Linear Integrated Circuits & Applications Lab

A MINIPROJECT REPORT

ON

Automated Home Lighting System

Submitted By

Varun (4NM17EC170)
Varun G Prabhu (4NM17EC171)
Varun N Naik (4NM17EC172)

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

NITTE EDUCATION TRUST | N.M.A.M. INSTITUTE OF TECHNOLOGY
(An Autonomous Institution affiliated to Visvesvaraya Technological University, Belagavi)
Nitte – 574 110, Karnataka, India
ISO 9001:2015 Certified, Accredited with 'A' Grade by NAAC
☎: 08258 - 281039 – 281263, Fax: 08258 – 281265

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1. INTRODUCTION

Employment to Population ratio has increased drastically with increasing living standards. Home Automation plays an important role in maintaining these living standards of employed population by providing a secure & convenient environment. Home automation is similar to smart home, digital home, e-home and intelligent household. They both mean a high living condition with many smart devices. It is the residential extension of building automation which is using automation technology, computer technology and telecommunication technology to give the user a developed living condition, entertainment and security. It helps people to reduce house working and household management by its automation. The Home Automation Systems not only benefit the employed population but it also helps the disabled and elderly population. The aim of our system is to build a perfect companion for someone to be at home.

Automated Home Lighting System allows the user to control and adjust brightness of the light, without the user's conscious input. With smart home lighting, user need not worry about switching the lights off or on. The Automated Home Lighting System makes use of IR sensors to automatically turn on or off or change the intensity of the lights without using a switch. Each room entrance is equipped with two IR sensors to detect a person's entry and exit. The output of these sensors is given to monostable multivibrators (IC 555) which provide pulses of desired duration. The output pulses are given as up/down input to a counter. Similar circuit is designed for the other room and the outputs of all counters are given to decoder connected to the lights through relays. When a person enters the first room, the lights turn on in that room and lights in other room dim and when the person enters the second room lights brighten in that room and lights remain on in the other room. When there is no one in any of the rooms, all the lights switch off.

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2. BLOCK DIAGRAM

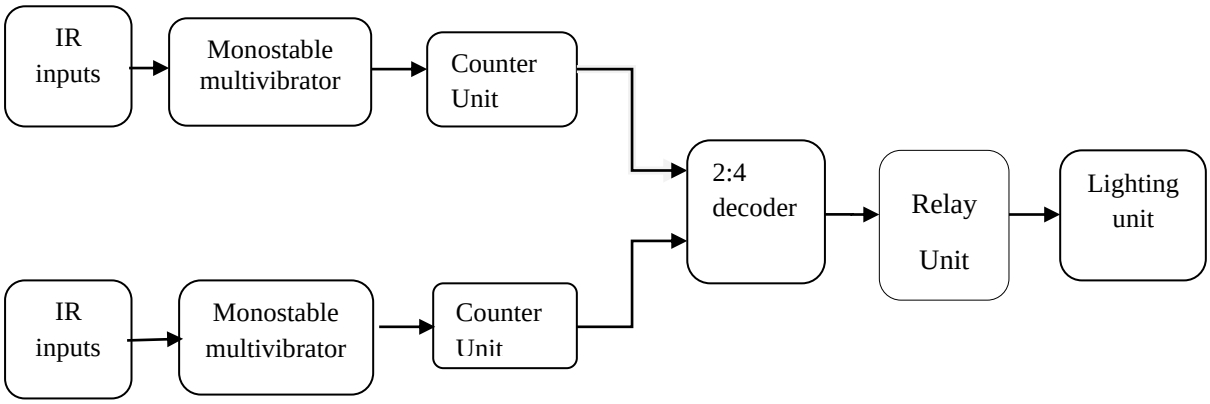

Figure 2-1: Block Diagram of Automated Home Lighting System

When an object comes in proximity to the IR sensor, it detects and sends an input signal to the monostable multivibrator. The negative trigger given to the multivibrator generates a mono pulse, which act as clock pulses to the counter unit, and the count is varied accordingly. The output of the counter is given to the decoder; the decoded output is given to the relay driver which in turn drives the relays. The relays connect the appropriate bulb circuit.

3. Circuit Design

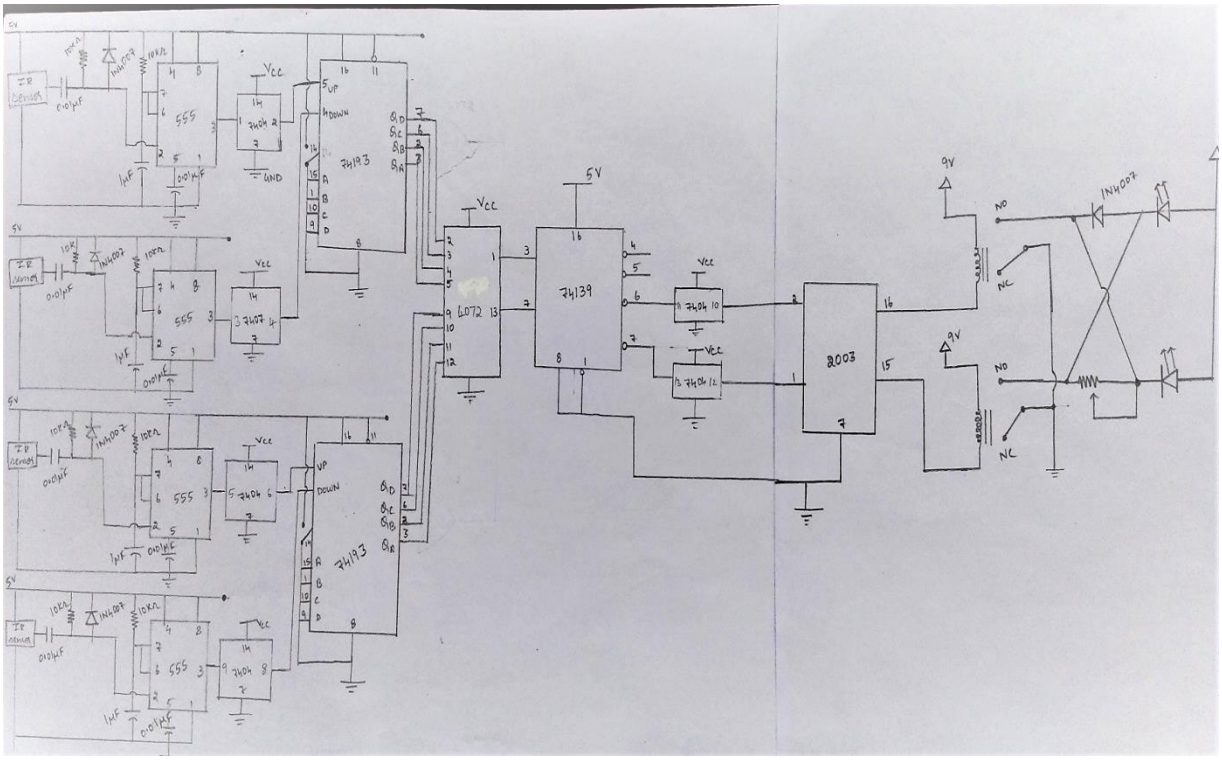

Figure3-1: Circuit Diagram of Automated Home Lighting System

Table 3-1 Component Table

SL.NO	COMPONENT	TYPE	QUANTITY
1	Monostable Multivibrator	NE555 Timer	4
2	Potentiometer-Preset	2k ohm	1
3	Decoder	IC 74139	1
4	Counter	IC 74193	2
5	Diode	1N4007	5
6	4 Input OR Gate	IC 4072	1
7	NOT Gate	IC 7404	1
8	Relay Driver	ULN 2003	1
9	Relay	5V	2
10	Led	20mA	10
11	Capacitor	0.01 µF	8
		1 µF	4
12	Resistor	10k ohm	8

Circuit Description

The circuit diagram of Automated Home Lighting System consists of IR sensor TCRT 5000 with specifications with transistor output Operating Voltage: 5VDiode forward Current: 60mAOutput: Analog or digital data Transistor collector current: 100m (maximum) Operating temperature: -25°C to +85°C. Next is the differentiator which gives a negative trigger to the monostable multivibrator which is a NE555 Timer shown in Figure 3-2. It operates from a wide range of power ranging from +5 Volts to +18 Volts supply voltage. Sinking or sourcing 200mA of load current. The output of the monostable multivibrator is inverted and then given to the counter IC74193 which is a synchronous up/down 4-bit binary counter. Synchronous operation is provided by having all flip-flops clocked simultaneously, so that the outputs change together when so instructed by the steering logic. The outputs of the four master-slave flip-flops are triggered by a low-to-high level transition of either count (clock) input. The output of the counter is given to a CMOS OR gate (IC 4072). The 4072 is a member of the 4000 Series CMOS range, and contains two independent or gates, each with four inputs. The pin diagram, shown in Figure 3-5, is the standard four-input CMOS logic gate IC layout: Pins 2-5 and 9-12 are gate inputs for the two gates. The output is then given to decoder IC74139, the output of the decoder is inverted since the decoder is active low and is given as input to the relay driver (ULN 2003).

The relay driver (IC ULN 2003) has the following specifications; Contains 7 high-voltage and high current Darlington pairs. Each pair is rated for 50V and 500mA, Input pins can be triggered by +5V. All seven Output pins can be connected together to drive loads up to (7×500mA) ~3.5A.Its configuration is shown in Table 3-2.which is given as input to the relay whose configuration is shown in Table 3-3. The relay acts as a switch to complete the bulb connection part shown in Figure 3-1, either to dim or turn on the light depending on the inputs given.

Calculations:

Time period of monostable multivibrator = 1.1*R*C 3-1

Where; R=10k ohm, C =1 µF

Hence, $T=1.1*10*10^{3}*1*10^{-6}$

T=11 ms.

3-1 NE555 TIMER

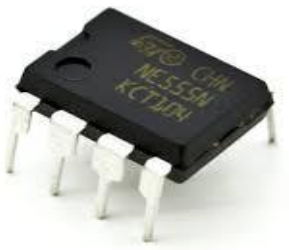

Figure 3-2: NE555 Timer

The 555 timer IC is shown in Figure 3-2. For a 555 timer working as a flip flop or as a multi-vibrator, it has a particular set of configurations. The timer IC is configured in monostable mode. The time period of the mono pulse is 11ms. It operates from a wide range of power ranging from +5 Volts to +18 Volts supply voltage. Sinking or sourcing 200mA of load current. The external components should be selected properly so that the timing intervals can be made into several minutes along with the frequencies exceeding several hundred kHz. The output of a 555 timer can drive transistor-transistor logic (TTL) due to its high current output.

3-2 ULN 2003

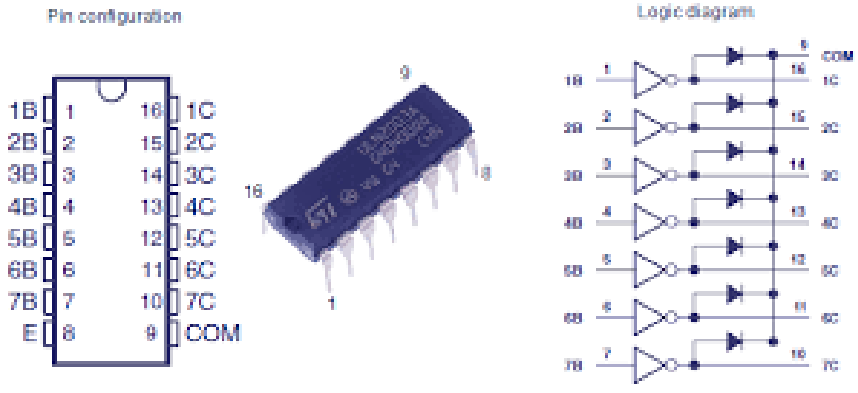

Figure 3-3: ULN2003

ULN2003 IC shown in Figure 3.2 is one of the most commonly used Motor driver IC. This IC comes in handy when we need to drive high current loads using digital logic circuits like Op-maps, Timers, Gates, Arduino, PIC, ARM etc. For example, a motor that requires 9V and

300mA to run cannot be powered by an Arduino I/O hence we use this IC to source enough current and voltage for the load. This IC is commonly used to drive Relay modules, Motors, high current LEDs and even Stepper Motors. The project the driver is used to drive two relays which are connected to bulb.

Pin Number	Pin Name	Description
	Input 1 to Input 7	Seven Input pins of Darlington pair, each pin is connected to the base of the transistor and can be triggered by using +5V
8	Ground	Ground Reference Voltage 0V
9	COM	Used as test pin or Voltage suppresser pin (optional to use)
10 to 16	Output 1 to Output 7	Respective outputs of seven input pins. Each output pin will be connected to ground only when its respective input pin is high(+5V)

Table 3-2: ULN2003 Pin Configuration

3-3 IR SENSOR

An infrared sensor is an electronic instrument that is used to sense certain characteristics of its surroundings. It does this by either emitting or detecting infrared radiation. Infrared sensors are also capable of measuring the heat being emitted by an object and detecting motion. The IR sensors that are being used are to detect person's entry and exit.

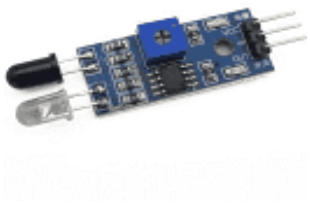

Figure 3-4: IR Sensor

3-4 IC 4072

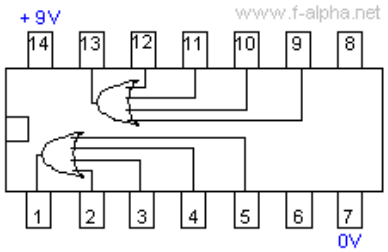

Figure 3-5: IC 4072 Pin Diagram

3-5 5V RELAY

Pin Number	Pin Name	Description
1	Coil End 1	Used to trigger (On/Off) the Relay, Normally one end is connected to 5V and the other end to ground
2	Coil End 2	Used to trigger (On/Off) the Relay, Normally one end is connected to 5V and the other end to ground
3	Common (COM)	Common is connected to one End of the Load that is to be controlled
4	Normally Close (NC)	The other end of the load is either connected to NO or NC. If connected to NC the load remains connected before trigger
5	Normally Open (NO)	The other end of the load is either connected to NO or NC. If connected to NO the load remains disconnected before trigger

Table 3-3: 5v Relay Pin Configuration

4. TESTING SCHEME

1) The inputs to the automated home lighting system are Infrared (IR) sensors. The IR sensor contains IR Light Emitting Diode (LED) and a photodiode. When a person is in close proximity to the sensor, it gives a high pulse whose pulse time period depends upon the duration the person is in proximity to the sensor.
2) When this high pulse is passed through a passive differentiator circuit, we get positive and negative going trigger pulses. When passed through a diode only negative going trigger pulses are passed.
3) The 555 timer IC which is in monostable configuration receives these negative trigger pulses at its trigger pin. As a result of which we get a positive one-shot pulse at its output whose period is 11ms.
4) The output of the monostable multivibrator is given to a hex inverter, due to which the positive one-shot pulse is converted into negative one-shot pulse.
5) These one-shot pulses are given as clock pulses i.e. up and down clock, to the 74193 binary counter which hold the count of the number of people in the room. This counter increments the count at the positive edge of the up-clock pulse while the down pin is held high. Similarly, it decrements the count at the positive edge of the down-clock pulse while the up pin is held high. This counter counts up to a maximum of 15 people.
6) The 4-input CMOS OR gate (4072 IC) receives the 4 outputs of the counter as input and gives a single output which is the logical OR of the inputs. If any one of the inputs is high the output is high.
7) The output of the OR gate is given as inputs to the 74139 2:4 decoder IC. When the first input is high and the second input is low, the third output is activated. Similarly, when both the inputs are high, the fourth output is activated. Here the outputs are active low and are passed through a hex inverter to get an active high output.
8) These hex inverter outputs are given as inputs to the ULN2003 IC which is used as a relay driver. The output pins of which are connected to the relays coil pins. The other end of the relay coil is connected to the power supply. When an input is high the corresponding output pin is grounded and current flows through the relay coil.
9) When the relay driver IC activates the first relay, the common pin gets connected to the normally open (NO) pin and both the bulbs are connected through the lowest resistance path, hence both bulbs have highest intensity. When the second relay is

activated, current flows through the inner room bulb through a potentiometer which results in its decreased intensity and current flows through the outer room bulb directly which results in highest intensity.

5. PROJECT OUTCOMES

Automated Home Lighting System is successfully implemented using Infrared sensors.

The intensity of the bulbs are varying according to the presence of people, no matter the number of people. When a person enters the outer room the bulb present in that room turns on while the bulb of the inner room dims. When a person enters the inner room, the inner bulb fully turns on while the bulb in the outer room still remains on. This lighting system works for more than one person.

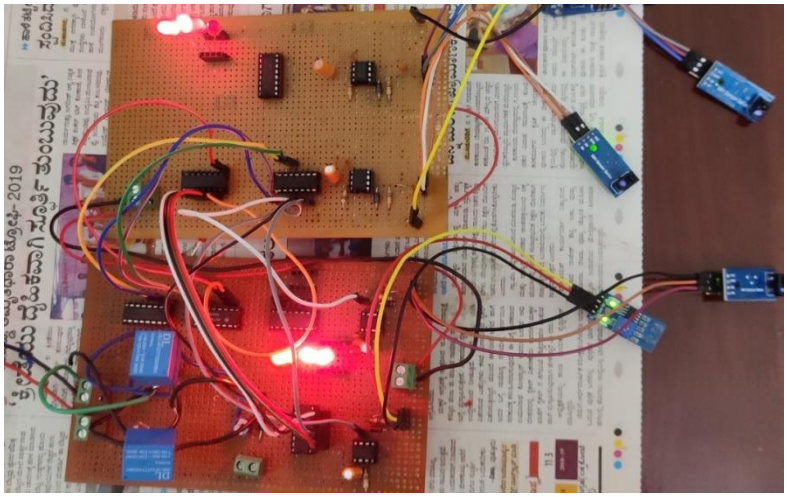

Figure 5-1: Front side of Automated Home Lighting System pcb

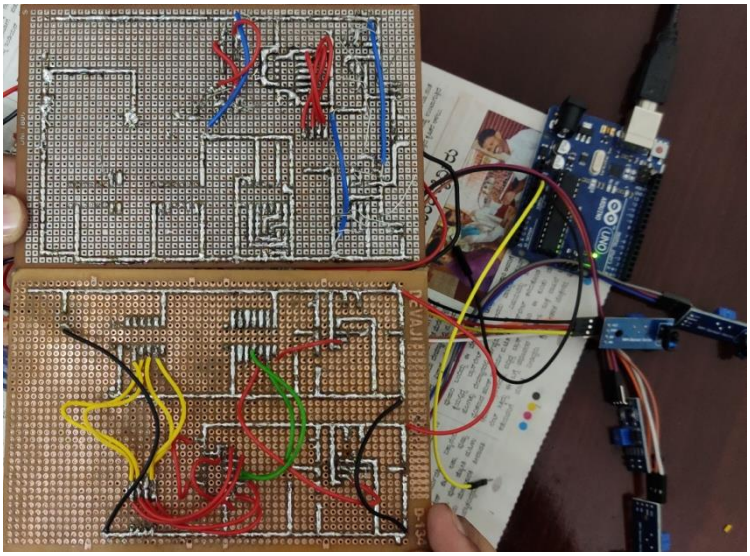

Figure 5-2: Back side of Automated Home Lighting System pcb

The design can be implemented in any offices, houses, hospitals. The design can be improved by increasing the person count, using better infrared sensors of higher sensing range and also by designing the circuit of a greater number of rooms.

REFERENCES

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[2] https://www.google.co.in/search?q=tcrt5000&source=lnms&tbm=isch&sa=X&ved=0ahUKEwj7tMXdsOzlAhWjwTgGHTtOCwsQ_AUIEigB

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