AUTOMATIC ROOM LIGHTING SYSTEM

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DECLARATION

I, **UGOKWE GOLIBE HEINRICH**, declare that this work was done by me and has never been presented elsewhere for the award of a degree. I also hereby relinquish the copyright to the Federal University of Technology Minna.

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DEDICATION

This project is fully dedicated to Almighty God for granting me the strength and inspiration all through my work.

ACKNOWLEDGEMENT

I owe a debt of gratitude to those who were so generous with their expertise and time. My profound gratitude goes to almighty God, who in his infinite mercies protected, guided, directed and inspired me during this masterpiece and most especially throughout my entire stay in this University.

Special thanks goes to my father Engr J.N Ugokwe for his, fatherly advice and cooperation, to the two women that mean so much to my life, my mother Mrs P.C Ugokwe and my only sister Mrs O.C Akande I want to thank God for using you to create a landmark during my school days. May you all live to receive the fruits of your labour. To my two elder brothers thank you for your encouragement and believing that I can do it.

My supervisor Dr Onwuka, I appreciate your effort despite your busy time schedule. to my special friends, you are so dear to me, and finally to TALENT THEATRE (2002-2006 members) a sub-society of Nigeria Federation of Catholic Students FUT Minna, may God bless you for lifting me up when I was down.

ABSTRACT

This circuit is used to switch ON and OFF automatically the light in a room. It uses an up/down counter, two infra-red transmitters and receivers, two comparator IC unit, two timers, a relay, some logic gates and a photo resistor. It also makes use of a seven segment display. It is based on the line of sight characteristics of the infra-red beam, in conjunction with the up/down counter. A person entering or leaving the room breaks abeam which activates the counter to count up or down. A photo- resistor is used to detect when it is dark, so that the device works only at night, thus saving power during the day.

This tested after construction and was found to perform satisfactorily. It could be used in residential homes but is much more useful in public places like halls or corridors where no one is particularly charged with the duty of switching the lights ON or OFF at required times.

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CHAPTER ONE

GENERAL INTRODUCTION

Advancement in our every day lives is of optimum importance. as the saying goes "Change is the only constant thing in life". As technological advancement in the society we belong has become a necessity, so does human being encounter problems and desire solutions for the problems encountered.

Manual operation of equipment, machines, home appliances, etc has been the order of the day, this has increased financial cost as bills of various kind has to be settled ranging from labour, utility, etc, increased time consumption. increased human energy dissipation. These are problems that seek solution s in our everyday lives.

In view of this, **automation** is a way of proffering solution. Automation is a process of writing a set of instructions that are designed, scripted and checked in by a person, then executed by a machine to produce results that can be analyzed. [1]

Against this back drop. the need for automatic control system in switching ON and OFF lights in the room. auditoriums, theatres, etc have made electronic systems more powerful and easier to use.

Electronic systems refine, extend or supplement human facilities and ability to observe, perceive, communicate, remember, calculate, or reason. Electronic systems are classified as either analog or digital.

Analog systems changes their signals linearly with the input and can be represented on a scale by means of a pointer, on the other hand, digital instruments or circuit, represents their output on a digital display either numerically or alphabetically.

There are various forms of automatic room light systems which include photo-electric automatic room light system, infrared automatic room light system, temperature automatic room light system, etc most of which operate on the same principle of turning ON and OFF, which is sensor dependent, also the combination of both analog and digital circuits in the realization of an automatic room light switch.

This project is an infrared automatic room light system of which the basic principle of this design is to turn ON the light when an individual enters the room and turn it OFF when the individual leaves the room, this works basically with the aid of sensors (photo-detector and infrared diode) These sensors, two in number are positioned at particular locations at the entrance of a door, sense's an individual(s) on entry and sends an information to the counter which counts in an ascending other and in descending other when the individual(s) leaves the room.

All systems have their merits and de-merit but the benefit of this system aids in solving or reducing to the barest minimum the afo-mentioned problems. This particular automatic room light systems advantage over the sound, is that one, need not make any sound what so ever for the system to function, moreso sound could conflict leading to improper functioning of the system.

Methodology: This automatic room lighting project is able to detect the number of people in a room, and only goes off when there is nobody in the room, the system is also able to detect if the light in the room is necessary, that is at dawn (when every where is bright, there is no need for the light to come on, since the light wont be noticeable, this thus saves utility bills on the light

Entry: On entry, an individual walks in and breaks infrared and photo-diode beam placed on entry to the room (sensors1), by doing so, a beam is broken. From the infrared to the photo-diode, an up/down counter is clocked and counts 1, at the same time the other infrared and photo-diode in the room (sensors2) is deactivated for 5 (five) seconds, thus making sensor2 non-functional. The purpose which is to avoid clocking of the up/down counter by the breaking of sensor2 by the same person who is entering the room. The two sensors (sensor1 and sensor2) are placed close to each other: so that the individual breaks the first beam and passes before 5 (five) seconds elapses.

If another individual enters the room again, the counter counts in ascending order.

Exit: On exit, if an individual leaves the room. the individual breaks sensors2's beam first, so it clocks the counter and it counts down. Thus if for instance the count in the room was three (3), it would count down to two (2), this it would continue in descending other, until it gets to the last count which is zero (0). At the same time sensor1 is deactivated for five (5) seconds, so the person passes sensor1 and goes out without affecting the count.

The light in the room only goes out if the count is zero (0), so if the last person leaves, the count reduces to zero and the light goes off automatically. the photo-resistor sensor is placed outside and connected to the voltage comparator of both sensor1 and sensor2, so that when it is day time it deactivates the sensors, so if someone goes in or comes out, the light would remain off. A reset button is available to reset the system in the event of any mal-function.

1.1 Aims and Objectives

Aim. Design and construction of an automatic room lightening system

Objectives: Reduce utility bills.

To ensure accurate count of individuals in a building.

CHAPTER TWO

LITERATURE REVIEW

The need for automation has come to stay and this dates back to 1500 when the first water pump for metal working rolling mills for coinage strips was developed [2] from then till date the automation world has continued to grow tremendously.

Automation is the art of making processes or machines self-acting or self-moving, it also pertains to the technique of making a device, machine, process or procedure more fully automatic, it is a self-controlling or self-moving processes. [3, 4]

Automation is usually characterized by two major principles: (1) mechanization. i.e machines are self-regulated so as to meet predetermined requirements (a simple example of self-regulation can be found in the operation of a thermostatically controlled furnace); (2) continuous process, i.e production facilities are linked together, thereby integrating several separate elements of productive process into a unified whole. [5]

Automation in the electrical, electronics and computing world has grown rapidly of which it dates back to 1940 when the first electronics computing machine was developed. [2], this has aided humans as it basically reduces/eliminates human intervention, of which automatic light switching system also makes the list of automation in the electro-computing world

Switches which are the bases of this project may be the most ubiquitous mechanical devices in our technological society. Most every machine needs to be turned on or turned off at some point, and that's typically done by activating a switch. There are an incredible variety of switches. One major switch manufacturer alone produces more than 3 million different switches! Digital and computerized switches are becoming more common in both the home and workplace, especially for automatic and semi-automatic applications.

Below is a short list of different types of switches:

Illuminated LCD programmable keylock, paddle, rocker and toggle, pushbutton and pushwheel, rotary.

The most basic electrical switch completes or breaks a circuit depending upon what position it is in. Back in time we recall constructing science projects or experiments that required us to build a small electrical circuit that included a battery and a flashlight bulb. When the simple switch was moved, it completed the circuit and the bulb would glow. More complex switches work in the same basic manner. In addition to turning machines on, they can change the speed of the motor or the strength of the lighting.

Some switches work automatically, incorporating a tiny microprocessor that turns the machine on (or off) according to preset instructions. An example of a low-tech (pre-digital age) automatic switch is the thermostat used to maintain a set temperature in a home or building. These switches used a small glass vial containing a drop of mercury. When the temperature indicator moved beyond a certain level, the drop of mercury would move into contact with metallic contact points that extended into the glass vial. Being a metal itself, the liquid mercury would complete the circuit and activate the furnace or air conditioner (as the case may be). Mercury switches are used rarely nowadays, and they should be disposed of using hazardous waste protocols due to the high toxicity of metallic mercury in the environment. [6]. Another example of switch that works automatically but a high tech one is an automatic room lighting system, which ranges from sound automatic room light system, infrared automatic room light system, temperature automatic room light system in addition to the basic principle stated above, the principle behind these automatic room light system is that the light turns ON and OFF automatically which is sensor dependent.

For this project design, the principle behind this is that when a person enters a room, a light sensor placed at a particular location gets a pulse and the light comes ON and when the person goes out, the same sensor gets another pulse and the light goes OFF. [7]

This automatic room lighting switch has both financial and security benefits.

Financial savings: By setting lights to come on only at certain times, you can reduce utility bills.

Security: With this kind of device, you can link lights to a timer so they come on when it gets dark. You'll never have to return home to a dark house.

One basic limitation to this device is that it encounters the problem that when more than one person enters the room one after the other the light sensors get more than one pulse and the light remains in the OFF state.

Modification of the above example of automatic room lighting system is solving the problem/limitation encountered, which is the introduction of two sensors and up/down counter. The system also uses a photo resistor to deactivate the system when the vicinity is bright, so the light only comes on at night when someone is in the room, thus deactivating the system during the day even if someone is in the room.

CHAPTER THREE

DESIGN AND IMPLEMENTATION

This project work undertaken should work in conformity with the design specifications. For the purpose of analysis, this project design is described with the aid of block diagram as presented below.

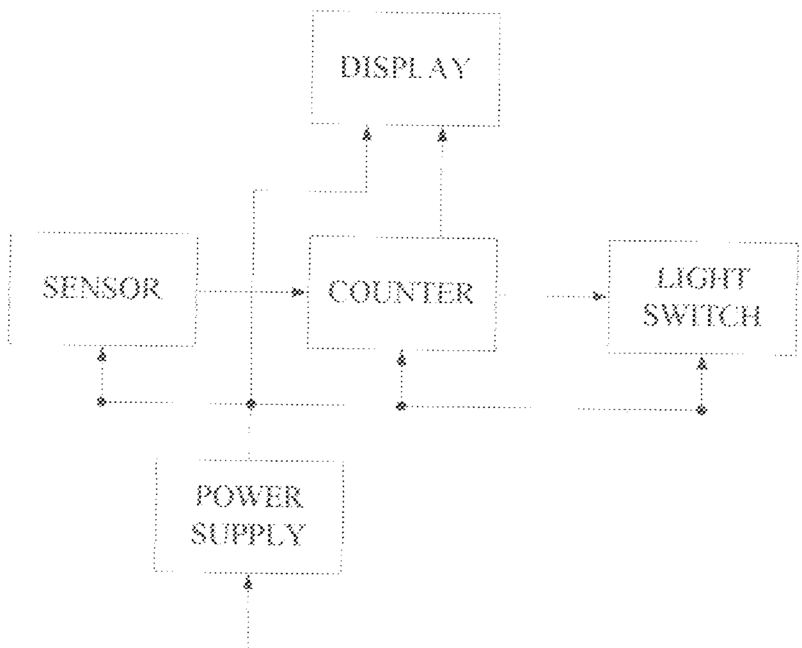

Figure 3.0 block diagram of the automatic light switch.

Design Specification

Input voltage:	220volts AC
Supply voltage:	+9volts
Infrared detection range:	1meter
Maximum count:	99 (i.e. no of people to enter the room)

3.1 Component Theory

3.1.1 Comparator (Lm 393)

The LM393 series consists of two independent precision voltage comparators with an offset voltage specification as low as 2.0 mV max for two comparators which were designed specifically to operate from a single power supply over a wide range of voltages. Operation from split power supplies is also possible and the low power supply current drain is independent of the magnitude of the power supply voltage. These comparators also have a unique characteristic in that the input common-mode voltage range includes ground, even though operated from a single power supply voltage. It has the following features: Wide supply (Voltage range: 2.0V to 36V. Single or dual supplies: ±1.0V to ±18V), Very low supply current drain (0.4 mA) independent of supply voltage, Input common-mode voltage range includes ground, Differential input voltage range equal to the power supply voltage

Application areas include limit comparators, simple analog to digital converters; pulse, square wave and time delay generators; wide range V_{CC}; MOS clock timers; multivibrators and high voltage digital logic gates

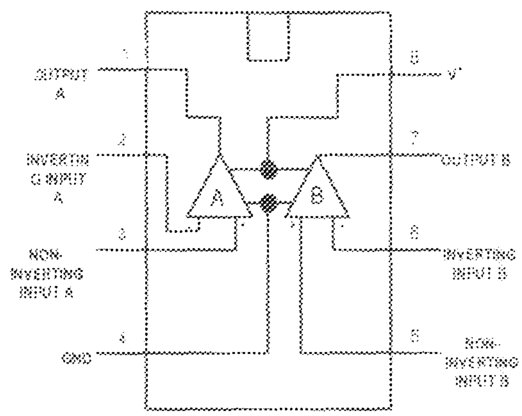

Fig. 3.1 top view of Lm 393 comparator

[8]

3.1.2 Timer IC (Lm555)

The LM555 is a highly stable device for generating accurate time delays or oscillation. Additional terminals are provided for triggering or resetting if desired. In the time delay mode of operation, the time is precisely controlled by one external resistor and capacitor. For astable operation as an oscillator, the free running frequency and duty cycle are accurately controlled with two external resistors and one capacitor. It has the following features: Direct replacement for SE555/NE555; Timing from microseconds through hours; Operates in both astable and monostable modes; Adjustable duty cycle, Temperature stability better than 0.005% per °C; Normally on and normally off output, Available in 8-pin

Precision timing; Pulse generation; Sequential timing, Time delay generation; Pulse width modulation; Pulse position modulation; Linear ramp generator

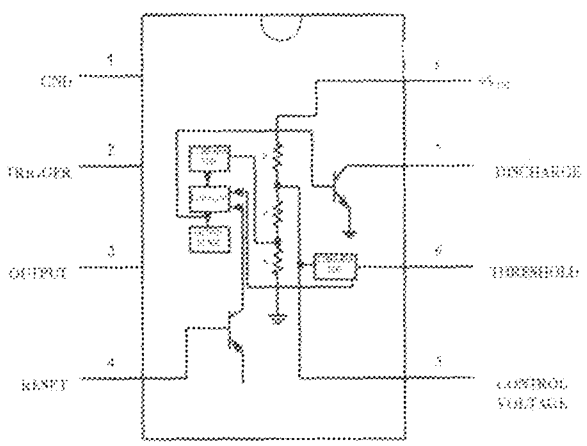

Fig. 3.2 Top view of Lm555

Monostable operation:

In this mode of operation, the timer functions as a one-shot (Fig. 3.1.2.1). The external capacitor is initially held discharged by a transistor inside the timer. Upon application of a negative trigger pulse of less than 1/3 VCC to pin 2, the flip-flop is set which both releases the short circuit across the capacitor and drives the output high.

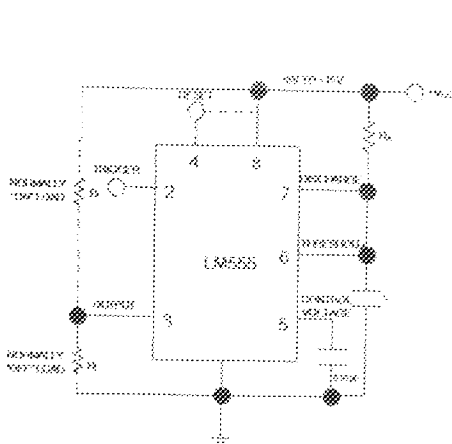

Fig. 3.3 internal circuitry of the monostable Lm 555

The voltage across the capacitor then increases exponentially for a period of $t = 1.1\ RA\ C$, at the end of which time the voltage equals 2/3 V_{CC}. The comparator then resets the flip-flop which in turn discharges the capacitor and drives the output to its low state. [9]

3.1.3. Photodiodes

Photodiodes are a two-electrode, radiation-sensitive junction formed in a semiconductor material in which the reverse current varies with illumination. They are used for the detection of optical power and for the conversion of optical power to electrical power. Photodiodes can be PN, PIN, or avalanche. PN photodiodes: This features a two-electrode, radiation-sensitive PN junction formed in a semiconductor material in which the reverse current varies with illumination. PIN photodiodes: These are diodes with a large intrinsic region sandwiched between P-doped and N-doped semi conducting regions. Photons absorbed in this region create electron-hole pairs that are then separated by an electric field, thus generating an electric current in a load circuit.

Avalanche photodiodes: These are devices that utilize avalanche multiplication of photocurrent by means of hole-electrons created by absorbed photons. When the device's reverse-bias voltage nears breakdown level, the hole-electron pairs collide with ions to create additional hole-electron pairs, thus achieving a signal gain.

The photodiode spectral response can be measured in X-ray, UV, visible, or IR. X-ray photodiodes are optimized for X-ray, gamma ray, and beta radiation detection. UV enhanced photodiodes are optimized for the UV and blue spectral regions, which requires special fabrication processes. Visible photodiodes operates in the visible range without enhancement for operation in UV or IR.

IR enhanced photodiodes are optimized for the near IR spectral region, which requires special fabrication processes. The spectral response range of incident light the photodiode detects is also called wavelength range. Important active area specifications to consider include active area diameter or length and active area height.

The active area height is applicable to photodiodes that are not circular. Photodiode arrays are packaged as multiples. Photodiode arrays will contain a certain number of elements (Photodiodes). Some photodiodes can be a position sensitive detector. Important photodiode performance specifications to consider include sensitivity, rise time, quantum efficiency, and operating temperature

Sensitivity is a measure of the effectiveness of a detector in producing an electrical signal at the peak sensitivity wavelength. Rise time is the time necessary for a detector's output to go from 10% to 90% of its final value. A photodiode's capability to convert light energy to electrical energy, expressed as a percentage, is its quantum efficiency. [10]

3.1.4 Dual D-type flip-flop with set and reset; Positive-edge trigger

The 74HC/HCT74 are high-speed Si-gate CMOS devices and are pin compatible with low power Schottky TTL(LSTTL). They are specified in compliance with JEDEC standard no. 7A. The 74HC/HCT74 are dual positive-edge triggered, D-type flip-flops with individual data (D) inputs, clock (CP) inputs, set ($\bar{S}_D$) and reset ($\bar{R}_D$) inputs; also complementary Q and $\bar{Q}$ outputs. The set and reset are asynchronous active LOW inputs and operate independently of the clock input. Information on the data input is transferred to the Q output on the LOW-to-HIGH transition of the clock pulse. The D inputs must be stable one set-up time prior to the LOW-to-HIGH clock transition for predictable operation. Schmitt-trigger action in the clock input makes the circuit highly tolerant to slower clock rise and fall times.

It features include the following, Output capability: standard, I_{CC} category: flip-flops

Table 3.1Pin Description

PIN NO.	SYMBOL	NAME AND FUNCTION
1, 13	$1\bar{R}_D, 2\bar{R}_D$	asynchronous reset-direct input (active LOW)
2, 12	1D, 2D	data inputs
3, 11	1CP, 2CP	clock input (LOW-to-HIGH, edge-triggered)
4, 10	$1\bar{S}_D, 2\bar{S}_D$	asynchronous set-direct input (active LOW)
5, 9	1Q, 2Q	true flip-flop outputs
6, 8	$1\bar{Q}, 2\bar{Q}$	complement flip-flop outputs
7	GND	ground (0 V)
14	V_{CC}	positive supply voltage

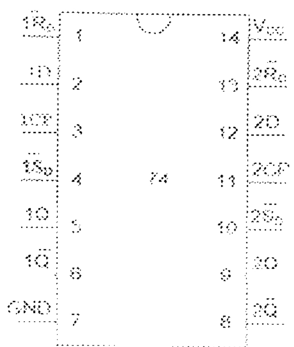

Fig.3.4 Connection Diagram of Dual D-type flip-flop with set and reset

Table 3.2 Functional Table 1

INPUTS				OUTPUTS	
$\overline{S_D}$	$\overline{R_D}$	**CP**	**D**	**Q**	$\overline{Q}$
L	H	X	X	H	L
H	L	X	X	L	H
L	L	X	X	H	H

Table 3.3 Functional table 2

INPUTS				OUTPUTS	
$\overline{S_D}$	$\overline{R_D}$	**CP**	**D**	Q_{n+1}	$\overline{Q_{n+1}}$
H	H	↑	L	L	H
H	H	↑	H	H	L

Note

H = HIGH voltage level
L = LOW voltage level
X = don't care
↑ = LOW-to-HIGH CP transition
Q_{n+1} = state after the next LOW-to-HIGH CP transition [11]

3.1.5. Presettable synchronous 4-bit binary up/down counter74HC/HCT190

The 74HC/HCT190 are high-speed Si-gate CMOS devices and are pin compatible with low power Schottky TTL (LSTTL). They are specified in compliance with JEDEC standard no. 7A. The 74HC/HCT191 are asynchronously presettable 4-bit binary up/down counters. They contain four master/slave flip-flops with internal gating and steering logic to provide asynchronous preset and synchronous count-up and count-down operation. Asynchronous parallel load capability permits the counter to be preset to any desired number. Information present on the parallel data inputs (D0 to D3) is loaded into the counter and appears on the outputs when the parallel load ($\overline{PL}$) input is LOW. As indicated in the

HIGH level on the count enable ($\overline{CE}$) input. When $\overline{CE}$ is LOW internal state changes are initiated synchronously by the LOW-to-HIGH transition of the clock input. The up/down ($\overline{U}$/D) input signal determines the direction of counting as indicated in the function table. The $\overline{CE}$ input may go LOW when the clock is in either state, however, the LOW-to-HIGH $\overline{CE}$ transition must occur only when the clock is HIGH. Also, the $\overline{U}$/D input should be changed only when either $\overline{CE}$ or CP is HIGH. Overflow/underflow indications are provided by two types of outputs, the terminal count (TC) and ripple clock ($\overline{RC}$). The TC output is normally LOW and goes HIGH when a circuit reaches zero in the count-down mode or reaches "15" in the count-up-mode. The TC output will remain HIGH until a state change occurs, either by counting or presetting, or until $\overline{U}$/D is changed. Do not use the TC output as a clock signal because it is subject to decoding spikes. The TC signal is used internally to enable the RC output. When TC is HIGH and $\overline{CE}$ is LOW, the RC output follows the clock pulse (CP). This feature simplifies the design of multistage counters.

Its features include the following; Synchronous reversible counting, Asynchronous parallel load, Count enable control for synchronous expansion, Single up/down control input, Output capability, standard, I_{CC} category: MSI

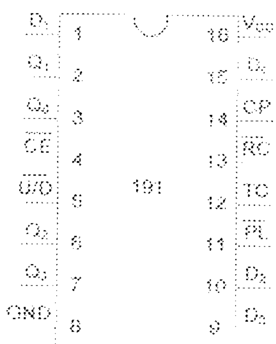

Fig. 3.5 Connection Diagram of up/down counter74HC/HCT190

Table 3.4 Pin Description up/down counter 74HC/HCT190

PIN NO.	SYMBOL	NAME AND FUNCTION
3, 2, 6, 7	Q_0 to Q_3	flip-flop outputs
4	$\overline{CE}$	count enable input (active LOW)
5	$\overline{U}/D$	up/down input
8	GND	ground (0 V)
11	$\overline{PL}$	parallel load input (active LOW)
12	TC	terminal count output
13	$\overline{RC}$	ripple clock output (active LOW)
14	CP	clock input (LOW-to-HIGH, edge
15, 1, 10, 9	D_0 to D_3	data inputs
16	V_{CC}	positive supply voltage

[12]

3.1.6 BCD to 7-Segment Decoder/Driver with Open-Collector Outputs

The DM74LS47 accepts four lines of BCD (8421) input data, generates their complements internally and decodes the data with seven AND/OR gates having open-collector outputs to drive indicator segments directly. Each segment output is guaranteed to sink 24 mA in the ON (LOW) state and withstand 15V in the OFF (HIGH) state with a maximum leakage current of 250 mA. Auxiliary inputs provided blanking, lamp test and cascadable zero-suppression functions.

Its features include the following: Open-collector outputs, Drive indicator segments directly, Cascadable zero-suppression capability, Lamp test input

Table 3.5 Pin Descriptions of a BCD to 7-Segment Decoder/Driver with Open-Collector Outputs

Pin	Names Description
A0–A3	BCD Inputs
$\overline{RBI}$	Ripple Blanking Input (Active LOW)
$\overline{LT}$	Lamp Test Input (Active LOW)
$\overline{BI}/\overline{RBO}$	Blanking Input (Active LOW) or Ripple Blanking Output (Active LOW)
$\overline{a}$ – $\overline{g}$	Segment Outputs (Active LOW) (Note 1)

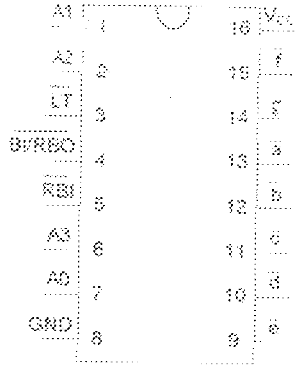

Fig. 3.6 Connection Diagram of a BCD to 7-Segment Decoder/Driver with Open-Collector Outputs

The DM74LS47 decodes the input data in the pattern indicated in the Truth Table and the segment identification illustration. If the input data is decimal zero, a LOW signal applied to the $\overline{RBI}$ blanks the display and causes a multidigit display. For example, by grounding the $\overline{RBI}$ of the highest order decoder and connecting its $\overline{BI}/\overline{RBO}$ to $\overline{RBI}$ of the next lowest order decoder, etc., leading zeros will be suppressed. Similarly, by grounding RBI of the lowest order decoder and connecting its $\overline{BI}/\overline{RBO}$ to $\overline{RBI}$ of the next highest order decoder, etc., trailing zeros will be suppressed. Leading and trailing zeros can be suppressed simultaneously by using external gates, i.e.: by driving RBI of a intermediate decoder from an OR gate whose inputs are $\overline{BI}/\overline{RBO}$ of the next highest and lowest order decoders. $\overline{BI}/\overline{RBO}$ also serves as an unconditional blanking input. The internal NAND gate that generates the RBO signal has a resistive pull-up, as opposed to a totem pole, and thus $\overline{BI}/\overline{RBO}$ can be forced LOW by external means, using wired collector logic. A LOW signal thus applied to $\overline{BI}/\overline{RBO}$ turns off all segment outputs. This blanking feature can be used to control display intensity by varying the duty cycle of the blanking signal. A LOW signal applied to $\overline{LT}$ turns on all segment outputs, provided that $\overline{BI}/\overline{RBO}$ is not forced LOW. [13]

3.1.7 Seven Segment Display

Many electrical calculators, clocks, cash register and measuring instruments have seven segments red or green Led displays as numerical indicators, each segment is a LED and depending on which segments is energized. The display lights up the numbers 0 to 9 Each segment requires a separate current limiting resistor and the entire cathode are joined together to form a common connection. [14]. Its features include the following: its characteristics include small size, reliability, long life, small current requirement and high operating speed.

3.1.8 Relay

A relay is a switch operated by an electromagnet, it is useful if we want a small current in one circuit to control another circuit containing a device such as lamp or electric motor which requires a large current, or if we wish several different switch contacts to be operated simultaneously [15] .In this project, a relay was used to control the switching effect of the bulb used.

3.1.9. Other Passive Components

Passive components are components, which cannot power and require an external power source to operate. They include resistors, capacitors, indicators, transformers, etc their application range from potential divider to control of current (as in resistors), filtration of ripples voltages and blocking of unwanted D.C voltages (as in capacitors). They form the elements of the work circuit oscillator stages and are also used generally for signal conditioning in circuits. Their schematic diagram and symbols are shown in fig. 3.7

Fig 3.7 Schematic representation of some passive components

3.2 Power Supply

This is the source of power to the entire system. It regulates the 220voltsAC voltage to supply 9volts, to different parts of the system. It also provides a common ground for the entire system.

Most of the electronic devices and circuits require a DC source for their operations. Dry cells and batteries are one form of DC source. They have the advantage of being potable and ripple free. However their voltages are low, they need frequent replacement and are expensive as compared to conventional DC power supplies. Since the most convenient and economical source of power is the domestic AC supply, it is advantageous to convert this alternating voltage (usually, 220V *rms*) to DC voltage (usually smaller in value). This process of converting AC voltage into DC voltage is called *rectification* and is accomplished with the help of a (i) Rectifier (ii) filter and (iii) voltage regulator circuit

These elements put together constitute DC power supply. Thus there are two types which are (i) Regulated (ii) Unregulated power supply.

For this project design we would be dealing with the regulated power supply because it is desired that a regulated supply is fed to the circuit and also it is the power supply whose terminal voltage remains almost constant regardless of the amount of current drawn from it.

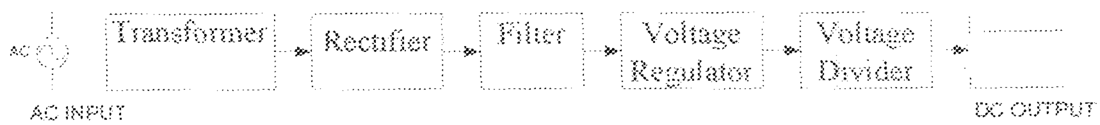

Fig 3.8 DC power supply stages

A typical DC power supply consist of five stages as shown above

1. **Transformer**. Its job is either to step-up or (mostly) step-down the AC supply voltage to suit the requirement of the solid state electronic device and circuits fed by the DC power supply. It also provides isolation from the supply line- an important safety consideration.

2. **Rectifier.** It is a circuit which employs one or more diodes to convert ac voltage into pulsating DC voltage

3. **Filter.** The function of this circuit is to improve the fluctuations of pulsations (ripples) present in the output voltage supplied by the rectifier.

4. **Voltage Regulator**. Its main function is to keep the terminal voltage of the DC supply constant even when AC input voltage to the transformer varies (deviation from 220V are common) or when the load varies

Usually, Zener diodes and transistors are used for voltage regulation purposes. NB It is impossible to get 100% constant voltage but minor variations are acceptable for most of the jobs

5. **Voltage Divider**. It s function is to provide different DC voltages need by different electronic circuits. It consists of a number of resistors connected in series across the output terminals of the voltage regulator. [16]

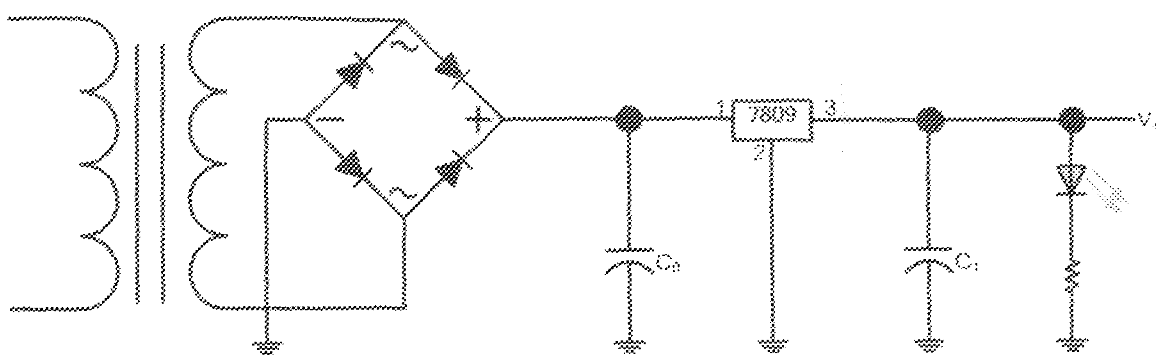

Fig 3.9 Power Supply Circuit

The rectifier is designed with four IN4007 diode to form a full wave bridge rectification. The IN 4007 diode is being used because it has a current rating of 1A and a voltage rating of 0-600v. The circuit design has 9V as its maximum circuit voltage. The voltage regulator to be used is a 7809 regulator as we desire a positive 9volts supply to the circuit, thus an appropriate step-down transformer rating is desired of which a 220/12V transformer suites best

3.2.1 Power Supply Design Analysis

For an rms voltage of 12V from the transformer

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

$= 12 \times \sqrt{2}$

$= 16.97V$

Hence letting

Ripple voltage dv = 3V

Current I = 1A

We use the formula $I = C\frac{dv}{dt}$ ....1_i

Where $C = C_1$

$C_1 = I\frac{dt}{dv}$ ....1_b

Where dt is time interval between peaks

$dt = \frac{1}{2}T$

but recall $T = \frac{1}{f}$

where f = 50Hz (Nigeria's standard frequency rating)

$$dt = \frac{1}{2 \times 50} = 0.01$$

$$\therefore C_1 = \frac{1 \times 0.01}{3} \text{ ------------from } I_b$$

$$C_1 = 3.33 \times 10^{-3}$$

$$= 3333\ \mu F$$

The preferred value of 3300μF for C_1 is being employed, a compensating capacitor C_2 of 100 μF is being employed to produce smother signal.

3.3 Sensors

This module is divided into to sub-module which are

1. Break Beam Door Sensor
2. Light Sensor

3.3.1 Break Beam Door Sensor

This consists of the infrared emitter and the photodiode receiver, positioned inside and outside the door, to sense when someone enters and leaves the room. The module also consists of comparators and passive components such as resistors and capacitors The break door beam controls a monostable multivibrator and counter The whole system consists of two break door sensor stages.

This module is made up of two stages the transmitter stage and the Receiver stage

3.3.1.1 Transmitter Stage

This stage is not to complex since no coding is involved. Basically it is made up of infrared emitter and passive component like resistor. The infrared diode is forward biased to meet the electrical conditions. which it operates. Fig. 3.10 below shows the infrared emitter stage.

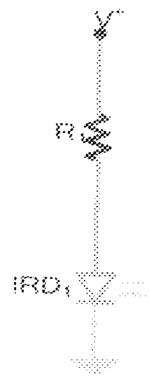

Fig. 3.10 Transmitter stage

V^+ = Power supply = +9V

R_1 = Limiting resistor

For the diode to be forward biased, the maximum forward voltage V_F = 1.7V

Maximum forward current. I_F = 150mA

The resistor R_1 would therefore be

$$R_1 = \frac{(V^+) - (V_F)}{I_F}$$

$$R_1 = \frac{9 - 1.7}{150mA}$$

R_1 = 48.67 Ω

A preferred value of 33 Ω was used

3.3.1.2 Receiver Stage

This stage is basically made up of photodiode receiver and the comparator. Fig. 3.11 shows the receiver stage.

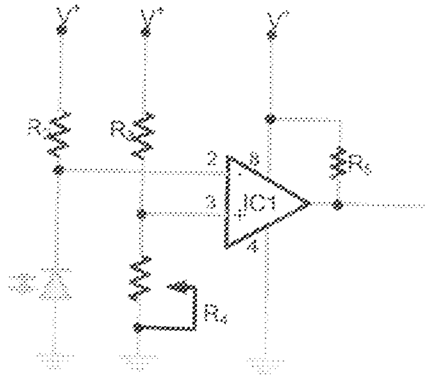

Fig. 3.11 Receiver Stage

A section of the receiver stage is made up of opto- device / transducer devices that responds to light energy to any other form of light energy. The opto- device employed is a photodiode (PW81) which responds to light and in effect reduces in resistance. The photodiode which senses the emission from the infrared, results in resistance reduction and when not sensing any emission results in resistance increment.

In the event of breaking the beam, the resistance increases. This increase in resistance can be used to control the circuit, in this way one is able to know that if the resistance of the photodiode increases then someone has broken the beam. In this way the motion of people can be sensed. This change of resistance of photodiode is observed using a voltage comparator LM 393 which is a dual comparator which compares voltages and gives output in the following manner. If the inverting input is greater than or equal to the non-inverting input, the output is high (1) and if the non-inverting inputs is greater than the inverting input, the output is low (0). The photodiode is connected to the non-inverting input of the voltage comparator via a voltage divider system. the maximum resistance of the photodiode is 1MΩ hence the maximum resistance of the input voltage is calculated thus

R_3 is set to 1MΩ

$V^+ = 9V$

The voltage drop across $R_3 = \frac{(R_2)\times(V)}{(R3)+(R_2)}$

$$V_{R3} = \frac{(1M)\times(9)}{(1M)+(1M)}$$

$V_{R3} = 4.5V$

Therefore when the beam is broken, the voltage into the non-inverting input is 4.5V at this instance however, a high is required at the output therefore the input into the inverting should be greater than 4.5V, so we use a voltage divider to get this voltage.

$R_4 = 4.7K\Omega$ preset resistor is to aid in setting the voltage at non-inverting input to be less than 4.5V thus making the output to be high when someone breaks the beam and low when the photodiode is sensing the infrared.

$R_5 = 1K\Omega$ resistor is known as the pull up resistor and it value is required as specified in data sheet. It is connected to pins 8 and 1 of the comparator. Pins 8 and 4 are power and ground pins respectively.

3.3.2 Light Sensor Module

This unit consists of the photo-resistor positioned outside the room/house to sense light, so the system does not put on the light if the vicinity is bright, since the light would not serve any purpose and the utility bills would be accumulating.

It also consists of a comparator and some passive components like resistors and capacitors

This module is made up of an opto-device that sense light, it's commonly called light sensor, comparator and passive components like resistor. Fig. 3.2.2.1 shows the light sensor module.

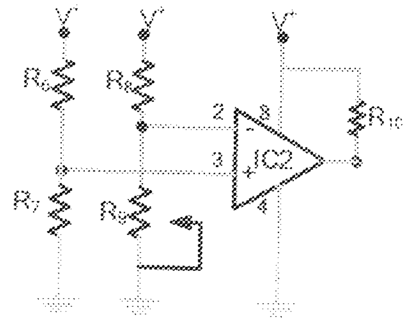

Fig. 3.12 Light sensor module

The light dependent resistor, light energy falling on semiconductor material, such as cadmium sulphide, causes a change in resistance. The resistance of an LDR in total darkness is about 10MΩ, in normal room lighting it falls to about 10KΩ and in bright sunlight about 100Ω. The LDR, with a surface which is exposed to light, can carry several milliamperes, an amount which is sufficient to operate a relay. They are used in photographic lightmeters, security alarms and street light controllers. [17]

The workability of this sub-module is same as that of the transmitter stage

3.4 Counter

It consists of two BCD counters, to count the number of people entering the room or leaving the room. This up/down counter (74190) counts up (increasing value) or counts down (decreasing value) depending on the input pulse applied to the count up pins and the count down pins. The maximum count of this counter is 99 (ninety nine). This unit also consists of passive components such as resistors and capacitors.

This module is made up of the following stages: the one shot monostable stage, astable stage, the memory latch and logic control stage, and up/down counter stage

3.4.1 One Shot Monostable Stage

The one- shot monostable stage is made up of a timer known as LM555. It generates one shot of clock pulse each time the sensor detects somebody entering the door. It's triggered from the output of the comparator, which senses the breaking of the beam and sends its clock to the input of and OR gate. The output of the 555 timer which is dependent on the output of the comparator is made an input of the second OR gate. Figure 3.13 shows the one shot monostable stage

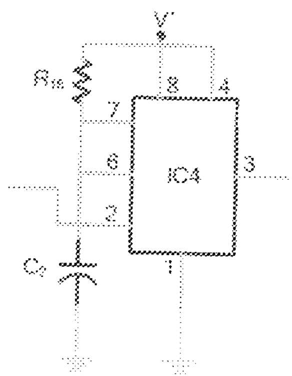

Fig. 3.13 One Shot Monostable Stage

3.4.1.1 One shot monostable stage Design Analysis

From the design it is set that this stage is to time for five seconds (to allow for fast triggering) thus going by the formula

$T = 1.1\,RC$

Where $R = R_{16}$ and assuming a value of 100K

$$C = \frac{T}{1.1 \times R} = \frac{5}{1.1 \times 100K} = \frac{5}{110000}$$

$C_2 = 45\mu F$

A preferred value of 47 μF was however employed.

3.4.2 Astable Stage

This stage is also known as the counter calibrated stage it generates sequences of which its output from pin 3 is fed to pin 3 of IC7 (D- flip-flop). Basically its function is to provide pin 3 of IC7 with steady clock pulse, as it is required by pin 2 of IC7. It is an astable 555 timer. Fig.3.14 shows the astable stage.

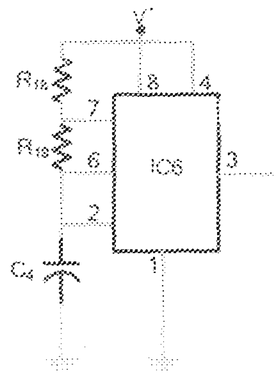

Fig.3.14 the astable stage.

3.4.2.1 Design Analysis of the Astable Stage

$$f = \frac{1}{T} = \frac{1.44}{(R_A + 2R_B)C}$$

Where $R_A = R_B = R_{18} = R_{19} = 10k$

Assuming $f = 5Hz$

$$C_4 = \frac{1.44}{(10k + 2 \times 10k)5} = \frac{1.44}{(10k + 2 \times 10k)5} = \frac{1.44}{150K}$$

$C_4 = 9.6\ \mu F$

A preferred value of 10 μF was employed

3.4.3 The Memory Latch and Logic Control Stage

This stage comprises of IC 7 (D- type flip-flop 7474), IC 12 and 13 (OR gates) and IC 14 (AND gates). Fig. 3.15 shows the memory latch and logic stage.

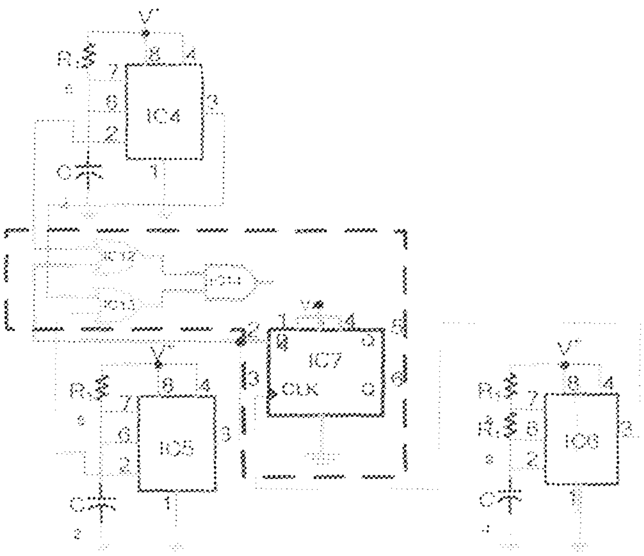

Fig. 3.15 shows the memory latch and logic stage which is enclosed in dotted line

3.4.3.1 Design Analysis of Memory Latch and Logic Control Stage

The inputs of IC12 is dependent on output of IC1 and IC5 while the input of IC13 is dependent on output of IC3 and IC4, it should be however noted that these input are dependent on the state of sensors. The outputs of these IC's (IC12 and 13) are made the input of IC14. The output of IC14 is sent to pin 14 of IC9.

Pin 3 of IC7 receives steady clock pulse from pin 3 of IC6. Pin 2 of IC7's input is dependent on the output of IC5. It should be noted that no mater what is received at pin 2 it would be the same that would be the output at pin 5 which would be sent to pins 5 of IC9 and 8.

3.4.4 Up/Down Counter Stage

This stage is made up of IC 9 and 8 (preseitable synchronous 4 bit binary up/down counter 74HC74HCT190). This IC employed has three clock inputs called CE (clock enable), CP (clock pulse), and U/D (up/down).

3.4.4.1 Design Analysis of Up/Down Counter Stage

The CE is set low, so it enables the CP. The CP is a one – shot clock pulse which clocks the IC when at the positive clock transition i.e from low to high clock transition. If the U/D is low at the instant of the clock pulse, the IC would count up and if the U/D is high at the instant of the clock pulse, the IC would count down and this takes place at pin 5. It should be noted that the operation of this stage is dependent on the sensor. Two ICs are employed here in the event of having more than nine counts.

3.5 Display

This consists of BCD- to – seven segment decoder driver (7447) and the seven segment display unit. The decoder converts the 4 BCD inputs from the up/down counters to seven outputs to light the seven LEDS that form the seven segment display.

This module basically consists of the decoder stage and the display stage. Fig.3.16 shows the display module

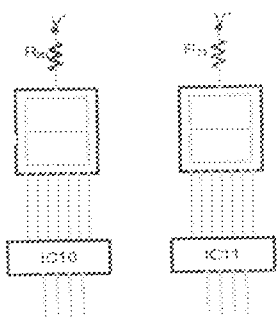

Fig 3.16 display module

3.5.1 Decoder Stage: This stage which is made up of IC10 and IC11 basically converts the 4 BCD inputs from the IC8 and IC9 to the two seven segment display.

3.5.2 Display Stage: This stage is made of two seven segment displays and passive component like resistors. The two segment display receives its input from IC10 and IC11 in other to generate an output. The value of limiting resistors employed (R_{20} and R_{21}) here are both 330Ω.

3.6 Light Switch

This consists of OR-gates and relays. The OR-gates OR'S the BCD outputs of the up/down counter and uses its output to drive a transistor switch, which controls the relay. When the count is zero, the OR-gate outputs a LOW and deactivates the relay (i.e returns to its rest position) and the light goes off. If there's any count at all from 1 and above, the OR gate outputs a HIGH and the relay is activated, thus making the room light to come on. This unit also consists of passive components such as resistors and capacitors

The OR-gates OR'S the BCD outputs of the up/down counter and uses its output to drive a transistor switch, which controls the relay.

The output of IC18 is made the input of the transistor. It should be noted that the input of IC18 is dependent on the output of IC17 and output of the light sensor module of the circuit. Pin 11 of IC8 and IC9 are connected to a push to make switch which operates only when individual(s) are in the room and the light needs to be turned off. Fig.3.17 shows the light switch module.

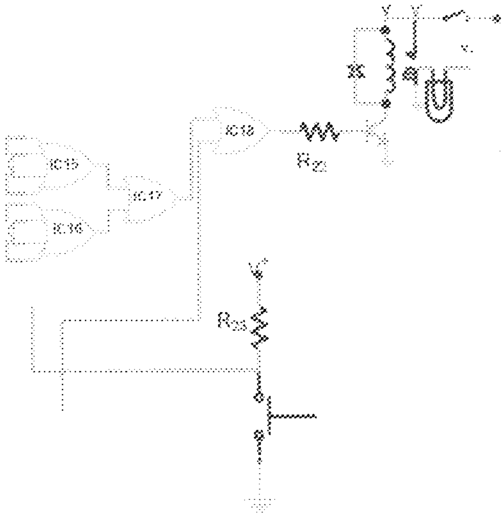

Fig.3.17 light switch module

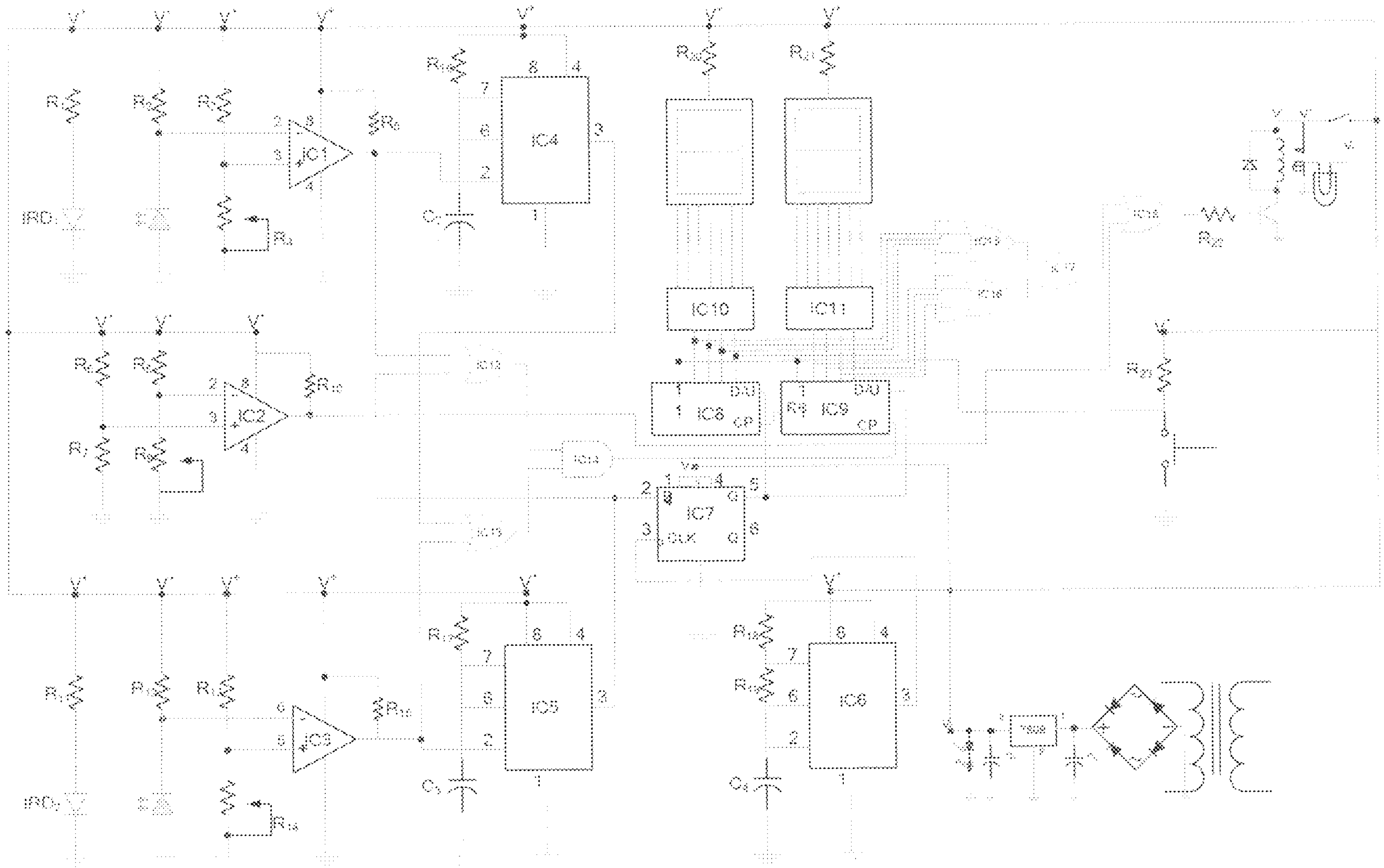

fig. 3.18 complete circuit diagram of the entire project

3.8 Component List

Table 3.6 Resistor values and rating

RESISTORS	VALUE (Ω)	POWER DESCRIPTION (W)	TOLERANCE (%)
R_0		1/4	5
R_1, R_{11}	220	1/4	5
R_2, R_{12}	1M	1/4	5
R_3, R_{13}	1K	1/4	5
R_4, R_9, R_{14}	4.7K	1/4	5
R_5, R_{10}, R_{15}	1K	1/4	5
R_6	220	1/4	5
R_7		1/4	5
R_8	1K	1/4	5
R_{16}, R_{17}	100K	1/4	5
R_{18}, R_{19}	10K	1/4	5
R_{20}, R_{21}	330	1/4	5
R_{22}	47K	1/4	5
R_{23}	1K	1/4	5

Table 3.7 types of capacitors employed and their values

CAPACITORS	VALUE(μF)	TYPE
C_0	3300	ELECTROLYTIC
C_1	100	ELECTROLYTIC
C_2 C_3	47	ELECTROLYTIC
C_4	10	ELECTROLYTIC

Table 3.8 Integrated circuits

INTEGRATED CIRCUITS	NAME
IC1,IC2,IC3	LM393
IC4,IC5,IC6	NE555
IC7	7474 (D-FLIP-FLOP)
IC8,IC9	74190(COUNTER)
IC10,IC11	7447(BCD DECODER)
IC12,IC13 IC17 IC18 (2 input)	7432(OR GATE)
IC15,IC16, (4 input)	7432(OR GATE)
IC14	4081(AND GATE)

Table 3.9 Diodes and their values

DIODES	VALUE
D1 – D4	IN 4007
PD1, PD2	PW81
IRD1, IRD2	PW81

CHAPTER FOUR

TEST, RESULTS AND DISCUSSION

4.1 Test

The physical realization of this project is very vital. This is where the fantasy of the whole idea meets reality, that is to say work is not only realized on paper but also as finished hardware

Connecting the plug to the main power supply turned on the device. It was then tested as follows

1. When neither of the beams was broken.
2. When beam A was broken on entry to the room NOTE beam B was also broken.
3. When beam B was broken on exit of the room NOTE beam A was also broken.
4. When beams A and B being broken before (i.e. someone is already in the room) is being broken again starting with beam A (i.e. on entry into the room)
5. When beams A and B being broken before (i.e. someone is already in the room) is being broken again starting with beam A (i.e. on entry into the room) for more than ten times say eleven times
6. When someone goes out of the room, thus breaking both beams starting with beam B, reducing the number of persons to ten.
7. When the last person in the room goes out, thus breaking both beams starting with beam B.
8. When beam A is not broken in less than 6 seconds.
9. What happens when its day or night

4.2 Results

The following results were gotten for the processes being tested as stated above respectively:

1. The light did not turn ON thus the seven segment display, displayed 0.
2. The light turned ON and the seven segment display, displayed 1.
3. The light went OFF and the seven segment display, displayed 0.
4. The light still remained ON and the seven segment display, displayed 2. (i.e. there are two persons in the room)
5. The light still remained ON and the seven segment display, displayed 11 (i.e there are eleven persons in the room) Thus indicating an improvement on the design.
6. The light still remained ON and the seven segment display, displayed. 10 (i.e. indicating that someone has left the room)
7. The light went OFF and the seven segment display, displayed 0
8. This activated beam B and if someone was in the room the light would go OFF on the individual.
9. When it is day, the light would not come one but it counts the number of individuals going in or out of the room, thus when its night the light comes ON, if someone is in the room, still taking note of the count.

4.3 Discussion

4.3.1 Problems Encountered

Several problems were encountered during the project. The problems ranges from design, to implementation, to construction problems. The major problems are as follows.

1. One major challenge was sourcing for a means of making the counter count more than 9 people, which was however resolved.
2. Getting the exact calculated values of components, thus leading to the use of preferred values which caused some drift, though negligible.
3. Proximity of getting components.
4. Soldering of components on the Vero-board, this was however solved by extensively practicing on a practice Vero-board and component.

The construction of this project was done in different stages which include the following, bread boarding (this was done to ensure proper functioning of each stage), soldering (this was carried out signifying that the connecting done on the bread board was done properly), and finally entire casing of the project.

The bread boarding was carried out at different modules, starting from the power supply, the sensor, the counter, and finally the display module, so also was soldering done on the Vero board.

The other stage of the project construction is the casing of the entire project; this was coupled into plastic glass, designed with special perforation and vents to ensure the system is not overheating to give ecstatic value.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

This project, which is the design and construction of an automatic room light switch has been successfully designed and constructed. The performance of the project after test met the design specifications; therefore, the aim has been achieved. The construction was done in such a way that it makes maintenance and repairs an easy task and affordable for the user should there be any system breakdown. All components were soldered on one Vero board, which makes troubleshooting easy.

The design and construction of this project was done considering some factors such as economy, availability of components and research materials, efficiency, compatibility, portability and durability. The general operation of the project and performance is dependent on the presence of a person(s) entering or leaving the door and how close the person is to the door. The light is meant to switch on automatically.

This project has really exposed me to digital electronics and practical electronics generally which is one of the challenges one would meet in the future. more knowledge and understanding on the various kind of ICs employed such as the 555 timers IC the comparator ICs, etc, relays, photodiodes, infra-red diode and other passive components. has been acquired.

However, like every aspect of engineering and with the rapid growth and current technological advancement in the world today there is still room for improvement and further research on the project as suggested in the recommendation below

5.2 Recommendations

1. A software model of the design should be done to further research and improve the performance of the system
2. The department should acquire more research oriented books in the department library, to make enough materials available for students to use

REFERENCES

[1] www.sqatester.com/glossary/

[2] www.nd.edu/manufact/Development in the History of Automation of Manufacturing Processes.htm

[3] www.st.com/stonline/press/news/glossary/glossary.htm

[4] www.oasismanagement.com/frames/TECHNOLOGYGLOSSARY/a.html

[5] broadway.sfn.saskatoon.sk.ca/business/sdlc/ab.html

[6] www.swiches.htm

[7] Floyd L. Thomas, Digital Fundamentals, Prentice-Hall, 6th edition 1997, pp 470-478

[8] http://priory.bromley.sch.uk/student/electronics/pdf/lm393/pdf
www.national.com © 2002 National Semiconductor Corporation DS005709

[9] http://priory.bromley.sch.uk/student/electronics/pdf/ne555/pdf
www.national.com ©2000 National Semiconductor Corporation DS007851

[10] www.photodiode.globalspec.com/industrial-Directory/photodiode

[11] http://priory.bromley.sch.uk/student/electronics/pdf/74hc74/pdf
Philips Semiconductors Product specification

[12] http://priory.bromley.sch.uk/student/electronics/pdf/74hc190/pdf
Philips Semiconductors Product specification

[13] http://priory.bromley.sch.uk/student/electronics/pdf/74hc47/pdf
www.fairchildsemi.com © 2000 Fairchild Semiconductor Corporation DS009817

[14] Tom Duncan, Success in electronics, Longman 2001, pp 115-116

[15] Tom Duncan, Success in electronics, Longman 2001, pp 121-122

[16] B.L Theraja AND A.K Theraja, A Text Book on Electrical Technology, S. Chand and Company 2003, pp 1922-1923

[17] Engr. Abdulahi Musa, Course material on Analog Electronics, Engr. Abdulahi Musa 2004 pp 11

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REFERENCES

[1] www.sqatester.com/glossary/

[2] History of Automation. www.nd.edu/manufact/Development in the History of Automation of Manufacturing Processes.htm

[3] Home Automation,www.st.com/stonline/press/news/glossary/glossary.htm

[4] Home Automation, www.oasismanagement.com/frames/TECHNOLOGY/GLOSSARY/a.html

[5] Automation Business. www.broadway.sfn.saskatoon.sk.ca/business/sdlc/ab.html

[6] Basics of switches. www.switches.htm

[7] Floyd L. Thomas, Digital Fundamentals, Prentice-Hall, 6th edition 1997, pp 470-478

[8] Lm393. © National Semiconductor Corporation DS005709 2002, www.national.com http://priory.bromley.sch.uk/student/electronics/pdf/lm393/pdf

[9] Ne555, National Semiconductor Corporation. 2000 http://priory.bromley.sch.uk/student/electronics/pdf/ne555/pdf

[10] Photodiode, www.photodiode.globalspec.com/industrial-Directory/photodiode

[11] Dual D Flip-flop 74F74. Philip Semiconductor Corporation, 1996 March 12, http://priory.bromley.sch.uk/student/electronics/pdf/74hc74/pdf

[12] Presettable synchronous 4-bit binary up/down counter74HC/HCT190, Philip Semiconductor Corporation, 1996 March 12, http://priory.bromley.sch.uk/student/electronics/pdf/74hc190/pdf

[13] BCD to 7-Segment Decoder/Driver with Open-Collector Outputs. Fairchild Semiconductor Corporation 2000 June 2. http://priory.bromley.sch.uk/student/electronics/pdf/74hc47/pdf

[14] Tom Duncan, Success in electronics, Longman 2001, pp 115-116

[15] Tom Duncan, Success in electronics, Longman 2001, pp 121-122

[16] B.L Theraja AND A.K Theraja, A Text Book on Electrical Technology. S. Chand and Company 2003. pp 1922-1923

[17] Engr. Abudulahi Musa, Course material on Analog Electronics. Engr. Abdulahi Musa 2004 pp 11