American Journal of Electrical and Electronic Engineering, 2016, Vol. 4, No. 6, 152-156
Available online at http://pubs.sciepub.com/ajeee/4/6/1

DOI:10.12691/ajeee-4-6-1

Principles of Smart Car Parking Management System (With Efficient Corridor Lighting)

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Abstract In this system, a RFID reader is used at the entry point for user authentication. A GSM module is used so that the parking slot no, the duration of parking and the fee deducted from his card is sent to the user when he exits the parking space. The lights in the parking space glow only when the vehicle is present. The system is designed in such a way that when it senses a vehicle, it starts functioning and light turns off when vehicle crosses it. The concept can be used for both basement parking and open parking lots. We have added a feature to the design that the system senses the intensity of light. During the day time, when light intensity is high, the lighting system remains off. It is possible because of the use of various motion sensors like IR Sensor, LDR Sensor, ATmega16 microcontroller and with the help of embedded C. IR Sensor detects the motion of the vehicle and allows the light to glow accordingly. LDR Sensor senses the intensity of light and makes the lights to remain off during the day time. ATmega16 is a powerful microcontroller which is used for interfacing and programming purpose which controls the whole system.

Keywords: *RFID reader, GSM module, IR sensor, LDR sensor, Embedded C, ATmega16 microcontroller*

Cite This Article: Sambandh Bhusan Dhal, Arun Agarwal, and Kabita Agarwal, "Principles of Smart Car Parking Management System (With Efficient Corridor Lighting)." *American Journal of Electrical and Electronic Engineering*, vol. 4, no. 6 (2016): 152-156. doi: 10.12691/ajeee-4-6-1.

1. Introduction

The major liability concerning the current parking system is wastage of manpower and uncontrolled power consumption due to lighting which reduces the efficiency of the system. The problem regarding parking slot allocation and fare issues are rampant in the current system so here, we have tried to devise an automated system. The second major issue is that the lights remain operational throughout the night irrespective of whether any vehicle is present or not. This leads to huge amount of power wastage as the same power could have been utilized for domestic purposes as and when required. The same applies to that of the huge basement parking lots in urban areas. Most of the time, even during daytime, because of low light intensity underground, the lights remain operational round the clockleading to power wastage. We, in our project, have tried to devise an effective lighting system with an aim to minimize power consumption.

2. Paper Overview

2.1. Automated Parking System

In this system, the basic concern is to eliminate the issues regarding parking fare and ambiguity concerning the parking slot. Here, we use a RFID reader which authenticates the driver and the gate opens. A LCD display is used which shows the parking slot which is vacant. The driver, on parking his vehicle, receives a message regarding the parking slot number which is done with the help of a GSM module. On exiting, he again uses his card at the RFID reader present at the exit which deducts the fare from his card and he receives a message regarding the fare deducted.

2.2. Power-efficient

In most of the parking spaces around the world, lights remain on throughout the night even when there is no vehicle parked. Here, we have come up with a design using IR sensors which detects the motion of the vehicles and the LDR sensor which detects the intensity of the light in the parking space. The lights glow only if the vehicle enters the parking space when the intensity of the light is low.

3. Product Architecture

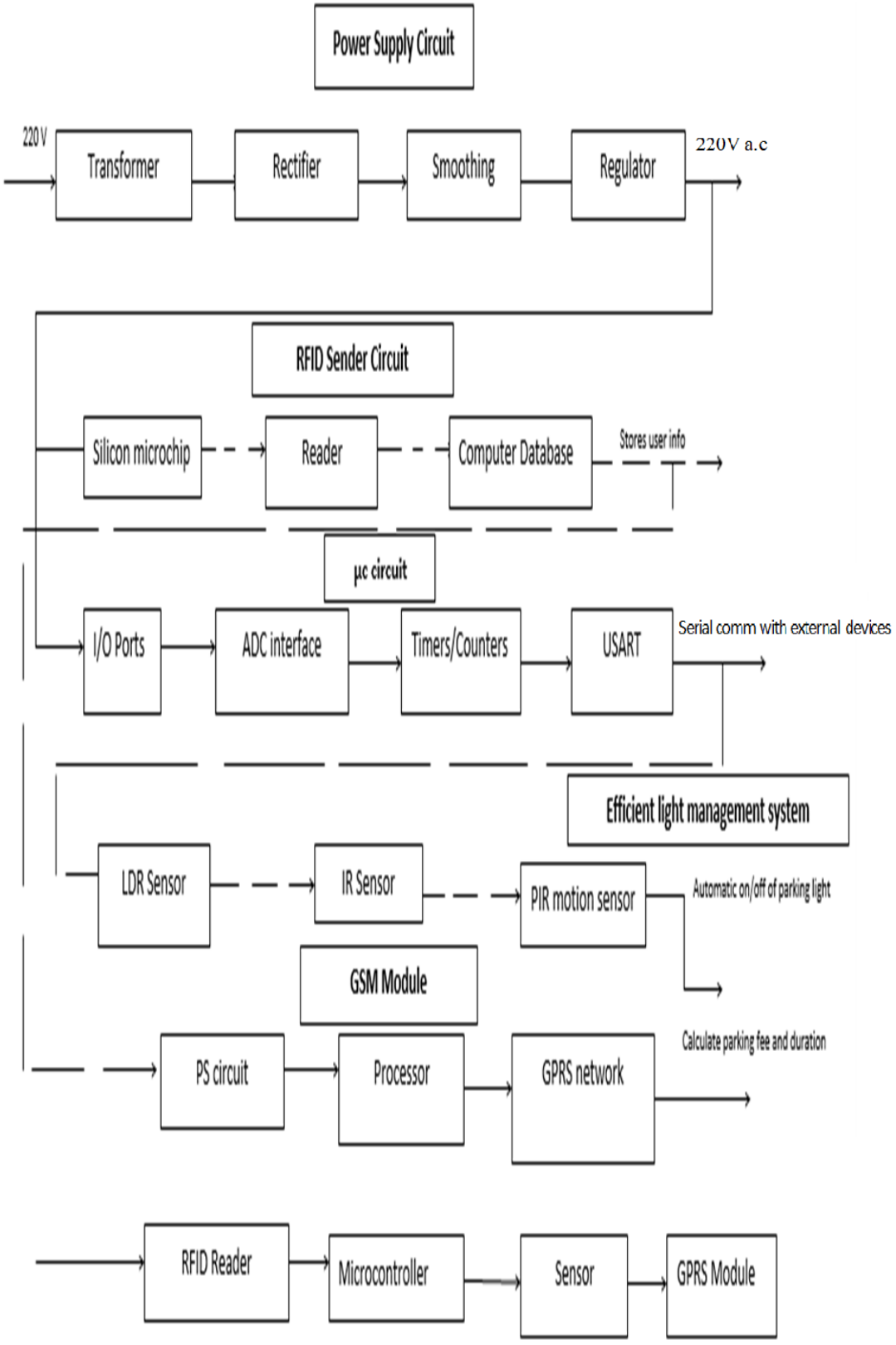

Figure 1. Basic cluster diagram of the entire set-up which has been implemented to achieve the automated power-efficient parking system

4. Explanation and Working

4.1. Power Supply Circuit

We get a 230 V AC voltage from the supply but our requirement is 5V DC. Hence, to achieve it, we use a step-down transformer to get a 12 V AC supply. It is then converted to 12V DC using a rectifier. The output of the rectifier is a Pulsating DC signal which contains ripples so in order to obtain a smoothed DC signal, we use power filter circuits like a capacitor. The 12V DC signal is then reduced to 5V DC signal using a positive voltage regulator chip 7805. Therefore, we obtain a fixed DC voltage of 5V.

4.2. RFID Sender Circuit

Figure 2. RFID reader module [9]

The RFID reader circuit works in the following manner. After the data stored in an RFID tag's microchip is read, the RFID reader's antenna sends electromagnetic energy to the tag's antenna. The tag sends radio waves back to the reader using power from its internal battery or power harvested from the reader's electromagnetic field. Subsequently, the radio waves are picked up by the reader and the frequencies are interpreted as meaningful data.

4.3. Microcontroller Circuit

The data received by the RFID reader is fed to the microcontroller. The set of instructions can either be in assembly language or in C language. We are using ATmega 16 microcontroller & the program is written in C. The program contains instruction for receiving the data from the RFID reader. For inventory management two modes are available, one for the entry/increment while other for the selling/decrement mode.

As the tags are swiped/interfaced with the reader, the increments/decrements are made accordingly to the modes selected & buzzer is sounded. The result (No. of items remaining/sold with date & time) is saved in the EEPROM (Internal data memory of the microcontroller) & the same is displayed on the LCD (Liquid Crystal Display). Hence in this way our stock is updated.

4.4. Light Management Circuit (Working of IR and LDR Sensor)

The IR circuit houses an IR source and an IR detector in such a way that light from the emitter LED strikes an external object and is reflected into a detector. The reflectivity of the surface determines the amount of light reflected into the detector. This principle is used in object detection, barcode detection and surface feature detection.

LDR sensors come in handy especially in circuits which use light/dark sensor circuits. Normally, the resistance of a LDR circuit is as high as 1000 000 ohms, but when illuminated with light, there is a drastic drop in its resistance.

4.5. GSM Module

SIM 300 is a Fixed Cellular Terminal (FCT) for data applications. This compact and portable terminal, with the help of a RS232 Serial Port, can be connected to a computer. It offers features like Short Message Services (SMS), Data Services and FAX Services. SIM300 is a Tri-band GSM/GPRS engine that works on frequencies EGSM 900MHz, DCS 1800MHz and PCS 1900MHz. SIM300 features GPRS multi-slot class10/ class8 (optional) and supports the GPRS coding schemes CS-1, CS-2, CS-3 and CS-4.

5. Application of Knowledge of Science

The three main components of RFID systems are: a small silicon microchip attached to an antenna, a reader and a computer database. The term "RFID Tags" is often used as a general term to describe RFID Tags, RFID Labels and RFID Cards. It is important to know the frequency at which a RFID solution operates and the type of product the tag can be affixed to.

The standard operational frequency of UHF (Ultra High Frequency) Tags, Labels and Cards is 915 MHz. These tags have a high range i.e. about 20-30 feet, can transfer data faster than LF and HF tags, but they consume a lot of power and have less penetration power i.e. they are less likely to pass through materials.

The operational frequency of HF (High Frequency) Tags, Labels and Cards is 13.56 MHz. HF RFID tags are used in applications that require read distances of less than three feet. These tags work better on objects made of metal (RFID Metal Tag) and can work around goods with high water content.

LF (Low Frequency) Tags, Labels and Cards are operational at a frequency of 125 kHz. They use comparatively less power and are able to penetrate through non-metallic substances.

Active IR Sensors are the type of IR Sensors that employs an IR source & IR detectors (emitter & receiver). They operate by the transmission of energy from either a light emitting diode (LED) or a laser diode. A phototransistor is used as an active IR detector. In these sensors, the target is illuminated by a LED or LASER diode and the energy reflected back is focused on a IR detector. In these cases, the detectors used are photoelectric cells, photodiodes and phototransistors. Various signal-processing algorithms are then used on the observed data to extract the desired information. These active IR detectors are useful as they provide a count of the objects, presence, speed, and occupancy data in both night and day operation.

Transmitter:

- Transmitter = LED (Light Emitting Diode)

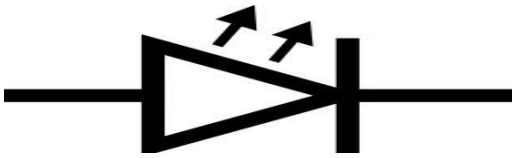

Figure 3. IR transmitter [2]

It is similar to normal LEDs but they emit infra-red light. Its glow can be seen either with a digital camera or mobile phone camera.

Receiver:

- Receiver = Photodiode/IR Transistor.

Figure 4. IR Receiver [2]

6. Application of Knowledge of Mathematics

This Light dependent resistor works on the principle of photo conductivity, so it is otherwise called as photo-resistor. These devices depend on the intensity of light, when light falls on the LDR then the resistance decreases, and increases in the dark. If a constant voltage "V' is applied to the LDR, the intensity of the light increases and current increases. The figure below represents the curve between resistance Vs illumination for a particular light dependent resistor.

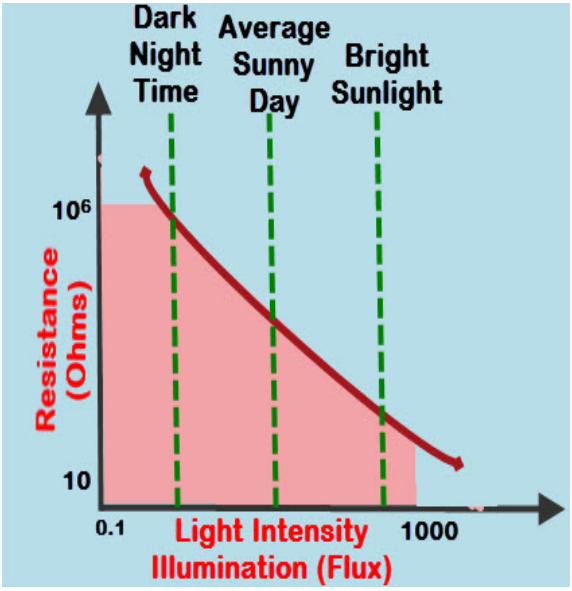

Figure 5. Resistance Vs Light Intensity [6]

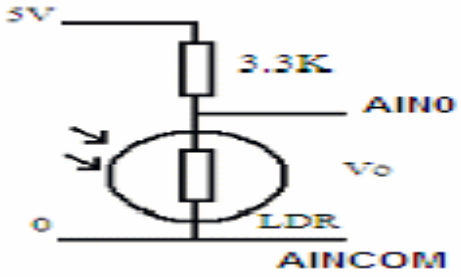

Figure 6. LDR Circuit Diagram [6]

We have calculated the output voltage of the rectifier by applying Integration method:

$$V_{av} = \frac{E}{\pi}\int_{\alpha}^{\pi} \sin\theta d\theta = \frac{E}{\pi}\times(1)[if\ \alpha = 0] = 7 \quad (1)$$

$$V_{rms} = E\times\sqrt{\frac{1}{\pi}\int_{\alpha}^{\pi} \sin^2\theta.d\theta} = 12. \quad (2)$$

7. Final Product Fabrication

We went through different phases of manufacturing to fabricate the final product.

- We divided the whole product into different sub modules and fabricate all the modules one after another.
- All the circuits are fabricated on a zero-board.
- The LDR,IR sensor circuits and power supply circuit were fabricated on zero board with help of shouldering machine.
- All of them were fitted to the ply board using nuts and screws.
- All the circuits were interfaced with the microcontroller.
- With the help of different software like AVR Studio, WinAvr, Sinaprog the programs were written and loaded into the microcontroller using a programmer.
- Then the product was tested against the requirements and the errors were detected and corrected.

8. Design and Manufacturing Tolerance

It is very difficult for us to place two RFIDs one at entry point and other at exit point. As the micro-controller memory was full so we were unable to add more programs to the micro-controller due to which we were forced to remove some of the features. It was not possible for us to place the display unit above the entry point because of the circuit complexities.

Taking the IR sensor into consideration, the Active IR sensor which we have used has a short range as a result, it cannot be used in major commercial applications.

9. Conclusion

On applying this prototype, the user did not face any issues while entering the parking lot. The LCD screen displayed the parking slot no. thereby reducing the ambiguity while entering the parking slot. As fare was deducted from the card, there was no issues concerning the fare. The most significant part of this model was that with the help of IR and LDR sensors, the lighting system used helped to increase the efficiency of the system by about 50%.

10. Suggested Improvements

In future, we have planned to create a database of the users develop an application where the users can find and book a parking place at any place from anywhere with just one click. The application will also navigate them to their destination. In commercial systems, smart card modules will be installed for payment management system. The users will be provided with real time recharge option. Users will get real time parking duration messages. At last but not the least a particular parking slot will be allotted to the user prior to entering in to the parking lot and that parking slot details will be sent to their mobile.

The IR sensor circuit that was designed by us had a very small range so we decided to go for the IR module which had a large area of coverage compared to that of the former circuit. However, due to budgetary limitations, we

could not go for the use of an IR RADAR which can otherwise be used to make our model practically realizable in real life applications.

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