ISSN 2277-2685
IJESR/July-Sep. 2025/ Vol-15/Issue-3/524-533
Mahima Tennyson *et. al.*, / International Journal of Engineering & Science Research

An Approach to Arduino Uno Based Smart Car Parking System

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Abstract
This project involves the development of a smart car parking system using Arduino, IR sensors, a servo motor, and an LCD display. The purpose of this project is to automate the detection of available parking slots and guide vehicles to these slots. The system uses IR sensors to monitor parking space occupancy and a servo motor to control parking gates. An Arduino processes the sensor data and updates the availability status on an LCD display. This smart parking solution aims to enhance efficiency, reduce human intervention, and improve the overall parking experience.

I. Introduction

Each passing day witnesses a surge in the fleet of personal vehicles navigating our roads, inevitably resulting in a growing challenge of finding parking spaces, particularly during peak hours. This phenomenon not only consumes drivers' valuable time but also contributes to unnecessary fuel consumption and exacerbates traffic congestion. Moreover, the rise in vehicular emissions negatively impacts the environment. Consequently, reservation-based smart parking systems have become a necessity. This Smart Parking Application aims to aid drivers in finding and reserving the most suitable parking area. Users can view various parking options and select their preferred location. If the desired parking slot is vacant, drivers can book the spot for a specific time, with the option to extend or cancel the reservation. The infrastructure employs available open spaces for parking, ensuring both convenience and security. Overall, this application tackles parking availability and traffic problems through an innovative solution. The technical backbone involves using image processing to identify occupied versus unoccupied parking slots. Specifically, Python scripts analyze camera images of parking spots to determine vehicle presence. We propose an Android application that allows drivers to book slots after verifying availability through the computer vision algorithm described above. This can significantly reduce the time spent hunting for a spot by allowing reservations.

II. Literature Review:

Research on Automatic Parking Systems Based on Parking Scene Recognition

This paper develops a smart parking system app enabling drivers to reserve vacant slots detected via computer vision. Cameras placed in parking facilities feed footage to image processing algorithms that identify unoccupied spaces. Drivers use the mobile application to book these vacant spots and access navigation to the reserved parking location. Our system uniquely employs scalable machine vision technology for parking monitoring and availability updates. This parking occupancy oversight bypasses a need for manual sensing or human oversight. The automated vision-based analysis is easily adapted across diverse parking configurations. [4]

Smart parking system with image processing facility

This Smart Parking System obtains real-time parking availability information through image processing algorithms. Cameras installed in parking facilities capture footage that is analyzed to identify vacant spaces. The system processes this visual data and allocates bookings for open slots. A prototype employs a rack-pinion mechanism to automatically lift and position vehicles in the reserved spot when drivers arrive. This robotic parking assist functionality, enabled through computer vision updates, constitutes an automated end-to-end smart parking solution.[3]

Automatic Parking Management System and Parking Fee Collection Based on Number Plate Recognition

An AI-Powered Parking Optimization Network Leveraging Vehicle Fingerprinting for Automated Access and Billing The goal is to create a parking system that enhances convenience and security while automatically handling fees without requiring magnetic cards. The system uses image processing and optical character recognition to identify vehicles by their license plates. This enables automatic parking guidance to available spaces as well as billing the corresponding vehicle owner. The entire parking process and access control runs via a pre-programmed controller for minimal human involvement. [5]

Automated car parking system commanded by android application

The Automated Car Parking System, controlled by an Android application, manages the number of vehicles parked in a facility through automated parking and exit processes. Sensors identify available slots, enabling optimized use of the parking space based on real-time occupancy. Entry and exit are controlled through an Android app. Users command the automated parking or retrieval of their vehicle via this mobile interface. Once commanded, the system automatically maneuvers the car to open parking spots or back to the exit gate through robotic machinery.[1]

Object Recognition using Tensor Flow and Convolutional Neural Network

Object detection from repository of images is challenging task in the area of computer vision and image processing in this work we present object classification and detection using cifar-10 data set with intended classification and detection of air plane images. So we used convolutional neural network on keras with tensorflow support the experimental results shows the time required to train, test and create the model in limited computing system. We train the system with 60,000 images with 25 epochs each epoch is taking 722to760 seconds in training step on tensorflow CPU system. At the end of 25 epochs the training accuracy is 96 percentage and the system can recognition input images based on train model and the output is respective label of images.

Traffic Light Detection Using Tensorflow Object Detection Framework

Traditional methods in machine learning for detecting traffic lights and classification are replaced by the recent enhancements of deep learning object detection methods by success of building convolutional neural networks (CNN), which is a component of deep learning. This paper presents a deep learning approach for robust detection of traffic light by comparing two object detection models and by evaluating the flexibility of the TensorFlow Object Detection Framework to solve the real-time problems. They include Single Shot Multibox Detector (SSD) Mobile Net V2 and Faster-RCNN. Our experimental study shows that Faster-RCNN delivers 97.015%, which outperformed SSD by 38.806% for a model which had been trained using 441 images.

Moving object detection using modified GMM based background subtraction

Detection of objects is the most important and challenging task in video surveillance system in order to track the object and to determine meaningful and suspicious activities in outdoor environment. In this paper, we have implemented novel approach as modified Gaussian Mixture Model (GMM) based object detection technique. The object detection performance is improved compare to original GMM by adaptively tuning its parameters to deal with the dynamic changes occurred in the scene in outdoor environment. Proposed adaptive tuning approach significantly reduces the overload experimentations and minimizes the errors occurred in empirical tuning traditional GMM technique. The performance of proposed system is evaluated by using open source database consists of seven video sequences of critical background condition.

An Embedded Real- Time Object Detection and Measurement of its Size

In these days, real-time object detection and dimensioning of objects is an important issue from many areas of industry. This is a vital topic of computer vision problems. This study presents an enhanced technique for detecting objects and computing their measurements in real time from video streams. We suggested an object measurement technique for real-time video by utilizing OpenCV libraries and includes the canny edge detection, dilation, and erosion algorithms. The suggested technique comprises of four stages: (1) identifying an object to be measured by using canny edge detection algorithm, (2)
using morphological operators includes dilation and erosion algorithm to close gaps between edges, (3) find and sort contours, (4) measuring the dimensions of objects. In the implementation of the proposed technique, we designed a system that used OpenCV software library, Raspberry Pi 3 and Raspberry Camera. The proposed technique was nearly achieved 98% success in determines the size of the objects.

Multifunctional Device for blind people

Getting around, whether indoors or outdoors, is one of the most difficult tasks for the visually impaired. Furthermore, the poor state of the roads makes walking outside even more difficult for them. They must remain vigilant at all times to avoid dangerous situations such as colliding with stationary or moving obstacles, ascending or descending staircases, or slipping on damp terrain. They may also be distressed and wish to send an alarm message to their relatives or friends about their whereabouts. The issues that blind individuals face can be solved with the use of technology. To offer a medium between the blind and the environment, the suggested solution uses the Internet of Things (IoT) paradigm. Several sensors can be used Obstacles, staircases, and damp terrains are all examples of abnormalities that can be detected. The smart blind stick prototype presented here is a simple, intelligent, and cost-effective smart blind stick with a variety of IoT sensors and modules.

III. Proposed System

The proposed Advanced parking system automates the detection and management of parking slots using IR sensors, an Arduino, a servo motor, and an LCD display. The IR sensors detect vehicle presence, and the Arduino processes this data to update the LCD display with real-time slot availability. The servo motor controls parking gates, guiding vehicles to available slots. This system reduces human intervention, improves efficiency, and ensures optimal use of parking spaces.

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IV. Block Diagram

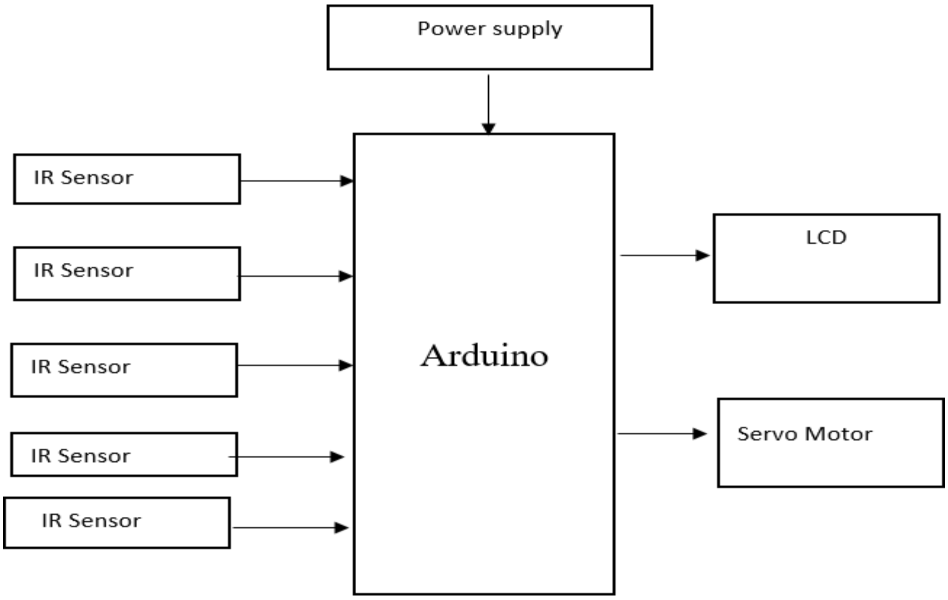

Fig -Block diagram of Arduino Uno Based Smart Car parking System

Arduino Uno Microcontroller:

Arduino UNO is based on ATmega328P Microcontroller, an 8-bit AVR Architecture based MCU from ATMEL. Arduino UNO comes in two variants: one consists of a 28-pin DIP Microcontroller while the other consists of 32 lead Quad Flat Package Microcontroller. Arduino UNO Board Layout. As you can notice, there is a Type-B USB connector on the left short edge of the board, which is used for powering on the board as well as programming the Microcontroller. There is also a 2.1 mm DC jack to provide external power supply.

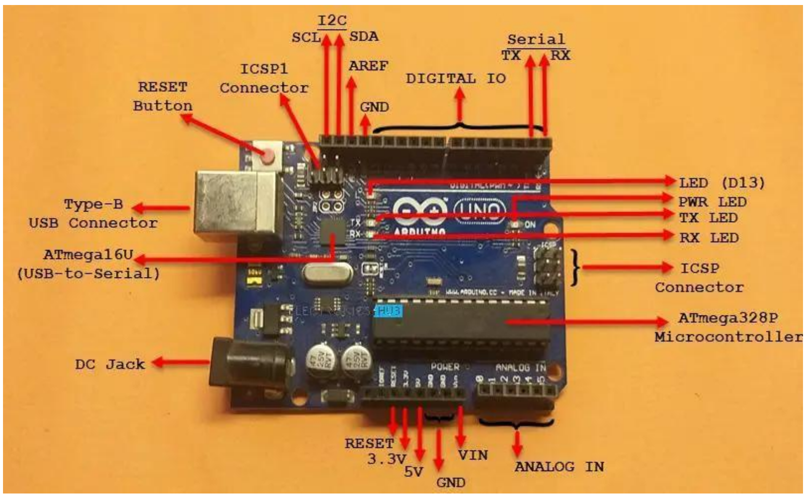

Fig – Arduino Uno Pin Out

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Features of Arduino Uno:

- It is based on the ATmega328P microcontroller.
- The operating voltage is 5 volts.
- It accepts a recommended input voltage of 7 to 12 volts.
- It has 14 digital input/output pins.
- Six of the digital pins can be used as PWM outputs.
- There are 6 analog input pins available.
- It runs at a clock speed of 16 MHz.
- The board has 32 KB of flash memory, with 0.5 KB used by the bootloader.
- It includes 2 KB of SRAM.
- It has 1 KB of EEPROM for non-volatile data storage.
- USB connectivity allows easy programming and communication with a computer.
- It can be powered through an external power jack.
- An ICSP header is available for direct programming.
- A reset button is included for restarting the board or uploading code.
- A built-in LED on pin 13 is useful for simple tests and debugging.

Arduino Uno Pin Description:

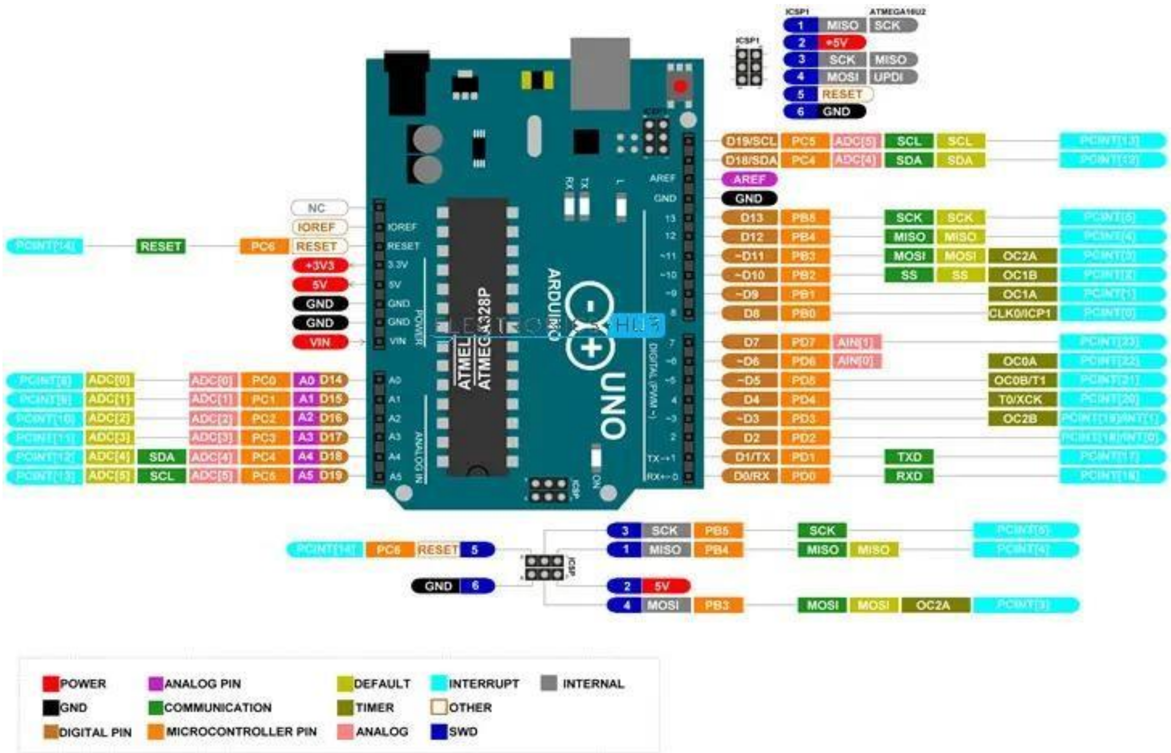

Fig- Arduino UNO Pin Out

IR SENSOR

IR sensor is an electronic device that emits the light in order to sense some object of the surroundings. An IR sensor can measure the heat of an object as well as detects the motion. Usually, in the infrared spectrum, all the objects radiate some form of thermal radiation. These types of radiations are invisible to our eyes, but infrared sensor can detect these radiations.

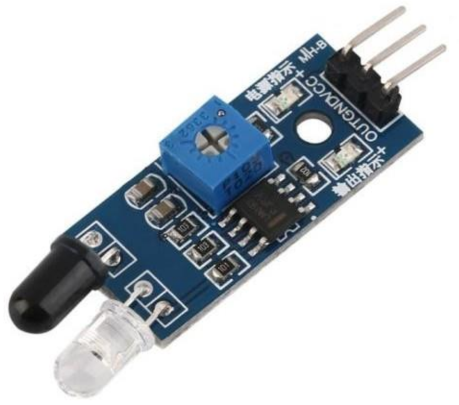

Fig 4.4- IR Sensor

The emitter is simply an IR LED (Light Emitting Diode) and the detector is simply an IR photodiode. Photodiode is sensitive to IR light of the same wavelength which is emitted by the IR LED. When IR light falls on the photodiode, the resistances and the output voltages will change in proportion to the magnitude of the IR light received. There are five basic elements used in a typical infrared detection system: an infrared source, a transmission medium, optical component, infrared detectors or receivers and signal processing. Infrared lasers and Infrared LED’s of specific wavelength used as infrared sources. The three main types of media used for infrared transmission are vacuum, atmosphere and optical fibers. Optical components are used to focus the infrared radiation or to limit the spectral response.

IR Sensor Working Principle

There are different types of infrared transmitters depending on their wavelengths, output power and response time. An IR sensor consists of an IR LED and an IR Photodiode, together they are called as Photo Coupler or OptoCoupler.

IR Transmitter or IR LED

Infrared Transmitter is a light emitting diode (LED) which emits infrared radiations called as IR LED’s. Even though an IR LED looks like a normal LED, the radiation emitted by it is invisible to the human eye.

The picture of an Infrared LED is shown below.

Fig 4.5- IR Receiver

Infrared receivers or infrared sensors detect the radiation from an IR transmitter. IR receivers come in the form of photodiodes and phototransistors. Infrared Photodiodes are different from normal photo diodes as they detect only infrared radiation. Below image shows the picture of an IR receiver or a photodiode,

Fig 4.6 - Photodiode

Different types of IR receivers exist based on the wavelength, voltage, package, etc. When used in an infrared transmitter – receiver combination, the wavelength of the receiver should match with that of the transmitter.
The emitter is an IR LED and the detector is an IR photodiode. The IR photodiode is sensitive to the IR light emitted by an IR LED. The photo-diode's resistance and output voltage change in proportion to the IR light received. This is the underlying working principle of the IR sensor.

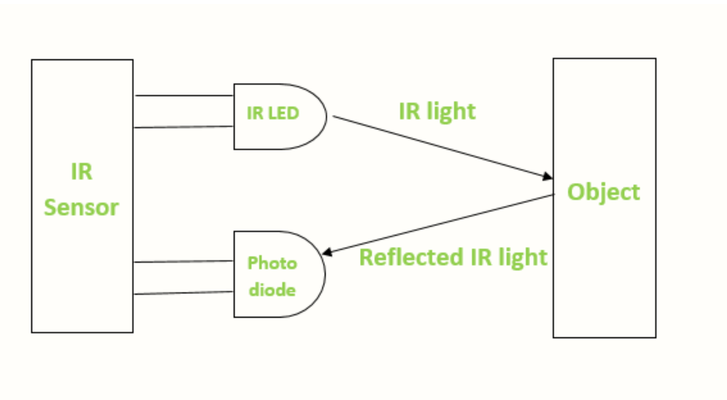

Fig 4.7- IR Sensor schematic diagram

When the IR transmitter emits radiation, it reaches the object and some of the radiation reflects back to the IR receiver. Based on the intensity of the reception by the IR receiver, the output of the sensor defines.

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V. Schematic Diagram

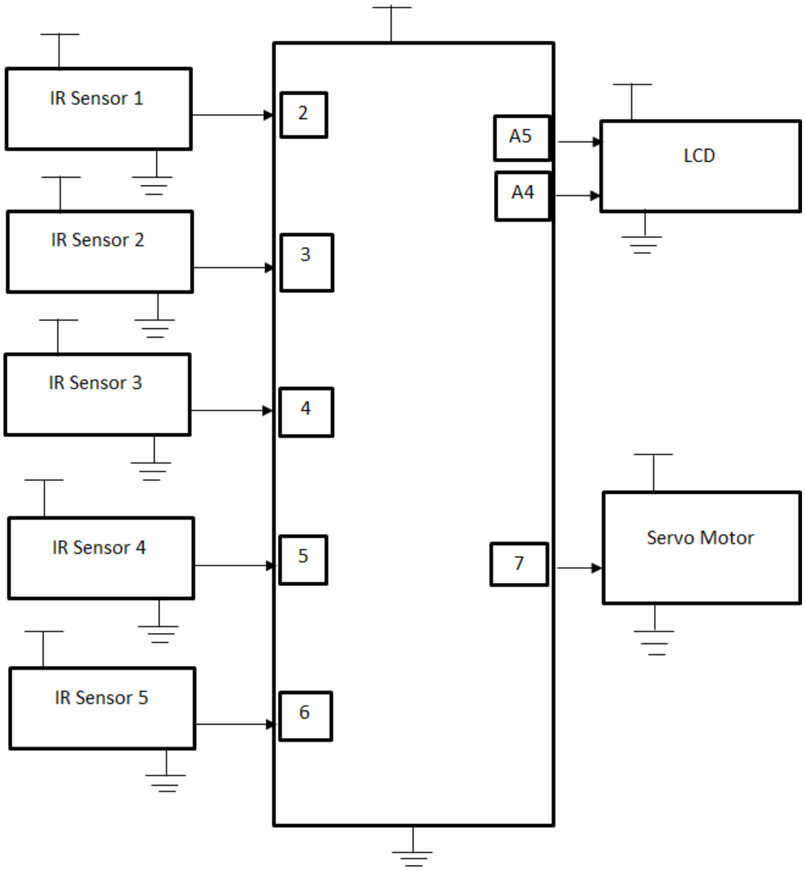

Fig – Schematic Diagram of Arduino Uno Based Smart Car Parking System

VI. Result

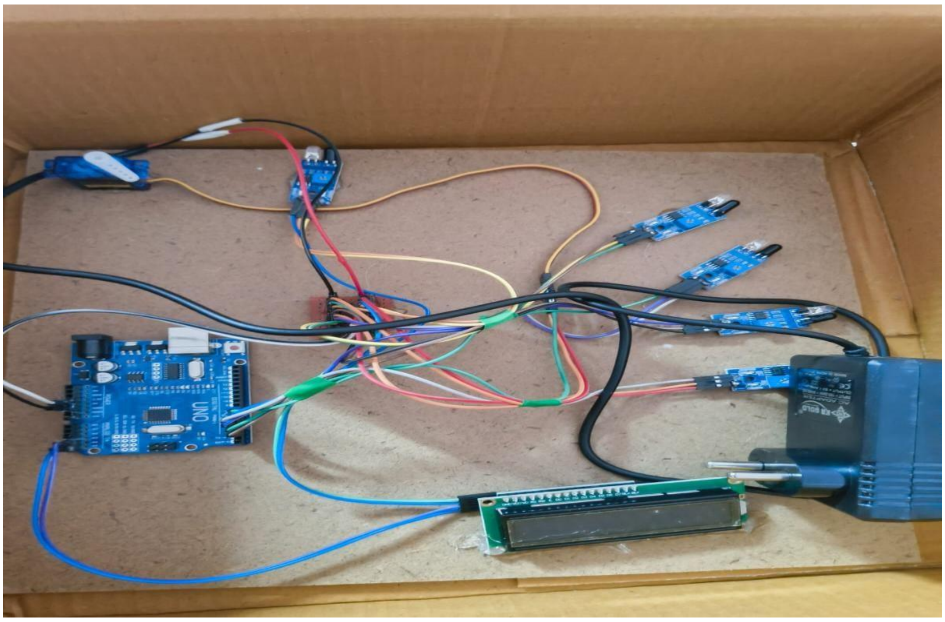

Fig – Hardware Kit

VII. Results:

The successful development of the smart farming robot for greenhouse environmental monitoring led to the following outcomes:

1. **Automated Entry & Exit:** Vehicles are detected automatically, enabling barrier control without manual intervention.
2. **Real-Time Slot Detection:** Uses sensors to monitor and display available parking slots in real-time.
3. **Efficient Space Utilization:** Maximizes use of parking space by guiding vehicles to free spots.
4. **Reduced Human Effort:** Minimizes the need for security personnel to manage parking manually.
5. **Faster Vehicle Flow:** Reduces waiting time at entry/exit points, improving traffic flow.
6. **Power-Efficient Operation:** Low power consumption through use of energy-efficient components like ultrasonic sensors and LEDs.
7. **User-Friendly Interface:** LCD or mobile app integration provides easy user interaction.
8. **Cost-Effective Solution:** Offers a low-cost, scalable alternative to commercial smart parking systems.

VIII. Future Scope:

The smart farming robot for greenhouse monitoring has immense potential for expansion and improvement in agricultural automation. Some key future directions include:

- **Mobile App Integration:** Develop a smartphone app for real-time slot booking, navigation, and payment.
- **IoT & Cloud Connectivity:** Enable data storage, remote monitoring, and analytics using cloud platforms.
- **AI-Based Traffic Prediction:** Use AI to predict peak hours and manage parking availability accordingly.
- **Automatic Number Plate Recognition (ANPR):** Integrate camera systems to identify vehicles and enhance security.
- **Smart Payment Systems:** Implement digital payment options like UPI, RFID, or NFC for seamless transactions.
- **Renewable Energy Support:** Use solar panels to power the system, making it eco-friendly and sustainable.
- **Multi-Level Parking Management:** Expand the system for complex parking structures with multiple floors.
- **Integration with Smart Cities:** Connect with broader smart city infrastructure for optimized urban traffic and parking solutions.

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