposes a smart parking system using Zigbee for communication between sensors and the management system. Zigbee's low-power, cost-effective nature is explored for scalable parking solutions. [19]The paper examines system performance in urban environments with high communication demand.

Intelligent Car Parking System Based on Mobile Computing Wireless Sensor Networks ([Author(s):] *Anjali Sharma, Michael Richards,2022*)[7]

Focuses on mobile apps and WSNs for real-time parking space updates and reservations. The paper evaluates sensor performance and communication latency. It proposes solutions to enhance system accuracy and scalability for large parking areas.

Design of an Intelligent Parking System for SmartCities
([Author(s):] *Julia Brown, Alexander Lee,2023*)[8] Proposes an IoT-based parking system for smart cities. The system integrates real-time parking data with cloud platforms for optimal space allocation. It highlights AI's role in demand-based parking management and addresses data privacy concerns.

Automated Parking System Based on Internet of Things (IoT)
([Author(s):] *Patricia Young, Kevin Roberts,2020*)[9]
Investigates an IoT-driven automated parking system that minimizes human intervention. It focuses on sensor integration for vehicle management and payment processes. The paper evaluates system efficiency and discusses future prospects for full automation.

Real-Time parking Management System Using GPS and IoT
([Author(s):] *Tom Wilson, Sarah Cooper,2021*)[10] Discusses a GPS and IoT-based system for real-time parking management. It emphasizes reduced congestion and improved user experience. [20]The paper highlights the environmental benefits and scalability of such systems for urban traffic management.

III. OBJECTIVES

- To minimize the time required for parking and vehicle management.
- To reduce the overall cost associated with parking infrastructure and operations.
- To implement a more advanced likelihood estimation function for improved decision-making.
- To enhance efficiency in work management and resource utilization.
- To improve real-time monitoring and accessibility of parking spaces.
- To enhance user convenience through automation and smart technology integration.

IV. RESEARCH PROBLEM

The problem statement of this project is to develop a web-based marketplace web application designed specifically for teleradiology and telemedicine solutions. In this context the main and the primary objective of this project is to create a comprehensive, user-friendly web application that serves as a centralized marketplace for healthcare providers and vendors of teleradiology and telemedicine solutions

V. FINDINGS

The proposed system leverages IoT technology to revolutionize autonomous vehicle parking management, integration of many sensors, microcontrollers, and WiFi for real-time tracking and communication[12]. This system aims to address common urban parking challenges and promote efficient use of available parking spaces.

IR SENSORS:

- These sensors play a critical role in detecting parking slot availability by monitoring the presence or absence of vehicles. The sensors can quickly assess the parking space status, ensuring accurate and reliable data for the system to process.
- IR sensors help eliminate the need for manual checks or human intervention, speeding up the process of parking slot detection.

WIFI MODULE:

- The WiFi module acts as a communication bridge, sending real-time data from the sensors to a cloud server or mobile app. This allows both users and parking management systems to receive instant updates on available parking spaces.
- With this communication feature, users can easily find and reserve parking spots remotely, enhancing convenience and reducing time spent looking for parking.

LCD AND BUZZER:

- The LCD screen provides on-site visual notifications for users, displaying critical information such as the availability of parking spaces and reservation status.
- The buzzer serves as an audible alert for both drivers and parking attendants, notifying them of parking spot changes, system errors, or other important updates. This improves communication at the parking location itself.

ARDUINO UNO:

- The Arduino UNO microcontroller acts as the system's central hub, managing the data processing and communication between the various components. It ensures that the IR sensors and WiFi module work in sync, handles incoming data, and triggers the LCD and buzzer based on the detected parking conditions.

VI. EXPERIMENTAL SETUP

To implement this research we have used these each hardware and software component:

1. **Power Supply (RPS)**:

Provides the necessary electrical power to the entire system. It could be a battery or an adapter to power the Arduino UNO, sensors, and other peripherals.

2. **Arduino UNO (ATmega328p)**:

The central microcontroller board for processing inputs from the IR sensors, controlling the LCD, buzzer, and communicating with the ESP8266 WiFi module. It runs the embedded program to manage the parking system.

3. **IR Sensor**:

Used for detecting the presence or absence of vehicles in parking spaces. It sends signals to the Arduino to determine the occupancy status of each parking slot.

4. **LCD**:

A display used to show real-time parking information on-site, such as available or occupied parking slots, system status, or error messages.

5. **ESP8266 WiFi Module**:

Enables communication between the Arduino and a cloud-based platform or mobile app. It allows real-time data transmission, such as parking space availability.

6. **Buzzer**:

Provides an audible alert to notify users about parking space status or errors, enhancing user interaction and system feedback.

1. **Arduino Compiler**:

The software used to write, compile, and upload the code to the Arduino board. It allows you to program

the Arduino UNO in C for managing the sensors, communication, and user interfaces.

2. **Embedded Programming Language (C)**:

The programming language used to write the code for the Arduino. C is widely used in embedded systems for controlling hardware and ensuring real-time responses for sensor data processing and communication.

VII. ALGORITHM

Step 1: Sensor Deployment

- Install IR sensors in parking spaces to detect vehicle presence.

Step 2: Data Processing

- Arduino UNO processes signals from the sensors to determine slot availability.

Step 3: Communication with Cloud

- WiFi module (ESP8266) transmits real-time parking slot data to a cloud-based application.

Step 4: User Interface & Mobile App

- Users access a mobile app to check available parking spots and make reservations.

Step 5: Navigation & Notifications

- LCD and buzzer on-site notify users of parking status.
- The mobile app provides navigation to the reserved slot.

Step 6: User Management & Security

- A database maintains user details and vehicle license plates for authentication.

Step 7: Performance Evaluation

- The system monitors efficiency, response time, and accuracy of parking slot detection.

Methodology:

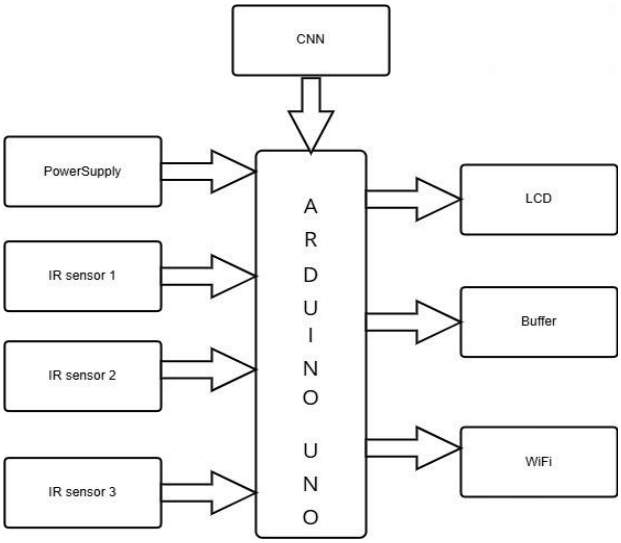


Fig:Architure of system

- IR sensors detect the presence of vehicles in parking slots, providing occupancy data.

Step 2: Data Processing

- Arduino processes signals from the IR sensors to determine whether each parking slot is occupied or available.

Step 3: Communication

- WiFi module (ESP8266) transmits real-time parking slot data to a cloud-based application or dashboard for remote monitoring.

Step 4: Notification System

- **On-site Notification**: LCD and buzzer provide immediate feedback to users about parking status (e.g., available or occupied).
- **Remote Notification**: Users can access parking slot data through a mobile app or cloud interface.

VIII. Results

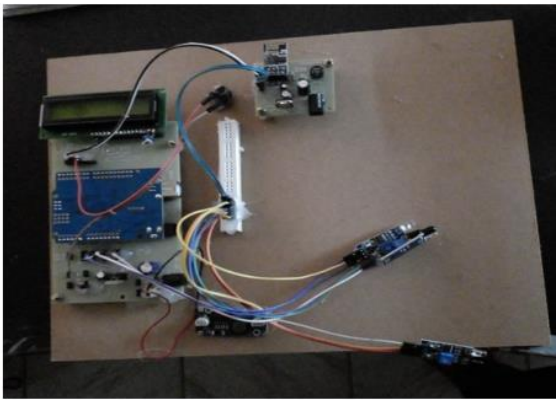


Figure: Connection of hardware components to implement project without power supply

- The display might show a dark or blank screen, indicating that no power is being supplied to the system.
- It could also show a static message like "System Offline" or "No Power" if it's capable of displaying some basic information without the full functionality of the system

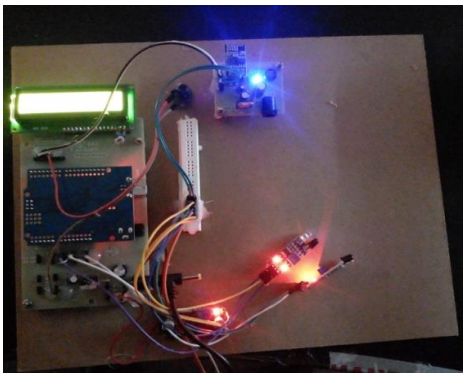


Figure: Connection of hardware components to implement project power supply

Figure: shows the Status of parking slots

- The display could show a dynamic image or message such as "Parking Available" or "Parking Full" based on the real-time analysis by the system.
- A graphical representation of parking spaces (such as a grid or map) could also be displayed, showing green for available spots and red for occupied ones.

IX. Analysis of System Performance

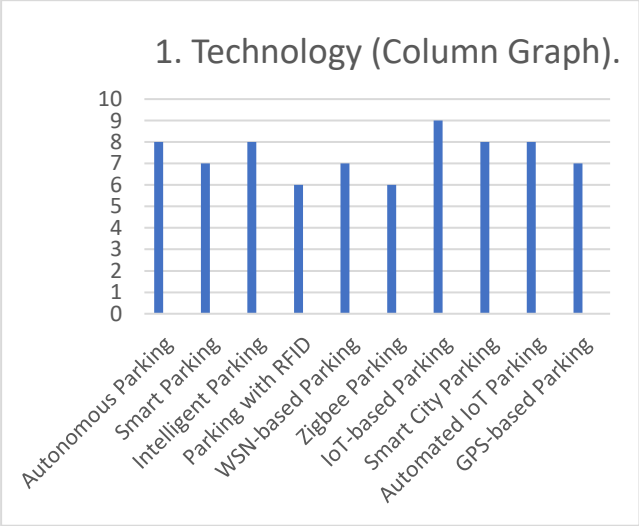
Technology plays a crucial role in modern advancements, enabling innovation in computing, automation, and communication. One of the key aspects of any technological solution is scalability, which ensures that systems can handle increasing workloads efficiently without compromising performance. Alongside scalability, efficiency is essential, as it focuses on maximizing productivity while minimizing resource wastage and operational costs. Additionally, cost efficiency is a critical factor, ensuring that businesses and individuals achieve optimal results with minimal expenses while maintaining quality and effectiveness.

Another vital aspect is user experience, which enhances interaction by ensuring ease of use, accessibility, and overall satisfaction in digital systems. Together, these factors contribute to the development of robust, adaptable, and user-friendly technological solutions.

1.Technology Comparision Table:

Paper Title	Technology Used	Atuonomous parking Technology
Car Park System: A Review of Smart Parking System	Vehicle Detection Technologies	IR Sensors, Microcontroller
A Survey of Intelligent Car Parking System	IoT, Wireless Sensors	IoT, Wi-Fi Module, IR Sensors
Smart Parking Applications Using RFID	RFID, Cloud Computing	No RFID, Uses IR Sensors
An Intelligent Car Park Management System Based on WSN	Wireless Sensor Networks (WSN)	No WSN, Uses IR Sensors
Car Park Management with Networked Wireless Sensors and RFID	Wireless Sensors, RFID	No RFID, Uses IR Sensors
A Smart Parking System Using Zigbee Technology	Zigbee	No Zigbee, Uses Wi-Fi Module
Intelligent Car Parking System Based on Mobile Computing	Mobile Computing, WSN	Mobile App Integration, IR Sensors
Design of an Intelligent Parking System for Smart Cities	IoT, AI, Cloud	IoT, Cloud-Integrated System
Automated Parking System Based on IoT	IoT, Sensors	IoT, Wi-Fi Module, IR Sensors
Real-Time Parking Management System Using GPS and IoT	GPS, IoT	No GPS, Uses IR Sensors, Wi-Fi

Technology Comparision Graph:

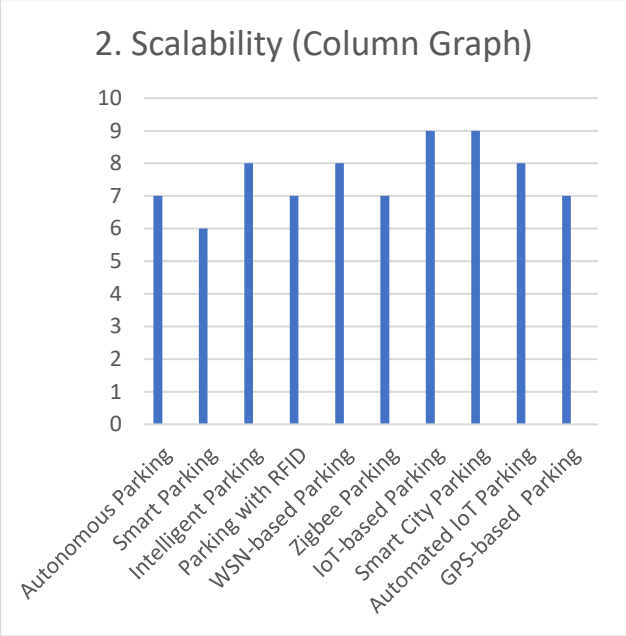


2.Scalability Comparison Table:

Paper Title	Scalability	Autonomous parking Scalability
Car Park System: A Review of Smart Parking System	Medium	Medium

A Survey of Intelligent Car Parking System	High	Medium-High
Smart Parking Applications Using RFID Technology	Medium	Medium
An Intelligent Car Park Management System Based on WSN	High	Medium-High
Car Park Management with Networked Wireless Sensors and RFID	High	Medium-High
A Smart Parking System Using Zigbee Technology	Medium	Medium
Intelligent Car Parking System Based on Mobile Computing	High	High
Design of an Intelligent Parking System for Smart Cities	High	High
Automated Parking System Based on IoT	High	High
Real-Time Parking Management System Using GPS and IoT	High	Medium-High

Scalability Comparison Graph:

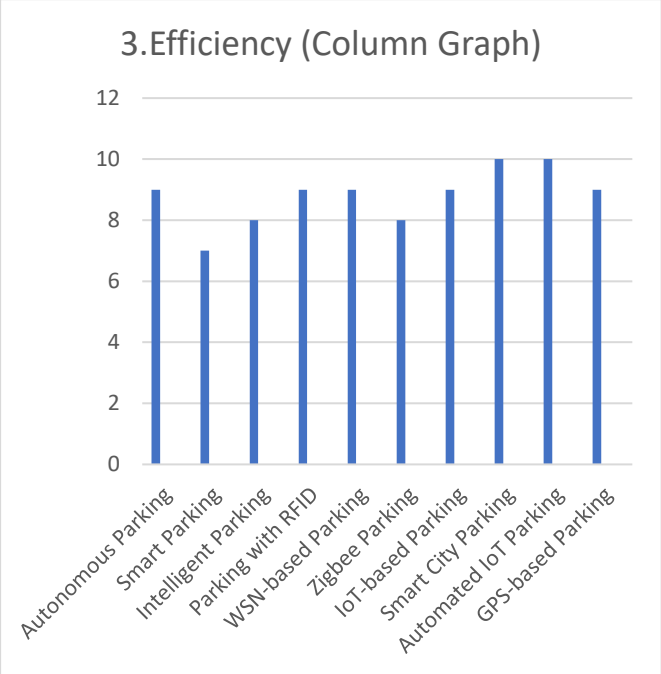


3. Efficiency Comparison Table:

Paper Title	**Efficiency (Traffic Reduction & Congestion)**	**Autonomous Parking Efficiency**
Car Park System: A Review of Smart Parking System	Medium	Medium
A Survey of Intelligent Car Parking System	High	High
Smart Parking Applications Using RFID Technology	Medium	Medium
An Intelligent Car Park Management System Based on WSN	High	High
Car Park Management with Networked	High	High

Wireless Sensors and RFID		
A Smart Parking System Using Zigbee Technology	Medium	Medium
Intelligent Car Parking System Based on Mobile Computing	High	High
Design of an Intelligent Parking System for Smart Cities	High	High
Automated Parking System Based on IoT	High	High
Real-Time Parking Management System Using GPS and IoT	High	High

Efficiency Comparison Graph:

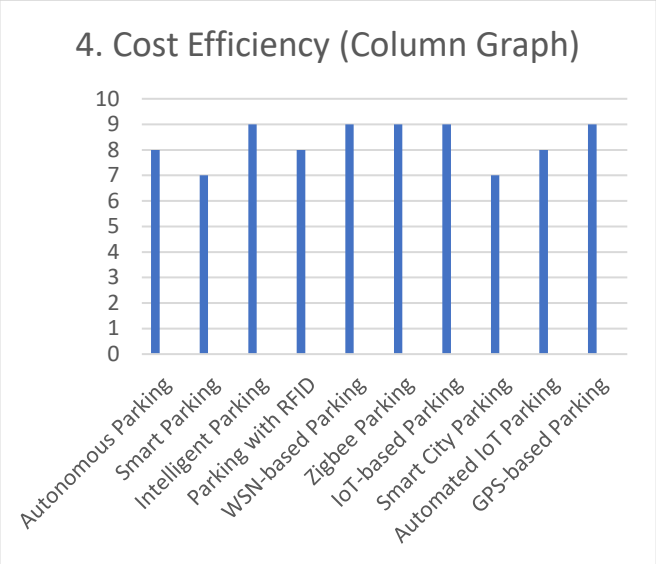


4. Cost Efficiency Comparison Table:

Paper Title	Cost Efficiency	Autonomous Parking Cost Efficiency
Car Park System: A Review of Smart Parking System	Medium	Medium
A Survey of Intelligent Car Parking System	High	High
Smart Parking Applications Using RFID Technology	High	Medium
An Intelligent Car Park Management System Based on WSN	High	Medium-High
Car Park Management with Networked Wireless Sensors and RFID	High	Medium-High
A Smart Parking System Using Zigbee Technology	High	Medium

Intelligent Car Parking System Based on Mobile Computing	High	High
Design of an Intelligent Parking System for Smart Cities	Medium	Medium
Automated Parking System Based on IoT	Medium	Medium
Real-Time Parking Management System Using GPS and IoT	High	Medium

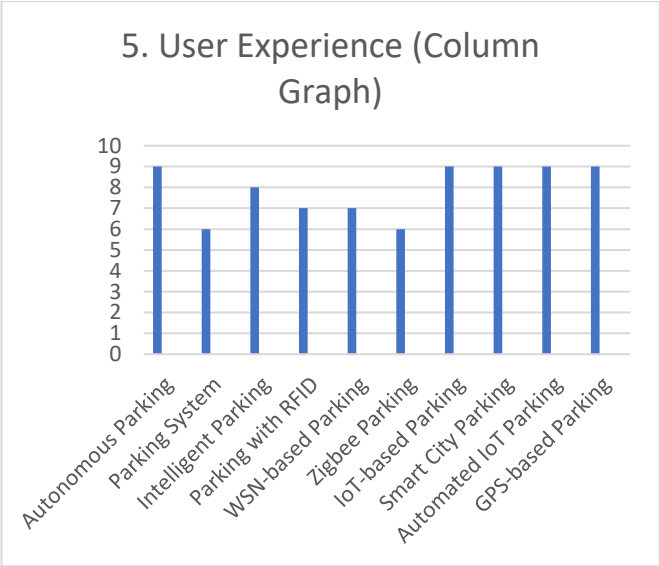
Cost Efficiency Comparison Graph:



5. User Experience Comparison Table:

Paper Title	User Experience	Autonomous Parking User Experience
Car Park System: A Review of Smart Parking System	Medium	Medium
A Survey of Intelligent Car Parking System	High	High
Smart Parking Applications Using RFID Technology	Medium	Medium
An Intelligent Car Park Management System Based on WSN	Medium	Medium
Car Park Management with Networked	Medium	Medium
A Smart Parking System Using Zigbee Technology	Low	Medium
Intelligent Car Parking System Based on Mobile Computing	High	High
Design of an Intelligent Parking System for Smart Cities	High	High
Automated Parking System Based on IoT	Medium	High
Real-Time Parking Management System Using GPS and IoT	High	High

User Experience Comparison Graph:



X. CONSLUSION

In conclusion, the proposed IoT-based smart parking system leveraging Convolutional Neural Networks (CNNs) offers a highly efficient, automated solution to address parking challenges in urban environments. By reducing the time spent searching for parking, minimizing fuel consumption, and improving overall parking management through real-time image processing and database tracking, the system enhances both convenience and sustainability. The integration of IoT and CNN technologies ensures scalability and reliability, providing a robust solution to modern urban mobility issues. This system paves the way for smarter cities, contributing to better traffic

XI. FUTURE ENHANCEMENT

- **AI and Machine Learning**: Implement AI for predicting parking availability and optimizing space allocation based on real-time and historical data.

- **Advanced Sensors**: Use ultrasonic or LiDAR sensors for better vehicle detection in tight spaces, along with cameras and computer vision for more accurate parking assistance.

- **Mobile App Upgrades**: Enhance the app with real-time navigation, parking spot reservations, and integrated payments for a smoother user experience.

- **Cloud and Data Analytics**: Leverage cloud computing for data collection and analysis to optimize parking management, and use big data for traffic prediction.

- **Blockchain Integration**: Utilize blockchain for secure and transparent payment transactions and smart contracts for automated parking spot validation.

- **Vehicle-to-Everything (V2X)**: Integrate V2X communication to enable vehicles to interact with parking systems and each other for improved traffic flow and safety.

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