Implementation of a Wireless Control Method for Varying Indoor Lighting Intensity Using Radio Frequency

Awuhe T. Samuel[1], Tingir T. James[2], Odinya, O. Jotham[3]
[1, 2, 3]*Department of Electrical and Electronics Engineering, Federal University of Agriculture Makurdi, P.M.B. 2373, Makurdi, Benue State, Nigeria*

Abstract: **The research focuses on implementation of a wireless method that varies the light intensity of lighting points of indoor units. The major components used are HT12E Encoder, HT12D decoder, an RF transmitter module, an RF receiver module, a switching circuit (BC547 NPN transistor) and relays. The decoder sends the signals in binary form to the RF transmitter which transmits the signal using a radio frequency of 433MHz. The RF receiver intercepts the signal sent from the transmitter. The decoder interprets the signal and sends it to the relays which send different voltages to load according to the sent instructions. The intensity of the lighting varies accordingly, based on the signal sent from the encoder.**

Keywords: **Wireless Control, Radio Frequency, HT12E Encoder, HT12D decoder, Lighting Intensity**

I. INTRODUCTION

Before the advent of modern computing devices, mechanical switches were developed to connect conductors for current/voltage signal transfer. As civilization unfolded, electronic switches were developed to replace mechanical switches, which gave room for convenience and better control of electrical signal transfer from a source to some other circuits.

A lot of research works have been carried out on wireless control of electrical and electronic devices using radio frequency, microwave, infrared, or other types of electromagnetic or acoustic waves. The importance of the control of light intensity in domestic and industrial environment cannot be overemphasized; but when it involves wireless control, it becomes more convenient and safer.

The objectives of this work are as follows:

- To design a wireless system that varies the light intensity of indoor lighting.
- To design a system that reduces the rate of energy consumption for indoor lighting.

II. LITERATURE REVIEW

Jayant (2015), designed a remote controlled light switch using Infrared (IR) Television (TV) remote control unit which uses IR LED to emit IR light. "This IR is received by the receiver TSOP 17xx (TSOP 1738 used in TV). TSOP17xx receives the modulated IR waves and changes its output. The last two digits represent the frequency (in KHz) of modulated IR rays, on which TSOP responds". In his design, he used TV remote control unit to change the states (ON/OFF) of the IR receiver by pressing any button of the TV remote. The IR receiver receives the pulse as logic ON which is used to clock-pulse a 4017 decade counter with one of the counter's output tapped to the relay to control the AC bulb.

Mbunwe (2017), also designed and constructed remote control switching device for household appliances. In her design, RF was used to control appliances – either to switch ON or OFF. The design incorporates RF transmitter and receiver modules (RF High Fidelity 433MHz), encoder and decoder, push buttons, electronic and electromechanical switches, step-down transformer with the load attached to the decoder section. The encoder and decoder used were HT12E and HT12D respectively

Mohamaddoust *el al* (2011) proposed a Lighting Automatic Control System (LACS). The LACS system contains a centralized or distributed architecture determined by application requirements and space usage. The system optimizes the calculations and communications for lighting intensity, incorporates user illumination requirements according to their activities and performs adjustments based on external lighting effects in external sensor and external sensor-less architectures.

III. MATERIALS

The designed system uses a HT12E Encoder, HT12D decoder, an RF transmitter module and an RF receiver module, a switching circuit and relays. The system utilizes the HT12E Encoder to encode binary data. It consists of N address bits and 12-N data bits. A signal from the HT12E encoder is sent to the HT12D decoder via an RF transmitter module. An RF receiver module is incorporated in the system to receive the signals from the transmitter and pass it to the HT12D decoder which interprets received serial addresses and data from the programmed encoder. A switching circuit

(transistor) considers the ON and OFF state of the decoder and sends the appropriate voltage to the relays, which close accordingly allowing a certain voltage level to the load.

IV. METHODS

The functional block diagram of the system is shown in Figure 1.

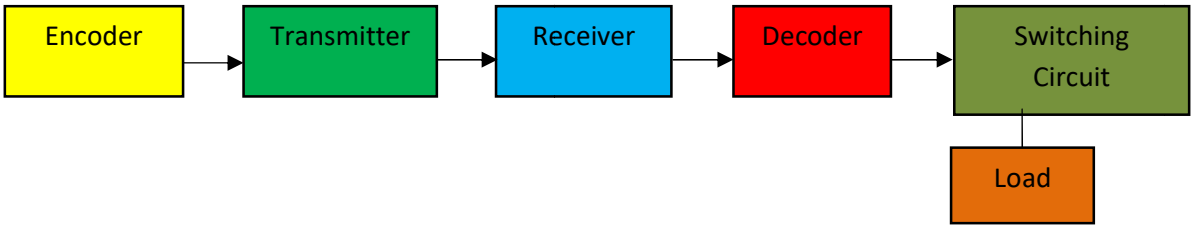

Figure 1. Functional block diagram

The Encoder consists of N address bits and 12-N data bits. Each address/data input can be set to one of the two logic states. The four data lines are the four inputs of this encoder. If a binary signal 0101 is needed as the output, then the data pins AD8, AD9, AD10 and AD11 will be supplied with logic states '0101' This signal (0101) is transmitted out from the D_{OUT} (data output) pin of the encoder. A schematic of the encoder is shown in Figure 2.

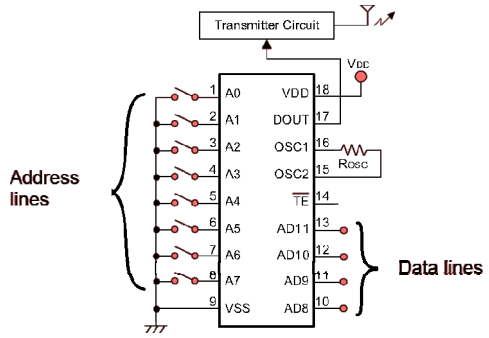

Figure 2. HT12E Encoder

The internal oscillator of the encoder is used to determine frequency. The RS pins (15 and 16) can be used however, if an external oscillator is required. A logic state circuit with low resistant path to the ground is designed to determine the logic state 0 or 1 signal input to the HT12E encoder. For instance, by pressing the first switch, the input for data line A becomes zero (0).A feedback LED is provided for each switch via current limiting resistors.

Determination of resistor values:

$$R = \frac{V_{in} - V_{LED}}{I_{LED}} \quad (1)$$

The encoder output is sent to the RF transmitter

The RF transmitter is a small electronic circuit that is used to send encoded signal by means of a radio frequency using wireless means through a certain distance range to a receiving point. The transmitter module operates at frequency of 433MHz and the principle which it operates is thus

$c = \lambda f$, where (2)

c = speed of light

f = frequency

λ = wavelength

Pin 2 (data) of the transmitter module receives the encoded signal from the encoder and sends it to the receiver via and antenna using Pin 4 (Ant.) The schematic for the transmitter module is shown in Figure 3

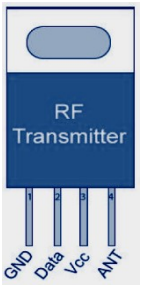

Figure 3. The RF transmitter

This RF Receiver is an electronic circuit that receives RF signal from the transmitter. It receives the signal through its antenna pin (8), the signal intercepted is converted to binary data and sent through data pin (2) to the decoder. It operates at a frequency of 433MHz. A schematic of the RF receiver is shown in Figure 4.

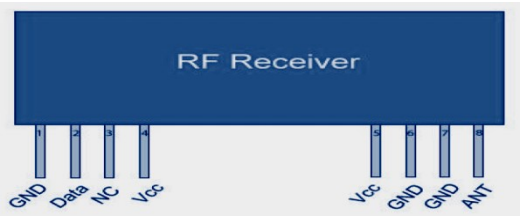

Figure 4. The RF Receiver

The HT12D Decoder receives serial addresses and data from the programmed HT12 Eencoder via the RF transmitter/receiver. The decoder compares the serial input data 3 times with the local address, if there is no unmatched logical code, the input data code is decoded and transferred to the output pins (like the encoder, the decoded data is obtained in parallel mode on the Data lines: D8, D9, D10 and D11). For instance if the data transmitted was '0101', then D8 and D10 will be low (0v) while D9 and D11 will be high (5V) respectively.

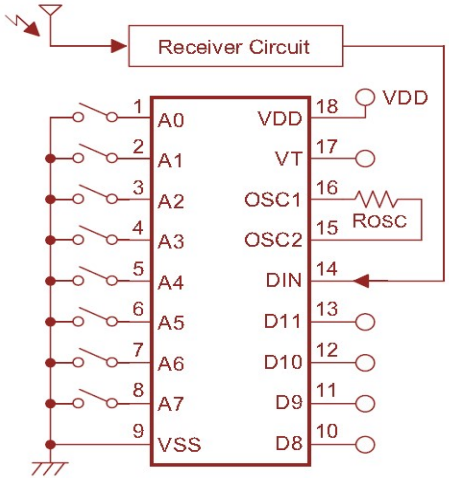

Figure 5. HT12D Decoder

The switching circuit is designed considering the logic value/state of the decoder, which is either 0 volt or 5 volts, this value is not sufficient to operate the 9 volts relay, hence the transistor circuit. The transistor is configured to operate as a switch thus operating in the cut-off and saturation regions respectively.

The transistor used is BC547 and its schematic is shown in Figure 6. The switching circuit is connected to the relay circuit.

The equation for base resistor is given by

$$R_b = \frac{V_{bb} - V_{be}}{I_B}$$

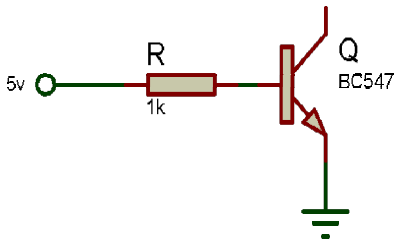

Figure 6. The BC547 transistor circuit.

A relay is a voltage-operated mechanical switch which closes a contact when supplied with voltage. The relay operates by electromagnetic induction. When a dc voltage is supplied to the coil, magnetic field is created which closes the common terminal (COM) to the normally open (NO) terminal thereby creating a connection with it. In this work, the COM terminal is connected to positive lead of the bulb. The NO terminal is connected to a voltage source that determines the voltage required for various brightness levels. The voltage values selected are 12V, 8V, 4V and 0V. Each voltage is tapped from one of the four (4) relay circuits.

V. RESULTS

The construction of Light Intensity Control using Remote control unit was done by selecting appropriate components based on calculation and analysis. The light intensity control system was tested. The system worked in such a way that when the push switch was pressed, signal was transmitted using the RF transmitter module. The received signal was demodulated by the decoder, hence the LED connected to the VT pin (17) of the decoder lit up momentarily. Different voltage levels were selected thereby varying the light intensity of the system. The complete circuit diagram of the wireless control method for varying indoor lighting intensity is shown in Figure 7.

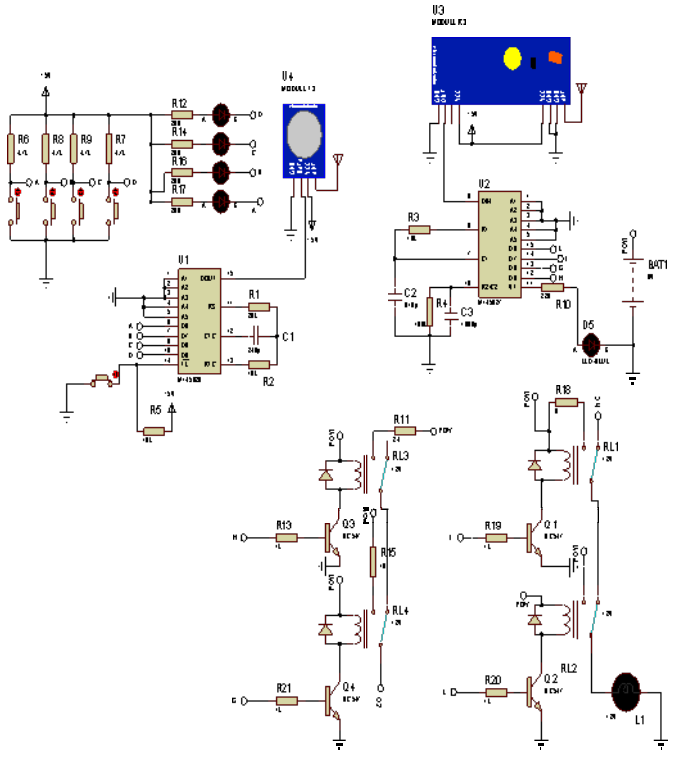

Figure 7. The complete circuit diagram of the wireless control method for varying indoor lighting intensity

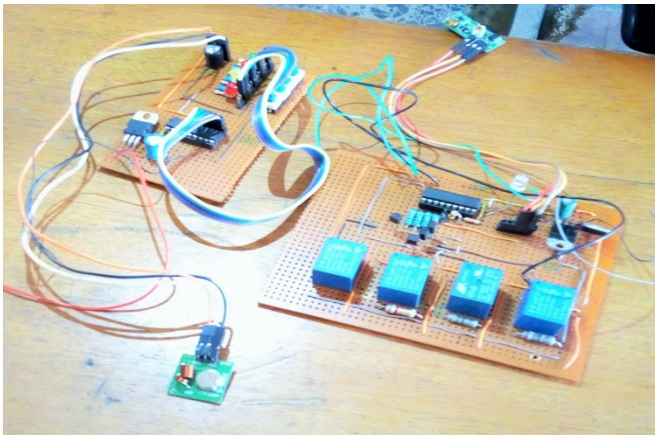

Figure 8. Physical implementation of the wireless control method for varying indoor lighting intensity

VI. RECOMMENDATION

The supply should be alternating current (AC) rather than direct current (DC) to reduce the cost of replacing or recharging the batteries every time they run down.

VII. CONCLUSION

The design and construction of wireless remote control method for varying indoor lighting intensity was achieved successfully.

REFERENCES

[1]. Mbunwe, M. J. (2017): "Design and Construction of a Remote Control Switching Device for Household Appliances Application". Advances in Science, Technology and Engineering Systems Journal Vol. 2, No. 4, pp. 154-164.

[2]. LM7809 Voltage regulator 9V/1A power dissipation _2018 Available: https://protosupplies.com/product/voltage-regulator-7809-9v-1a/ Retrieved: 10 April, 2019

[3]. Jayant (2015): "Remote Controlled Light Switch" Available: https://circuitdigest.com/electronic-circuits/remote-controlled-light-switch. Retrieved: 13th November, 2018

[4]. HOLTEK, "HT12E Encoder Datasheet". Available: http://www.alldatasheets.com. Retrieved:9th April, 2019.

[5]. HOLTEK, "HT12D Decoder Datasheet". Available: http://www.alldatasheets.com. Retrieved: 9th April, 2019.

[6]. RF Module – Transmitter & Receiver www.elprocus.com/rf-module. Retrieved: 9th April, 2019

[7]. Mohamaddoust, R., Haghighat, A. T.,[1] Sharif, M. J. M., and Capanni, N. (2011) A Novel Design of an Automatic Lighting Control System for a Wireless Sensor Network with Increased Sensor Lifetime and Reduced Sensor Numbers. *Sensors (Basel)* 11(9) 8933-8952