

RFID based Smart Parking System

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Abstract - The problem of parking in big cities, especially mega-cities, has become one of the key causes of traffic congestion, driver frustration & air pollution. Locating parking spaces in central areas, especially during peak hours, is a thoroughly cumbersome process. The issue arises from not knowing where parking spaces may be available at any given point of time. Even if known, many vehicles may be competing for limited parking spaces causing severe traffic congestions.

The developed system in this project monitors the availability of idle parking slots and guides the vehicle to the nearest such slot. The feature of pre-reservation of parking slots can also be incorporated in the system. The system's reservation-based parking policy has the potential to smoothen the operations of parking systems, as well as mitigate traffic congestion caused by parking search. As an added advantage it also saves the time required to check-in and get slots to park vehicles.

This project deals with an effective way of checking into the parking space and easily finding empty parking slots. This system also helps in managing the number of vehicles moving in and out in complex parking structures such as dedicated parking lots/buildings by detecting a vehicle using IR sensors and providing feedback. The fully automated smart car parking system is rudimentary and does not require heavy lines of code nor expensive equipment. It is a simple circuit built for demonstration and to fulfil the exact need of purpose.

Keywords – *RFID, Arduino, Smart Parking, Sensors, Servo Motor.*

INTRODUCTION

RFID based Car Parking System is a project that offers an efficient car parking management system using Arduino and RFID technology. As in the modern world everything is going automatic, we have built a system which will automatically sense the entry and exit of cars through the gate and then display the number of cars in the parking lot. Check-ins and check-outs will be handled in a fast manner without having to stop the cars so that traffic jam problem will be avoided during these processes. This developed technology can be used in any urban areas where the car parking is most. Some of the heavy traffic places where this project can be installed and used are shopping malls, hospitals, airports, cinema halls, apartments, etc.

The cost of land has grown exponentially in cities, so it becomes essential that the parking solution requires the least possible space and can accommodate the maximum amount of vehicles. Therefore, by this project we develop a parking system for an organization to have automated parking system for making best use of space,

decreasing the man power and providing authentication for the vehicles from avoiding the theft and other such mishaps.

PROBLEM DEFINITION

Improper parking often leads to inappropriate space that causes vehicles to damage each other. Insufficient parking spaces result in traffic congestion and driver frustration. There arises a situation which is called tailgating in which one vehicle follows the other vehicle blindly without proper identification. Most of the time gates are open which leads to entry of all kinds of vehicles inside the premises. Security guards are ineffective to allow selective vehicles inside the premises due to lack of proper identification system. The system of opening the gate is manual and dependent on the availability of the guard. In a large parking lot where there are hundreds of slots available for parking, finding an empty slot manually is a very tedious task. It is really time consuming and frustrating. The manual parking system consists of many tasks like issuing tokens, noting the check-in and check-out time, calculating fare and finally collecting the amount. The cost of land has grown exponentially in cities, so it becomes essential that the parking solution requires the least possible space and can accommodate the maximum amount of vehicles. An average person spends 10 to 15 % of his travel time looking for a suitable parking spot in metropolitan cities.

PROPOSED SOLUTION

This project is designed in such a way that only authorized personnel with a valid RFID card have access to park. The proposed car parking system uses RFID reader at the entrance to sense the authorized vehicle and allocates the available parking slots to the vehicle. This system clearly displays the total parking slots available and indicates the occupied slots and non-occupied slots in a display board so that user can check the slots before entering the parking area and can park his car in that slot without wasting his/her time. The parking slots are continuously monitored and data is continuously updated in the display board. Unauthorized entry will be denied access to the parking system.

LITERATURE SURVEY

Feng Yuan Wang and Yi Liu presented a paper in 2017^[1] titled 'Mechanical Parking System' that consisted of a rotary mechanism that allowed all the cars to travel in rotary motion. Cars were loaded and unloaded with the rotary motion of all cars. This system was preferable for 8 to 12 cars. Advantages were that it was easy to operate and easy parking of the vehicle was achieved. Limitations

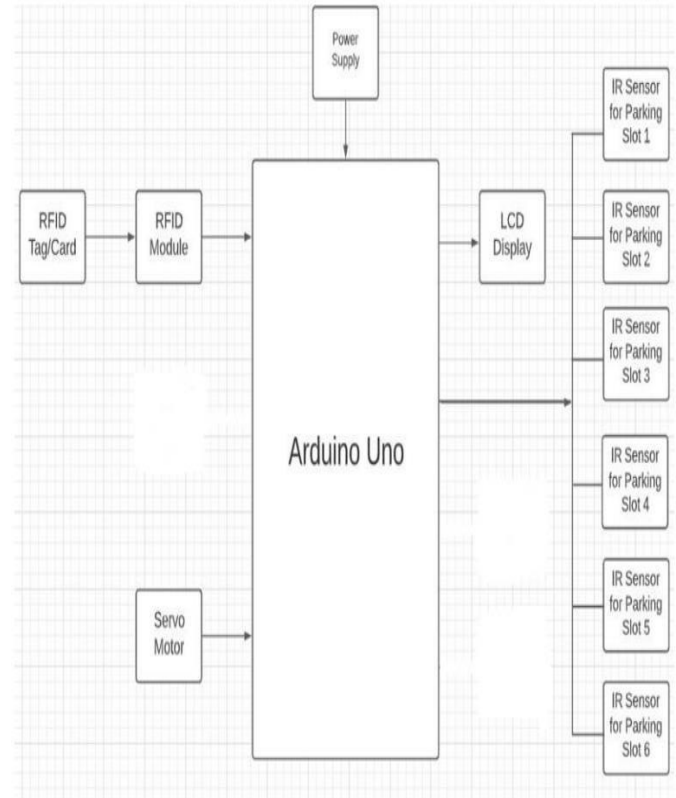
were that all cars need to be rotated to access one car, high initial cost and high maintenance and Complicated Structure.

Robin Grodi, Danda B. Rawat and Fernando Rios-Gutierrez published a paper in 2017^[2] titled 'Smart Parking Occupancy Monitoring and Visualization system for smart cities'. Robin Grodi, Danda B. Rawat and Fernando Rios-Gutierrez had done work on how the vehicle will occupy in the particular allocated place. RFID sensors detected the presence of a vehicle or other objects in the allocated slot. Once a vehicle was detected, the system needed a way to notify drivers or a parking spot being occupied. The disadvantage was that, the parking place would be detected only to the nearby places and there was no GPS sensor to search the parking slots from afar.

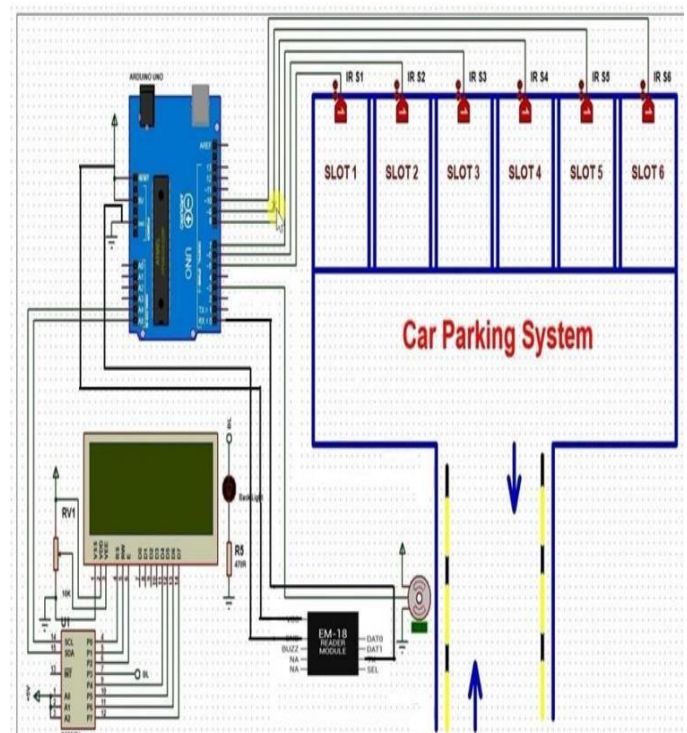
Dharmini Kanteti, D V S Srikar and T K Ramesh published paper titled 'Smart Parking System for Commercial Stretch in Cities' in 2017^[3]. They developed a Smart Parking System. In their model pre-registered IP cameras would capture the vehicle registration number and then they would proceed without interruptions. Their details like parking time estimate, their place of visit etc. would be recorded. For pre-registered users, the amount would be deducted from e-wallet and then the users would be notified. A similar pricing system would be followed for new users but the payment would be offline. The disadvantages were that the system could serve all the parking requests but beyond the number of 80 it couldn't accommodate more cars since the parking became full.

Vijay Paidi, Hasan Fleyeh, Johan Håkansson and Roger G. Nyberg presented a paper in 2018^[4] titled 'Smart parking sensors, technologies and applications for open parking lots'. The authors in the paper suggested smart parking sensors, technologies, and applications for open parking lots. This study proposed a mixture of machine vision, convolutional neural networks & multi-agent systems suitable for open parking lots because of less expenditure and resistance to varied environmental conditions. As reservation is not possible in an open parking lot, it becomes difficult to facilitate the driver in the decision-making process of choosing a parking lot.

Block Diagram of the designed Smart Parking System



Circuit Diagram of the designed Smart Parking System



WORKING OF THE SYSTEM

The circuit diagram above shows the design of an RFID based smart car parking system using Arduino Uno, in which only authorized personal with valid RFID card will have access to the Parking Lot. When the circuit is switched ON, information about the availability of slots is

displayed on the LCD display. If the card number is matched with saved number in the database, the Arduino will allow the car to park in the secured area. With the help of IR sensors placed in each slot the information about the occupancy of slots is displayed on the LCD display. A welcome message with the name of the card holder is also displayed on the LCD display. As the car enters, information about the free slots i.e., the free slot number is displayed on the LCD display. As the car exits the parking lot, there would be another RFID reader and the exit gate, to prevent multiple entries using a single card. This also prevents the entry of vehicles from the exit side. As the car leaves the parking lot through the exit, the number of available slots is updated and it displays the same on the LCD display.

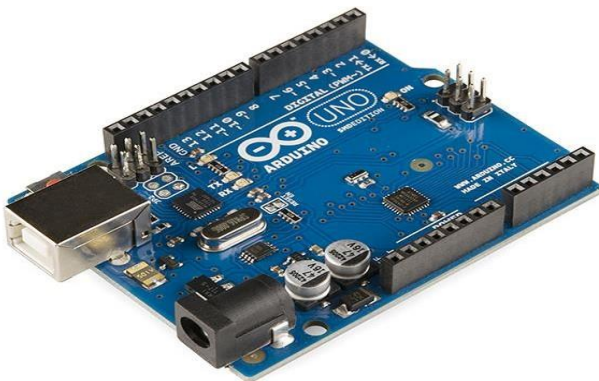
COMPONENT SPECIFICATIONS

1. Arduino Uno

Arduino UNO is a low-cost, flexible, and easy-to-use programmable open-source microcontroller board that can be integrated into a variety of electronic projects. Arduino UNO features AVR microcontroller Atmega328, 6 analog input pins, and 14 digital I/O pins out of which 6 are used as PWM output. This board contains a USB interface i.e., USB cable is used to connect the board with the computer and Arduino IDE (Integrated Development Environment) software is used to program the board.

Technical Specifications:

- Microcontroller: ATmega328P
- Operating Voltage: 5V
- Input Voltage (recommended): 7-12V
- Input Voltage (limits): 6-20V
- Digital I/O Pins: 24 (of which 6 can provide PWM output)
- Analog Input Pins: 6
- Flash Memory: 32 KB of which 2 KB used by bootloader
- SRAM: 2 KB
- EEPROM: 1 KB
- Clock Speed: 16 MHz



2. RFID Module

RFID or Radio Frequency Identification system

consists of two main components, a transponder/tag attached to an object to be identified, and a transceiver also known as interrogator/reader. A reader consists of a Radio Frequency module and an antenna which generates high frequency electromagnetic field. The powered chip inside the tag then responds by sending its stored information back to the reader in the form of another radio signal. This is called backscatter.

Technical Specifications

- Brand: EM18
- Operating frequency: 125KHz RFID module
- Operating voltage: 4.5V to 5.5V
- Current Consumption: 50mA
- Operating Temperature: 0 °C to +80 °C
- Range: Up to 5cm



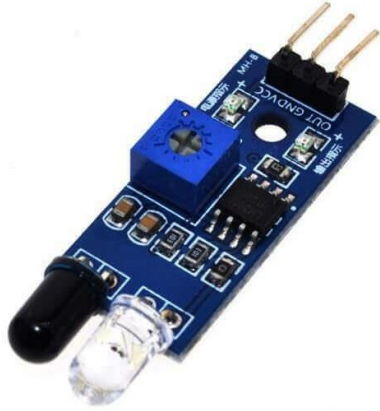
3. IR Sensors

An infrared sensor is an electronic device, that emits in order to sense some aspects of the surroundings. An IR sensor can measure the heat of an object as well as detects the motion. These types of sensors measure only infrared radiation, rather than emitting it that is called a passive IR sensor. The emitter is simply an IR LED (Light Emitting Diode) and the detector is simply an IR photodiode that is sensitive to IR light of the same wavelength as that 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.

Technical Specifications

- 5V DC Operating voltage
- I/O pins are 5V and 3.3V compliant
- Range: Up to 5cm

- Dimensions: 48 x 14 x 8 mm
- Built-in Ambient Light Sensor
- 20mA supply current



4. Servo Motors

A servo motor is a type of motor that can rotate with great precision. Normally this type of motor consists of a control circuit that provides feedback on the current position of the motor shaft, this feedback allows the servo motors to rotate with great precision. If you want to rotate an object at some specific angles or distance, then you use a servo motor. It is just made up of a simple motor which runs through a servo mechanism. Servo motor works on PWM (Pulse width modulation) principle, means its angle of rotation is controlled by the duration of applied pulse to its Control PIN. Basically, servo motor is made up of DC motor which is controlled by a variable resistor (potentiometer) and some gears.

Technical Specifications

- Operating Voltage is +5V typically
- Torque: 2.5kg/cm
- Operating speed: 0.1s/60°
- Gear Type: Plastic
- Rotation: 0°-180°
- Weight of motor: 9gm



5. LCD Display

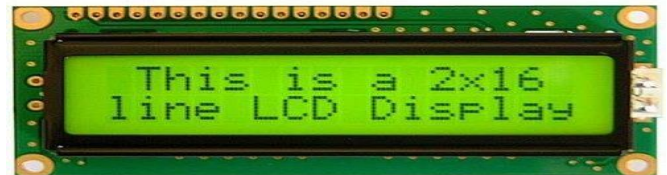
An electronic device that is used to display data and the message is known as LCD 16x2 display. As the name suggests, it includes 16 Columns &

2 Rows so it can display 32 characters

(16x2=32) in total & every character will be made with 5x8 (40) Pixel Dots. The 16 x 2 intelligent alphanumeric dot matrix display is capable of displaying 224 different characters and symbols. The basic working principle of LCD is passing the light from layer to layer through modules. These modules will vibrate & line up their position on 90° that permits the polarized sheet to allow the light to pass through it.

Technical specifications

- Operating Voltage is 4.7V to 5.3V.
- Current consumption is 1mA without backlight.
- Alphanumeric LCD display module, meaning can display alphabets and numbers.
- Consists of two rows and each row can print 16 characters.
- Each character is built by a 5x8 pixel box
- Font size of character is 0.125 width x 0.200 height LED colour for backlight is green or blue.



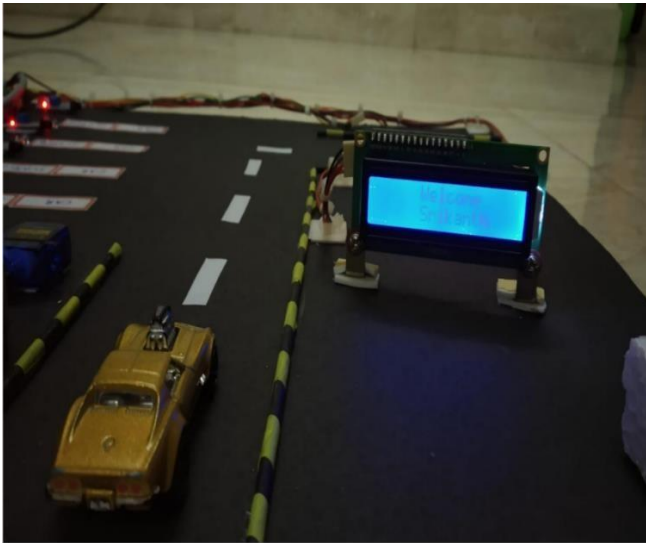
RESULTS

1. Parking is not available:



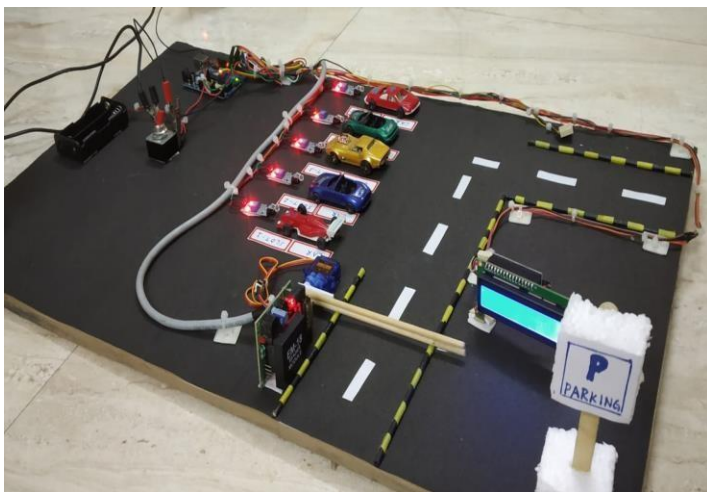
When all the available parking slots are occupied, the LCD displays a message such as 'Slots Full' along with the name of the card owner. The gate of the parking lot does not open.

2. Parking is available



When a vehicle with authorized car (here for example: Srikanth) wants to enter and park in the parking lot, the RFID reader reads the tag on the vehicle and displays the message on the LCD "Welcome Srikanth". After this Srikanth will get to see the available slots in the parking lot. He can choose any available empty slot to park his car.

Smart Parking System Prototype



CONCLUSION

This project has basically addressed the problems of efficient streamlined management of parking spaces. This system displays a welcome message and provides information about the availability of parking space. By using of this system, there would be a significant reduction of the cost incurred to hire personnel in order to control the traffic in the parking lot and traffic congestion problem will be solved by faster check in and check out. A successful implementation of this project would result in less traffic and chaos in crowded parking spaces like in malls and business buildings where many people share a parking space. As the Smart Car Parking System Requires

minimal manpower, there are minimum chances for human error, increased security in addition to a swift and friendly car parking experience for drivers. Developing a smart parking solution in various buildings within a city would also solve the problem of air pollution by vehicles.

FUTURE SCOPE

The future of smart parking system is expected to be significantly influenced by the arrival of automated vehicles (AVs). Several cities around the world are already beginning to trial self-parking vehicles, specialized AV parking lots, and robotic parking valets. The automated parking fee system would allow people to travel without cash. Also, as it would reduce the waiting time, long queues, tension, stress and increase the efficiency of the parking system. The smart parking management system can be applied for plane, ship and fleet management. For residential and domestic parking system the device can be interfaced with Home Automations which can control the various home appliances by sensing whether the user is arriving or departing from the parking space.

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