Smart Parking System with an Automated Gate and Car Counter

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Student Roles and Contributions:

- Reagan: Presentation, report and project design
- Landon: Editing presentation and report, implementation of design

***Abstract*–This project presents the design and implementation of a smart parking system using an Arduino Uno microcontroller. The system uses various sensors and actuators to monitor availability of parking, control of exit and entry, and use of RFID-based access control. The main components of the system include infrared (IR) sensors for car detection, an RFID reader for access control, a servo motor for gate operation, and an LCD display to give users automatic feedback. This report discusses the technical details of the system's interaction between components, presents its functionality through diagrams, figures and numerical graphs, and finishes with a conclusion of the system's strengths and limitations.**

I. INTRODUCTION

Across the entire world, there is an exponential growth in population. With an increase in people comes an increase in demand for automotives, and thus a place to park them, especially in locations with concentrated populations, like urban cities. This project aims to introduce a solution to a pressing need for efficient parking management, where traditional parking systems tend to not address many issues, such as inefficiency and automotive congestion. By introducing an automated parking system, we can optimize parking space, streamline exit and entry, and strengthen security through RFID-based access control. This system holds promise in alleviating parking challenges and changing the user's overall experience in real-life situations, which helps to alleviate emotional stresses when trying to find a spot as well. The smart parking system can expedite the search for available spots, mitigating traffic congestion in parking areas, and create a seamless entry and exit process.

The structure of the report is as follows: The Methods section states technical insights into the implementation and design of the smart parking system, including details about the sensors, actuators and computational devices that are used. Following this, the Results section demonstrates a graph of the system's functionality, showcasing this functionality using numerical outcomes to prove it true. To finish, the Discussions and Conclusions section gives a breakdown on the system's strengths and limitations, concluding the report with a comprehensive overview of the project as a whole.

II. METHODS

Sensors:

1. Infrared (IR) sensors: These sensors operate based on emitting infrared light and detecting its reflection to determine the presence of objects. In our project, they detect the hot wheelz cars.

When a hot wheelz car is in the range of detection, the IR sensor detects the reflected light, triggering an output signal that indicates the presence of the car. The output signal takes the form of the digital signal, where a "HIGH" state signifies the presence of a vehicle, and a "LOW" state indicates there is no presence.

- Characteristics: Range 2-30cm, Resolution 1 cm

2. Radio-frequency identification (RFID) reader: The RFID reader communicates with RFID tags that are scanned using radio frequency signals. When a vehicle with an RFID tag enters the reading range of the RFID, the reader emits radio waves that power the RFID tag or key fob. The tag then transmits its unique identification (UID) data back to the reader, which processes this data to determine the identity of the tag, and whether or not the vehicle should be granted or denied access to the parking lot.
    - Characteristics: Range: 0-60mm

Actuators:

1. MSG90 Servo motor: Servo motors are electromechanical devices that control the angular position of an output position of a shaft, located inside the motor, based on the input signal it receives. In the context of this project, the servo motor is responsible for controlling the operation of the exit and entry gate. When triggered by the system (either the entry or exit IR sensor), the servo motor rotates its shaft to a specific angle, either opening or closing the gate. The input signal to the servo motor consists of a pulse-width modulation (PWM) signal, where the width of the pulse determines the desired position of the shaft. When the width of the input pulses vary, the system can precisely control the angle of rotation of the motor, allowing for more accurate gate operation.
    - Characteristics: Rotation Range 0-180 degrees, Resolution 1 degree

Computational Devices:

1. Arduino Uno microcontroller: The Arduino Uno R3 is a popular and versatile microcontroller. It serves as the brain of the system, coordinating the operation of sensors, actuators and all other components. The Arduino Uno specifically works by giving instructions provided by the code uploaded from the computer into its memory. In this project, the Arduino Uno interfaces with various sensors, such as infrared sensors and RFID readers, to collect data about parking spot occupancy and vehicle access. For example, the microcontroller receives input from the infrared sensors to detect the presence of cars in parking spots and processes this information to

update the parking availability status. Similarly, Arduino Unos interface with actuators, such as servo motors, to control the operation of the exit and entry gate. They receive commands from the system to open or close the gate based on what events have been detected, such as a car entering or exiting. The integration is done through the hardware as well, because the microcontrollers's digital and analog input/output pins are used to connect the sensors and actuators, allowing the Arduino control over all aspects.

2. Liquid Crystal Display (LCD): The 20x4 Liquid Crystal Display (LCD) is a display module used in many embedded systems, including our smart parking system. It consists of a grid of 20 characters per row and 4 rows. The display operates based on liquid crystal polarization, where electrically controlled liquid crystals generate characters on the screen. Control is facilitated through the Arduino Uno microcontroller. The Arduino communicates with the LCD display using the I2C (Inter-Integrated Circuit) protocol, a serial communication interface that aids the LCD in exchanging information over a short distance. This protocol from the I2C module allows the Arduino to send commands and data to the LCD display for controlling the content displayed on the screen. The integration into the system enables the automated parking system to provide automatic updates to users regarding parking availability and system status, enhancing the overall user experience even further.

Figure 1:

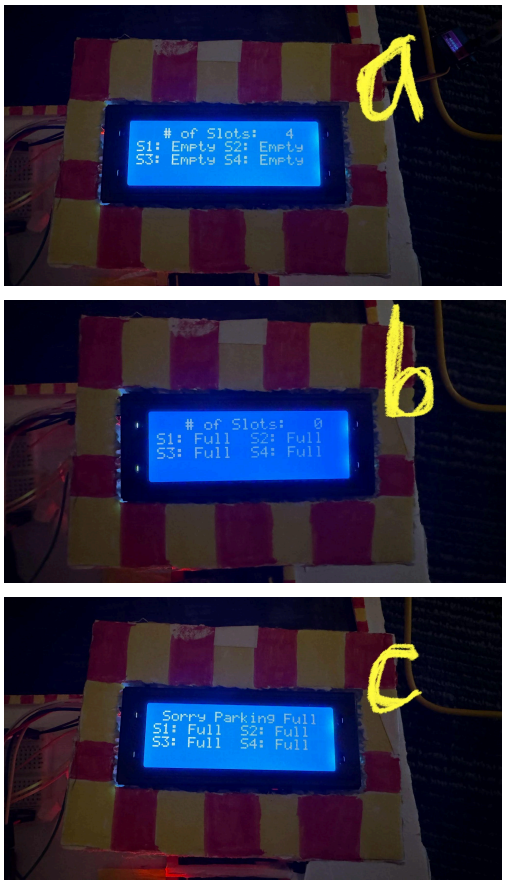


Fig 1: a) Initial display of LCD, all slots empty, b) Finished display of LCD, all slots full, and c) display showing "Sorry Parking Full".

Figure 2:

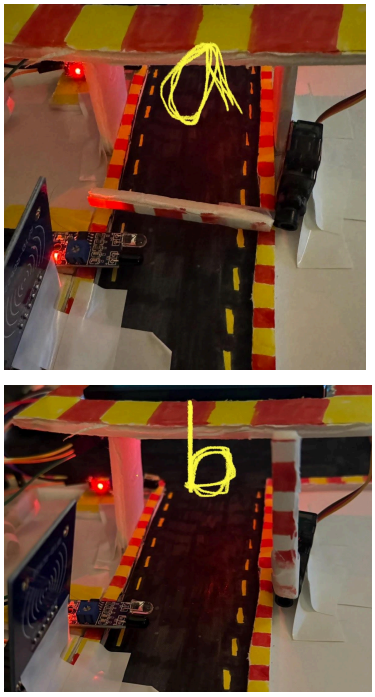
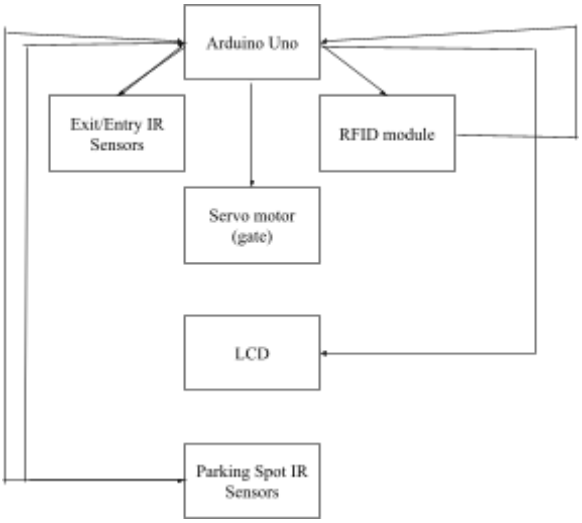


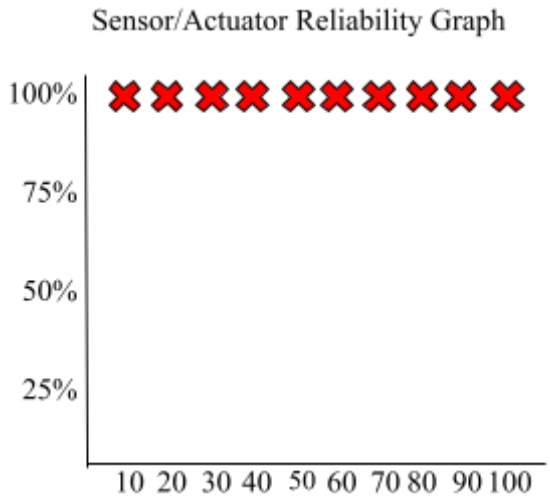
Fig 2: a) Initial position of servo motor, used for the gate, b) Upright position of servo motor, open gate position

Diagram:
This diagram is an overview of the entire project implementation. It demonstrates the complex interconnections of all of the devices that are used in the system.



III. RESULTS

A test was run on the system's sensors and actuators. The sensors and actuator (servo motor) were triggered 100 times, and each time they worked effortlessly. The results are displayed in the graph below:



IV. DISCUSSION/CONCLUSION

In conclusion, the design of our automated parking system offers many benefits in terms of optimizing parking space, improving traffic flow, enhancing security, and providing an effortless user experience. By integrating a variety of sensors, actuators and computational devices, the system efficiently manages parking entry and exit processes, effortlessly monitors parking slot occupancy, and ensures secure access control through RFID technology. The automatic feedback provided by the 20x4 LCD display enhances user interaction and contributes to a much smoother parking experience.

Despite its advantages, the smart parking system may encounter several limitations. The complexity of implementation can cause issues, and be too complicated for someone to want to implement. Setup costs are high, further pushing people away, There are also possible reliability issues associated with sensor and actuator malfunction. Additionally, the system's effectiveness may be influenced by

external factors such as environmental conditions and user behavior. However, with maintenance and a slight change in design when implemented in the real world, a smart parking system represents a viable solution for addressing the challenges of urban parking management. It will definitely offer a more efficient and convenient alternative to the traditional parking systems that we have today.

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