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ARDUINO BASED SMART CAR PARKING SYSTEM

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Abstract: The growing number of vehicles in urban areas has intensified the need for efficient parking management systems. Traditional parking methods are often inefficient, time-consuming, and contribute to traffic congestion and increased fuel consumption. This paper presents the design and implementation of an Arduino-based smart car parking system that automates the process of detecting and displaying the availability of parking slots. The system employs ultrasonic sensors to monitor individual parking spaces, an Arduino UNO micro-controller for processing sensor data, and an LCD to display real-time slot availability. The proposed system is cost-effective, scalable, and easy to deploy in small to medium-sized parking areas. Experimental results demonstrate the system's accuracy in detecting vehicle presence and effectiveness in reducing parking time and improving user convenience. The research highlights the potential for integration with mobile applications and IOT platforms for enhanced user experience and broader smart city applications.

Keywords: Arduino, Smart Parking, IoT, Ultrasonic Sensors, Embedded System, Automation

I INTRODUCTION:

Urbanization has led to an exponential increase in vehicle usage, resulting in limited parking space and traffic congestion. Traditional parking systems are inefficient in managing parking space availability, leading to time loss and increased fuel consumption. A smart parking system using an Arduino micro controller and sensors can address these issues by providing real-time monitoring and control. This study focuses on designing and implementing a cost-effective, scalable parking management system using Arduino Uno, ultrasonic sensors, and an LCD interface. The proposed system can detect vehicle presence and communicate slot availability to users.

II LITERATURE SURVEY:

The increasing demand for efficient and intelligent parking management systems has prompted extensive research into automated and smart car parking technologies. Various methodologies and technologies have been explored to optimize parking space utilization, reduce traffic congestion, and improve user convenience.

Ahmed et al. (2019) developed an IR sensor-based car parking system integrated with a GSM module to notify users of available slots via SMS. While effective for small-scale use, the system lacked scalability and real-time feedback mechanisms.

Patel and Mehta (2021) proposed an IoT-based smart parking system utilizing NodeMCU and cloud platforms like Firebase. Their system provided real-time parking updates to users via a mobile app. However, dependency on continuous internet connectivity posed limitations in low-connectivity regions.

Sharma (2020) implemented an Arduino-based solution using ultrasonic sensors to detect vehicle presence. The system displayed parking slot status on an LCD screen. Although simple and cost-effective, it was limited in its ability to manage larger or multi-level parking areas.

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Gaurav and Singh (2022) enhanced vehicle detection accuracy by integrating machine learning algorithms with sensor-based systems. This approach, while innovative, increased the complexity and cost of implementation, making it less practical for budget-constrained environments.
Kumar and Reddy (2018) focused on smart parking systems for public spaces and integrated RFID for vehicle identification. Although this provided better access control, the system's setup was more expensive and required significant infrastructure changes
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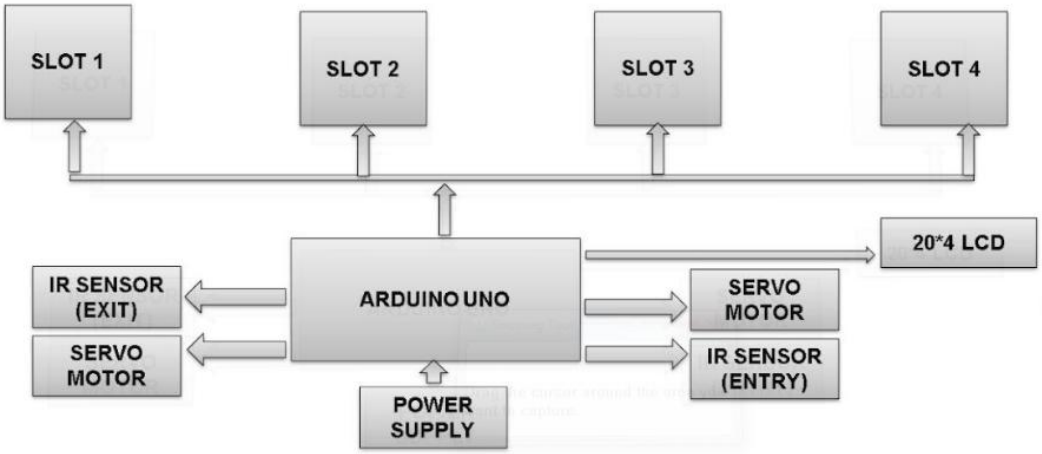
III DESIGN SYSTEM:

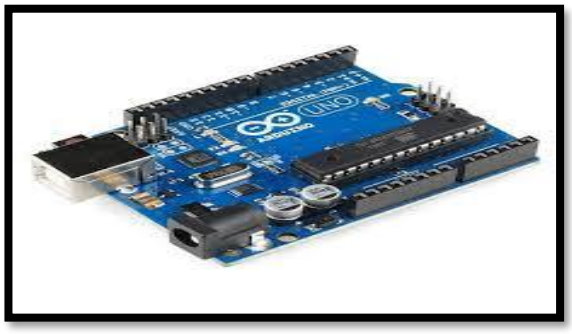
BLOCK DIAGRAM



COMPONENTS LIST AND SPECIFICATION

ARDUINO UNO

Arduino Uno, a widely-used microcontroller board designed for electronics prototyping and embedded system development. It features a blue printed circuit board with various components and connectors. Central to the board is the ATmega328P microcontroller, which handles all processing tasks. The board includes 14 digital input/output pins, 6 analog input pins, a USB port for programming and power, and a barrel jack for external power supply. It also has headers for connecting sensors, actuators, and other modules, making it an ideal platform for hobbyists, students, and engineers working on interactive projects. The Arduino Uno is known for its simplicity, ease of use, and strong community support.



Arduino UNO Board

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IR SENSOR The image shows an IR (Infrared) Obstacle Avoidance Sensor Module, commonly used in robotics and embedded systems projects. This module consists of an IR transmitter (typically a clear LED) and an IR receiver (usually a black photodiode), which work together to detect obstacles by reflecting infrared light off nearby surfaces. The module also features a potentiometer (the blue knob) to adjust the sensitivity of detection, and a comparator IC to process the signal. The output is typically a digital HIGH or LOW, indicating the presence or absence of an obstacle. The module has three pins: VCC, GND, and OUT, making it easy to interface with microcontrollers like Arduino. It is widely used in autonomous robots for tasks such as line-following or obstacle avoidance.

IR Sensor

20*4 LCD With I2c MODULE

The image displays a 20x4 I2C LCD display module, which is commonly used in electronics projects to show alphanumeric data. The bottom component is the LCD itself, capable of displaying 20 characters across 4 rows, making it suitable for presenting multiple lines of text or sensor data. The top component is an I2C interface module, which is mounted on the back of the LCD. This adapter converts the parallel communication of the LCD into I2C, significantly reducing the number of pins required to connect it to a microcontroller like an Arduino—only VCC, GND, SDA, and SCL are needed. The module also includes a potentiometer (the blue knob) for adjusting the contrast of the display. This combination is ideal for projects where space and pin usage are limited, while still requiring clear textual output.

20*4 Lcd With I2c Module

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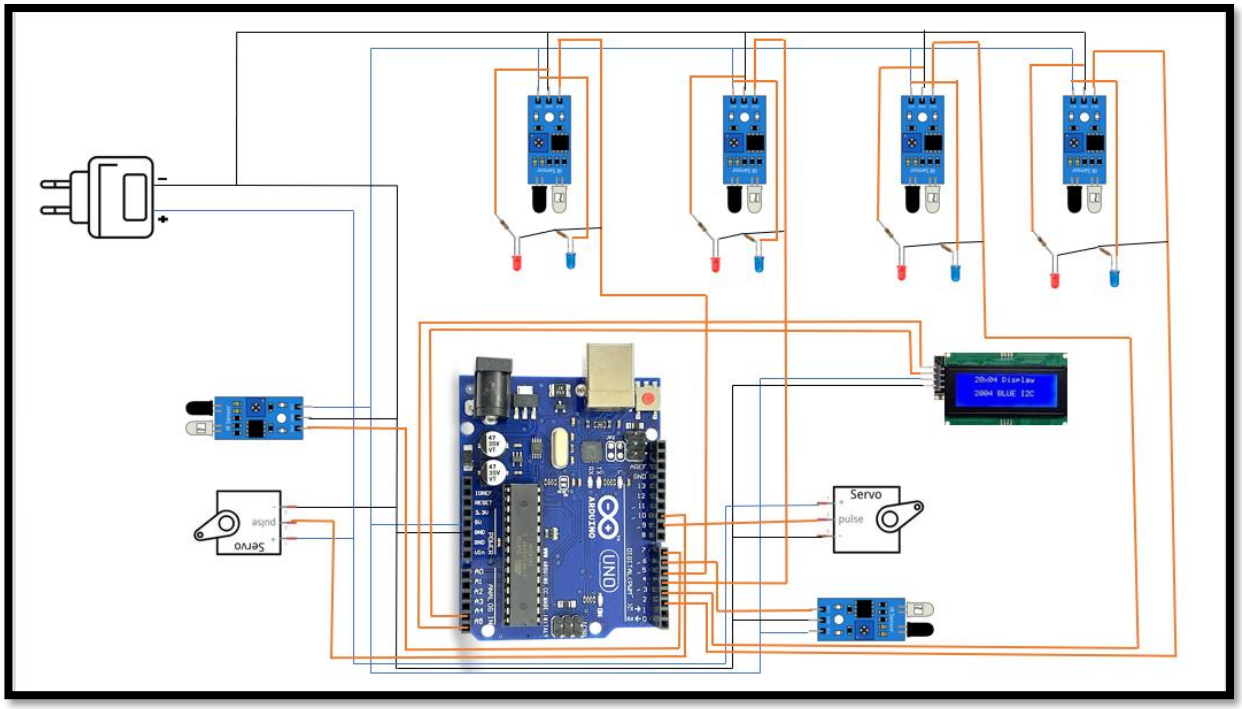
SG90 MICRO SERVO MOTOR

SG90 micro servo motor, a compact and lightweight actuator widely used in robotics, RC (radio-controlled) vehicles, and DIY electronics projects. The servo consists of a small plastic gear motor housed in a transparent blue casing, along with control electronics. It operates on a PWM (Pulse Width Modulation) signal and typically rotates between 0 to 180 degrees. The motor has three wires—orange (signal), red (power), and brown (ground)—for easy interfacing with microcontrollers like Arduino. Also included are a set of plastic servo horns and screws for attaching to mechanical components. Known for its precision and ease of use, the SG90 is ideal for applications requiring controlled motion, such as robotic arms or steering mechanisms.

SG90 micro servo motor

CIRCUIT DIAGRAM:

smart parking system with four individual parking slots. Each slot is equipped with an IR sensor and two LEDs (red and blue). An Arduino Uno is centrally positioned to collect data from the sensors, control the LEDs, servo motor, and update the LCD display.



Circuit Diagram smart parking system

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IV WORKING MECHANISM :

Vehicle Detection: Each slot has an IR sensor which continuously checks for the presence of a vehicle.

Green LED ON: Indicates the slot is empty.

Red LED ON: Indicates the slot is occupied.

Entry Request: When a vehicle approaches, the user presses a button.

The system checks if there is any vacant slot.

If a slot is available, the servo motor opens the gate.

The LCD shows the number of available slots.

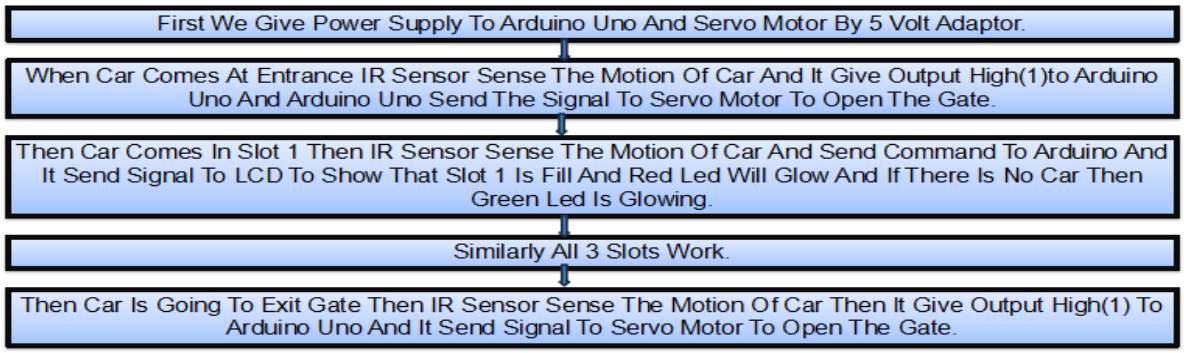
Slot Status Update: As the car enters a slot, the corresponding IR sensor detects it, switches off the blue LED and turns on the red LED.

Real-Time Monitoring: The LCD display constantly updates to show how many slots are free.

SERVO and DISPLAY CONTROL

The **servo motor** acts as a gate, connected to one of the PWM pins of Arduino. It rotates to allow or block entry based on slot availability.

The **LCD** is connected via I2C or parallel connections and displays messages like “Slots Available: 3”.



Working Principle of smart parking system

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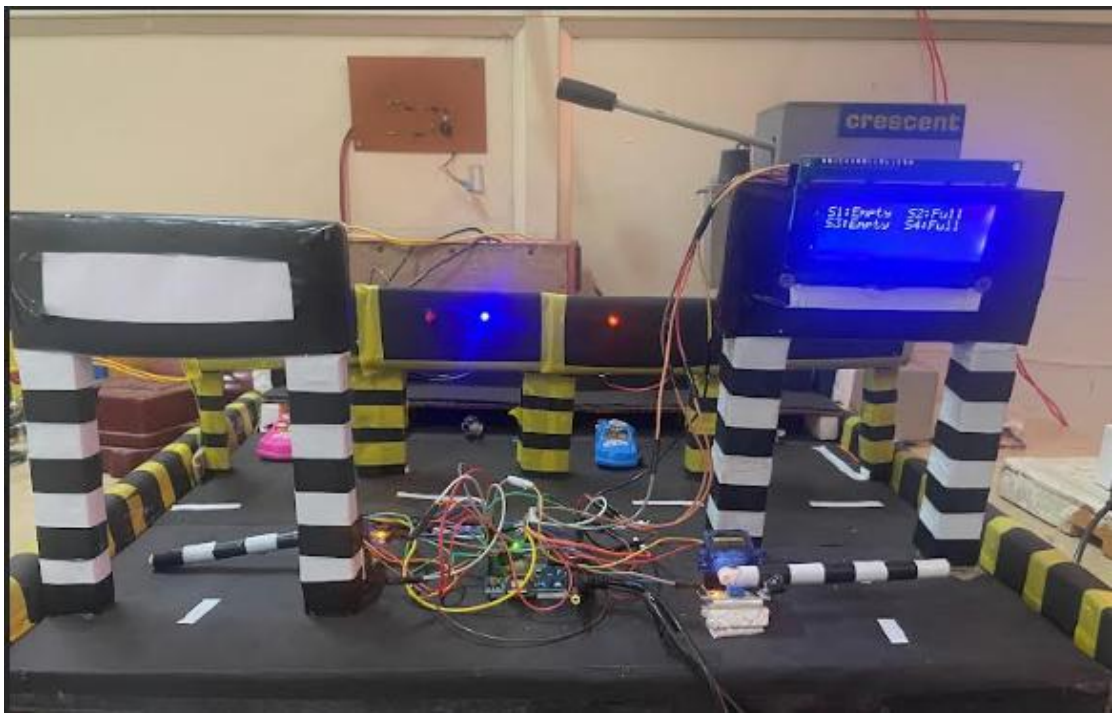
V ARDUINO CODE SAMPLE:

```
#include <LiquidCrystal.h>
#define trigPin1 2
#define echoPin1 3

LiquidCrystal lcd(7, 8, 9, 10, 11, 12);

void setup() {
  lcd.begin(16,2);
  pinMode(trigPin1, OUTPUT);
  pinMode(echoPin1, INPUT);
}

void loop() {
  digitalWrite(trigPin1, LOW);
  delayMicroseconds(2);
  digitalWrite(trigPin1, HIGH);
  delayMicroseconds(10);
  digitalWrite(trigPin1, LOW);

  long duration = pulseIn(echoPin1, HIGH);
  int distance = duration * 0.034 / 2;

  lcd.clear();
  if(distance < 10){
    lcd.print("Slot 1: Occupied");
  } else {
    lcd.print("Slot 1: Free");
  }
  delay(1000);
}
```

VI RESULT and DISCUSSION :



The system was tested with up to four parking slots. It accurately detected vehicle presence and updated the LCD in real-time. The detection range was consistent within a 2 cm margin of error. The cost per unit was estimated at under $25, making it viable for budget implementations.

VII CONCULSION :

This paper presents a functional, low-cost smart parking system using Arduino. The system enhances parking management through real-time slot detection, display, and optional control mechanisms. Future work may include cloud integration, mobile app interface, and solar-powered modules for energy efficiency.

VIII FUTURE SCOPE :

In future works, this framework can be enhanced by including different applications. For Example : internet booking by utilizing GSM

We can use wireless communication to enhance the usage of the system and can book a place from home.

We will attempt to decrease the mechanical structure and attempt to make it eco-friendly

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