Smart Parking System

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***Abstract*—The surge of automobiles in metropolitan cities has created a critical need for proper regulation of parking spaces. The Smart Parking System seeks to resolve this challenge through automation of vehicle parking with the use of IR sensors, ultrasonic sensor, servo motor, 16x2 LCD module, and Arduino Uno board. The available parking spots are automatically detected and updated for appropriate users in real time. Once a vehicle is within range, IR and ultrasonic sensors pick up the vehicle while the system automatically lifts and closes the barrier gate using a servo motor. The 16x2 LCD module enables users to know the number of slots that are currently available or occupied in real-time. With this automation, the system enhances the parking efficiency, mitigates traffic congestions, and provides improved user satisfaction.**

I. INTRODUCTION

In this project, we have aimed towards designing a Smart Parking System that automates the functioning of parking using Arduino boards with IR sensor, ultra sonic sensor, Servo motor and a 16x2 LCD module. With rapid development in cities and an increase in the number of vehicles, the congestion of vehicles in the parking lot has raised in prominence. This has led to wastage of time, fuel and, cause disturbances in traffic. The conventional ways are very labor intensive and rely heavily on human guarding. This is what causes the problem to have reduced efficiency as well as mismanagement. The computerized smart parking system automates the entire process of detecting the availability of parking slots, allowing vehicles to access them, and most importantly, enhancing efficiency in parking facilities. Sensor based automation takes away the human operators' fatigue, reduces waiting time, and overall improves customer satisfaction. Coupling real time surveillance with automation truly increases overall efficiency in any sort of system. In the case of parking, it helps to increase the efficiency.

This system, in a nutshell, manages and detects parking space with the IR sensors, ultrasonic sensor, and servo motor-controlled barrier. It identifies vacant slots, displays their availability in real time on a 16x2 module LCD, and allows access to the vehicles accordingly. The system integrated all these components to ensure efficient parking management to minimize manual effort, while optimizing the utilization of space, hence allowing or prohibiting vehicle entry based on slot availability in just a moment.

Thus, this project showcases not only practical usage of embedded systems but also the aspect of automation in modern parking management. By means of IR and ultrasonic sensor-based monitoring of the space, the system minimizes human intervention and ensures space detection accuracy. The 16x2 LCD module provides real-time updates to allow less congestion and better parking conditions for the user. Such solutions increase city parking efficiency and convenience.

This project can further extend and modify for several applications such as automated parking systems, smart traffic managements, and urban parking solutions. IoT, cloud computing, and AI-wise would enhance efficiency for use in malls, offices, and public parking. The future adaptability has used IR and ultrasonic sensors integrated with real-time LCD monitoring.

II. LITERATURE SURVEY

Smart Parking System: An Automated Iot-Based Parking management and monitoring solution using sensors.

This study seeks to optimize space utilization and decongestion through automated parking solutions using IoT and sensor technology. The role of IR and ultrasonic sensors is to detect slots in real time, hence improving efficiency and the convenience of use. [1]

Design and Implementation of an Arduino-Based Smart Parking System – T The article details a smart

parking system using Arduino Uno, IR, and ultrasonic sensors to detect vehicles and allocate parking. A servo motor controls entry barriers, ensuring efficient embedded system use.[2]

IoT-Enabled Parking Management System with Real-Time Slot Monitoring – This study proposes an IoT-based parking system using IR and ultrasonic sensors for slot detection, with cloud-based real-time monitoring to reduce parking delays by guiding drivers to free slots. [3]

Automated Parking Barrier Control Using Sensor Networks – This study does an extensive study of automated entry and exit gate control mechanisms in parking systems. The study opens itself to a variety of sensor technologies from IR to ultrasonic sensors for improving detection accuracy. The system regulates vehicle entry on the basis of slot availability by a servo motor. [4]

Smart Parking System with Real-Time Monitoring and User Guidance – A parking system has been developed using an Arduino-based architecture to automatically detect vacant slots and display the information regarding availability on a 16x 2 LCD module—processing IR and ultrasonic sensor data to generate the occupancy status and control the barrier with the help of a servo motor. [5]

AI-Based Smart Parking System Using Embedded Sensors The paper discusses the implementation of a smart parking solution integrating sensor-based detection and AI algorithms. The system employs multiple IR and ultrasonic sensors to monitor parking spaces and provide predictive analysis for optimal slot allocation. [6]

III. METHODOLOGY

To develop the Smart Parking System, various components must be selected, including an Arduino Uno microcontroller, IR sensors, an ultrasonic sensor, a servo motor, a 16x2 LCD module, and jumper wires. The system is supposed to detect vehicle presence, operate the entry barrier, and display real-time slot availability. Hardware setup includes connecting the IR and ultrasonic sensors for slot detection, connecting the servo motor for gate control, and connecting the 16x2 LCD module for user guidance. Arduino is programmed using proper logic to manage sensor data, control barrier movement, and give accurate parking updates. Calibration of the sensor assures precise detection of cars, after which preliminary tests are carried out to check for any malfunctionality. On integrating all components in the right configurations, optimization is made, and field tests are carried out to ensure smooth operations. Elaborate documentation in regard to circuit diagrams, Our Code, calibration techniques, and respective test results would be run through for analyses and reporting purposes.

IV. ARCHITECTURE

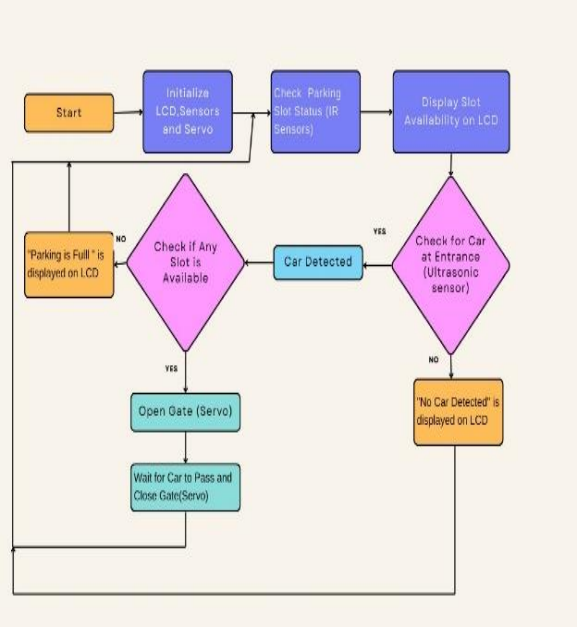

Fig 4.1: - Block Diagram

V. RESULT

The Smart Parking System has shown reliable performance in most of the tests performed. These results validated the integration of IR and ultrasonic sensors for vehicle detection, servo motor for controlling the barrier, and 16x2 LCD module for up-to-the-minute parking updates. Such automation in parking management helps to curb congestion and capacity management. Future improvements could involve the introduction of AI-based predictive analysis for superior slot allocation, as well as improved accuracy of sensors under different environmental conditions. As IoT and automation technologies advance, these findings contribute to the development of more efficient and intelligent parking solutions.

VI. OUTPUTS

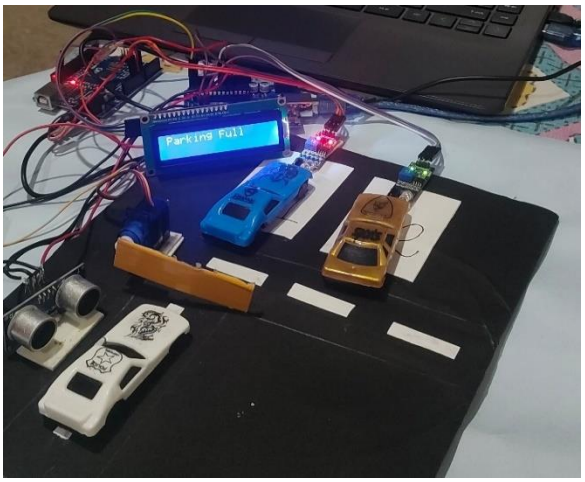

Fig 6.1: - Proposed model

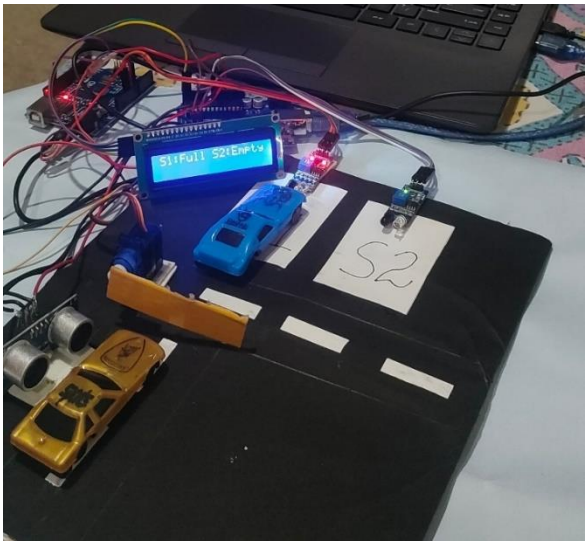

Fig 6.2: - Single car

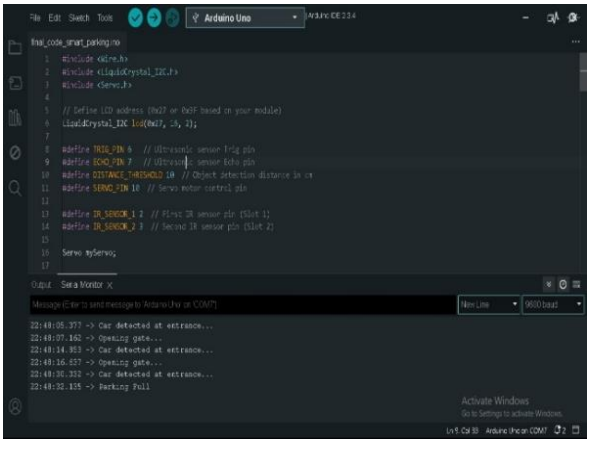

Fig 6.3: - Arduino IDE Software

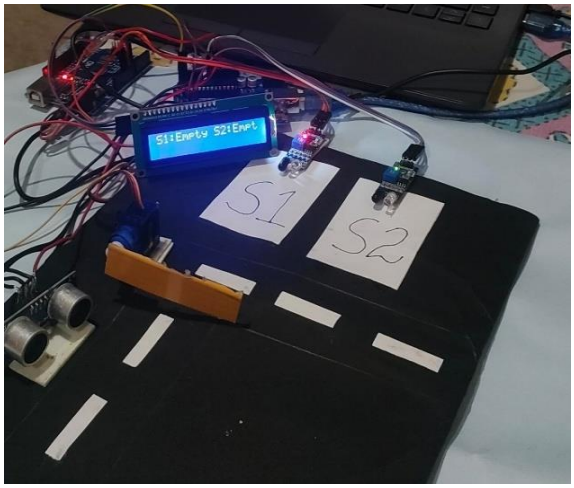

Fig 6.4: - LCD modules and sensors

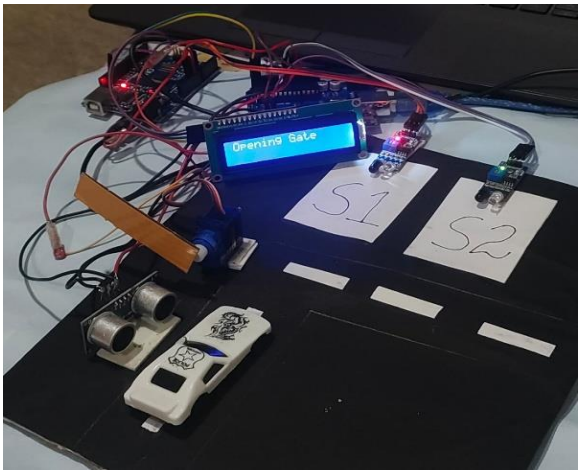

Fig 6.5: - Opening gate

VII. CONCLUSION

This project describes the Smart Parking System developed with Arduino, IR sensors, an ultrasonic sensor, a servo motor, and a 16x2 LCD module. The system was designed to allow automatic detection of parking slots, real-time monitoring, and efficient management of vehicle entry. Besides demonstrating the practical applications of IoT and automation, the project also serves as an educational tool for students and technology enthusiasts. The Smart Parking System was finally successful in fulfilling its goals of optimized parking management and reduction of congestion. The results prove how effective the used hardware and software were and indicate a significant opportunity for further development in intelligent parking solutions.

REFERENCE

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