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Intelligence Parking Management System for Commercial Places

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ABSTRACT

The proposed project introduces an IoT-based Smart Parking System designed to alleviate parking congestion and enhance user experience in urban areas. Leveraging advanced technologies such as RC522 RFID for authentication and billing, IR sensors for slot detection, a WIFI module for cloud connectivity to platforms like ThingSpeak, servo motors for entry/exit gates, and an LCD display for real-time parking space information, the system provides an efficient and user-friendly solution to manage parking spaces effectively. Upon entry, users authenticate themselves using RFID cards or tags via the RC522 RFID module, which logs their entry time for billing purposes. The system employs IR sensors to detect available parking slots, updating the status in real-time on an LCD display and sending the information to an IoT cloud platform like ThingSpeak via the WIFI module. This enables users to access real-time parking availability information through a mobile application, facilitating informed decision-making and minimizing the time spent searching for parking spots. Further more, the system ensures seamless exit procedures through servo motors-controlled entry/exit gates, allowing authorized vehicles to exit after payment verification. Billing is calculated based on the parking duration, providing a fair and transparent payment mechanism. By integrating IoT technology, the Smart Parking System optimizes parking space utilization, reduces traffic congestion, enhances user convenience, and promotes efficient urban mobility.

Keywords: Arduino, Servo Motor Sg90, LCD Display, Node MCU, IR Proximity sensor, Buzzer

1.INTRODUCTION

Urbanization and population growth have led to an increase in vehicular traffic, resulting in parking congestion and inefficiencies in urban areas. Finding parking spaces in crowded cities hasbecome a daunting task for drivers, leading to traffic congestion, environmental pollution, and frustration among commuters[1]. To address these challenges, the introduction of an IoT-based Smart Parking System offers a promising solution to optimize parking space utilization, enhance user experience, and alleviate urban traffic congestion [2]. The Smart Parking System

leverages Internet of Things (IoT) technology to provide real-time monitoring and management of parking spaces [3]. By integrating advanced sensors, RFID authentication, cloud connectivity, and mobile applications, the system offers a comprehensive solution to streamline the parking process [4]. Users can conveniently locate available parking spaces, make reservations, and pay for parking using their mobile devices, reducing the time and effort spent searching for parking spots [5]. This project aims to introduce an innovative Smart Parking System that not only improves parking space management but also promotes sustainability, efficiency, and convenience in urban mobility. By harnessing the power of IoT technology, the Smart Parking System contributes to creating smarter and more liveable cities while addressing the pressing challenges of parking congestion and traffic management [6].

2. LITERATURE SURVEY

Almagambetov. A, Velipasalar. S, and Casares.An important aspect of collision avoidance and driver assistance systems, as well as autonomous vehicles, is the tracking of vehicle taillights and the detection of alert signals (turns andbrakes). In this paper, we present the design and implementation of a robust and computationally lightweight algorithm for a real-time vision system, capable of detecting and tracking vehicle taillights, recognizing common alert signals using a vehicle- mounted embedded smart camera, and counting the cars passing on both sides of the vehicle. The system is low-power and processes scenes entirely on the microprocessor of an embedded smartcamera

Jung. H.G, Cho. Y.H, Yoon. P.J, and Kim. Recently, customers have shown a growing interest in parking aid products. A parking aid system consists of target position designation, path planning, and parking guidance by user interface or path tracking by active steering. For target position designation, various sensors and signal processing technologies have been tried. In the case of parallel parking, an ultrasonic sensor-based method plays a dominant role. In the case of perpendicular parking, a graphical user interface (GUI)-based method and a parking slot marking-based method have been commercialized. However, methods developed for the recognition of free parking space between vehicles have their respective drawbacks. This paper proposes a method for the recognition of free parking space between vehicles using scanning laser radar. This proposed method consists of range data preprocessing, corner detection, and target parking position designation.The authors developed a novel corner-detection method consisting of rectangular corner detection and round corner detection. The newly developed corner detection is unaffected by cluster orientation and the range data interval and is robust to noise. Experimental results showed that even in situations where other methods failed, the proposed scanning laser radar-based method could designate target parking position to viable free parking space. The recognition rate was 98.21%,and the average processing time was about 600 ms. Finally, it is argued that the proposed method will eventually be a practical solution because of the decreasing price of scanning laser radar and multiple-function integration strategies.

Kaempchen.N, Franke U, and Ott R, The ability of generating and interpreting a three-dimensional representation of the environment in real-time is one of the key technologies for autonomous vehicles. While active sensors like ultrasounds have been commercially used, their cost and precision is not favourable. On the other hand, integrating passive sensors, like video cameras, in modern vehicles is quite appealing especially because of their low cost. However, image processing requires reliable real- time algorithms to retrieve depth from visual information. In addition, the limited processing power in automobiles and other mobile platforms makes this problem even more challenging. In this paper we introduce a parking assistance system which relies on dense motion-stereo to compute depth maps of the observed environment in real- time. The flexibility and robustness of our method is showcased with different applications: automatic parking slot detection, a collision warning for the pivoting ranges of the doors and an image-based rendering technique to visualize the environment around the host vehicle. We evaluate the accuracy and reliability of our system and provide quantitative and qualitative results. A comparison to ultrasound and feature-based motion-stereo solutions shows that our approach is more reliable.

Sumalee, H.W. Emerging technologies toward a connected vehicle-infrastructure-pedestrian environment and big data have made it easier and

cheaper to collect, store, analyse, use, and disseminate multi-source data. The connected environment also introduces new approaches to flexible control and management of transportation systems in real time to improve overall system performance. Given the benefits of a connected environment, it is crucial that we understand how the current intelligent transportation system could be adapted to the connected environment.

3. PROPOSED METHODOLOGY

The proposed Smart Parking System is designed to address the limitations of existing parking management methods by leveraging IoT technology, real-time data analytics, and user-friendly interfaces to optimize parking space utilization and enhance the overall parking experience for users. The system consists of several key components and functionalities:

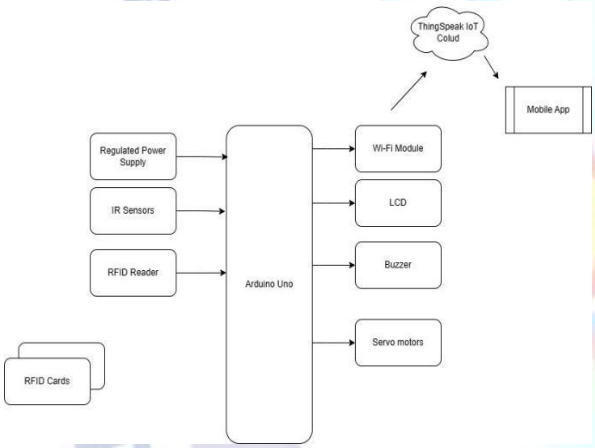

Figure 1: Block Diagram

HARDWARE COMPONENTS

Here, in this project we are using the following components to get desired output:

Figure 2: Hardware Kit

ARDUINO UNO:

The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega8U2 programmed as a USB-to-serial converter. "Uno" means one in Italian and is named to mark the upcoming release of Arduino 1.0. The Uno and version 1.0 will be the reference versions of Arduino, moving forward. The Uno is the latest in a series of USB Arduino boards, and the reference model for the Arduino platform;

Figure 3:Arduino UNO

TABLE 1:Technical specifications of Arduino:

COMPONENTS	RANGE
Microcontroller	ATmega328
Input Voltage (recommended)	7-12V
Input Voltage (Limits)	6-20V
Digital I/O Pins 14	Which 6 provide PWM output
Analog Input Pins	6
DC Current per I/O Pin	40mA
DC Current for 3.3V Pin	50mA
Flash Memory	32 KB
Boot loader	0.5 KB
SRAM	2 KB
EEPROM	1 KB
Clock Speed	16 MHz

LCD 16×2:

The term LCD stands for liquid crystal display. It is one kind of electronic display module used in an extensive range of applications like various circuits & devices like mobile phones, calculators, computers, TV sets, etc.

These displays are mainly preferred for multi-segment light-emitting diodes and seven segments. The main benefits of using this module are inexpensive; simply programmable, animations, and there are no limitations for displaying custom characters, special and even animations, etc.

Figure 4:LCD 16×2

BUZZER:

An audio signaling device like a beeper or buzzer may be electromechanical or piezoelectric or mechanical type. The main function of this is to convert the signal from audio to sound. Generally, it is powered through DC voltage and used in timers, alarm devices, printers, alarms, computers, etc. Based on the various designs, it can generate different sounds like alarm, music, bell & siren.

Figure 5:Buzzer

SERVO MOTOR SG90:

A Servo motor is a type of motor that is powered by a DC source, either from an external supply or by a controller. A small and lightweight servo motor with high output power is called a micro servo motor sg90. This means that the sg90 micro servo motorwill only work as hard as is required to complete the task at hand. A wide range of applications

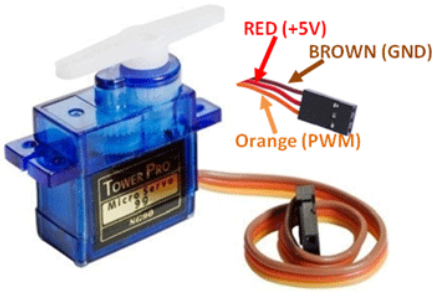

Figure 6:Servo Motor SG90

RC522 RFID module:

The RC522 is a MHz RFID module that is based on the MFRC522 controller from NXP semiconductors. The module can supports I2C, SPI and UART and normally is shipped with a RFID card and key fob. It is commonly used in attendance systems and other person/object identification applications.

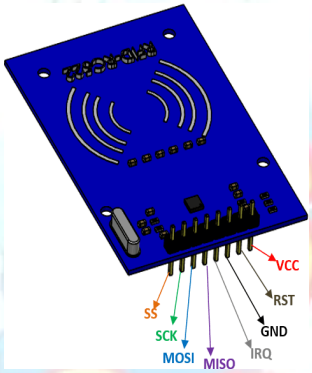

Figure7:RC522 RFID module

NODEMCU ESP8266:

Node MCU is an open-source Lua based firmware and development board specially targeted for IoT based Applications. It includes firmware that runs on the ESP8266 Wi-Fi SoC from Expressive Systems, and hardware which is based on the ESP- 12 module.

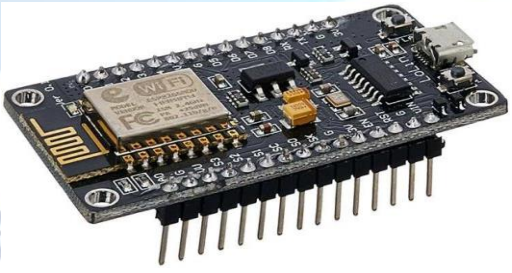

Figure 8: NodeMCU ESP8266

WIFI MODULE:

It is an open-source firmware and development kit that helps you to prototype or build IoT products. It includes the hardware which is based on ESP8266 (NodeMCU) module. Here, it is used as an embedded controller that

is programmed through Arduino, to handle analogue or digital data received from mobile application and to transmit over the Internet. At the same time, it accepts commands from the Web and accordingly actuates connected devices or actuators.

Figure 9: WIFI Module

IR(INFRARED) PROXIMITY SENSOR:

IR proximity sensor, also known as an infrared proximity sensor, is a device that detects the presence or absence of an object within a certain range using infrared light. It emits infrared radiation and measures the reflection or absorption of this radiation to determine the proximity of an object. These sensors are commonly used in various applications such as automatic doors, robotics, security systems, and touchless switches. They are preferred for their accuracy, reliability, and ability to work in different lighting conditions.

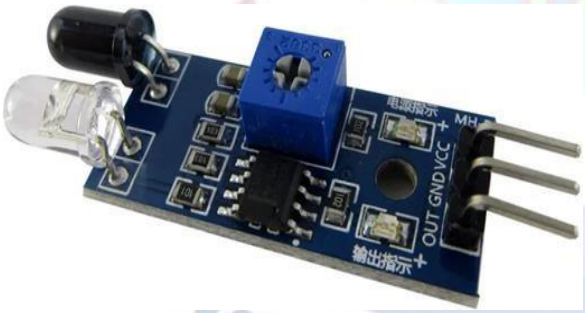

Figure 10: IR (Infrared) Proximity Sensor

4. SOFTWARE DESCRIPTION:

This project is implemented using Arduino IDE. The Arduino Integrated Development Environment - or Arduino Software (IDE) - contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino and Genuino hardware to upload programs and communicate with them.

- Writing programs in Arduino IDE
- Compiling and assembling programs

5. WORKING

There are three parking slots in this project, IR sensor placed at slot-1, 2, and 3 respectively. Servo motor is used to operate the common entry and exit gate. The LCD display is placed near the entry gate. The system used IR sensors detect whether theparking slot is empty or not and IR sensor-1, and 2 for detecting vehicles arriving or not at the gate. In the beginning, when all parking slots are empty,then the LCD display shows all slotsareempty. When a vehicle arrives at the gate of the parking area then the IR sensor-1 detects the vehicle and the system allowed to enter that vehicle by opening the servo barrier. After entering into the parking area when that vehicle occupies a slot thenthe LED display shows that the slot is full. In thisway, this system automatically allows 3 vehicles. In case the parking is full, the system blocked the entrance gate by closing the servo barrier. And the LED display shows that slot-1, 2, and 3, all arefull. When a vehicle leaves a slot and arrives at the gate of the parking area then the IR sensor-2 detectsthat vehicle and the system open the servo barrier. Then the LED display shows that the slot is empty. Again the system will allow entering a new vehicle.

TABLE: Components Specifications

Components	Current rating	Voltagerating	Power rating
Arduino UNO	50 mA	5V	5v
Servo Motor Sg90	100mA	4.8V	1W
LCD	50mA	5V	5W
NodeMCU	70mA	4.5V	0.33W
IR Proximity sensor	20mA	3.5V	0.1W
Buzzer	20mA	5V	0.1W

6. HARDWARE RESULTS

Figure 11:Hardware result

Figure 12:Graphs

Using Thing View's, and the accompanying graph, we can determine how many slots are empty or how many slots are filled is used by the appliances. Here three slots are filled.

7. CONCLUSION

In conclusion, the Smart Parking System offers a comprehensive solution to address the challenges associated with parking congestion and inefficiencies in urban areas. By leveraging IoT technology, real-time data analytics, and user- friendly interfaces, the system optimizes parking space utilization, improves traffic flow, and enhances the overall parking experience for users. Through real-time monitoring of parking availability, convenient mobile app access, dynamic pricing models, and automated entry/exit processes, the Smart Parking System streamlines the parking process, reducing search times for drivers and minimizing traffic congestion. Additionally, the system promotes sustainability by minimizing vehicle emissions and fuel consumption, contributing to environmental conservation efforts. he applications of the Smart Parking System span across various sectors, including urban parking management, commercial facilities, corporate parking lots, smart cities initiatives, transportation hubs, and tourist attractions/events. Its versatility and scalability make it suitable for implementation in diverse parking environments, catering to the needs of both users and parking operators.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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