JOURNAL FOR UNDERGRADUATE RESEARCH

Centre For Undergraduate Research
University of Abuja
Vol.1, No 2, Dec, 2023
ISSN: 1115-7534
Published by Centre for Undergraduate Research

Design and Construction of Automatic Hall Light Control with Visitor Counter System Circuit

Rukayya Ahmad[1], Abdullahi Bako[1*], Yasir Musa Sagagi[1], Ruhullah Muhammad[1] & Buhari Samaila[1]

[1]*Federal University Birnin Kebbi, Nigeria*

Correspondence: Rukayya Ahmad, Federal University Birnin Kebbi, Nigeria.
1710209011@ug.fubk.edu.ng

***Mentor:** Abdullahi Bako, Federal University Birnin Kebbi, Nigeria.

Abstract

In today's world, a digital world indeed, use of technology is very advanced and we prefer things to be done automatically without any human efforts. This Research helps to reduce human efforts with the increase in standard of living, there is a sense of urgency for developing circuits that would ease the complexity of life. In this paper an automatic hall light control with visitor counter system circuit was designed and constructed. This research depends on the lighting system among the three power plans for green house buildings. it can be used for auditoriums, halls, shopping malls, rooms and others. Every electronic device comprises of three (3) units input, signal processor and output, in this research microcontroller (ATmega 328), lighting system, alphanumeric LCD, IR Sensor (transmitter and receiver) are used as the units. The system counts both people entering and leaving an auditorium, hall, or other location. A break in the sensor allows the system to detect the entry and exit of visitors and a successful implementation of the system will display the number of visitors in the auditorium or room. The microcontroller gives command signals to a relay driver which turns the relays such that the lamp turns ON and OFF. When the person's count is greater > 1 the lamp will turn ON automatically, but when the persons' count is zero, lamp will turn OFF automatically. Complexity of life will surely be simple if more of this is implemented.

Keywords: Controls, Lighting, Microcontroller, Systems, Voltage

1. INTRODUCTION

In today's world, there is a continuous need for automatic control systems. With the increase in standard of living, there is a sense of urgency for developing circuits that would ease the complexity of life (Ogherohwo, Igbekele, Jangfa, & Zumji, 2018).

Wastage of electricity is one of the main problems which we are facing nowadays. In our homes, schools or industries. We see that fan and lighting point are kept ON even if there are nobody in the room or area. This happens due to negligence or because we forgot to turn lights OFF or we are in a hurry (Mahmud, Nazmul, & Jahid, 2017).

Controls are an excellent way to reduce lighting energy while enhancing lighting quality. Occupancy sensors can eliminate wasted lighting in unoccupied spaces. Day lighting controls or advanced load management can reduce lighting demand when energy is most expensive, and manual dimmers, which allow occupants to adjust light levels to their preference are becoming more affordable. Lighting controls have been shown to reduce lighting energy consumption by 50% in existing buildings and by at least 35% in new construction (Hussain & Helal 2018).

The ability to remotely control building lighting systems is particularly important for facilities facing high or uncertain electricity costs. One method of reducing those costs is to limit the facility's demand for electricity during peak-use periods when rates are the highest. During these times, the lighting control system can turn off as many lighting system components as possible, or dim those systems that are equipped with dimming ballasts. With building lighting systems accounting for such a large portion of the electrical load, reduction in lighting load during peak-rate periods will translate into savings, in both energy use and energy demand charges (Saddam, *et al*, 2019).

Adjardjah, Essien & Ackar-Arthur (2016) presented the design and construction of a digital bidirectional visitor counter (DBVC). When somebody enters the room then the counter is incremented by one (+1) and when any one leaves the room then the counter is decremented by one (-1). The total number of persons inside the room is also displayed on the LCD (Liquid Crystal Display). The microcontroller is used for detecting an entry or exit action and computing the figures (addition and subtraction) to acquire accurate results. It receives the signals from the sensors, and this signal is operated under the control of embedded programming code which is stored in ROM of the microcontroller. The microcontroller continuously monitors the Infrared Receivers.

Farooq, Shakoor & Siddique (2016) presented ARM based Bidirectional Visitor Counter and Automatic Room Light Controller using PIR sensors. With limited energy resources, it is the need of time to revolutionize the traditional methods of counting visitors inside hotels, recreational places, meeting rooms and cinemas to control the electrical appliances and improved living standards demand developing circuits that would ease the complexity of life. In this paper, we have used state of the art components to develop a practically applicable system, and the system was deployed and tested in real world situations to enumerate its efficiency.

Rath (2018), designed Arduino based Smart Light Control System and advanced light control system that is capable of replacing the old generation light control system. The system is

implemented on an embedded platform & is equipped with a photo sensitive detector (LDR) which gives the required input for operation.The embedded main board including the Microcontroller chip, memory (flash), and communication port are used as a processing module for the input that we get from peripheral devices (LDR).The cited work was implemented using an Arduino Development Board which is quite costly.

This research described a microcontroller-based model used to count the number of persons entering in a particular room and accordingly lights in the room/hall will be control simultaneously according to the number of people in the hall. The main purpose of our proposed system is to save energy by making the lights ON or OFF according to the presence of the person in a room, to reduce the efforts required to switch ON/OFF the lights in the hall/room. Automatic hall light control with visitor counter system is a reliable circuit that takes over the task of controlling hall lights as well as counts the number of people/visitors in the hall. Most times people come outside the hall and forget to turn off lights, thus electricity is wasted. To overcome this problem automatic control system is employed.

The block diagram for the system as shown in figure 1 which consists of microcontroller (ATmega 328), lighting system, alphanumeric LCD, IR Sensor (transmitter and receiver).

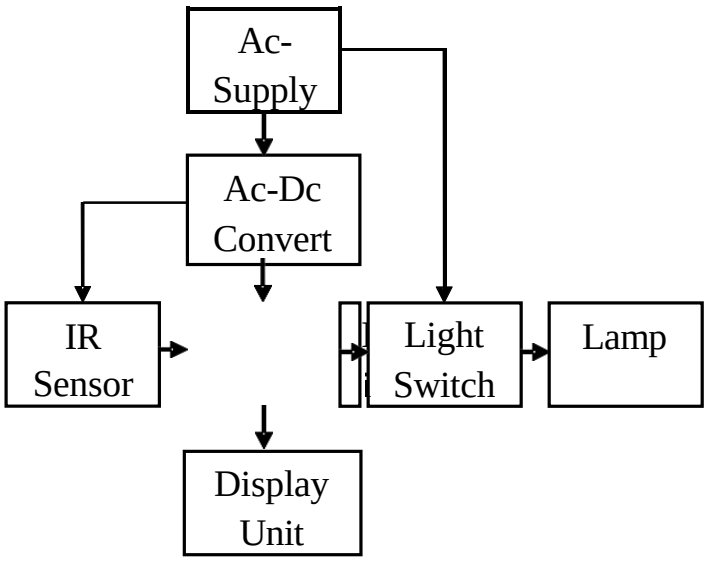


Fig 1: Block Diagram of Automatic Hall Light Control with Visitor Counter System

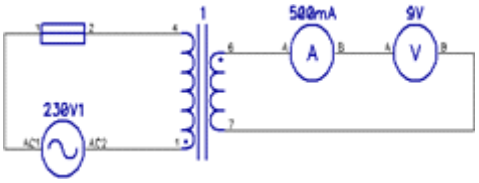
2. MATERIALS AND METHOD MATERIALS

Design Consideration

The real layout and unique planned picks in choice of suitable implementation systems and hardware additives had been made. Priority turned into given to low-fee availability, reliability, flexibility and simplicity.

Selection of Step-down Transformer

The voltage requirement for the system is 5Volt DC. Therefore, 230V/9V 50Hz step down



transformer was selected to power the circuit.. Fig 2: Transformer Circuit Diagram
The maximum voltage of the transformer is given with the aid of using

$$V_{max} = V_s \times \sqrt{2} \quad \ldots\ldots (1)$$

Where V_s is the voltage of the secondary winding of the transformer

$V_{max} = 9 \times \sqrt{2} = 12.72$ and I_{max} is determined as

$I_{max} = \sqrt{2}\, X I_{rms}$.....(2)

Where I_{rms} is the root mean square current

$I_{max} = \sqrt{2} \times 500 \times 10^{-3} = 707mA$

the average DC value current can be determined from the equation below

$$I_{dc} = \frac{2I_{max}}{\pi} \quad \ldots\ldots (3)$$

$$I_{dc} = \frac{2 \times 707 \times 10^{-3}}{\pi} = 450mA$$

Similarly, the Dc output voltage of the transformer is given by

$$V_{dc} = \frac{2V_{max}}{\pi} \quad \ldots\ldots (4)$$

from equation 4

$$V_{dc} = \frac{2 \times 12.72}{\pi} = 8.10V$$

load resistance is given by

$$R_L = \frac{V_{dc}}{I_{dc}} \quad \ldots\ldots (5)$$

$$R_L = \frac{8.10}{0.45} = 18\Omega$$

Rectifier Diode's Selection

The output of a bridge rectifier circuit is given by

$$V_{rec} = V_{max} - 2V_f \quad \ldots\ldots (6)$$

$V_{rec} = 12.73 - 2 \times 0.7 = 11.33V$

For full wave bridge rectifying circuit, peak inverse voltage (PIV) is giving by

$$PIV = V_{max} + V_f \quad \ldots\ldots (7)$$

Where V_f is forward drop of a diode (about 0.7V for silicon diode)

$PIV = 12.73 + 0.7 = 12.08V$

From the above fact, the cheapest available rectifier KBP310 having a PIV of 50V was chosen for rectification.

Filter Capacitor

C= $\frac{V_{av}}{\Delta V f_p R_l}$ ..... (8)

And f_p = 2f = 2 x 50 = 100Hz

ΔV = differential voltage

ΔV = V_{av} - V_{min} =16.25 - 7.5=8.75v

C= $\frac{16.25}{8.75 \times 100 \times 18}$ = 0.001032=1032µf

The nearest standard value of 1500µf 16V capacitor is selected for the filtration action.

Voltage Regulator

Voltage regulator is fabricated into the form of an integrated circuit which is capable of providing a nearly constant DC output voltage. In this research work, positive 5V regulator (LM7805) was used to provide +5V DC voltage to the circuit and to improve stability of the circuit. The selected voltage regulator has the following electrical specifications.

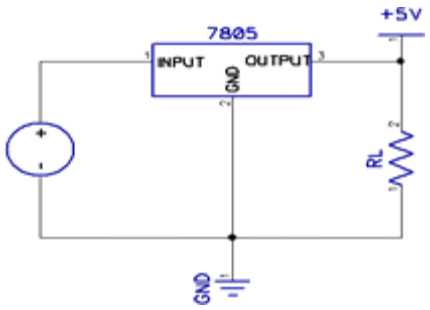


Fig 3: Voltage Regulator Circuit

Minimum input voltage (V_{min}) = 7.0V

Maximum input (V_{max}) = 25.0V

The average DC voltage is given by

$V_{av} = \frac{V_{max} + V_{min}}{2}$ ..... (9)

Where V_{min} and V_{max} are the maximum and minimum voltage of the regulator.

Using equation 9

$V_{av} = \frac{25 + 7.0}{2} = 16.0V$ ..... (10)

Microcontroller Stage

An ATmega328 is a microcontroller chip positioned on Arduino Uno boards. ATmega328 microcontrollers are from the 8-bit Atmel microcontroller family. ATmega 328 has 1KB Electrically Erasable Programmable Read Only Memory (EEPROM).This property suggests if the

electric powered supply furnished to the micro-controller is removed, even then it can store the statistics and can supply effects after providing it with the electric powered supply. Moreover, ATmega-328 has 2KB Static Random-Access Memory (SRAM).It operates ranging from 3.3V to 5.5V then again usually it makes use of 5V as a standard. Programming the Microcontroller.

Programming the Microcontroller

To application the microcontroller, it will need a USB ISP AVR programmer, which is a tool used to flash the bootloader and software code to the ATmega328p.Before code can be uploaded to the ATmega328p onboard there is a want to flash the Arduino bootloader onto the chip. The Arduino bootloader is a little software program that runs on the microcontroller that approves it to apprehend code being uploaded from the Arduino IDE. When one buy an Arduino board, it comes pre-flashed with the Arduino bootloader. In this case, though, the ATmega328 used is blank. The bootloader ought to be uploaded onto the chip, this manner is known as burning the bootloader. Burning the bootloader will solely take few minutes and as soon as a "successful" message is verified at the backside of the IDE once the manner is completed. The bootloader has been effectively flashed onto the ATmega328p; one can now upload the authentic code that will run the microcontroller.

Verify and Upload Source Code

The verify stage checks the code for errors, then compiles the ready-for-uploading code to the microcontroller.

Fig 4: Verifying the Source Code

The upload stage actually takes the binary data, which was created from the code, and uploads it to the microcontroller via the serial port.

Fig 5: Uploading the source code

TABLE 1: PIN DESCRIPTION OF LCD

Pin No	Function	Name
1	Ground (0V)	Ground
2	Supply voltage; 5V (4.7V – 5.3V)	Vcc
3	Contrast adjustment; through a variable resistor	V_{EE}
4	Selects command register when low; and data register when high	Register Select
5	Low to write to the register; High to read from the register	Read/write
6	Sends data to data pins when a high to low pulse is given	Enable

7	8-bit data pins	DB0
8		DB1
9		DB2
10		DB3
11		DB4
12		DB5
13		DB6
14		DB7
15	Backlight V_{CC} (5V)	Led+
16	Backlight Ground (0V)	Led-

Infrared Transceiver Module (Proximity Sensor)

Proximity Sensor are used to become aware of objects and limitations in the front of sensor. Sensor maintains transmitting infrared mild and when any object comes near, it is detected the sensor by means of monitoring the mirrored mild from the object. It can be used in robots for obstacle avoidance, for automatic doors, for parking aid units or for safety alarm systems, This Infrared obstacle/object detection sensor is convenient to use and it comes with on board potentiometer to adjust the sensitivity. The output is digital signal so it is effortless to interface with any microcontroller such as Arduino/Genuino UNO*Fig 6: Pictorial Diagram of IR Module*

3. METHODOLOGY

Testing of Power Supply Circuit

The power supply circuit was tested in accordance with the Fig 7 and Various results were read at the output of each unit and recorded.

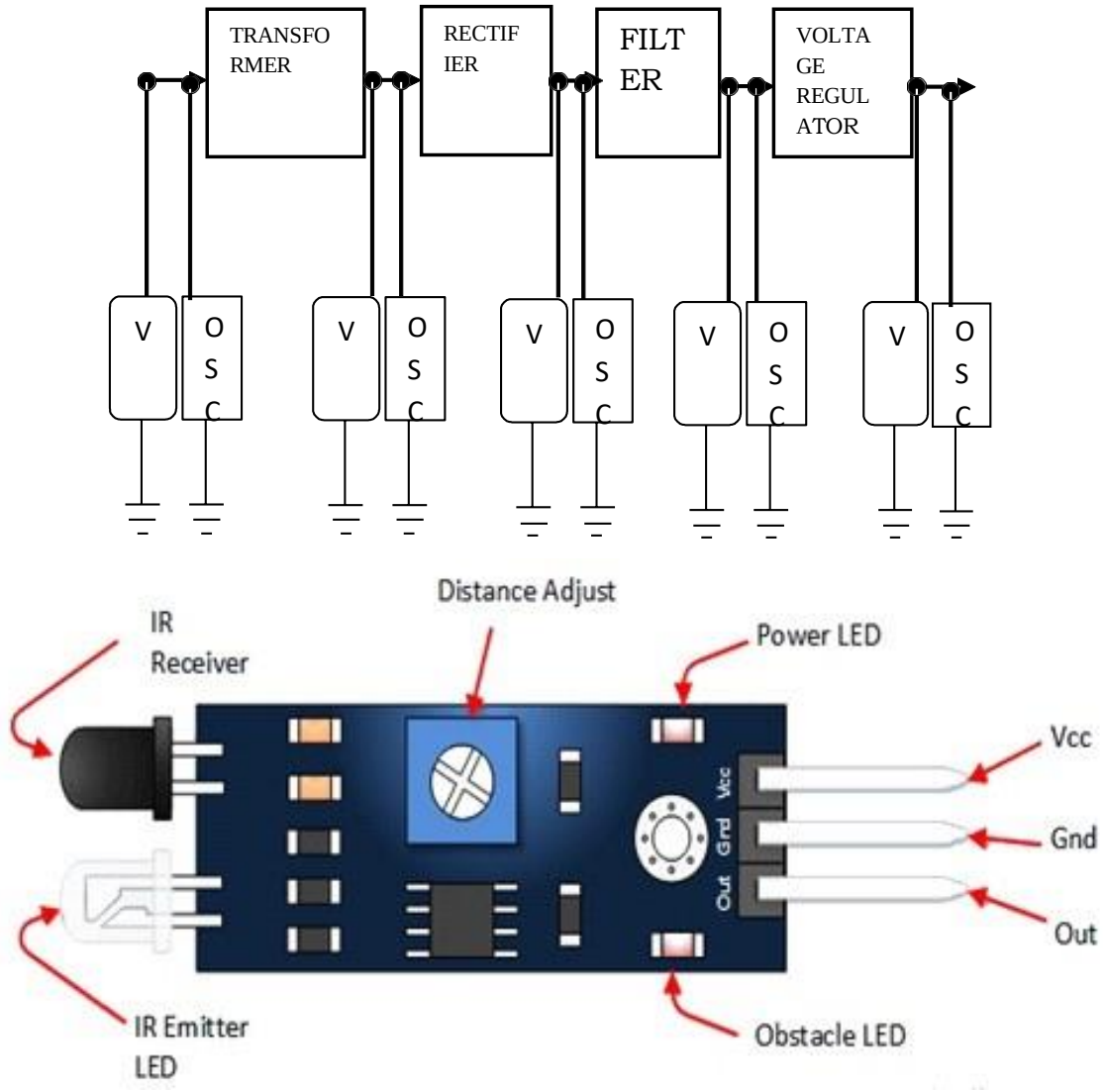


Fig7: Block Diagram of Power Supply Unit Test

The overall circuit was tested by powering the circuit from the mains switching ON DC supply to the Sub circuitry units. The hardware setup consists of two sets of IR transmitters and receivers. These IR sensors are placed in such a way that they detect a person entering and leaving the room. When a person enters into the room, an IR beam is obstructed between the IR transmitter and the receiver. This IR obstruction from the sensor1 gives the corresponding signal to the microcontroller. The microcontroller is programmed in such a way that by the reception of the signal from the sensor-1 count an increment. The typical circuit used to be examined via powering the circuit from the mains switching ON DC Supply to the Sub circuitry units. The hardware setup consists of two units of IR transmitters and receivers. These IR sensors are placed in such a way that they detect a individual coming into and leaving the room. When a man or woman enters into the room, an IR beam is obstructed between the IR transmitter and the receiver. This IR obstruction from the sensor1 presents the corresponding sign to the microcontroller. The microcontroller is programmed in such a way that through the reception of the sign from the sensor-1 count an increment.

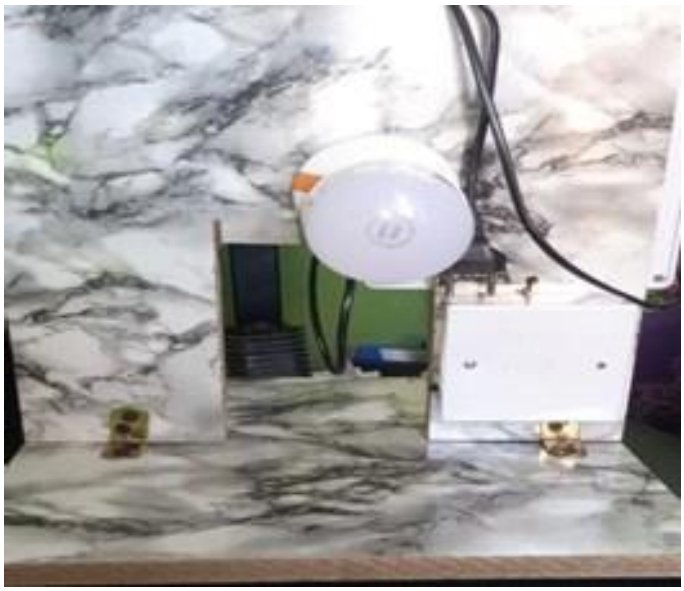


Fig 8: Front view of complete construction in its plastic casing

Fig9: Back view of complete construction in its plastic casing

4. RESULTS AND DISCUSSION

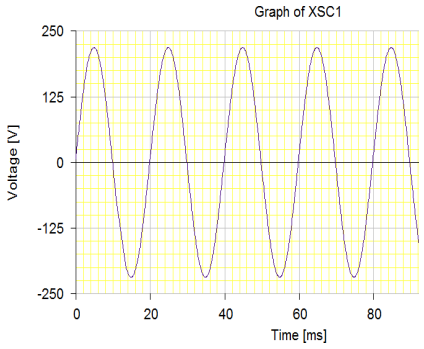
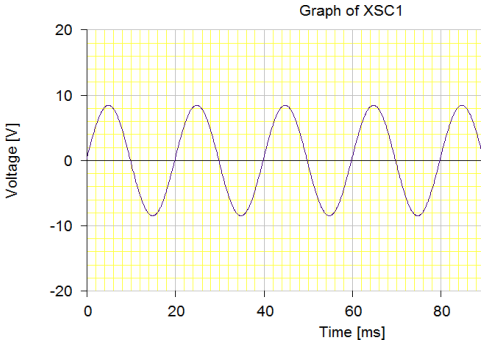
4.1 Results

The output of the Digital Multi-meter is as shown in table 2

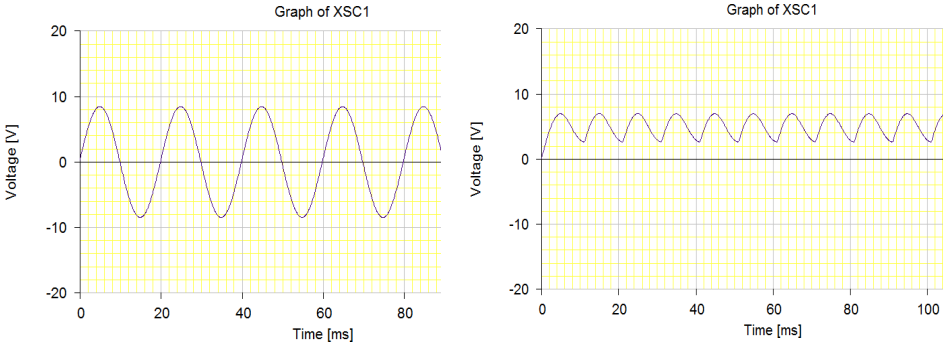
Table 2: Power Supply Test Results

Element	Input	Output	Comment
Transformer	225.70 V AC	8.87V AC	It steps down the supply voltage to lower value
Bridge rectifier	8.87 V AC	8.18V DC	It changes the transformer output sinusoidal AC voltage to pulsating DC
Filter capacitor	8.18V DC	8.18V DC	It reduces fluctuations at the output of the bridge rectifier
Voltage regulator	8.43V DC	5.00V DC	It regulates its output Voltage to predetermined constant DC value.
The wave shape of every level is as proven in the table underneath			

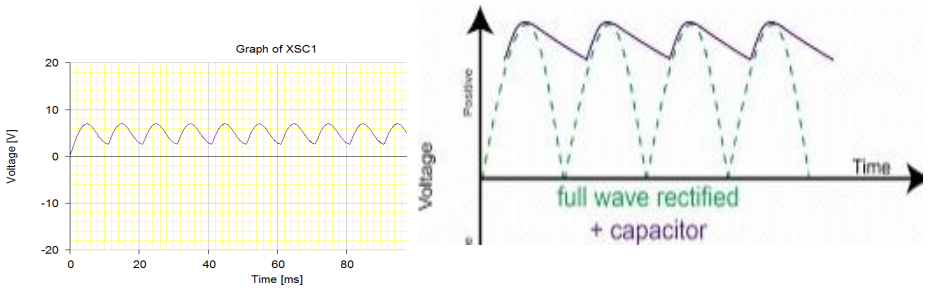
Table 3: Voltage wave shape of electricity deliver circuit Stage

Stage	Input	Output
Transformer		

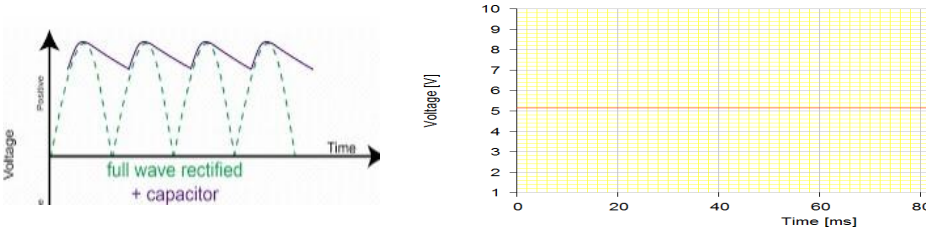
Rectifier



Filter



Regulator



4.2 DISCUSSION

The electricity deliver effects had been satisfactory, even though a few measured values were not the precise values, however had been within the operational range. The effects received in table3 indicates that the sensors are running and may offer out alerts to microcontroller. Thus, the microcontroller offers command alerts to a relay driving force which turns the relays such that the lamp turns ON. When the individual leaves from this room, sensor-2 allow and supply manage alerts to the microcontroller. Furthermore, the microcontroller reads the virtual enter from sensors and calculates the quantity of humans within the room, and then shows it at the LCD. When the humans' be counted number is extra than one, the microcontroller activates the room mild turns ON and whilst the humans' be counted number is zero, it turns off the mild.

5. CONCLUSION

The layout of this studies has been efficiently achieved. Bi-directional means that it is able to study each the incoming and outgoing visitors of humans. This venture is a dependable circuit that mechanically plays the mission of controlling lighting fixtures points, in addition to

counting the quantity of humans inside the room very accurately. This layout may be deployed to be used in rooms of small/medium potential together with library, laboratory, garage, classrooms, engineering workshops, seminar halls, etc. And higher still, the additives required are so small and few that they may be packaged right into a small inconspicuous container.

REFERENCES

Adjardjah, W., Essien, G., & Ackar-Arthur, H. (2016). Design and Construction of a Bidirectional Digital Visitor Counter. *Computer Engineering and Intelligent Systems*, *7*(2), 50-67.

Farooq, M. U., Shakoor, A., & Siddique, A. B. (2016). ARM based Bidirectional Visitor Counter and Automatic Room Light Controller using PIR sensors. *Advances in Science, Technology and Engineering Systems Journal*, *1*(5), 15. https://doi.org/10.25046/aj010503

Hussain, S., & Helal, A. (2018). Automatic control system for lighting of a single door room with bidirectional people counter. *International Conference on Mechanical, Industrial and Energy Engineering*, *26*(4), 12.

Mahmud, H. J., Nazmul, I., & Jahid, H. (2017). Automatic room light control using bidirectional visitor counter and gas detection. *International Journal of Engineering Science and Computing*, *4*(1), 12.

Ogherohwo, E. P., Igbekele, O. J., Jangfa, T. Z., & Zumji, J. J. (2018). Bidirectional automatic room light controller using visitor counter. *Nigerian Journal of Physics*, *27*(2), 23. https://www.researchgate.net/publication/335219738_

Rath, F. (2018). Design and implementation of arduino based smart light control system. *International Journal of Research in Engineering and Technology*, *5*(3), 22.

Saddam, D., Sowdhamini, R., Gowthami, D. R., Deepika, H., & Santosh, K. V. (2019). Microcontroller based room automation and bidirectional visitor counter. *International Journal of Advance Research in Science and Engineering*, *8*(1), 1259. http://www.ijarse.com/images/fullpdf/1527744585_Reva717ijarse.pdf