SMART PARKING FOR PARKING SLOT AVAILABILITY

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ABSTRACT

Smart parking is one of the advanced parking management systems that uses Innovative technologies to help drivers to show available parking spaces that are available. It depends on sensors, cameras to monitor parking areas that are available in real time. The main thing for the smart parking is to reduce the time spent for searching the parking slots, decrease the traffic congestion, and provide a smooth and convenient experience for users. By using automation and digital tools, smart parking improves the overall capability of parking spaces in cities, malls, offices, airports, and residential complexes. For proper working, smart parking system using the embedded systems use IR sensors that detect the availability parking spots or slots. These sensors are placed either on the ground or on the top to determine whether the parking spot is unfilled or occupied using the IR sensors. The main advantage of smart parking is its contribution to reduced traffic congestion. When drivers spend less time searching for parking slots, fuel consumption decreases, and emissions are reduced, resulting in improved air quality. The main advantage of smart parking is its contribution to reduced traffic congestion. When drivers spend less time searching for parking slots, fuel consumption decreases, and emissions are reduced, resulting in improved air quality. In the most of the modern cities it is difficult and expensive to create more parking spaces for vehicles since the numbers of vehicles that are running on the road are increasing day by day and the count of the free spaces in the cities are the same. This problem leads to congestion for parking seekers and drivers. To an Embedded System's based framework that targets parking management which is the biggest challenges in smart cities. Some of the advantages are it faces certain challenges. Installing sensors and smart infrastructure requires, high initial investment for the building of the smart parking slot availability system.

Keywords: -Embedded systems, User Identification, Vehicle Parking places, Arduino, IR Sensor, Indian smart parking system

INTRODUCTION

Currently we are using the so many Embedded Systems applications in our day-to-day life and that are blooming tremendously, and there is also a growing trend in so many applications of smart cities which can help in improving to reduce modern or smart cities issues. In Smart City we face so many difficulties while developing, to solve that issues we have to create such system which is combination of the new technologies with low cost and different network combinations of the Internet. One of the major issues that was occurred in the smart city is the Parking of the vehicles in the cities. The project entitled smart parking system is to manage all the parking facilities to a user. The recent growth in economy and due to the availability of low-price cars in the market, every average middle-class individual can afford a car, which is good thing, however the consequences of heavy traffic jams, pollution, less availability of roads and spot to drive the motor car. One of the important concerns, which is to be taken in accounting, is the problem of parking those vehicles. Though, if there is space for parking the vehicle but so much time is squandered in finding that exact parking slot resulting in more fuel intake and not also environment friendly. It will be a great deal if in some way we find out that the parking itself can provide the precise vacant position of a parking slot then it'll be helpful not limited to the drivers also for the environment. Initially when the user is about to enter the location the LCD displays the number of empty and filled spots and when the user is with its vehicle near to the parking detect sensor where they should park their vehicle.

RELATED WORK

The main important benefit of a smart parking system is its advanced technology. It follows the latest technologies and concepts to assure profitable outcomes. The design and implementation of smart parking is very easy to supervise and manage. This system can be easily handled by the staff members because of its well-organized structure.

At present some countries have portals which users can gain information about parking areas via the internet. This system can give users the information about parking space, but it won't be able to give which parking slot is vacant and occupied. Hence, such a system cannot smartly handle the issue. Car lifts along with an automated robotic system, which automatically takes the car to a particular parking spot as soon

as the car enters on a platform. This system cannot be installed by medium scale shopping malls, movie theatres as it can cost them a huge amount. At many public places, the system only shows the availability but it cannot show the exact slot and path to the slot available. Hence, there is the need to smartly find the path to the vacant spot. A smart parking system using IR sensors and LED is a simple project that helps detect the availability of parking slots and display the status using LEDs and an LCD screen. This system is commonly used in model parking lots and small prototypes. The setup uses IR sensors to detect cars in parking slots, LEDs to indicate availability, and an Arduino Uno to process sensor data and show results on the LCD display. The idea behind our methodology is very simple, usually users spend most of their time in looking for an empty slot where they can park their vehicle which increases fuel consumption and time wastage. We came-up with a new method where we provide the user an empty slot number where he can park his vehicle without wasting his time for finding one. Similarly, we try to display the start time and end time so that the user can know for what amount of time he has parked his vehicle.

LITERATURE SURVEY

India is getting motorized i.e. the rate of private vehicles is more as compared to public transports. As the rate of people owning their vehicles increases, the need of parking slots to park vehicles also increases. But currently the scenario is that there are not sufficient parking slots available or there is also possibility that people are not now aware about the legal parking slots available in their locality. This situation leads to the unnecessary crowding of vehicles on the road and also results in inconveniency of people walking on the road. To overcome above problems, We are proposing the solution in the form of a multilingual android application which will be helpful for the people to find their parking slots digitally. By digitally we mean that this particular system will assign the parking slot based on the current location of the user and the parking slot which the user wants according to his/her ease. Ease in terms of finding the exact slot. The payments can be done digitally or through vending machines. The end user can register and login with his/her account which will help the system to find the location and displaying the nearest parking area and nearest parking slot, whether it is available or not. If not then it will direct user to the next nearest slot and so on. The existing system comprises of both traditional and application-based approach for parking. If we talk about the traditional approach, it utilizes manual method of

parking i.e. user has to find the spot for parking by traveling to far distances and paying extra money. An application-based approach consists of the applications which provides the parking slots for the particular locality for example. The application named 'Parking Panda' provides the parking slots to the areas like stadium, sports leagues etc. Transportation is the key-success for any of the country. Now a day, many people have options to use their own vehicle for travelling. This will surely increase the demand in trading but one of the problems created by road traffic is "parking". To park all these vehicles in the major metro cities is quite tedious and difficult task and it became problematic to park vehicles. Lot of research and development is being done all over the world to implement better and smarter parking management mechanisms. The current smart parking systems or Wireless Sensors Network Parking requires the combination of wireless sensor networks module, Embedded web-server, Central Web-Server. Sensor networks make use of Infrared (IR) Sensor nodes to check the parking slot state and send this information to embedded web-server. It thereby displays the information on a LED screen with which the user can check for empty vehicle slots. These systems not guide the users to reach to the parking lot. If the slot is not available at that time than drivers will start searching for another parking zone so that this process is time consuming and will increase the traffic congestion. cThis paper proposes a Reservation-based Smart Parking System for avoiding the traffic problems that provides the pre- booking of slots through the use of the mobile application. This application is expected to provide an efficient and cost- effective solution to the vehicle parking problems. Application must be installed in the user's mobile. Unlike the existing system, our idea is to use client-server architecture where client request for the reservation of slots and server responds with the slots which are available at that time. Our system is that the user has an option to go for the parking area according to his/her convenience. The advantage of this will greatly reduce the time taken by the vehicle to search for a parking area. Advanced payment modules are also included like e- wallet, debit card, credit card from which the user can pay. Penalty will be added on late exit as well as an over use of the slot after user specified entry and exit time. The refund will be given on cancelation of parking slot and early exit. The supervisor is required to monitor the area.

EXISTING SYSTEM

An Existing System utilizes RFID tags and manual labour combined technology with

human assistance to optimize parking management. Here's how it could work. RFID Tags: Each vehicle is equipped with an RFID tag, which contains unique identification information. RFID Readers/Gateways: At the entrance and exit points of the parking IOT, RFID readers or gateways are installed. These devices can read the tags on vehicles as they enter and exit the parking area. Database Management System: A database is used to store information about the RFID tags, including vehicle details, entry and exit times, and parking space availability. Automated Entry/Exit: When a vehicle with an RFID tag approaches the entrance, the RFID reader scans the tag and checks the database for available parking spaces. If there is space available, the gate opens automatically, allowing the vehicle to enter. Similarly, when the vehicle exits, the RFID reader records the exit time and updates the database accordingly. Manual Labor: While the RFID system handles the automated entry and exit process, manual labour can still be utilized for various tasks: Guiding Vehicles: Person can assist in directing vehicles to available parking spaces, especially in crowded or complex parking space. Customer Assistance: Employee can provide assistance to customers who may have questions or issues with the parking system. Maintenance: Manual labour can be employed for routine maintenance task to ensure smooth operation of the parking facility. Monitoring and Management: Managers can use a central monitoring system to oversee the entire parking operation, employee performance.

PROPOSED SYSTEM

The proposed system introduces a smart parking solution that overcomes the limitations of the existing manual parking system by using embedded technology and IR sensors. The main objective of the proposed system is to efficiently monitor parking slot availability and provide real-time information to users, thereby improving parking management and reducing congestion within parking areas.

In this system, each parking slot is equipped with an IR sensor that detects the presence or absence of a vehicle. When a vehicle occupies a parking space, the corresponding sensor detects the change and sends the status to the embedded controller. Similarly, when the vehicle leaves the slot, the sensor updates the status, ensuring accurate and continuous monitoring of all parking spaces. The embedded controller processes the data received from the sensors and displays the parking slot availability information on a display unit such as an LCD. This allows drivers to quickly identify vacant slots without unnecessary searching. The system

operates in real time, making the parking process more organized and user-friendly.

By reducing random vehicle movement inside parking areas, the proposed system helps minimize traffic congestion and improves overall safety. It also contributes to reduced fuel consumption and lower emissions by limiting idle time and repeated circulation of vehicles. The proposed system is cost-effective and suitable for implementation in various environments such as malls, offices, residential complexes, and public parking facilities. Since it focuses on optimizing existing parking infrastructure rather than expanding physical space, it provides an efficient and scalable solution for modern urban parking challenges. In recent years, rapid urban development and the continuous growth in the number of vehicles have created serious challenges in parking management. In most cities, the availability of parking spaces has remained almost constant, while vehicle usage has increased significantly. This imbalance has resulted in traffic congestion, fuel wastage, increased pollution, and frustration among drivers. One of the major reasons for these problems is the lack of an efficient system to manage and monitor parking spaces in real time. The Smart Parking System proposed in this project aims to address these challenges by providing an efficient and reliable parking management solution using embedded systems and IR sensors. The primary objective of the project is to detect the availability of parking slots and present accurate information to users, thereby reducing the time spent searching for parking spaces. By focusing on optimizing the usage of existing parking infrastructure, the system helps improve traffic flow and overall parking efficiency. The proposed system uses IR sensors installed at individual parking slots to detect the presence or absence of vehicles. These sensors continuously monitor the status of each parking space and send real-time data to an embedded controller. The controller processes this data and updates the parking slot status accordingly. The availability information is displayed using an LCD, allowing users to easily identify free and occupied parking spaces. Unlike conventional parking systems, where drivers rely on visual inspection or manual guidance, the smart parking system provides accurate and updated information. This reduces unnecessary vehicle movement within parking areas and prevents congestion caused by random searching. As a result, parking becomes more organized, systematic, and user-friendly. The system is designed to operate efficiently in various environments such as shopping malls, office buildings, airports,

residential complexes, and public parking areas. In these locations, parking demand is usually high, and improper management often leads to delays and congestion. By implementing the proposed system, parking facilities can handle higher vehicle volumes without the need for physical expansion. One of the key advantages of the smart parking system is reduced traffic congestion. When drivers are informed about slot availability in advance, they can directly move toward vacant spaces instead of circulating through the entire parking area. This results in smoother traffic flow and minimizes bottlenecks, especially during peak hours.

The reduction in unnecessary vehicle movement also leads to lower fuel consumption. Vehicles spend less time idling or moving slowly within parking areas, which directly reduces fuel wastage. This contributes to reduced air pollution and improved environmental conditions, particularly in densely populated urban areas. Safety is another important aspect addressed by the proposed system. Reduced congestion and organized vehicle movement help minimize accidents caused by distraction or sudden stops. Clear parking information also improves pedestrian safety within parking premises. Additionally, parking management and security personnel benefit from improved visibility of parking space usage. From a management perspective, the smart parking system allows better monitoring and control of parking areas. Real-time data on parking slot usage helps in understanding parking patterns and identifying areas that require improvement. This information can support future planning and better decision-making related to parking management.

The system is cost-effective as it uses low-cost IR sensors and a simple embedded controller. It focuses on improving efficiency using existing infrastructure rather than relying on expensive construction or expansion of parking facilities. This makes the solution practical and suitable for real-world implementation. The proposed smart parking system also enhances user experience by reducing confusion, stress, and delays associated with traditional parking methods. Drivers can park their vehicles quickly and efficiently, leading to higher satisfaction and improved convenience. In the context of smart cities, efficient parking management plays a crucial role in improving urban mobility. The proposed system supports smarter city development by reducing traffic congestion, lowering pollution levels, and promoting efficient use of resources. It aligns with the goals of sustainable urban development and intelligent transportation systems.

Overall, the Smart Parking System presented in this project provides a reliable, efficient, and scalable solution to modern parking challenges. By integrating embedded systems and IR sensor technology, the project demonstrates a practical approach to improving parking management, traffic flow, environmental sustainability, and user convenience.

The system highlights how simple technological solutions can create a significant positive impact in urban environments.

ARCHITECTURE

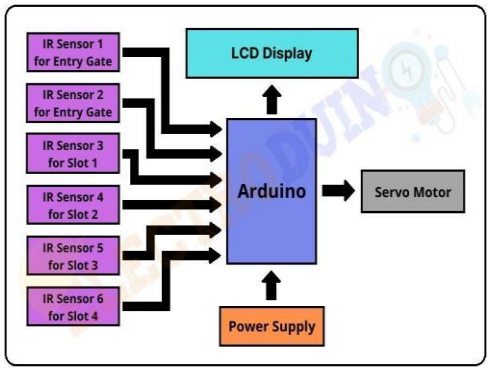

Fig 1: Block Diagram

SOFTWARE AND HARDWARE REQUIREMENTS

Arduino Uno

Fig 2.1: 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 ceramic resonator, 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 Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter. Revision 2 of the Uno board has a resistor pulling the 8U2 HWB line to ground, making it easier to put int Revision 3 of the board has the following new features:

1.0 pinout: added SDA and SCL pins that are near to the AREF pin and two other new pins placed near to the RESET pin, the IOREF that allow the shields to adapt to the voltage provided from the board. In future, shields will be compatible both with the board that use the AVR, which operate with 5V and with the Arduino Due that operate with 3.3V. The second one is a not connected pin, that is reserved for future purposes. "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; for a comparison with previous versions, see

IR SENSOR

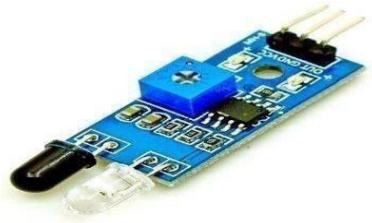

Fig 2.2: IR Sensor

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. Usually, in the infrared spectrum, all the objects radiate some form of thermal radiation. These types of radiations are invisible to our eyes, that can be detected by an infrared 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.

An IR sensor consists of two parts, the emitter circuit and the receiver circuit. This is collectively known as a photo-coupler or an optocoupler. The emitter is an IR LED and the detector is an IR photodiode. The IR photodiode is sensitive to the IR light emitted by an IR LED. The photo-diode's resistance and output voltage change in proportion to the IR light received. This is the underlying working principle of the IR sensor. The type of incidence can be direct incidence or indirect incidence. In direct incidence, the IR LED is placed in front of a photodiode with no obstacle in between. In indirect incidence, both the diodes are placed side by side with an opaque object in front of the sensor. The light from the IR LED hits the opaque surface and reflects back to the photodiode.

SERVO MOTOR

Fig 2.3: Servo Meter

Servo motor works on the PWM (Pulse Width Modulation) principle, which means its angle of rotation, is controlled by the duration of pulse applied to its control PIN. Basically, servo motor is made up of DC motor which is controlled by a variable resistor (potentiometer) and some gears.

Mechanism of servomotor:

Basically, a servo motor is a closed-loop servomechanism that uses position feedback to control its motion and final position. Moreover, the input to its control is a signal (either analogue or digital) representing the position commanded for the output shaft.

The motor incorporates some type of encoder to provide position and speed feedback. In the simplest case, we measure only the position. Then the measured position of the output is compared with the command position, the external input to controller. Now if the output position differs from that of the expected output, an error signal generates. This then causes the motor to rotate in either direction, as per need to bring the output shaft to the appropriate position. As the position approaches, the error signal reduces to zero. Finally, the motor stops.

The very simple servomotors can position only sensing via a potentiometer and bang-bang control of their motor. Further the motor always rotates at full speed. Though this type of servomotor doesn't have many uses in industrial motion control, however it forms the basis of simple and cheap servo used for radio control models.

Servomotors also find uses in optical rotary encoders to measure the speed of output shaft and a variable-speed drive to control the motor speed. Now this, when combined with a PID control algorithm further allows the servomotor to be in its command position more quickly and more precisely with less overshooting

Working of servomotors

Servo motors control position and speed very precisely. Now a potentiometer can sense the mechanical position of the shaft. Hence it couples with the motor shaft through gears. The current position of the shaft is converted into electrical signal by potentiometer, and is compared with the command input signal. In modern servo motors, electronic encoders or sensors sense the position of the shaft

We give command input according to the position of shaft. If the feedback signal differs from the given input, an error signal alerts the user. We amplify this error signal and apply as the input to the motor hence the motor rotates. And when the shaft reaches to the require position error signal become zero, and hence the motor stays standstill holding the position.

The command input is in form of electrical pulses as the actual input to the motor is the difference between feedback signal (current position) and required signal, hence speed of the motor is proportional to the difference between the current position and required position. The amount of power require by the motor is proportional to the distance it needs to travel.

LCD

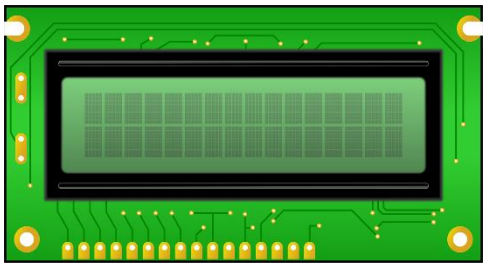

Fig 2.4: LCD

The I2C 1602 LCD module is a 2 line by 16-character display interfaced to an I2C daughter board. The I2C interface only requires 2 data connections, +5 VDC and GND to operate For in depth information on I2C interface and history, visit: http://www.wikipedia/wiki/i2c

Specifications: 2 lines by 16 characters I2C Address Range 0x20 to 0x27 (Default=0x27, addressable) Operating Voltage 5 Vdc Backlight White, Contrast Adjustable by potentiometer on I2c interface, Size 80mm x 36mm x 20 mm Viewable area 66mm x 16mm.

LED

Fig 2.5: LED

A Light Emitting Diode (LED) is a semiconductor device that emits light when an electric current passes through it. Unlike traditional light sources such as incandescent bulbs, LEDs do not rely on heating a filament to produce light. Instead, they operate based on the principle of electroluminescence, where light is generated due to the movement of electrons within a semiconductor material. Because of this working principle, LEDs are highly efficient, consume very low power, and have a long operational life. An LED is made using semiconductor materials such as gallium arsenide, gallium phosphide, or gallium nitride. When a forward voltage is applied across the LED terminals, electrons and holes recombine at the junction, releasing energy in the form of light. The colour of the emitted light depends on the energy band gap of the semiconductor material used. Common LED colours include red, green, yellow, blue, and white. White LEDs are typically created by using a blue LED coated with a phosphor material. One of the major advantages of LEDs is their low power consumption. LEDs require very small current and voltage to operate, making them ideal for embedded systems and battery-operated applications. Due to their energy efficiency, LEDs generate very little heat compared to conventional lighting devices. This not only improves safety but also increases the overall reliability of electronic systems.

LEDs are widely used as indicators in electronic circuits because of their fast response time and clear visibility. They turn on instantly without any warm-up time and can switch on and off at very high speeds. This makes them suitable for signalling and status indication applications. In embedded systems, LEDs are often used to represent system states such as power ON, fault conditions, or operational status. In the context of the smart parking system, LEDs play an important role in indicating the availability of parking slots. Different coloured LEDs can be used to represent vacant and occupied parking spaces. For example, a green LED may indicate an available slot, while a red LED may show that the slot is occupied. This visual indication helps drivers quickly identify parking status, reducing confusion and improving parking efficiency.

CONCLUSION

The concept of Smart Cities has always been a dream for humanity. Since the past couple of years ago large advancements have been made in making smart cities a reality. The growth of Internet of Things and Cloud technologies have given rise to new possibilities in terms of smart cities. Smart parking facilities and traffic management systems have always been at the core of constructing smart cities. In this project, we address the issue of parking and present an IoT based Cloud integrated smart parking system. The system that we propose provides real time information regarding availability of parking slots in a parking area. Users from remote locations can able to know about the parking slots in different areas. The efforts made in this project are intended to improve the parking facilities of a city and thereby aiming to enhance the quality of life of its people.

FEATURE SCOPE

Addition of RFID or License Plate Recognition for Vehicle Logging As a future enhancement, the smart parking system can be extended by integrating vehicle identification technologies such as Radio Frequency Identification (RFID) or License Plate Recognition (LPR). These technologies can be used to automatically log vehicles entering and exiting the parking facility, further improving parking management and monitoring efficiency. In an RFID-based approach, each vehicle can be equipped with a passive RFID tag, while an RFID reader is installed at the entry and exit points of the parking area. When a vehicle passes through these points, the reader detects the unique identification number of the RFID tag and records the vehicle's entry or exit time. This information can be stored in a database for monitoring and analysis purposes. RFID-based logging is reliable, fast, and suitable

for controlled environments such as residential complexes and office parking areas.

License Plate Recognition is another advanced option that uses cameras and image processing techniques to identify vehicle number plates automatically. Cameras installed at the parking entrance capture images of vehicles, and software algorithms extract the license plate information. This method eliminates the need for physical tags and can work effectively in public parking areas. LPR can assist in tracking vehicle movement, detecting unauthorized vehicles, and enhancing security within parking facilities. Integrating RFID or LPR with the existing smart parking system allows detailed logging of vehicle activity. Combined with real-time parking slot detection using IR sensors, this feature provides a comprehensive parking management solution. Parking administrators can maintain accurate vehicle records, analyze parking usage patterns, and improve security monitoring.

These technologies also support better traffic organization within parking areas by reducing manual checks and improving entry and exit flow. Although RFID and LPR require additional hardware and initial investment, they significantly enhance system capability and reliability. Overall, the addition of RFID or license plate recognition as a future feature expands the scope of the smart parking system, making it more intelligent, secure, and suitable for large-scale smart city applications.

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