

An Infrared-Aided Lighting Control System For Physically Impaired

Oludayo H. Omotosho, Michael O. Kolawole

Department of Electrical and Electronics Engineering, Federal University of Technology, Akure, Nigeria

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ABSTRACT

In recent years the need to provide greater convenience for the physically impaired community is a challenging issue: the reason being that more reliable and cost effective system are required. This paper proposes a cost effective infrared-based solution for automatic control of electrical circuitry and systems in a residential building to aid easy access for physically impaired and/or elderly people. This electronic system has been designed to meet the need of users such that it switches ON the lighting circuits on the detection of entry into a room and switches OFF the circuit as soon as the room is empty. One of the most important features of this design is the ability to automatically adjust the power consumption on the basis of human presence in a room. The device is simple both in its functionality and implementation.

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Corresponding Author:

Oludayo Hannah Omotosho

Department of Electrical and Electronics Engineering, Federal University of Technology, Akure

P. M. B. 704, Akure, Ondo State, Nigeria.

Email: dayotosh@yahoo.com

1. INTRODUCTION

Increasingly, a great deal of research studies is being carried out that attempts to making the lives of disabled people in our communities as pleasant as possible including: on mobility (Mazo et al., 1992), in security (Borenstein and Koren, 1991), in navigation assisted (Chen et al., 1993; Patil et al., 2011) to name but a few.

In the home environment where disabled people spend most of their time, the home should be freely accessible, i.e., enter freely, move around and have the lighting system to switch ON or OFF on arrival or departure from a building unaided. Aside the convenience, the automatic control or switching helps to reduce power bill because most of the times, electrical appliances, (such as fans, lights, and air conditioners) are always switched on when the occupier is out of the room for short spells. Atif and Galasiu (2003) quantified the category of savings for home utilities: 68% of energy consumed during main occupancy for the continuous dimming system, and 31.5% for the automatic on/off switching.

There are various approaches of achieving automatic lighting control, from the nonconventional approach, which include Home Automation-Ubiquitous computing systems-that allow household electrical appliances and other information equipment connect with each other (Dong et al., 2010) and Artificial Neural Network Based-which uses pattern recognition method, classifying for each moment the light state-(Machado and Mendes, 2009)-to the conventional approach such as the use of photosensors-that automatically adjust the output level of electric lights based on the amount of light detected (Mistrick and Casey, 2011), wireless sensor and actuator networks-autonomous light control systems based on the feedback from light sensors carried by users (Yeh et al., 2010), and some microcontroller based techniques (Shoureshi et al., 1992; Belgaonkar et al., 2012). The major difference in these approaches is the type of sensors and the logic circuit that are used.

The novelty in the proposed model involves designing a control system for determining the presence or absence of individuals in an apartment and the positioning of the designed infrared transmitter and receiver systems safe operating frequencies. In our model the principle of infrared radiation and reception is used to detect entry and exit, and the lighting control system receives information, decides what to do with the information, and changes the operation of the lighting system, to either ON or OFF.

The rest of the paper is arranged accordingly. Section II briefly describes the background theory of the design and Sec. III discusses the system design. The result outlines the effectiveness of the design in Sec. IV, while Sec. V concludes the study.

2. RESEARCH METHOD

Infrared aided lighting control system uses the principle of infrared radiation and access control to develop a system that automatically switches on and off lighting units. The infrared beam from the transmitter continuously reaches the receiver. When the light falling on the receiver is obstructed its output would go low and return high again. The output falling edge of the receiver is connected to the interrupt pin of the microcontroller that is programmed to count the number of times obstruction occurs on the receiver and in what order.

Figure 1 shows an infrared aided lighting control system, which is made up of an infrared transmitter *TX*, Infrared receivers (*RX1*, *RX2*), regulated power supply, system microcontroller and the controlled device-i.e., a light switching unit, such as *liquid crystal display (LCD)*.

When a person enters the room the light falling on *RX1* is first obstructed before that of *RX2* is obstructed and a trigger is sent to interrupt 0 and interrupt 1 of the microcontroller respectively. This process executes the line of code to increase the count for the number of occupants by one, which then displays on the liquid crystal display (*LCD*), and the light switches ON. This procedure continues as long as people enter the room. When a person leaves the room the light falling on *RX2* is first obstructed before that of *RX1* is obstructed and a trigger is sent to interrupt 1 and interrupt 0 of the microcontroller respectively. This process executes the line of code to decrease the count for the number of occupants by one, which, again, is displayed on the *LCD*. This procedure continues as long as people leave the room. As soon as the count for the number of occupants equals zero the light is switched OFF automatically.

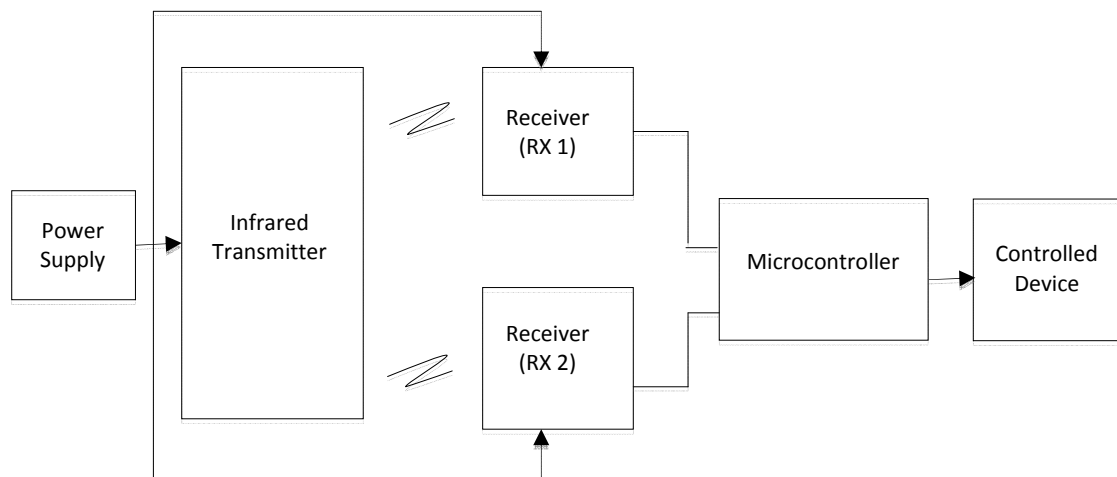


Figure 1. An infrared-based automatic lighting control system

Each of the elements comprising the infrared-based automatic lighting control system, depicted in Figure 1, was designed. The transmitter and receivers operate at 38kHz frequency. The receiver modules utilize TSOP 1238 capable of suppressing extraneous disturbances (Vishay 2001). An AT89S52 microcontroller was used for the control unit. The microcontroller was programmed in C-language, suitable for atmel to decode the data, count the number of entry and exit into the room, activate the load switching mechanism and display data through a 16-character, two-line (16x2) liquid crystal display *LCD*. Figure 2 shows the system's control circuit.

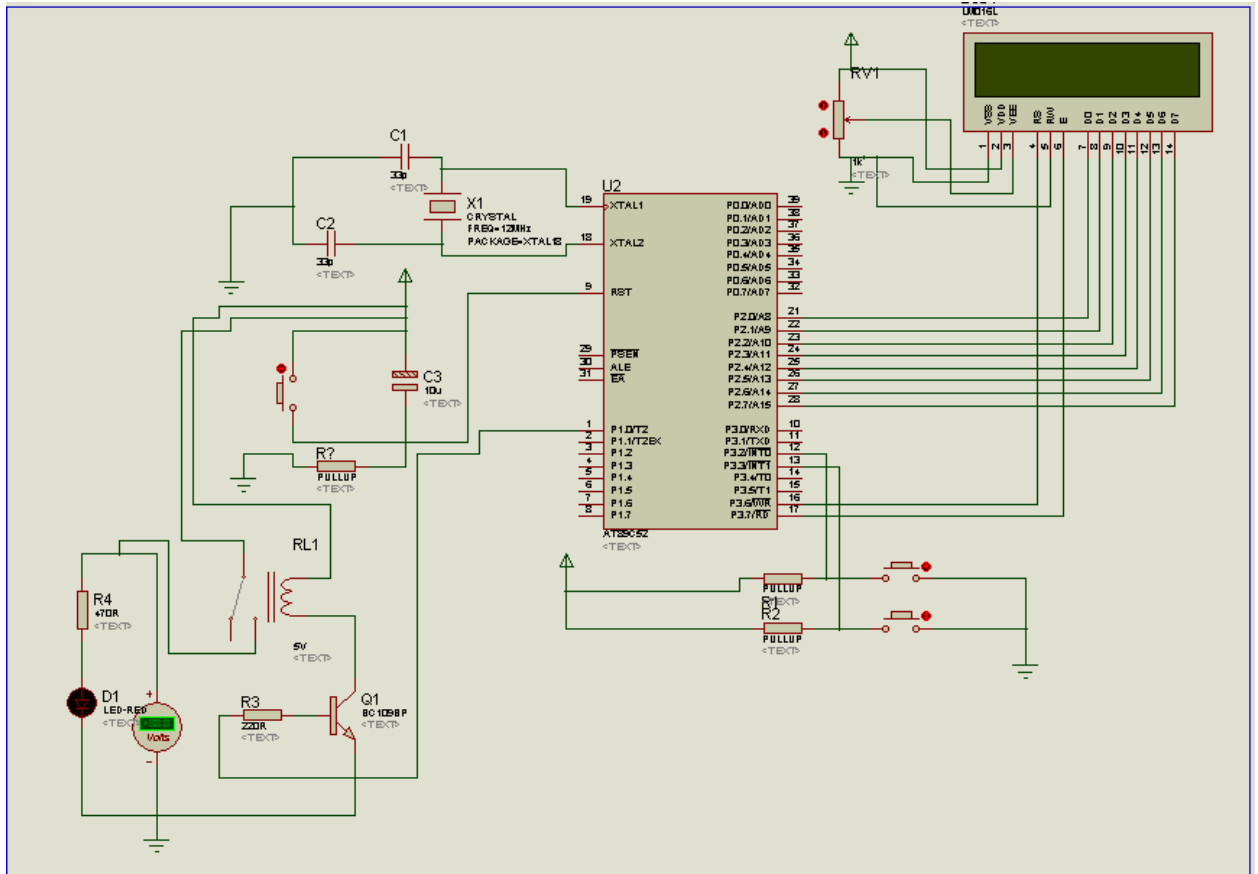


Figure 2. Electric circuit of the System Control Unit

3. RESULTS AND ANALYSIS

A series of tests were carried out on the transmitter, receiver, and the system control unit. The transmitter section was tested to see if the infrared LED is emitting infrared light. The infrared light though not visible to the human eyes is made visible under a digital camera. Figure 3 shows the captured infrared signal transmitted by digital camera. As soon as the receiver is powered its output is at 5V. When placed in the line of sight of the transmitter the receiver output suddenly drops to 0V and returns back to 5V immediately. This falling edge is what is required for the microcontroller stage.

The transmitter and receivers were positioned at a distance sufficient to allow the movement of an individual. The transmitter is then switched on allowing individuals to walk into the room. In response to this action, the bulb came ON, counting and displaying the number of people that have gone through, as shown in Figure 4, for the case of two people. As people walk into the room the number of counts increases, and the light remains ON. Also, as those in the room begin to move out one after the other, the count reduces until the last person exits, i.e., as soon as the count equals to zero the bulb goes OFF. As people walk in or out the count increment or decrement respectively and the bulb only goes OFF when the count is zero. This process, by extension, attempts to increase power usage efficiency.

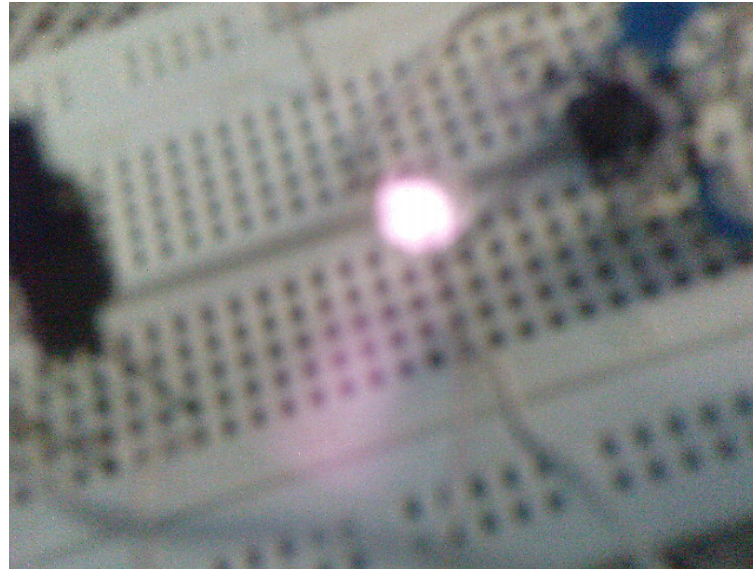


Figure 3. Infrared light as seen under a digital camera

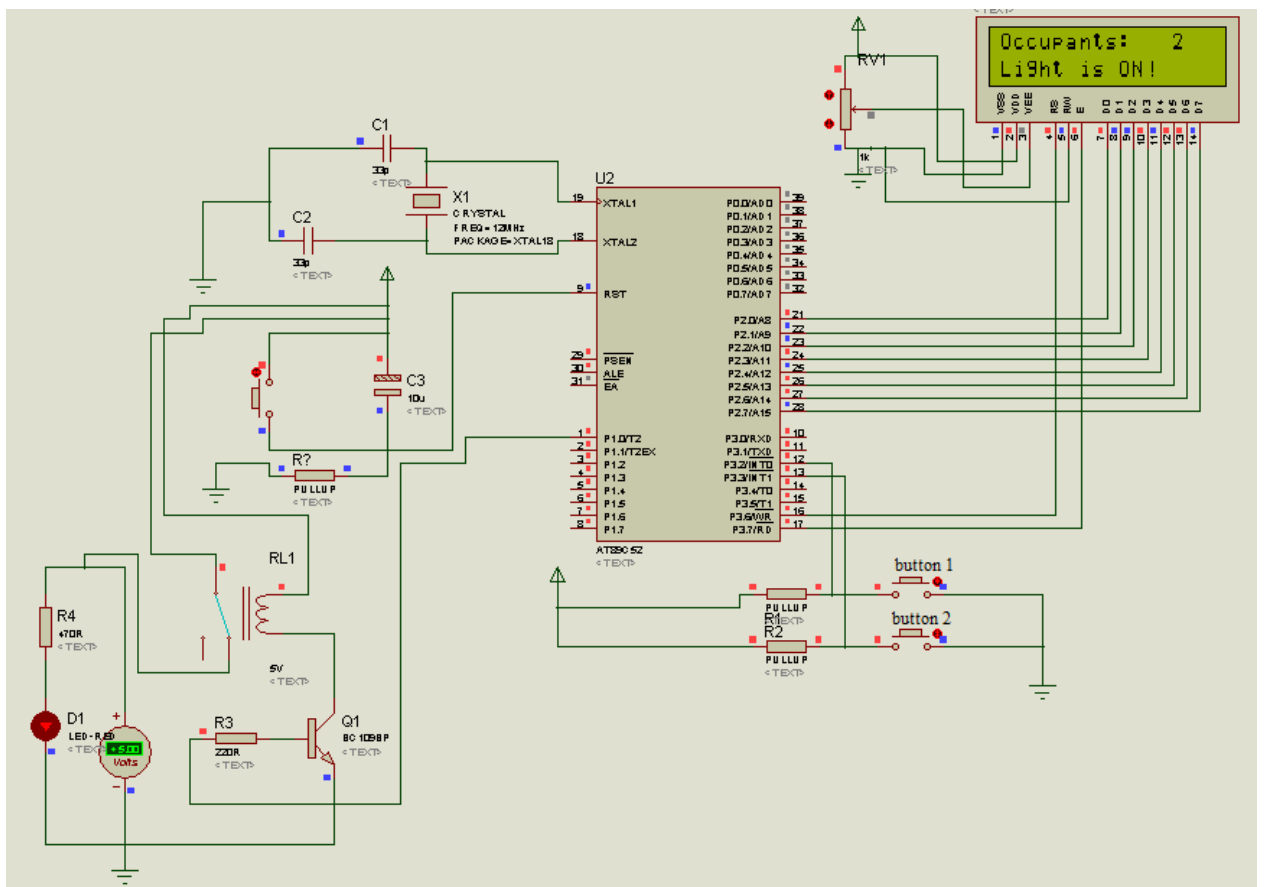


Figure 4. Microcontroller test showing the light ON and the number of occupants in the room

4. CONCLUSION

Lighting control system for the physically impaired has been designed using the principle of infrared technology. The design includes infrared transmitter, infrared receiver and a system control unit. The infrared

transmit and receive method was chosen due to its cost effectiveness and reliability. The designed system works satisfactorily and has diverse applications.

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