International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 05 Issue: 04 | Apr-2018 www.irjet.net p-ISSN: 2395-0072

RFID Based Automatic Parking Control and Toll Collection

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Abstract - *Nowadays it is seen that as the population across the country is increasing and people are finding very much difficulties in finding a parking space, as the number of vehicles entering the roads are increasing. Also there is a problem like lack of sufficient space for parking. The drivers are wasting a lot of time for parking. So parking has become a great problem in the country. So we propose a system which will enable booking of parking slots and speedy operations at the collection gate. Our system also automates the toll collection at toll booths and reduces long queues thus reducing traffic blocks. Any customer can book a slot in the parking space with his unique RFID number and use the tag in the entrance where the money will be automatically deducted from the linked bank account. Other customers (not booked) can also see the number of vacant spaces from a display board just outside the parking area. The toll collection centers will have a separate lane for vehicles with RFID tags. The money is automatically deducted from a bank account linked to that RFID number*.

Key Words: **RFID module, Servomotor, GSM module, , Gas detection**

1. INTRODUCTION

Enabling a sustainable urban mobility is one of the most challenging goals of the smart cities vision, and in such context, the optimal management of parking areas represents a key aspect. The proper operation of these systems heavily depends on their ability to automatically detect the presence of vehicles in the parking spaces. This problem is solved by expensive wireless/wired systems. It is estimated that 30% of the daily traffic congestion in urban areas is caused by vehicles cruising for parking spaces, and that a driver spends an average of 7.8 min to find a vacant parking spot. It causes waste of time and fuel for drivers looking for parking, but also increases air pollution and drivers frustration.

To improve parking efficiency and achieve higher levels of customer satisfaction, the adoption of intelligent parking systems is advocated. They are able to guide the drivers towards the nearest vacant parking spots either by using informative display panels located throughout the parking areas, or by means of customized smartphone applications. If the parking slot availability is known in advance one can save precious time and fuel wastage.

This system proposes an RFID based parking slot allocation system where an intended user can be booked early for a particular parking location by a Short Messaging Service. RFID is a technology that helps to identify the animate or inanimate through radio waves. RFID is one of the most fundamental technologies that enables wireless data transmission. Although it has been known for a long time, has not been very often used in industry. Because it was expensive and there was no standardization among the manufacturing companies. It took a long time to be widely utilized. Proposed system can reduce the construction and management overhead of a manual parking management system.

The intentions of the utilization of the RFID technology have been encouraged by the use of RFID technology, manually achieved workloads will be decreased considerably. RFID technology is universal, useful and efficient. This technology is much more secure compared to other networks. It plays an important role as an inventory tracking technology. RFID technology is an efficient vehicle identification system that is useful and requires no personnel.

Vehicles are identified and parking-lot fees are collected automatically via this system. RFID system enables vehicles to check-in and check-out under fast, secure and convenient conditions. RFID readers control check-in and check-out barriers. RFID is a technology that collects parking fees without having to stop vehicles.

2. PRINCIPLE OF RFID

Principle of RFID is continuously emitting radio frequency signals by reader. When RFID tag entered the sensing range, it can generate an induced current to obtain required power and can respond to sensor. Take passive tag for example, before entering the sensing rage of sensor, tag is completely static. When tag entered the sensing range, it turns to be activated. The SOP is the sensor which emits radio frequency electromagnetic waves to eTag, and then eTag responses messages to sensor. The radio frequency of RFID includes low-frequency (125-135 kHz), high-frequency (13.56 MHz), ultra-high-frequency (UHF) (860-930 MHz) and microwave (2.45 GHz), etc. Different types of applications derive from different characteristics of frequencies. In high-frequency and ultra-high-frequency read distance of RFID are about 1 meter and 1.5 meters. For faster reading from objects moving in high speed and for longer reading distance, RFID technique should be implemented by UHF. Hence, eTag specification has used the frequency 902-928 MHz.

Basically an RFID system consists of three components - an antenna or coil, a transceiver with decoder and a transponder (RF Tag) electronically programmed with

unique information. There are many different types of RFID system in the market .These are categorized on the basis of their frequency ranges. Some of the most commonly used RFID kits are low frequency (30 -500 kHz) , mid frequency (900 kHz-1500MHz) and high frequency(2.4-2.5GHz) .An RFID reader is a device that is used to interrogate an RFID Tag. The reader has an antenna that emits radio waves. The Tag responds by sending back its data.

An RFID tag is a microchip combined with an antenna in a compact package. The packaging is structured to allow the RFID tag to be attached to an object to be tracked. The tags antenna picks up signals from an RFID reader or scanner and then returns the signal , usually with some additional data (like a unique serial number or other customized information) A passive tag is an RFID tag that does not contain a battery .The power is supplied by the reader. When radio waves from the reader are encountered by a passive RFID tag, the coiled antenna within the tag forms a magnetic field. The tag draws power from it, energizing the circuits in the tag. The tag then sends the information encoded in the tags memory. The RX and TX pins of RFID reader connected to TX and RX pins of microcontroller respectively. Then the reader senses the data from the tag and transmits the sensed data to microcontroller via serial port.

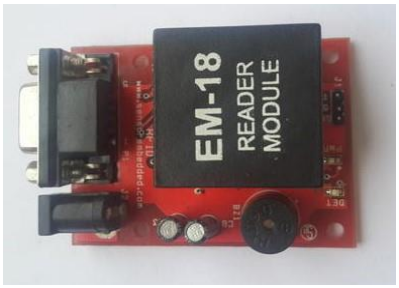

Figure-2:RFID module

3. COMMUNICATION STRATEGY

GSM stands for global system for mobile communication (GSM) that requires a long range communication. It is used for transmitting mobile voice and data services operates at the 850MHz, 900MHz, 1800MHz and 1900MHz frequency bands. GSM system was developed as a digital system using time division multiple access (TDMA) technique for com munication purpose. A GSM digitizes and reduces the data, then sends it down through a channel with two die rent streams of client data, each in its own particular time slot. The digital system has an ability to carry 64 kbps to 120 Mbps of data rates.

GSM modem is a highly flexible plug and play GSM 300 modem for direct and easy integration RS232, voltage range for the power supply and audio interface make this device perfect solution for system integrators and single user. It also comes with license free integrated Python. Python is a powerful easy to learn programming language. Such a Python driven terminal is 5 times better and faster and 5 times cheaper than standard PLC/RTU with communication interface and external GSM / GPRS modem. The GSM Modem supports popular AT command set so that users can develop applications quickly. The product has SIM Card holder to which activated SIM card is inserted for normal use. The power to this unit can be given from UPS to provide uninterrupted operation. This product provides great feasibility for Devices in remote location to stay connected which otherwise would not have been possible where telephone lines do not exist.

Figure- 2: GSM Module

4. GATE CONTROL

Gate control for both parking and toll collection can be done using servomotor. Servo refers to an error sensing feedback control which is used to correct the performance of a system. Servo or RC Servo Motors are DC motors equipped with a servo mechanism for precise control of angular position. The RC servo motors usually have a rotation limit from 90 to 180. Some servos also have rotation limit of 360 or more. But servos do not rotate continually. Their rotation is restricted in between the fixed angles. The servo motor can be moved to a desired angular position by sending PWM (pulse width modulated) signals on the control wire.

The servo understands the language of pulse position modulation. A pulse of width varying from 1 millisecond to 2 milliseconds in a repeated time frame is sent to the servo for around 50 times in a second. The width of the pulse determines the angular position. A servo motor mainly consists of a DC motor, gear system, a position sensor which is mostly a potentiometer, and control electronics. The DC motor is connected with a gear mechanism which provides feedback to a position sensor which is mostly a potentiometer. From the gear box, the output of the motor is delivered via servo spline to the servo arm. The potentiometer changes position corresponding to the current position of the motor. So the change in resistance produces an equivalent change in voltage from the potentiometer. A pulse width modulated signal is fed through the control wire. The pulse width is converted into an equivalent voltage that is compared with that of signal from the potentiometer in an error amplifier. The Servo motors are used for precision positioning. They are used in robotic arms and legs, sensor scanners and in RC toys like RC helicopter, airplanes and cars.

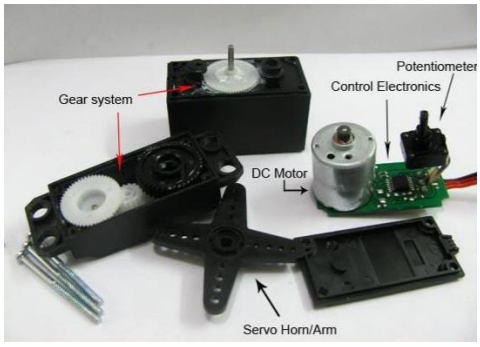

Figure -3: Servomotor

5. GENERAL STURUCTURE AND DESIGN OF THE SYSTEM

In this study, controlling of two parking-lots check-ins and check-outs has been achieved. Arduino UNO is the microcontroller used in the system. The parking efficiency and toll collection can be efficiently managed by using RFID technology. With the use of same RFID tag both car parking and toll collection can be controlled. When a person sends an SMS with his unique RFID number to the specified number of the parking system, a slot is booked in his name. This communication is established using a GSM module. When he comes near the gate, he can access his parking slot by scanning his RFID tag using an RFID module. LCD display will show the number of vacancies and the amount deducted from his account. The opening and closing of gate is controlled using a servomotor. In the toll collection system the RFID module scans the RFID tag and money is instantly deducted from his bank account. The application of RFID technology reduces the artificial identification time and significantly increases the efficiency. Without having to stop vehicles, check-ins and check-outs will be possible. In that way, there won't be any traffic jam problems. As is in the traditional parking lot systems, drivers will not have to take and process parking tickets during check-ins and check-outs. Figure 4 shows the circuit diagram for the system.

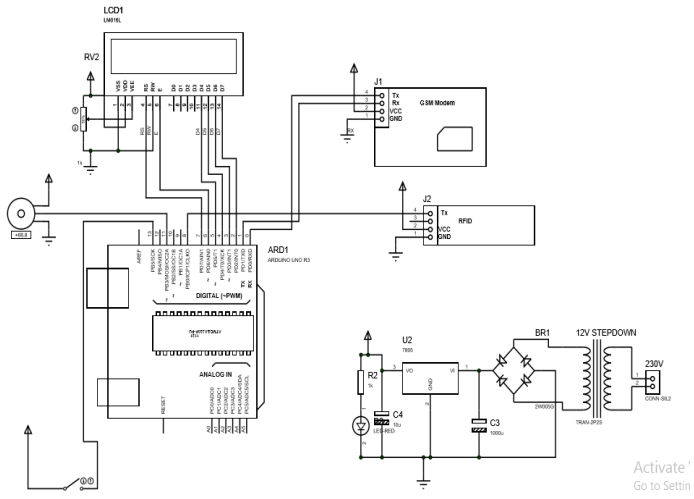

Figure- 4: Circuit Diagram

ATmega328 is the control unit. By using a GSM module and a smartphone a person can prebook a parking slot using the RFID code. When that person comes near the gate, RFID reader scans the tag and then the code is sent to the PB0 pin of the microcontroller. Controller checks whether the code received from GSM and RFID reader is same. If it is same controller makes the pin PB3 high and sent a signal to the servomotor. If a person comes near the gate without booking, controller checks for any free parking slots. If parking slots are available controller opens the gate. Otherwise LCD displays that there is no vacant spaces available. By making the switch high, the whole system works as a parking management system and when it is low, it will be a toll collection system. Figure 5.2 shows the hardware setup of the proposed system.

6. RESULT

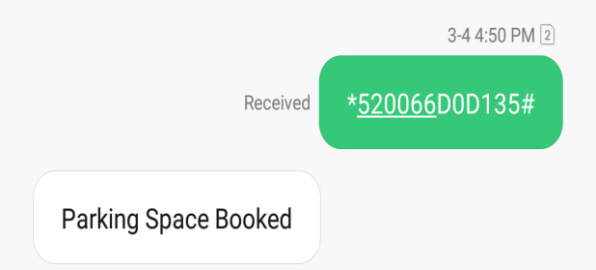

Figure- 5: Booking by a Mobile

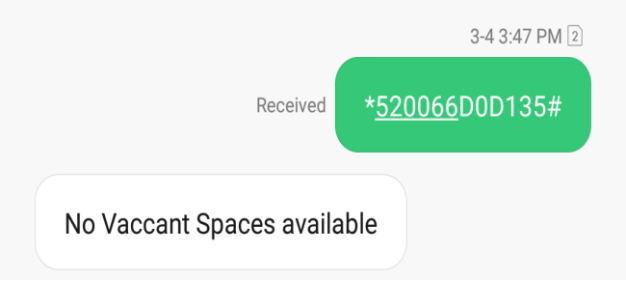

Figure- 6: Message received if there is no vacant slots.

Figure- 7: LCD Display Showing the balance if a person enters the parking slot

Fig-8 shows the hardware setup of the system. The main advantage of the system is that, with the same RFID tag both parking and toll collection can be controlled.

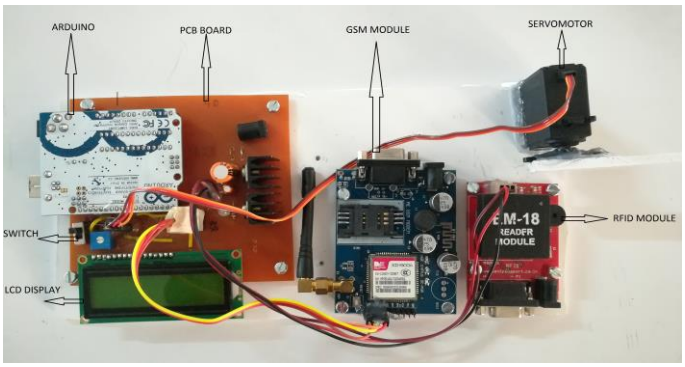

Figure- 8: Experimental Setup

A person books for a parking slot with his unique RFID tag number. If there is any vacant slots, he will receive a message "Parking space booked" in his mobile as it is shown in figure - 5. If there is no parking slots available, then it sends a message to the customer as shown in figure 6. When a person scans his RFID tag, the system checks whether he is booked or not. If he is booked, the gate will open and LCD display will displays as shown in figure 7 and figure 9. In this system there are two slots and if two slots are filled, LCD displays the number of vacant spaces as 2/2. If one of the slots are free, then a person without booking can enter the parking slot with his RFID tag. Customer with low balance is not allowed to the parking slot. LCD displays as in figure 11.

Figure- 9: Number of Vacant Spaces after a customer enters the parking area

Figure- 10: Zero vacant spaces

Figure- 11: Customer with Low Balance

3. CONCLUSION

RFID based automatic parking control and toll collection system is an efficient method to manage parking slots in cities. The proposed systems main contribution is the reduction of the time of entering and finding a parking space. Without having to stop vehicles, check-ins and check-outs will be possible. In that way, there won't be any traffic jam problems. As is in the traditional parking lot systems, drivers will not have to take and process parking tickets during check-ins and check-outs. Moreover there won't be any ticket-jamming problems either. The cost of this project is found to be low and efficient. This will ensure a shorter response time. Vehicle owners will not have to make payments upon every check-out. This will provide a smooth traffic flow within the parking-lot thus preventing the emission of gas. With the same RFID tag the toll collection is also possible. In future, a centralized database system, a remote access and administration of the system is also possible. Over the internet, administrators will be able to view identification and depth information of any vehicle and monitor the efficiency and functionality of RFID-enabled parking-lots.

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