THE DESIGN AND CONSTRUCTION OF A SHADOW ACTIVATED SWITCHING SYSTEM FOR CAR PARK CONTROL

R. O. Opara [1], **G. N. Ezeh** [2], **C. K. Agubo** [3]

Electrical/Electronic Engineering Department,
Federal University of Technology,
Owerri, NIGERIA.

[1] raykyop@yahoo.com

ABSTRACT

With the significant increase in the number of automobiles on our roads, adequate space management is very important both in commercial and residential areas. This research was necessitated by the urgent need to manage parking spaces in banks, shopping malls and sports stadia which are areas identified as currently experiencing the worst parking problems. The aim of the study was to improve the parking arrangement of vehicles in an organized and accessible way, reduce stress and create aesthetics. In this research, shadow activated space management system (SASMS) was designed to address the challenges associated with car parking by combining the good qualities of the existing system and eliminating their setbacks. Modular robust methodology were adopted in the design and light dependent resistor (LDR) was used to construct a parking system. On testing, the five modules were found to be functioning effectively and the combined system also functioned as specified.

Keywords: Car parking, adequate space management, light dependent resistor (LDR), shadow activated switching system

INTRODUCTION

With the significant increase in the number of automobiles plying on our roads, finding adequate parking spaces in banks, shopping mall, stadia and recreational areas becomes a problem. Good space management creates an enabling environment for easy access and transportation. It also contributes to the beauty of the affected areas . Commercially and socially, the establishment of good parking facilities cannot be over emphasised.

Most developed countries especially in Europe and Asia continue to lead the way in the provision of good parking structures and systems, most of which integrate software programmes to existing infrastructure and machinery. Such machinery include; lifts, gates, meters,etc. But in developing countries, people on daily basis are faced with hassles in public places such as banks, shopping mall and stadium during peak period.This is caused by poor parking structures and arrangements in such establishments. Although, there exists various ways that have been deployed towards solving these problems. The study, designed and implemented the shadow activated switching system as a modifications of an existing products.The intention is to compact more cars in the same space, for efficient space management. The system can be situated on the plain ground, above ground and below ground or a combination of both. The shadow activated space management switching system is composed of electronic components, such as:

1. Operational amplifiers, or comparators, which are use to compare between a fixed voltage level and a varied one, to give its output.
2. Bridge of rectifiers, to convert the AC to DC voltage.
3. Seven segment displays, to show the different signs and displays in the circuit.

Copyright © 2013 SAVAP International
www.savap.org.pk

4. Light Dependent Resistors, which are really the main sensors.
5. Transistor circuits, to act as control switches for the displays.

OBJECTIVES OF THE STUDY

The main objective of this study was:

1. To develop an electronic based project to act as a tool that helps in parking lot allocation and arrangement, which will involve less human input and gives greater efficiency.

MATERIAL AND METHOD

There are various methods of space management for car parking which include Programmable Logic Controller (PLC) based car parking system, multi level car parking system, robotic parking systems, and elevator parking system among others**.** Major problems of PLC are the complexities of the high level programming and its application is only on specialized machines. There is also the problem of recognizing smaller vehicles [3]. Robotic parking systems ensured safety by use of a parking safety zone and multiple safety sensors. Its operation is governed by a computer and the status is monitored on an ongoing basis. It is also easier to operate. The need for a parking system that will be able to combine the good qualities of existing methods with elimination of their setbacks gave impetus to this present design of shadow activated switching system for car park control.

Operations

The shadow activated system for car park control works basically with the principle of photoelectric sensing and transistor switching. It involves the design of a special circuit that acts as a switch to turn OFF or ON an indicator. The LDR (light dependent Resistor) functions as the sensing material in the circuit. It is buried in the parking slots, where the cars will run over it. The car parks over it and casts a shadow over the sensor, this causes a voltage change on the LDR, which in turn triggers the whole circuit by sending an electrical signal from the comparator unit to the indicators. This system requires a constant power supply, to ensure that the system is ON and ready for use.

This whole system operates with the principle of monostable switching, where the system remains at a constant state until the LDR senses a shadow cast from a car. This principle can also be seen in the typical door bell [Gururaj,B.I, 1963]

System Overview

The design of shadow activated switching system was achieved in five different modules, shown in fig. 1.0. Each module was designed individually and then joined together to form a complete module for shadow activated system for car park control.

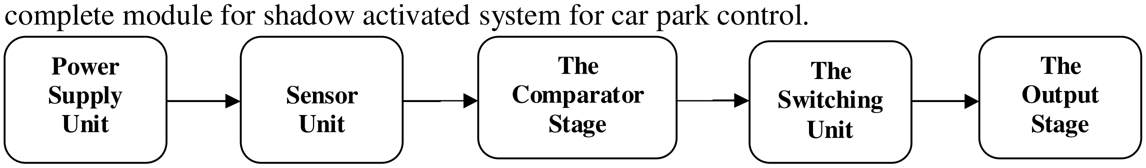

Figure 1. A block diagram of a shadow activated switching system for car park

Power Supply Unit

A standard power supply that converts AC voltage from the mains to a regulated DC voltage is designed. The power supply comprises of a transformer, a rectifier, a filter and a regulator. The transformer converts a.c supply of about 240V to a lower voltage value, suitable for rectification. The rectifier unit converts alternating voltage or current to direct current (d.c) in this design, some component parameters are assumed for their safe operation.

Design Targets Of The Power Supply Unit

Required D.C voltages = +12V , -12V

Ripple contain f_c of the D.C output = 5mV

Input frequency of the A.C source input =50Hz

Assumed Values

Load resistance ,R_h = 300ΩForward biased voltages of the LED =12VForward biases current of the led =10mA

Design Calculations

Input a.c voltage was taken to be 220V (rms) at 50Hz frequency. This value was, however the root mean square (rms) content measured with a digital voltmeter. The peak-to-peak values was calculated using the formula

$$V_{dc} = (2xV_{peak})/\pi$$

$$12 = (2xV_{peak})/\pi$$

$$V_{peak} = 12\pi/2 = 6\pi = 18.9V$$

$$But V_{peak} = V_{rms} x\sqrt{2}$$

$$V_{rms} = V_{peak}/\sqrt{2}$$

$$V_{rms} = 18.9/\sqrt{2} = 13.4V$$

Choices of the transformer and the rectifying diodes are based on the V_{rms} and the peak voltage (V_p) values.

T_1 taken to be a step-down type of rating 220V-24V center-tapped

The rectifying diodes needed were to have their peak inverse voltages for above the calculated peak voltage (20V). Therefore, diodes 1N4001 were chosen for D1-D4 since their peak inverse voltage value is 50V

For the filtering capacitor, the ripple factor formulae for full-wave rectification was used

$C = 1/4\sqrt{3} * V_r * F_o * R_L$

Where F_o= 2 * input frequency

=2 * 50 =100

V_r = 5mV

R_L = 300Ω

Where V_r and R_L are already assumed

$C = 1/4\sqrt{3} * 5*10^{-3} * 100 * 300$

= 0.000962F

Or C = 962μF

Standard values chosen =1000 μF

C1 = C2 = 1000μF

Copyright © 2013 SAVAP International
www.savap.org.pk

ISSN-L: 2223-9553, ISSN: 2223-9944
Vol. 4 No. 4 July 2013

In calculating the LED indicator circuit, the formular

$V_{DC} = V_{R1} + V_{LED}$

$12 = V_{R1} + 2$

$V_{R1} = 12\text{-}2$

$=10V$

Also, $V_{R1} = R_1 * I_{LED}$

$R_1 = (10 * 1000)/10$

$R_1 = 1000\Omega$

$= 1K\Omega$

Summary of the components Values

$T_1 = 220V/24V$

$D_1\text{-}D_2 = IN4001$

C_1 and $C_2 = 1000\mu F$

$R_1 = 1K\Omega$

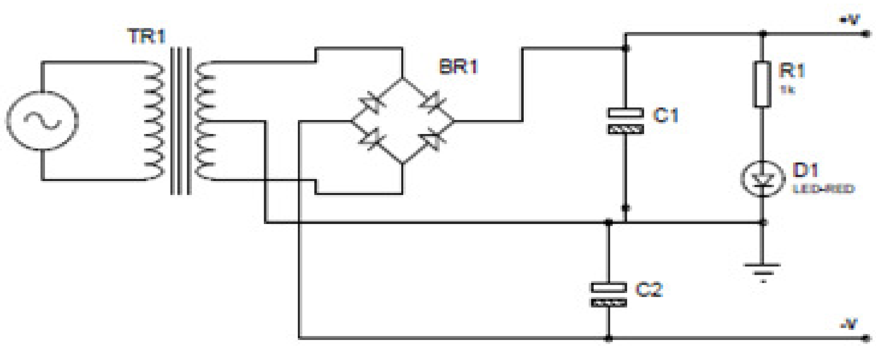

Figure 2. Showing the power supply unit

Reference / Sensor Unit

Two voltages divider circuits forms the sensor and the reference voltages. A fixed resistor and a zener diode form the first voltage divider circuit producing the reference output, while variable resistor connected as rheostat and the photo resistor form the other voltage divider producing the variable voltage. The two output voltages - the sensor and the variable outputs are fed to an operational amplifier for comparison. The zener voltage is fixed at 6.2V while the photo–resistor produces a varying output due to the level of shadow cast on it. All the variable resistors used for the three stages are the same and equal in value. $VR_1 = VR_2 = VR_3 = 10K\Omega$. While the fixed resistor, R_3 is 5. 6 kΩ in value.

$LDR_1 = LDR_2 = LDR_3$ = Photo resistor.

The Comparator Unit

An operational amplifier (OP-AMP) µA 741 was connected as a voltage comparator with its two inputs from the sensor and reference units. Normally, a comparator has two inputs and one output. A positive difference between the two input produces a high output (1). But a zero or negative difference between the two inputs will give a low output (0). The voltages from the light dependent resistor were set at values lower than the reference voltage (zener

Copyright © 2013 SAVAP International
www.savap.org.pk

voltage).

V_{LDR} = 4.2V'and V_Z = 6.2V.

Any shadow across the photo resistors increased their output voltages to about 8.6V. The reference voltage was connected to the inverting input terminal –pin2 of the operational Amp, and the varying voltage to the non inverting input terminal –pin3. All arrangements for the three operational amplifies used were the same.Output of the comparators were divided into two - one part to switch on a visual digital display and the other to bias a bi-polar NPN transistor into saturation. When there was a car on any of the sensors, the corresponding digital number configure with a seven display came **ON**.

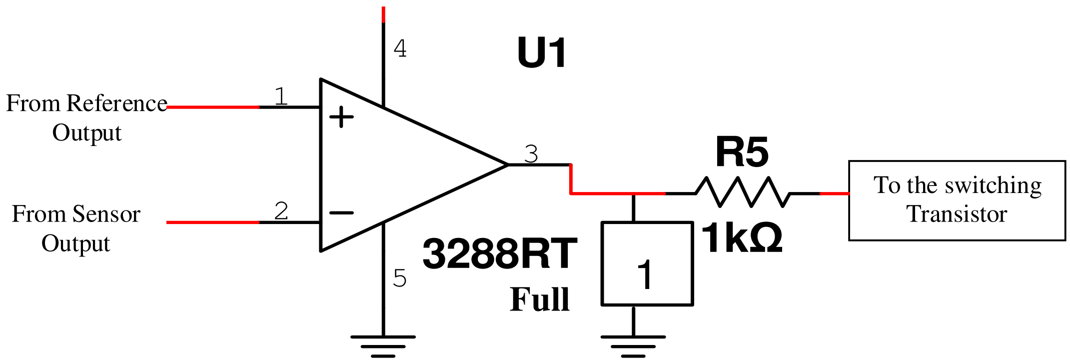

Figure 3. Comparator Unit

The Switching Unit

This unit comprises of fixed resistors, switching transistors and an interfaced relays. A high output of the comparators will be immediately biased the transistors to saturation. This provides enough power to energies the relays connected at their collector regions as loads. All the normally-open contacts of the three relays are serially connected. When all three are energized, There will be a complete path for current flow through resistor R7, R8, and R9.

Output Unit

Once the required number of cars are parked over the spaces provided, the corresponding digit number will be displayed. In addition visual message showing "FULL" will be put ON. This is made possible by passing a voltage through the three relays connected in series to bias another NPN transistor (Q_4) for the activation of the configured seven segments "FULL" message display. once another car leaves a space, the "FULL" message display goes OFF alongside the corresponding digit number for the open space re-created. The complete circuit diagram of the shadow activated switching system is shown in figure 4.

Construction and Prolems Encountered

The construction of the circuit on the board is made easier because of the simplified nature of the line diagram, the construction/wiring shows how the components used in this project were laid out on the circuit board. Some steps were taken to ensure proper work and good outlook.

The components were neatly soldered. Proper care was taken to ensure that there was no short circuit, or open circuit, the surface of the board was thoroughly cleaned to ensure shadow activated switching system, that the joints were firm by using the correct flux and appropriate heat for soldering the components.

One of the main draw back in this study is its inability to cater for other forms of machines like motorcycles and bicycles.

Copyright © 2013 SAVAP International
www.savap.org.pk

ISSN-L: 2223-9553, ISSN: 2223-9944
Vol. 4 No. 4 July 2013

Construction of casing

The casing for this project was constructed with a plywood that is large enough to accommodate the circuit board, openings were made for seven segment display to fit on the case as well as for the input socket, the circuit board of the shadow activated system was mounted inside the case.

After construction of the device, it was taken to the electronics laboratory for testing, this was necessary because the device had to be tested to avoid short or open circuit faults.. Separate testing was also done on the transistors, zener diodes, relays, the seven segment display and ICs to ensure their outputs were as desired. The target of this work was to be realized at the prototype level. As a result, an improvised car park spaces were created with the photo-sensors positioned at areas where maximum change in luminosity can be easily detected. All the visual display messages were sited at the entrance gate of the car park, directly facing any approaching vehicle.

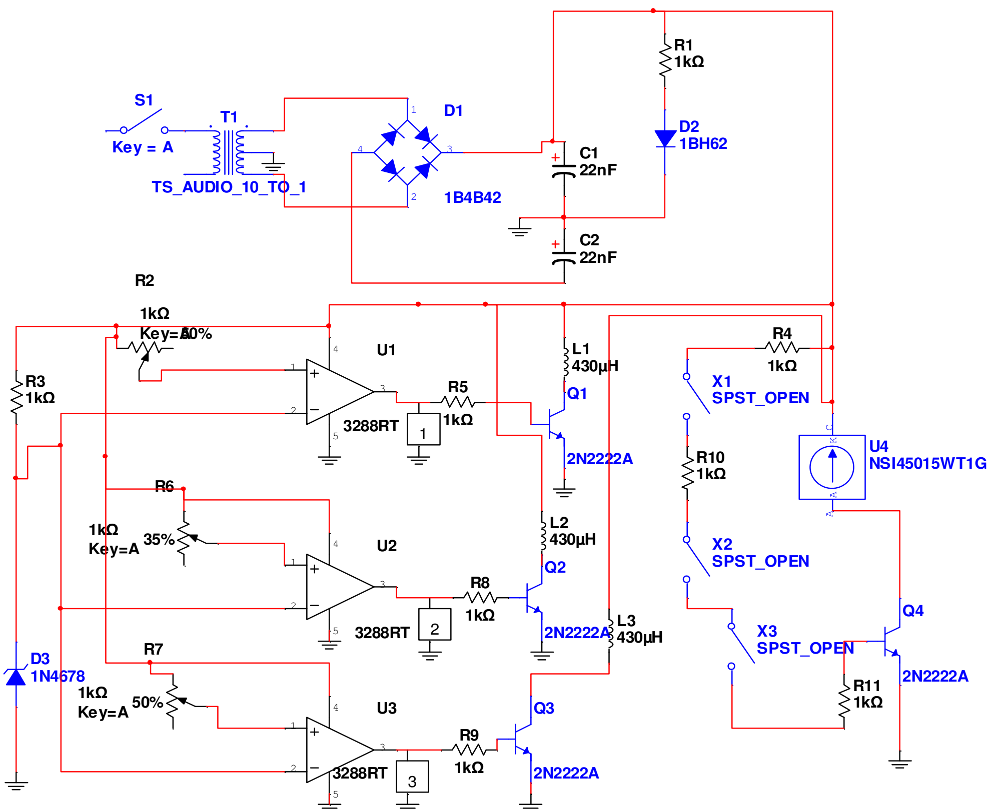

Figure 4. Circuit diagram of the shadow activated switching system

RESULT

A prototype of the switching system for car control using shadow sensor activators has been realized.The output voltage of the power supply unit was measured with a voltmeter to read +14v and -14v when the input supply was 209v. The reference voltage measured across the zener diodes gave 6.2v. This value was confirmed at the non-inverting terminals of the operational amplifier ICs. The first car ran across to cover the first parking space, digit 1 immediately appeared on the display board. Digit 2 came up when the second car moved to its appropriate position. As soon as the third car covered the last space provided, the “FULL” message came up on the display overhead.

Copyright © 2013 SAVAP International

CONCLUSION

In conclusion the aim of this work was achieved which was to design and construct a shadow activated switching system for car park control that is able to manage space well. It was achieved using electronic components.

ACKNOWLEDGEMENT

The authors are grateful to Messer's Chimbuoyim Achigbu, Thomas Onyeka and Ifeanyi Ofortube for their help in this study. The contribution of Federal University of Technology, Owerri, Nigeria through provision of facilities used in this study is hereby appreciated.

REFERENCES

Gururaj, BI (1963). Natural Frequencies of 3-Pkase Transformer Windings. In: *IEEE Transactions on Power Apparatus and Systems*, 82 (66). pp. 318-329.

Mike, C. (2004). *Principles and Practice of CCTV*. Carlifornia: CRC Press.

Kahraman, F. & Gokman, M. (2003). *License Plate Character Segmentation Based on the Gabor Transform and Vector Quantization*. Mumbai: Mumbai Press.

Ondy M.,Brno University of technology, (2007). *Algorithm and Mathematical principles of number plate recognition*. Russia: Brno University Press.

Yorem, H. (2005). *License Plate Recognition A Tutorial*. UK: University Press.

ACPO, (2005). *ANPR Strategy for Police Service*. Texas: Association of Chief Police Officers-ACPO.

Chika, U. (2009). *Use of LDR in Truck Height Measurement.* Nigeria: NIPCO

Khedkar, M. K. (2000). *Basic Electrical Engineering.* India: Nagur Press.

Traneka, S. G. (2000). *Electrical Devices Circuit*. India: Gupta Press,

Guatnan, B. (2000). *Light Sensitive Devices*. India: Banglore Press

BBC, (2007). *Met given real time c-charge data.* Retrieved from British Broad Coasting Coporation (BBC) websit http://news.bbc.co.uk/2/hi/uk_news/politics/6902543.stm

Mathieson, S.A. (2003). *Kepping 1984 in the past.* Retreived from website of the Guardian http://www.guardian.co.uk/technology/2003/jun/19/newmedia.media

http://www.pariparking.com. "2-step Parking System" Retrieved 2008-10-03.

http://www.hardingsteel.com, "Elevator car parks" Retrieved 2002-05-04.

http://www.totalparkingsolutions.com "Car parking systems for space management" Retrieved 2001-07-02

http://www.woehr.de/car-parking-system "Hydraulic Parking Systems" Retrieved 2004-08-07

Copyright © 2013 SAVAP International
www.savap.org.pk