DESIGN AND CONSTRUCTION OF AN AUTOMATIC CLOTH DRYING HANGING SYSTEM

BY

SHAIBU SALIFU USMAN
2001/12116EE

A Thesis submitted to the Department of Electrical and Computer Engineering, Federal University of Technology, Minna.

NOVEMBER, 2007.

Dedication

I dedicate this project to my father Mr. Shaibu Usman, who has been of immense encouragement to me and most of all the Almighty Allah for all His mercies.

Declaration

I, Shaibu Salifu Usman, declare that this project 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.

SHAIBU SALIFU USMAN

(Name of Student)

4/12/07

(Signature and Date)

DR TSADO JACOB

(Name of Supervisor)

4/12/07

(Signature and Date)

....

(Name of H. O .D)

....

(Signature and Date)

....

(Name of External Examiner)

....

(Signature and Date)

Acknowledgement

I appreciate and remain eternally grateful to Almighty Allah for His grace and loving kindness in my life.

I remain indebted to my caring and loving parents, Mr. & Mrs. Shaibu Usman for their prayers, moral and financial support.

My profound gratitude to Dr. J. Tsado who dedicatedly supervised my work and making out time in his tight academic schedules to scrutinize this project.

My thanks to the H.O.D. Engr. M.D Abdullahi and all members of staff of Electrical & Computer Department for the advice and knowledge they impacted in me during these years of my studies.

I specially acknowledge my dearest brothers & sisters who held me with high esteem and love during these years of my study.

Finally, I will not forget my numerous friends, Ramat, Bello, Atene, Ubiene, Tauheed, Malik, Musa, Umar (Omoh), Muda Siru, my loving neighbours and my course mates whom without their encouragement and support I wouldn't have come this far. You all will remain indelible on the scrolls of my heart.

Abstract

This project presents the construction and implementation of an automatic cloth drying hanging system, using rain and wind detectors as the active sensor. The project report addresses the problems posed by "rainy days" and provides a cost effective solution for detecting rain and wind. The rain and wind sensors use the concept of electric conduction in liquids and metals respectively to automatically activate a DC electric motor, which rolls the cloth line in or out of the shade in the presence of rain or wind as the case may be. The output of the comparator triggers the monostable module, depending on the output of the rain or wind sensor. This output is high when it is windy or rainy. The monostable module activates a relay which powers a DC electric motor that controls the cloth line. The rain sensor worked better when constructed with a plastic that has a small base area, and the wind sensor worked better with metals made of aluminum and its alloys.

Table of Contents

List of Figures

List of Tables

CHAPTER ONE

INTRODUCTION

The contributions individuals sometimes make to the society are mostly fuelled by experiences borne personally and complimented by our depth of knowledge of a particular field of study. The world of electronics is one field that has contributed immensely to the heights of technological advancement attained so far [2].The heart of technology as always been the ability to move with the tides of the present time [1].Man's innovative spirit and need for elegance as always pushed him to the extreme trying to make things much more beautiful and easier to use.

In Nigeria, when people wash their clothes, they are mostly hung on rail lines or ropes to dry. The weather in Nigeria is very unpredictable, it could suddenly get windy and showers began to pour (this sometimes happens within minutes). In situations such as this, where cloths are hung, and there is no one to look after them pending when they get dry, and somehow it rains coincidentally such clothes gets wet, sometimes drop to the ground when unclipped and eventually get messed up by the moist ground.

1.1 Project Introduction

Automatic cloth drying hanging system is a device that can be used to put clothes into the building when there is rain or wind.

1.2 Methodology.

This project work helps to put the clothes in when it rains or gets windy. This performance is based on two locally constructed sensors using the idea and knowledge of the physics of conductors [5]. The two sensors on which the performance of this project is hinged upon are the rain sensor and the wind sensor. The output of these sensors are compared by a digital comparator which sets the input of an exclusive- or gate which allows only one transistor to be high in 5 seconds hence enabling timing of the motor at different directions, since opposite polarity voltage are fed to the motor in different direction to pull- in and pull out the cloth-line via a mechanical pulley system [1].

The application and broad nature of this project work can not be over emphasized. It has both luxury and convenience. It`s more convenient when a cloth- line is pulled- in automatically when wind or rain come calling. This piece can be installed in homes, hospitals, offices, prisons e. t. c. The mechanical outline of the cloth line is done such that the line slides in automatically with the control of a d. c motor and a bearing mechanism upon sensing either the wind or rain.

1.3 Project Objectives

The principal objectives of the project are:

I. To make cloth drying on a cloth- line more convenient, to save cost of running back home to remove cloths from railings when it rains.

II. To save cost and time of washing clothes again whenever they drop down as a result of wind or rain.

1.4 Project Outline/ Scope of Work

This project report details the various stages of the project for a comprehensive understanding of operations.

Chapter one contains a general introduction to the topic and also gives an insight of the project, methodology and objectives of automatic cloth drying hanging system

Chapter two explicitly deals with the theoretical background supporting the project works which are source from Textbooks, Journals, Course materials and Internet.

Chapter three contains the design operations in detail, the analysis and calculations.

Chapter four details the construction and test of the work carried out and discursion of the result obtained.

Chapter five contains the conclusion, problems encountered and possible recommendations for future designs.

1.5 Source of Information

The materials used for this project were sourced from course materials, Journals. Textbooks and Internet.

CHAPTER TWO

THEORETICAL BACKGROUND

2.1 Hanger History

No one really knows who made the first hanger and what it may have looked like. Some historians believed the first wooden hanger was invented by the third president of the United States, Thomas Jefferson [6].

What is basically known is that throughout most of the 15th century, clothes were either hung on hooks or was laid flat for storage. It was not until around 1850 that people began using hangers to hang clothes in wardrobes [6, 28]. Victorian women's bustle and skirts needed careful storage, hanger inventors and manufactures came to their aid with all kinds of adjustable components and spring systems to allow the skirts to retain their pleats and hold waistband [28].

Hanger improvement did not stop there, all kinds of new designs began to appear such as traveler's hangers which can be collapsed and folded, hangers with extra hooks for belts. Tailors and clothing merchants were the first to see that these specialty hangers could be used to advertise their business [3, 28].

The immediate idea after washing clothes is to sun-dry them. Before they are placed in the sun, the question about whether it will rain, get windy or not comes bugging the mind; but for the fact that one has little or no choice, one goes on to sun-dry them. Wherever a person is during this period away from home, constantly, the mind roams towards the direction of the house (where the clothes are spread) and sometimes when there's a sudden change in weather forecast and it gets windy or begins to rain, one is left with little or no choice of having to run home to get such clothes back into house to avoid them dropping to the ground; causing them to be rewashed.

Till now, the issue of cloth hanging for sun-drying had not been solved in spite of technological and developmental heights reached. It is against this background the idea of developing an automatic cloth drying hanging system was born.

2.2 System Overview

This system is an integration of fundamental units with the sole objective of achieving its target (which is the automatic sliding in –and - out of clothes when it rains or gets windy). The automatic cloth drying hanging system build is hinged basically on two sensors. That is, the RAIN SENSOR AND WINDY SEANSOR.

This system consist of a rail-line (thin), two sensors, a motor, two comparators, a 555 timer, a OR gate, NOT gate, AND gate, switch to mention but a few.

The principle with which this machine operates is such that the first comparator output goes high when it rains, the second comparator goes low when it is not windy, the output of these two comparators are fed into an OR gate whose output is used to trigger the 555 timer. The outputs of the two comparators are also fed into an AND gate, which triggers the relay to drive the motor outside the shade. A low is needed for the triggering of the 555 timer while a high triggers the AND gate which operates the relay. The 555 timer has a time constant of 5s, this is because the wind sensor output pulses, so the 5s one-shot monostable gives a steady low output when it is not windy.

The output of the OR-gate is high whenever there is wind or rain and output of the 5s monostable stays high for 5s. Since the AND gate has a high output only when the inputs are high, this then switches the relay which sets the motor in motion pulling – out the cloth line.

When it stops raining and is no longer windy, the output of the OR gate goes low, the output of the 5s timer goes low and the AND gate output goes high. The circuit is powered by a 9v supply (rectified) and a 9v back- up battery, in the case where there is power failure so the clothes will always be rolled–in.

2.2.1 Components of the System

The system consists of the following components described below:

2.2.2 IC 555timer

The 555 timer is a versatile integrated circuit (I C) [20]. It comes usually in an 8-pin dual-in-package and it's cheap. It can be made to operate as monostable from milliseconds to several hours [20, 21]. It can operate from power supplies from 5V to 18V and can thus be made to operate with transistor-transistor logic (TTL) mode. The device can source or snit up to 20mA allowing it to drive relays, lamps and other large loads directly. The 555 timer itself takes about 5mA in the reset state (low output); to this must be added the load current [20].

2.2.3 Monostable

The basic 555 timer is obtained in 8 lead (D. I. L) pack with connections. Vcc (the supply voltage) and ground (OV) is given as shown in Fig 2.1. When the output is true (high going), the trigger input is low. The device is decoupled hence the output stays up longer than the time period. The device is not triggered in its basic form.

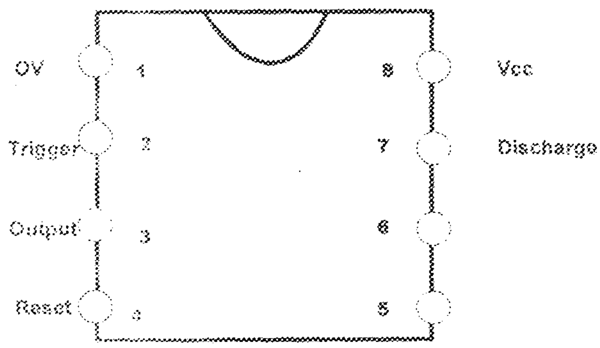

Figure 2.1 Pin assignment of 1C555 timer

To construct a monostable, a resistor R_t and a capacitor C_t are added to the 555 timer and the corresponding responses are as shown in figure 2.2.

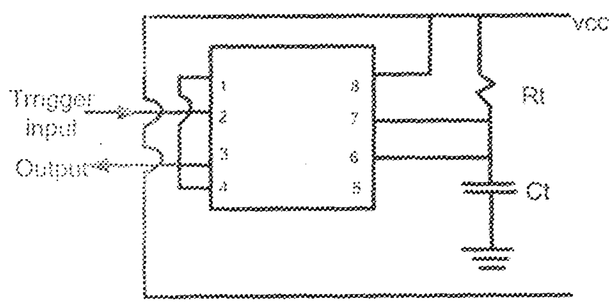

Fig 2.2 A response type of monostable

The trigger input sets the flip flop and the output goes high [19,20]. The discharge transistor turns OFF and C_t reaches the control voltage defined by the three resistor chain. the comparator 1 set the flip flop. the output goes low and the discharge transistor turns ON again to discharge Ct .The current can be triggered again by another output. The timed period is the time it takes R_t to charge C_t to the control voltage Ov as the three resistors are equal. The control voltage is 2/3 Vcc and since R_t is also connected to Vcc, the timed period is independent of Vcc [18].

The timed periods is given by $T= 1.1R_t C_t$ where R_t is given in ohms and voltage is brought out to pin 5. With this facility, the control voltage can be decoupled to improve the noise immunity of the device or changed to give a control voltage other than 2/3Vcc. By varying C_t and R_t the period can be controlled from 5μs to about an hour. Although above 5 minutes, the accuracy and reliability starts to fall because of the large value components necessary [18]. In long time application, the ZN1034 (manufactured) is a better device.

There are no limits to C_t apart from cost. Large value electrolytic capacitors have high leakage currents which can cause leakage variation away from the calculated timed periods [16]. If very large values are used, the discharge transistors may take an appreciable time to discharge C_t.

2.2.4 Edge Triggering

The 555 timer is decoupled if the input is held low beyond the timed period, the. output stays until the input goes back high [14]. To make the 555 timer into an edge triggered device, an additional resistor, capacitor, and diode (R_1,C_1,D_1) are needed as shown in fig 2.3

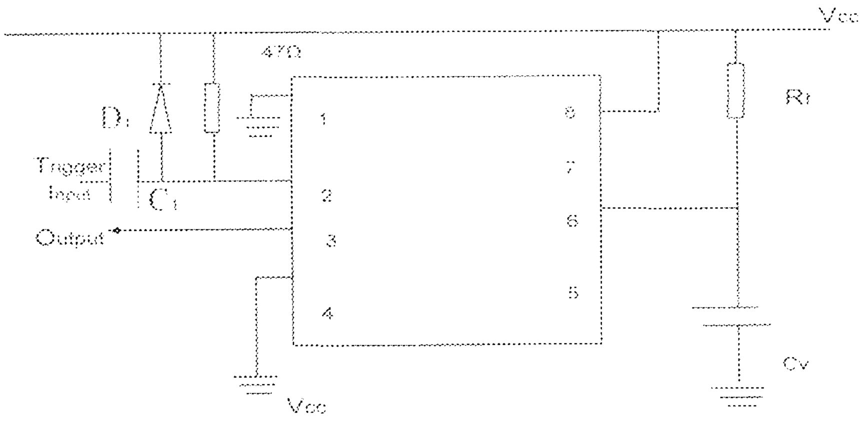

Fig 2.3 Making a 555 timer into edge triggered device.

The small network differentiates the input signal to give a small pulse which triggers the 555 timer. The value will be adequate for all timed periods.

2.2.5 Reset Facility

Pin 4 in the 555 timer is called the reset. If the reset pin is taken to Ov, internal flip-flop resets; the output goes low and the discharge transistor turns ON to discharge to C_t. If the reset pin is taken back to Vcc, the 555 timer will remain in its reset State [5,20].

The reset pin can be left disconnected but for safety from spurious noise, it should be tied directly to Vcc by a 47kΩ resistor if a push button reset is be used. The control voltage (which determines the monostable periods are the stable frequency) is brought out to pin 5. This primarily is done to allow a capacitor to be added for decoupling a noisy environment [8].

2.2.6 Transistors

A transistor is three layers, two junctions' semiconductor device [8, 18, and 19]. It consists of a sandwich of semi conductor metals containing alternate layers of N -type material. The transistor may be PNP type consisting of two layers of P- type material or the NPN type consisting of two layers of N- type material [18]. The arrangement of each is shown in figure 2.4 and the circuit representation is shown in figure 2.5.

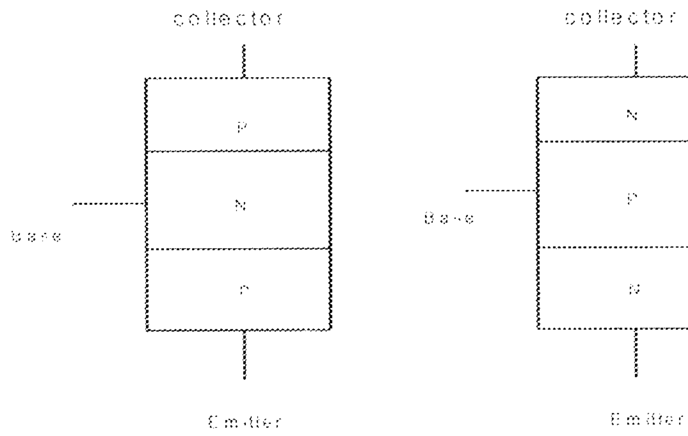

Figure 2.4: Pictorial representation of PNP and NPN transistors

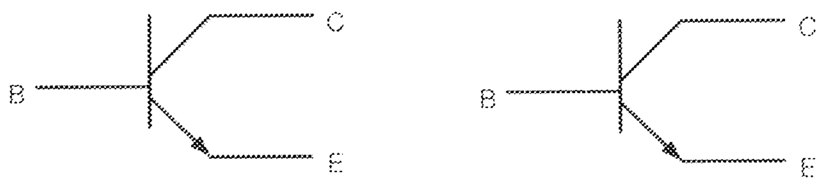

Figure 2.5: Circuit of a PNP and NPN transistor.

In the normal operation of a transistor, the emitter- base junction is forward biased and the collector base is reverse biased [7, 21]. When biased in this manner, the transistor has a low resistance emitter - base junction and a high resistance collector- base junction.

When transistors are used as an amplifier, the emitter- base circuit is used as the input circuit and the collector--base circuit as the out put circuit. The ability of the transistor to transfer circuit from a low resistance input to a high resistance output gives its name TRANSFER RESISTOR; which when contracted forms the word transistor [9, 10].

2.3 Passive Components

A passive component is an element of electronic circuit that is not a source of energy, such as a resistor, capacitor or inductor.

2.3.1 Capacitors

Capacitor is an electronic component capable of storing and discharging electrical charges [11]. It is one of the most important elements in designing of circuits. Capacitors consist of any two conducting surfaces (plates) separated by an insulating medium.

If electrons are drawn from one of the plates and passed to the other, then a state of charge exist between them across the insulating medium (positive charge on the plate which has gained electrons). Essentially, a capacitor consists of two conducting surfaces separated by a layer of insulating medium called dielectric [13]. The conducting surfaces may be circular, rectangular or cylindrical in shape. There are so many types of capacitors ranging from electrolytic to non-electrolytic types. An example of electrolytic capacitor used in this project is polarized capacitor because it has both the positive and negative terminals.

2.3.2 Resistors

Resistors are found to limit excess current flowing in a circuit; they are very useful in supplying desired voltage to other electronic components [16]. The resistance of a resistor is usually measured in ohm (Ω). The higher the resistance in a circuit, the lesser the current value becomes and the higher the voltage. Ohms law theoretically analyses the effect of resistors as

$$V = IR \quad (2.1)$$

$$R = V/I \quad (2.2)$$

Where I = current,

V = Voltage,

R = Resistance

There are two categories of resistors usually used industrially;

I. linear resistors- this group of resistors obeys ohms law

II. Non linear resistors- This group of resistors do not obey ohms law and has three common uses;

a. Photo-resistor:- light sensitive

b. Thermistors:- Heat sensitive

c. Voltage dependent resistors.

Linear resistors were used in this project work because they are readily available and they obey ohms law. The symbol for linear resistor is given as shown in fig. 2.6 below.

Figure 2.6 Circuit symbol for linear resistors

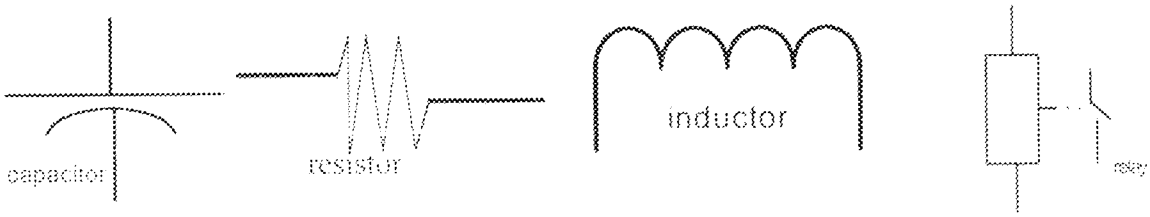

Figure 2.7 Shows the schematic representation of passive components.

2.4 Voltage Comparator (LM 393)

This device consists of two independent voltage comparators that are designed to operate from a single power supply over wide range voltages [4]. Operation from dual supplies also is possible as long as the difference between two supplies is 2V to 36V and Vcc is at least 1.5V more positive than the input common-mode voltage. Current drain is independent of the supply voltage. The output can be connected to other open collector outputs to achieve wired - AND relationships. The LM 393 is characterized for operation from 0^0 C to 70^0 C [5].

Figure 2.8 shows the pin- assignment of a voltage comparator from top view.

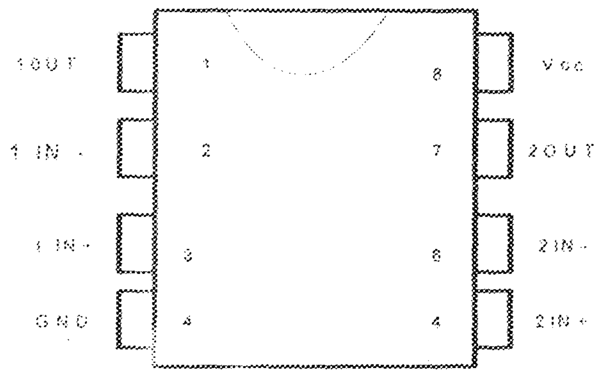

Figure 2.8 Pin- assignment of a voltage comparator

Voltage comparators have the following characteristic which makes it fit into the construction of this project work;

I. Single supply or dual supplies
II. Wide range of supply voltage (with maximum rating between 2v to 36v)
III. Low supply- current drain independent of supply voltage
IV. Low Bias current
V. Low input offset current
VI. Low input offset voltage
VII. Low common-mode input voltage range including ground
VIII. Differential input voltage range equal to maximum rated supply voltage
IX. Low saturation voltage.

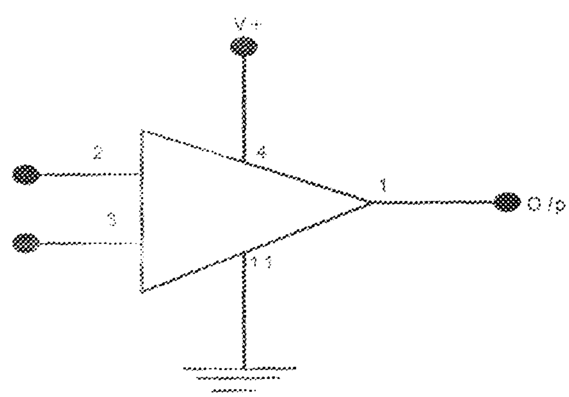

Figure 2.9 Shows the symbol of the LM393 voltage comparator

Absolute maximum rating over operating free-air temperature range (unless otherwise noted).

Supply voltage, Vcc.................................. 36V

Differential input voltage, V_{id} 36V

Input voltage range, Vi 0.3VT036V

Output voltage, V_0 ....36V

Output current, I_0 ....20mA

Operating virtual junction temperature, T_j..........150^0c

Storage temperature, T_{stg}..............................65^0c to 150^0c

2.5 Relays

A relay is a switch which is operated by an electromagnet [8,34 and 35]. Relays come in three types namely:

1. Electro-mechanical relay
2. Solid state relay
3. The hybrid (which is the combination of electro-mechanical and solid state relays).

The electro-mechanical relay is the type we are dealing with in the case of this project and is drawn as shown in figure 2.10 below.

It consists of a coil and a stationary iron core. A coil with a given amount of E.M.F is able is to produce a much greater amount of flux when an iron core is inserted in to the coil; since the permeability of iron is so much greater than that of the air. Very powerful magnet called electromagnet may be made by placing a coil around an iron core [1, 7].

The relay contacts are mounted on a hinged iron bar called armature. When the electromagnet is energized by a current passing through the coil, it is attracted to the electromagnetic core there by closing the relay contacts. The contacts are opened by a spring, when the coil is de-energized.

A very small amount of current is required to energize a relay electromagnet and close the relay contacts. Relays therefore can be used when desired to control device with high current rating from a remote point [35].

A diode is always connected across the terminal of the coil of the electromagnet of the relay in the reverse bias mode as to protect the coil from the effect of the flow of the E. M. F which is dangerous to the coil [35].

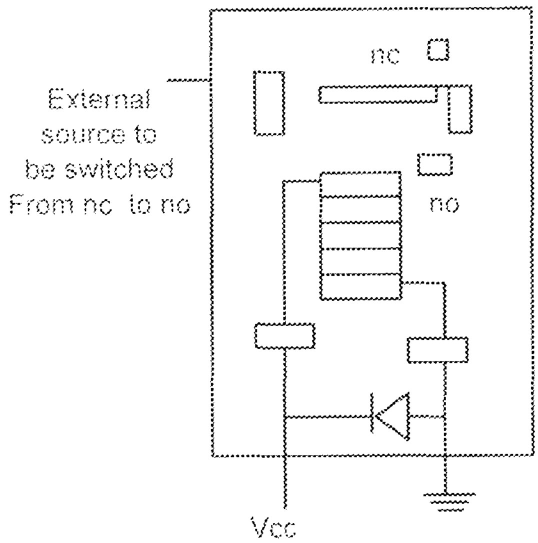

Figure 2.10 Circuit diagram of an electro-mechanical relay

2.7 Transformer

A transformer is an electrical device that transfers energy from one circuit to another by magnetic coupling with no moving parts as shown by figure 2.11. It comprises of two or more coupled windings or a single tapped winding and in most cases, a magnetic core to concentrate magnetic flux [10, 18]. An alternating current in one winding creates a time-varying magnetic flux in the core, which induces a voltage in the other windings. Transformers are used to convert between high and low voltages, to change impedance and to provide electrical isolation between components.

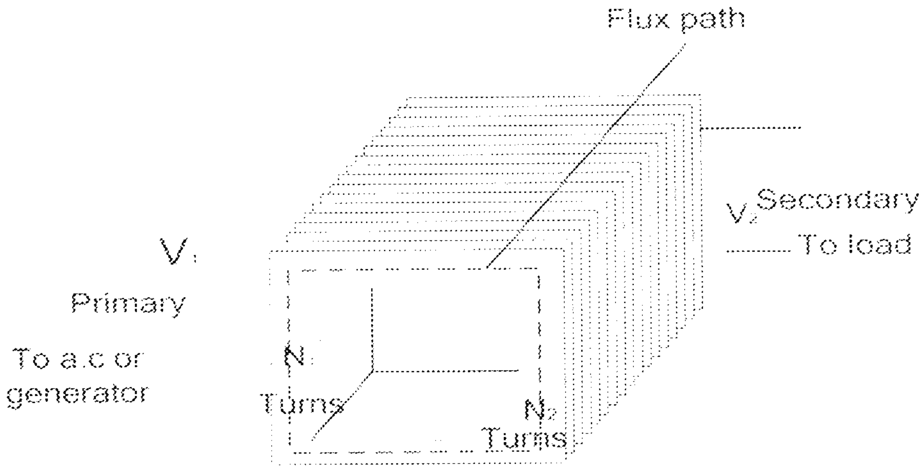

Figure 2. 11A step down transformer

If a time varying voltage Vp is applied to the primary winding of N_p turns, a current will flow in it producing a magneto motive force (MMF). Just as an electromotive force (EMF) drives current around an electric circuit, so MMF tries to drive magnetic flux through magnetic circuit. The primary MMF produces a varying flux ϕ_p , in the core and with an open circuit. Secondary winding, induces a back electromotive force (EMF) in opposition to Vp. In accordance with faraday`s law of electromagnetic induction, the voltage induced across the primary winding is proportional to the rate of change of flux [18];

$$V_p = \frac{N_p d\phi_p}{dt} \quad \text{and} \quad V_S = \frac{N_S d\phi_S}{dt} \qquad \ldots\ldots\ldots\ldots\ldots\ldots(2.3)$$

Where V_p and V_s are the voltages across the primary winding and secondary winding. N_p and N_s are the number of turns in the primary winding and secondary winding.
$d\phi_p / dt$ and $d\phi_S / dt$ are the derivatives of the flux with respect to time of the primary and secondary windings. Substituting and solving for the voltages shows that:

$$\frac{V_p}{V_s} = \frac{N_p}{N_s} \ldots\ldots\ldots\ldots\ldots\ldots(2.4)$$

V_p and V_s are voltages across primary and secondary.

Np and N_s are the numbers of turns in the primary and secondary respectively.

Hence in an ideal transformer, the ratio of primary to secondary voltages is equal to the ratio of the number of turns in their windings. Alternatively, the voltage per turns is the same for both windings. The ratio of the currents in the primary and secondary circuit is inversely proportional to the turn's ratio [18]. This leads to the common use of the transformer converting electrical energy at one voltage to energy at a different voltage (as it is its function in this project) by means of winding with different numbers of turns. In a practical transformer, the higher- voltage winding will have more turns, of smaller conducting cross -section, the lower voltage windings.

An ideal transformer would have no looses and would therefore be 100% efficient.

2.7 Gates

2.7.1 IC7408 (AND Gate)

The AND gate is shown in the fig 2.12 and its corresponding truth table is shown in table 2.1. The AND gate gives a ''high'' at the output when the input are high, but when the inputs are low, it gives an output of zero [1, 6].

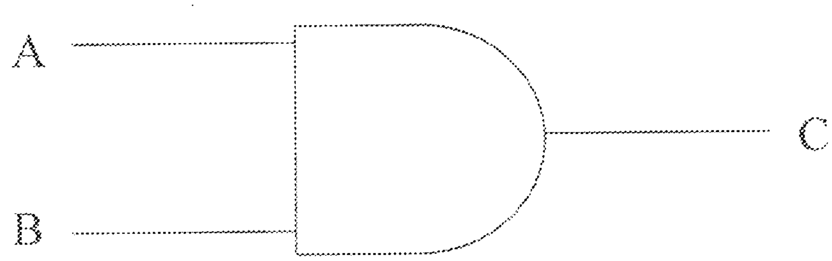

Figure2.12 AND gate

Table 2.1 Truth table of the AND gate

INPUT 1	INPUT 2	OUTPUT
A	B	C
0	0	0
0	1	0
1	0	0
1	1	1

2.7.2 4071 Quad 2 – Input or Buffered B Series Gate

These quad gates are monolithic complementary MOS (CMOS) integrated circuits, constructed with N–channel and P-channel enhancement mode transistors. They have equal source and sink current capabilities and conform to standard B series output drives. This device also has buffered outputs that improve transfer characteristics providing very high gain [1].

All inputs are protected against discharge with diodes to V_{DD} and V_{SS}

2.7.3 4001 Quadrupile 2 - Input NOR Gate

Symmetrical circuit has output swings essentially equal to the supply voltage. This results in high noise immunity over a wide supply voltage range. No DC power other than that caused by leakage current is consumed during static conditions. All inputs are protected against static discharge and latching conditions [1].

2.8 Principles of Operation

This project employs a rain sensor and a wind sensor to activate cloth line, to take the cloth in to a shade to prevent it from been wet by rainfall or rumpled by wind. This uses a locally constructed rain sensor and wind sensor. A voltage comparator (LM393) compares its input with a reference input.

The reference input is kept constant while the other input changes with the weather (rain and wind). When it rains or is windy the output of the LM393 goes high which triggers the 555 timer. The 555 timer has a time constant of 5s.

This drives two relays which causes the DC motor to rotate. The DC motor turns clockwise to roll the cloth line in the shelter when rain or wind is sensed and turns anticlockwise when there is no wind or rain. The break down of each stage of the project is illustrated as shown in the next chapter.

CHAPTER THREE

CIRCUIT DESIGN, ANALYSIS AND IMPLEMENTATION

3.1 Circuit Design

The operation of the entire project depends on the circuit and hence the design of the circuit is the main focus of this project work.

An understanding of the operation of an automatic cloth drying hanging system is necessary. The principle of operation of the entire project is subdivided into the following sub-system:

- Design outline
- Power supply unit
- Sensor stage
- Timer stage
- Driver stage

3.1.1 Design Outline

One major argument that still holds very strongly in the bid to design is the concept of form and function. It is based on this general design outline (block diagram) is presented as shown in fig 3.1.

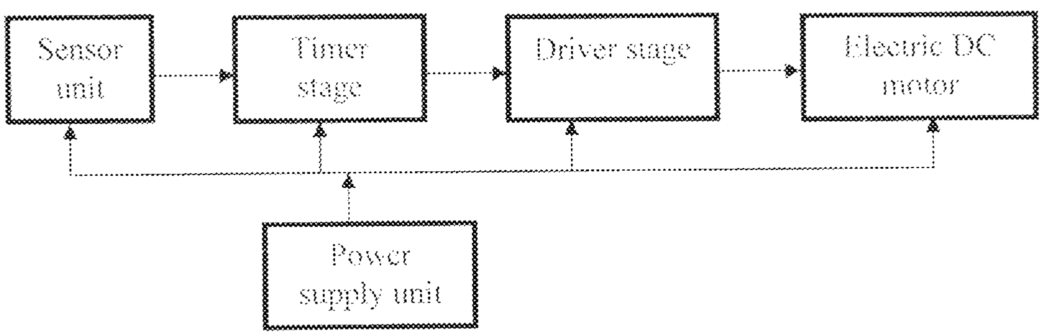

Fig. 3.1 Shows the block diagram of the main circuit.

3.1.2 Design Specification

- Input voltage — 220V A.C mains
- Supply voltage — 9V D.C.
- Physical prototype of cloth line — metal 20 x 20mm
- Max current — 1000mA

3.2 The Power Supply Unit

The power supply unit is of great importance in this project work since without the components being powered, amplification can not take place.

The power supply unit is made up of:

- The main power supply unit.
- The alternative power supply unit.

In the case of the project, emphasis is laid on the main power supply unit because inadequate fund to implement the alternative power supply unit.

3.2.1 Main Power Supply Unit

The main power unit supplies DC voltage to the circuit from the AC main. The skeletal circuit of the power supply is shown in figure 3.2.

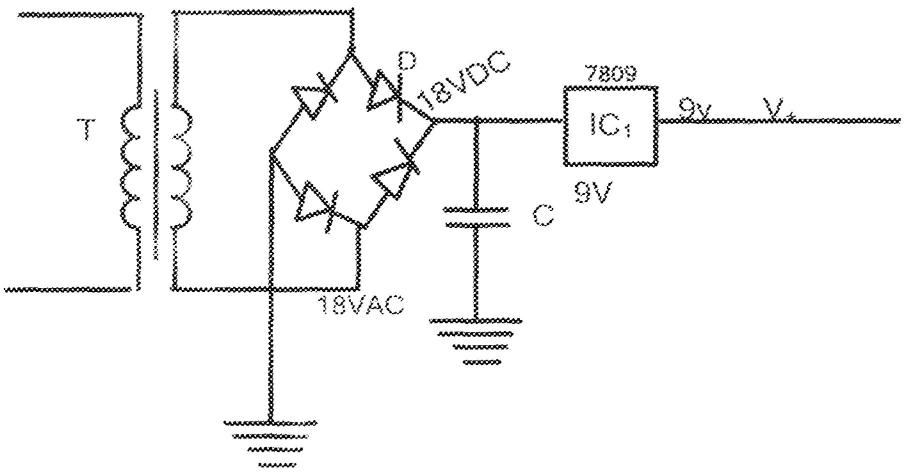

Figure 3.2 power supply circuit.

V+ is the output voltage; the output is required to be 9v. Since the component which requires the highest voltage is the 9V relay,

$V_+ = 9V$

IC_1 is the voltage regulator IC; the voltage regulator IC produces a desired regulated voltage. Since 9V is required, it implies that a 9V voltage regulator IC is required, which is the 7809IC.

The transformer voltage, which is the peak value of V_{out} and the 2 diode drops imposed by the bridge rectifier when the transformer is specified, follows the convention that uses $V_{r.m.s}$ and not V_{peak} ($V_{r.m.s}$ defines the dc voltage that would deliver the same power as the particular waveform). For a sine wave,

$$V_{r.m.s} = \frac{V_{peak}}{\sqrt{2}} \quad \text{.......(3.1)}$$

Assuming V_{out} to 15V after ripple, then V_{out} (peak) should be the volts around 17V.

$$V_{r.m.s} = \frac{17V}{\sqrt{2}} = 12V \quad \text{.......(3.2)}$$

Hence, a transformer of 220/12V rating is required to determine C_0. Using

$$I = C\frac{dV}{dt} \quad \text{.......(3.3)}$$

Where dV = ripple voltage

dt = time between peaks of the input waveform

I = peak out put current

C = filtering capacitor.

Assuming a ripple voltage of 3V

And $$dt = \frac{1}{2}T = \frac{1}{2F} \quad \text{.......(3.4)}$$

Where T = period

and F = frequency of AC

We have that:

$$dt = \frac{1}{2 \times 50H_z} = \frac{1}{100} = 0.01s$$

F = $50H_z$ in Nigeira

The maximum current I = 1A

$$\therefore C = I\frac{dt}{dv} = \frac{1\times0.01}{3} = 3.33\times10^{-3}F$$
$$=3330\times10^{-6}F$$
$$=3330\mu F$$

A Preferred value of 3300 μF is chosen, because 3330 μF is not a standard value. Silicon rectifying diodes are chosen for the full wave bridge because they are readily available and drops less voltage compared to germanium. The silicon rectifying diodes chosen are those with voltage rating of 600V, so that it can accommodate power surges which is the IN4007 [13].

3.3 Sensor Stage

At this stage, the circuit detects either rain or wind using two locally constructed sensors: (the RAIN SENSOR and the WIND SENSOR). The rain sensor uses two copper rods because they have high electrical conductivity. The two rods are placed very close to each other so that even one drop of rain will cause it to conduct. The sensor is connected to a voltage comparator which compares the input voltage with a reference to give the desired output. The voltage comparator used is LM393. This is a dual comparator which has the symbol shown in figure 3.3 below.

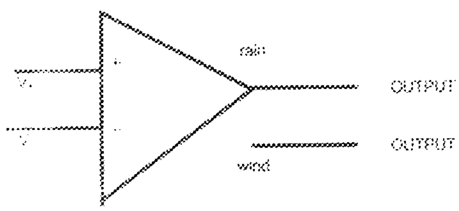

Figure 3.3 Symbol of voltage comparator.

The sensor is connected to the non-inverting input by voltage divider theorem as show in figure 3.4

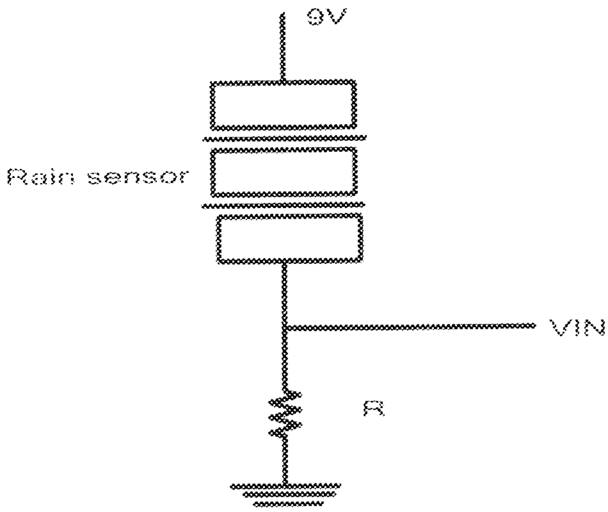

Figure 3.4 The sensor connection with the non-inverting input

Since the rain sensor conducts when it rain, it acts like a switch. If there is no rain, V_{in} would be zero and if there is rain V_{in} would be 9v. The resistor R is to prevent short circuit. R can be any resistor: it is there to produce a voltage drop across it. The power is not connected directly to the ground when the sensor conducts. R =1K Ω (chosen)

LM393 gives a high output when V_{ref} α V_{in} and vice –versa. Since a high output is required when it rains, V_{ref} would set to be less than V_{in} when it rains, hence 4.5v was the chosen voltage for V_{ref} as it is below 9v (v_{in}). To achieve 4.5v, voltage divider theorem was used as shown in figure. 3.5 below.

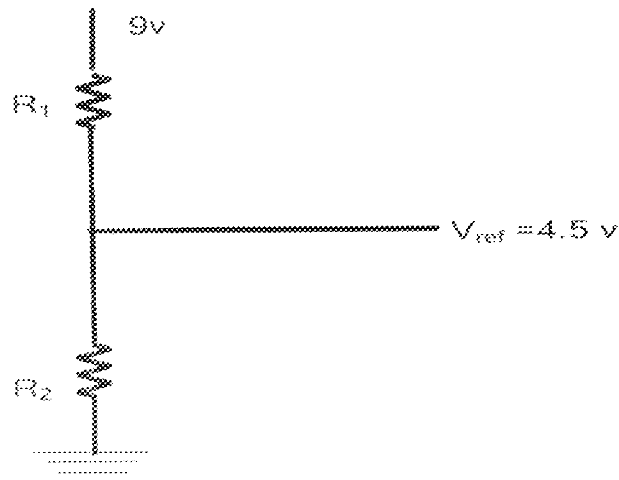

Figure 3.5 The use of voltage divider theorem to achieve V_{ref}

Using voltage divider theorem:

$$V_{ref} = 4.5V = \frac{R_2 \times 9v}{1k + R_1} \quad (3.5)$$

$$\Rightarrow 4.5k + 4.5R_1 = 9R_2$$

$$\Rightarrow 9R_2 - 4.5R_1 = 4.5k$$

$$\Rightarrow 4.5R_1 = 4.5k$$

$$\Rightarrow R_1 = \frac{4.5k}{4.5} = 1k\Omega$$

$$\Rightarrow R = 1k\Omega$$

The rain sensor circuit is shown in figure 3.6 below.

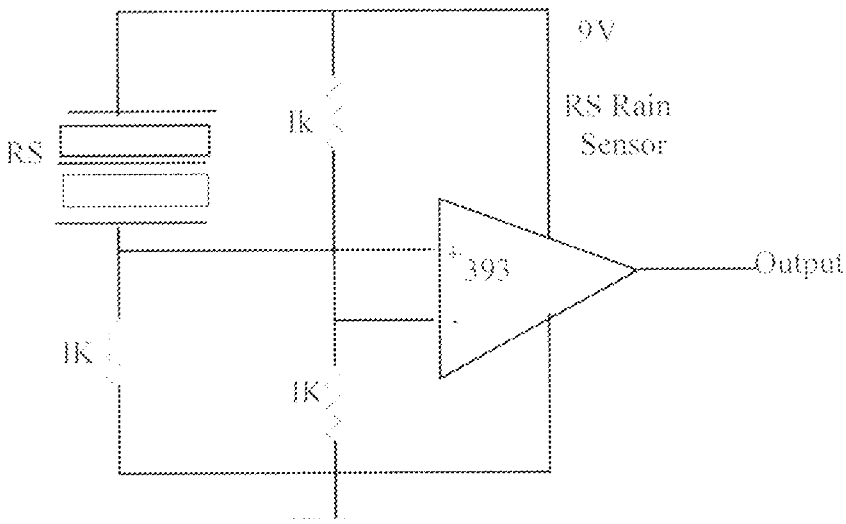

Figure 3.6 The rain sensor circuit

The wind sensor uses aluminum as the sensor because it is light (not heavy) and does not react with water. The wind sensor is mounted on the core, when there is heavy wind; the aluminum hits the core and conducts electricity, just like the rain sensor. It acts like a switch.

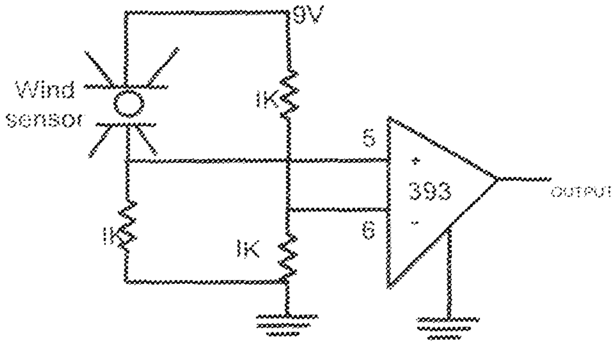

Figure 3.7 The circuit diagram of a wind sensor

For V_1, if it is windy, using voltage divider theorem.

$$V_1 = \frac{9x1k}{1k+0} = 9V \quad (3.6)$$

If not windy,

$$V_1 = \frac{0x1k}{1k+0} = 0v \quad (3.7)$$

3.4 Timer Stage

This controls the timing of the motor. The electric motor starts to rotate and pulls in the cloth line when it senses either wind or rain. This stage helps to time the motor, so that it does not continue rolling as long as the rain fall or as the wind continues.

A555 timer is used to achieve this, it is designed to achieve 5 secs, that is, the timer gives a time constant of 5 secs. The 555 timer in monostable mode is shown in figure 3.8 below.

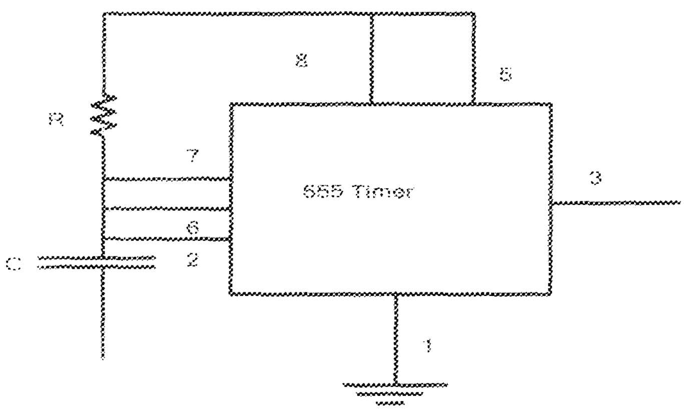

Figure 3.8 Shows the timer in monostable mode.

Using this equation:

$T = 1.1RC$ ....(3.8)

Where:
T = time in seconds
R = timing resistor
C = timing capacitor

Since T = 5sec.

Set $C = 100\,\mu F$

$$R = \frac{T}{1.1C} \quad \text{..(3.9)}$$

$$= \frac{5x10^6}{1.1x100}$$

$$= 4.5x10^4\,\Omega$$

$$\Rightarrow \quad R = 45k\Omega$$

A 47kΩ variable resistor was chosen so that the resistor can be set to 45kΩ.

The complete circuit diagram of a 555 timer with a 47kΩ resistor is shown in Fig 3.12 below.

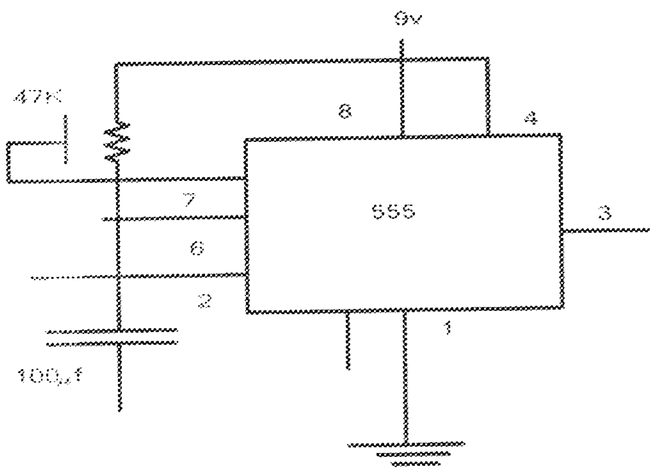

Figure 3.9 Shows the complete circuit diagram of a 555 timer with a 47kΩ variable resistor.

3.5 Driver Stage

This comprises of an AND gate and relays that controls the electric motor. The complete circuit's diagram of the driver stage is shown in figure 3.13

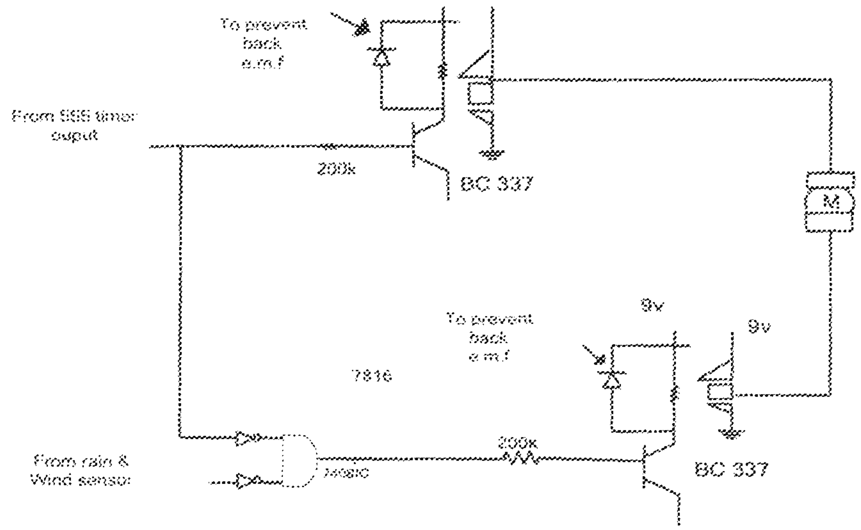

Figure 3.10 Circuit diagram of the driver stage.

The AND gate reverses the polarity of the motor when the rain or the wind has stopped. The logic symbol and truth table of an AND gate is given in figure 3.11 and table 3.1 respectively.

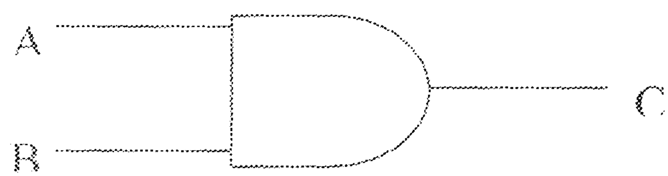

Figure 3.11 Logic symbol of an AND gate.

Table 3.1 Shows the truth table of an AND gate

A	B	C
0	0	0
0	1	0
1	0	0
1	1	1

If the inputs of the AND gate are low, the output will be zero. And if the inputs are high, the output will be high. When it rains, the 555 timer triggers the first relay which causes the motor to turn in one direction for a while (5secs), when the rain or the wind stops, the

AND gate input becomes high and it turns the motor in the other direction. The relay is triggered using transistor acting in the cut off region. The transistor is biased when the base is high (i.e. off) and the collector is low, this causes the relay to switch (on or off) state which the transistor is acting as. The calculation is as follows:-

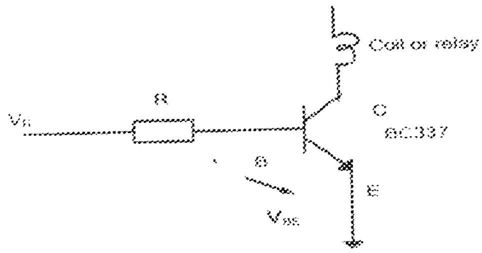

Figure 3.12 Shows the transistor acting as a switch

From the transistor equation;

$$V = IcRc + Vc\varepsilon \qquad \text{.......................................(3.10)}$$

If transistor acts as switch;

$V_{CE} = 0$ ....(3.11)

$V_{+} = I_C R_C$ ....(3.12)

$I_c = \frac{V_+}{R_c}$ (400Ω is the resistance of the relay)

$\Rightarrow I_c = \frac{9V}{400\Omega} = 0.0225A$

But

$h_{fe} = \frac{I_c}{I_B}$ ....(3.13)

$\Rightarrow I_B = \frac{I_C}{h_{fe}}$ where $h_{fe} = 300$, for BC337, NPN transistor

$I_B = \frac{0.0225}{300} = 4.5 \times 10^{-5} A$

Also $V_B = I_B R_B + V_{BE}$ ....(3.14)

$V_{BE} = 0.6v$ for silicon transistor

And $V_B = 9$ v (output of the AND gate)

$$R_B = \frac{V_B - V_{BE}}{I_B}$$

$$= \frac{(9 - 0.6) \times 10^{5}\ \Omega}{4.5}$$

$$= 1.87 \times 10^{5}\ \Omega$$

$$R_B = 187K\ \Omega$$

A preferred value of 200kΩ was chosen.

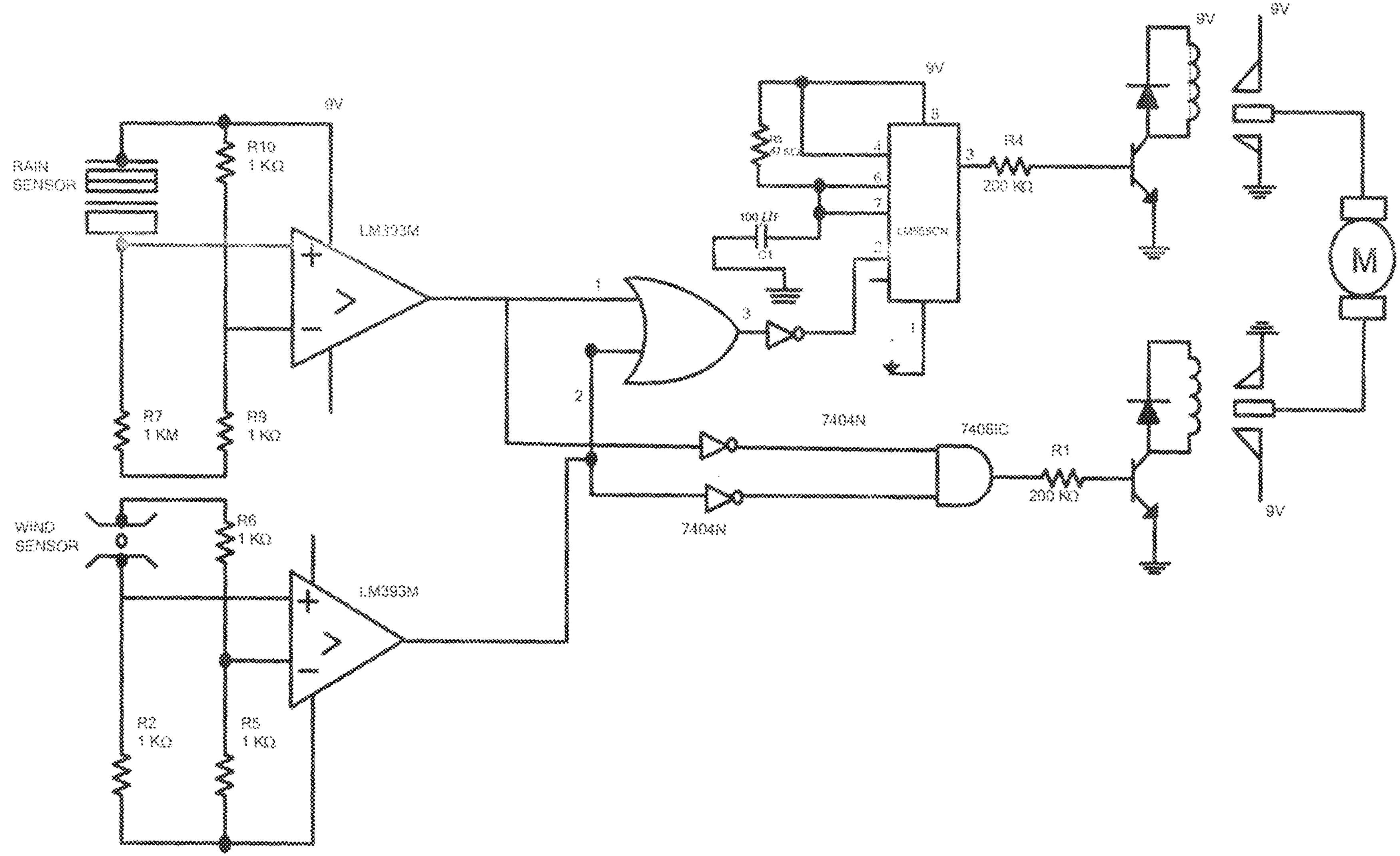

FIG 3.2B Shows the comprehensive circuit of an automatic cloth drying hanging system

CHAPTER FOUR

CONSTRUCTION, TESTING AND RESULT.

4.1 Layout and Construction

In this chapter, an overview of the type of material used in the construction and general layout of the project design is reviewed.

4.2 Construction of the Rain and Wind Sensor

The rain sensor was made of cooper rods, soldered on a tiny piece off Vero board. The soldered joints was covered form rain water using a plastic material. this is to prevent the soldered joints from reacting with water.

The wind sensor was made from an alloy of zinc material which is light. The zinc which is hanging was arranged in such a way as to make contact with metal core when it is windy.

A multimeter was used to test the sensors to ensure the right voltages when it rains or when it is windy.

4.3 Construction and Testing of the Main Circuit

The design of the various circuits comprising of the sensor stage, timing and driver stage were tested using specified components. It was tested on a breadboard to ensure full workability of the design. Breadboard are prototype boards which are modules containing well arranged pin – sockets for firings – in components. The breadboard is ideal for testing full working of the component and system as it serves as a temporary construction board. For this project design, all the components used in the work were laid out on the breadboard, according to the specifications of the project design. Some adjustments were made, the effects of interchanging components was observed and noted.

The breadboard proved to be very convenient and reliable and played an integral role in the circuit design of this project work as theoretical design were realized with ease and components were easily experimented with. It was however noted that the breadboard should not be used for circuits with operating frequencies exceeding 10MHz. When the system was certified to be working, the components were then permanently fixed on a Vero board.

The Vero board is an insulator strip, comprising of several parallel tracks of strips with small holes drilled along its length, given a matrix format. It is made up of hard plastic and provides adequate insulation between connected components.

The components are transferred to the Vero board by playing each pin of the component in a separate hole and in accordance with the specified design. This ensures firm hold of the component and this stage of construction is referred to as the final circuit construction.

Soldering of the components was done with great care to prevent damage to the components. The tip of the soldering iron was cleaned, sharpened with a chisel and a high grade soldering lead was used. The temperature of the solder was regulated to avoid over heating.

4.4 Construction of Casing

The choice of material for casing was the plastic glass, because of its light weight and it is relatively cheap. The dimensions of the casing were considered with respect to the size of the components and space was given to accommodate any subsequent improvising (addition). The casing was first designed on paper and modifications were made before the actual construction to ensure that the finished work closely resembled what was conceived first as an ideal.

The various components comprising the whole cloth drying system were put together by fixing them in their appropriate positions in the constructed plastic glass casing. Screws were used to couple down the circuit board in the casing and glue to hold together the sides of the casing. This was allowed to ease maintenance and modifications.

4.5 Precautions

Quite a number of precautions were taken in the design and construction of this project. This was done to ensure that the system worked well and components were not damaged in the process of construction so as to maintain a low cost of production. Some of the precaution taken include:-

i. Proper soldering techniques were applied. Stray soldering was carefully avoided to prevent short circuits and bridging. High grade soldering lead was used and the heat of the soldering iron was regulated to avoid damage to the components.

ii. The circuit design was made easy to understand methods used in previous designs, so as to save time and prevent too much experimentation with components.

iii. The values of circuit components were chosen to be very close to the calculated values.

iv. Proper identification of components, their parts and values were done at the time of purchase during the design.

CHAPTER FIVE

CONCLUSION

The design and construction of the automatic cloth drying hanging system has been carried out in this project. The project contains adequate information and explanation about the operation of an automatic cloth line.

The importance of automatic cloth drying hanging system has been better appreciated. after carrying out this project work.

The construction of this project was achieved at low cost with the best available materials. The system is designed to be user friendly.

Working on this project was challenging, but it turned out to be interesting and very enlightening. It was noted that there is difference between the theoretical and practical values obtained due to human errors.

5.1 Problems Encountered

1. The problem of getting a safe distance for the cooper rods constituting the rain sensor was a major problem. This was solved by making adjustments in the distance while using the digital multimeter to test for the resistance of water between the copper rods.
2. Getting the D.C motor to rotate at an appropriate speed so as to allow the cloth-line roll in at the set time was a major problem; this was solved by connecting a resistor to the motor, which reduce the voltage across the motor, causing it to slow down.

5.2 Recommendation

It is suggested that students who carryout similar project in future be made to improve upon the following:-

- The rain sensor can be made using materials of higher conductivity.
- The wind sensor can be replaced with anemometer with which the wind can be measured.
- The voltage comparator can be replaced with more sophisticated analogue to digital exchange.

- An alternative power supply unit, like a 12vDC battery can be used, so as to power the circuit when there is no power from the mains.

REFERENCE

[1] http:// www. Play- hookey. Com/ XOR motion.

[2] Robert Boylestad and Louis Naslelsky. Electronic device and circuit theory, eight Edition, prentice- hill India, 2005, pp. 125, 201 – 204.

[3] http:// Design – NET. Com

[4] http: // anc. Org/lab/circuit design- html

[5] Ricard J. Fowler. Electricity principle and applications, MC Graw- Hill Inc. Gregg Division, 1979, pp 20, 125, 202 – 207.

[6] www. Wikipedia. com.

[7] www.Electronic solution. com

[8] Engr. M.S. Ahmed, ECE529 (Industrial Electronic) course material, 2005/2006 Session F.U.T .Minna.

[9] www. alldatasheets.com

[10] www. Easy circuit.com

[11] www. Electronics project.com

[12] http: // www. Kaba.co.uk/product/automatic-cloth line.asp.s

[13] Aremu Abiodum (1997/5946EE) "Design, Construction and Testing of Automatic Light sensitive switch", F.U. T.Minna. (unpublished undergraduate thesis). 2003.

[14] Tokumbo Akeem Akinola "Automation of the Electrical and Computer Engineering Department of F.U.T. Minna. using object Orientated Programming (OOP)" F.U.T. Minna. (Unpublished Undergraduate thesis). 2003.

[15] http: // automatic h drying hanging system electronic. Com. Tw/sensor – for- Automatic – cloth drying hanging system. Htm.

[16] Donald, F.G (1982): Electronics Engineering Book Publishers, Chris Treensien, Second Edition, pp 150-161

[17] Ronald J. Tocci and Neal S.Widmer, Digital systems: principles and Applications 8^{th} Ed. Pearson Education, 2003. ISBN: 81-7808-559-3 pp 237.

[18] B.L.Theraja and A.K. Theraja, A Textbook of Electrical Technology, Schand and

Company Ltd, 1998, ISBN: 81 – 0289 – 4, pp1942, pp625-643.

[19] Winfield Howwitz (1982): The art of electronics. Revised Edition. pp220-225.

[20] Toney Van Room, 555 timer tutorials. Vanrex Lc. Ltd, 2004, pp 2,3,6,9,10,11.

[21] Giorgio Rizzoni, Principle and Application Engineering, Ragendra Ravindra (Pvt) Ltd, 2005, pp. 362 - 365

[22] http:// home automation.com.

[23] http:// en. Wikipedia. Org/wiki/dc motor

[24] www.ies.com

[25] http:// www.roll al.com

[26] Everand M Upjohn "cloth hanger", Encyclopedia Americana, 1994 vol. 19, pp292 -294.

[27] Gordon J. Murphy, "Automatic control", Encyclopedia Americana, 1983 vol. 2 Pp.105-106

[28] Seymour Weimer, "Hanger History"," Encyclopedia Americana, 1983 vol. 15 pp. 169-170.

[29] Walter Buckingham "Automation: Its impact on Business and people" ", Encyclopedia Americana, 1983 vol. 2 pp 107-118.

[30] http:// www. Technology .Com/Ct/Science-Fiction- News. asp? News Num = 439.

[31] Jerry B.M (1979): general Physics with Bioscience Essays. John Wesley and Sons Inc.uk.

[32] www. National semiconductor/LM393

[33] www. AA5AVR.com/555

[34] Relay outputs circuits. By Ray Mars ton, Electronics Now Magazine, July, 1994.

[35] All about relay "By Rany L.Triethey" radio Electronics magazine, Dec, 1999