Design And Construction of A Double Axis 360 Degree Sun Position Solar Tracking with Automatic Irrigation System

A report submitted to the Department of Mechanical Engineering, Sonargaon University of Bangladesh in partial fulfillment of the requirements for the Award of Degree of Bachelor of Science in Mechanical Engineering.

Submitted by

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September, 2022

LETTER OF TRANSMITTAL

September, 2022

To

Niloy Sarkar

Lecturer

Department of Mechanical Engineering.

Sonargaon University of Bangladesh

Subject: Submission of Project Report.

Dear Sir,

We are pleased to submit the project report on "**Design and Construction Of A Double Axis 360 Degree Sun Position Solar Tracking with Automatic Irrigation System**". It was a great pleasure to work on such an important topic. This project has been done as per instruction of your supervision and according to the requirements of the Sonargaon University.

We expect that the project will be accepted by the concerned authority we will remain happy to further explanation that you may feel necessary in this regard.

Thank You

Sincerely yours,

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DECLARATION

We do hereby solemnly declare that, the work presented here in this project report has been carried out by us and has not been previously submitted to any University/ Organization for award of any degree or certificate

We hereby ensure that the works that has been prevented here does not breach any existing copyright.

We further undertake to indemnify the university against any loss or damage arising from breach of the foregoing obligation.

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[Authors]

ABSTARCT

Of all the renewable energies, solar energy is the only energy gained its popularity and importance quickly. Perpendicular proportionality of the solar panel with the sun rays is the reason lying behind its efficiency. This project is discussed all about the design and construction mechanism of the prototype for the solar tracking system having a double axis of freedom. The main control circuit is based upon Arduino Nano micro-controller. Programming of this device is done in the manner that the LDR sensor, in accordance with the detection of the sun rays, will provide direction to the servo motor that in which way the solar panel is going to revolve. Through this, the solar panel is positioned in such a manner that the maximum amount of sun rays could be received. Tracking helps in the wider projection of the panel to the Sun with increased power output.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

The most familiar ambient energy source is solar power. Solar panels for street lightning or anything are a clean renewable source of energy but had their advantages and disadvantages. Most applications (irrigation, street lights, motion sensor, speeding cameras, and traffic lights) are rated for 12 V. A 12 V panel may have an open circuit voltage of 16 to 22 V, which drops to battery voltage when connected. Panels that are already used in street lighting have wattage between 50 and 110 W. [1][2] This means that their maximum output amperage to a battery is between 3.30 and 6.30 A. Solar roadways are smart, micro processed, hexagonal solar units. At just 15% efficiency, far below what is expected, a 100% Each Solar Road Panel (roughly 12' by 12') interlinks with neighboring panels to form the Solar Roadways system.

New accessories such as LED lights could be added to reduce power consumption. The advantage is the LED long life, the best LED's used on the market today may still be producing over 82% of their initial light after 100 000 hours, meaning 25 years in typical applications in the field. Vibration energy can be used as an ambient source. [5] According to the survey conducted by the Bureau of Electrical Energy in India in 2011 there are around 18 million agricultural pump sets and around 0.5 million new connections per year is installed with average capacity 5HP. Total annual consumption in agriculture sector is 131.96 billion KWh (19% of total electricity consumption). As cited in paper [10] solar powered smart irrigation technique is the future for the farmers and a solution for energy crisis. This picture is almost the same for our country.

A power generator based on sensing mechanical vibrations can be embedded in surfaces subjected to constant stress and vibrations, and enclosed to protect it from hard environment. Plus it functions in a constant temperature field and doesn't depend on the weather. The most popular transducer for vibration energy is piezoelectric. [7][8] The environment that is probably most subjected to vibrations and stress is road surface. The idea of this study is to investigate and design a prototype and its correspondent energy harvesting device circuit that could be embedded in irrigation system. The huge amount of electrical power consumed in running pump motor, has to be reduced because the shortage of supply power in those areas.

This study describes the design of a system that can be used in irrigation system to water the lands during crop season that saves power by watering the land only when the moisture level of the soil drops down from a certain value. Another feature to be taken into account is preserving the batteries feeding the electrically constructed irrigation system, by designing a charging controller. [6][9]

1.2 Objectives

We have some specific objectives for this project and they are pointed below:

- To design a Double Axis 360 Degree Sun Position Solar Tracking with Automatic Irrigation System.
- To construct a Double Axis 360 Degree Sun Position Solar Tracking with Automatic Irrigation System.

1.3 Structure of the Project

This project book consists of six chapter. The first chapter contains the statement of the introduction, our background study for the project, objectives of the study in the project and the project organization. Chapter two contains literature review, history, block diagram, circuit diagram and components list. Chapter three describes details of component and instrument details of the whole project. Chapter four contains the methodology, working principle and our final project view. Chapter five deals with the result and discussion and shows the complete prototype of the project that we have built. In the final chapter, we discuss about future scope and conclusion of our project.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In this section topics related to “Design and Construction of a Double Axis 360 Degree Sun Position Solar Tracking with Automatic Irrigation System” are included. These provide a sampling of problems appropriate for application of dual axis solar tracking and irrigation system. The references are summarized below.

2.2 Literature Review

In previous decades, several number of work or project was done on solar system for different purpose. Some are describe below:

This literature review reveals the detailed work that has been carried out till date on the topic of Solar Tracking. N. Othman, M. I. A. Manan, Z. Othman, S. A. M. AlJunid have designed a two-axis sun tracking system with the use of five LDRs and an Arduino UNO controller [1]. The objective of this research is to design and construct the automatic dual axis solar tracker for maximum sun energy utilization. The only point of worry is that this system should consume energy as minimum as possible so that the difference between power conversion and power consumption would increase and hence the net profit of the system. Arduino UNO controller has been used and it is programmed in C language. LDRs are used to detect the maximum sunlight position in the sky and the program written performs calculations and drives the servo motors to make PV panels perpendicular to the sun [1].

The sun not only travels from east to west but there is a change of angle in north to south direction also. So the north and south directions should also be taken care of. Dual axis trackers do that. These trackers track the sun on a horizontal as well as vertical axis. Because of this operating ability the dual axis trackers have more output power than the single axis trackers. Light Dependent Resistors are used to find the brightest spot of the sun in the sky. LDRs are connected to Arduino UNO controller which gets to know the position of the sun in the sky and hence rotates the motors towards the sun.

Two Servo motors are used for panel rotation which also fulfils the low cost and lightweight criteria [1]. Md. Tanvir Arafat Khan, S.M. Shahrear Tanzil (2010) have designed and constructed a microcontroller based solar tracking system using LDRs to sense the intensity of sunlight and stepper motors to move the Photo-Voltaic (PV) panels in accordance with the sun [2]. Fabian Pineda, and Carlos Andres Arredondo (2011) have designed and implemented a two-axis sun module positioning by sensing the maximum brightness point in the sky. A geodesic dome based sensor has been built for the bright point tracking [3].

Authors Salabila Ahmad et al. have designed and constructed an open loop two axes sun tracking system with an angle controller. The hardware is selected such as it will maximize the power collected and minimize the power consumed as the efficiency parameter lies in between these two power parameters [4]. Solar tracking also helps in transmitting sunlight to dark area like basement. Authors Jifeng Song et al. have implemented the high precision tracking system based on a hybrid strategy for concentrated sunlight transmission via fibres [5]. Author Cemil Sungur (2008) has presented the multi-axes sun tracking system with PLC control. The azimuth and altitude angles of the sun are calculated for a period of 1 year at 37.6º latitude where Turkey is located. According to these angles, an electromechanical system which tracks the sun according to azimuth and altitude angle is designed and implemented [6].

Authors A.chaib et al (2013) have presented the heliostat orientation system based on PLC robot manipulator. It is presented that by mounting certain no. of heliostats and facing them towards central power tower water can be heated and turbines can be driven for energy conversion purpose. By applying MATLAB program for determining the sun's position for heliostat orientation and by using PLC robot manipulator it is presented that maximum amount of energy gets converted from solar to electricity. Concentrated Solar Power (CSP) is used in this experiment [7]. Authors Tao Yu and Guo Wencheng (2010) have introduced automatic sun-tracking control system based on Concentrated Photo Voltaic (CPV) generation. CPV generation works effectively when light panels trace the sun accurately. Stepper tracking control technology is used. This control relies on control circuit with ARM and camera which can provide powerful computational capability [8].

2.3 Summary

We try to do this project by reading the above literature, and we have been able to make our project successful by reducing the mistakes of last year's project.

CHAPTER 3

DESIGN, HARDWARE AND SOFTWARE ANALYSIS

3.1 Design

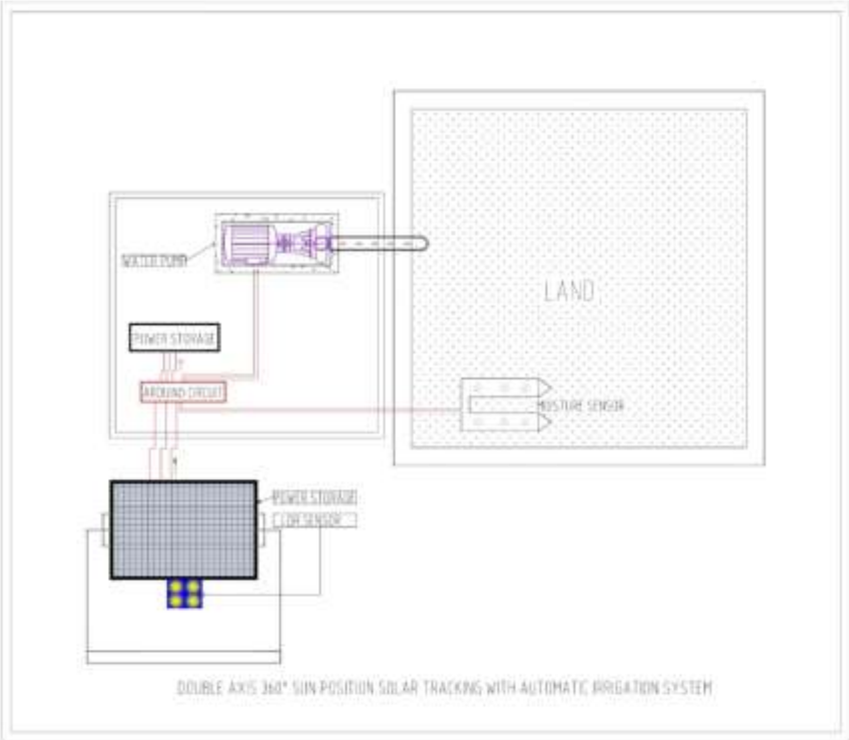

Figure 3.1: Design of A Double Axis 360 Degree Sun Position Solar Tracking with Automatic Irrigation System

3.2 Arduino Pro Mini

The Arduino Pro Mini is a micro-controller board based on the ATmega168. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, an on-board resonator, a reset button, and holes for mounting pin headers. A six pin header can be connected to an FTDI cable to provide USB power and communication to the board.

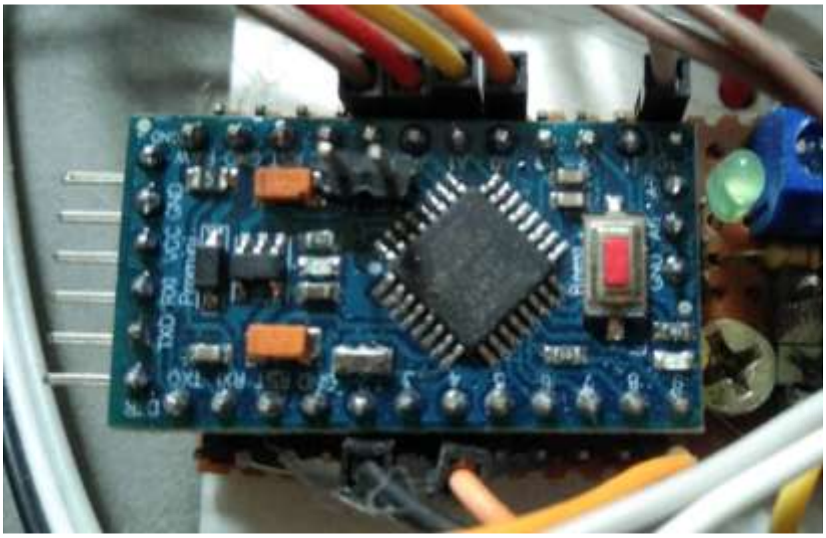

Figure 3.2: Arduino Pro Mini

Specification

(i) Micro-controller ATmega168

(ii) Operating Voltage: 3.3V or 5V (depending on model)

(iii) Input Voltage: 3.35 -12 V (3.3V model) or 5 - 12 V (5V model)

(iv) Digital I/O Pins: 14 (of which 6 provide PWM output)

(v) Analog Input Pins: 6

(vi) DC Current per I/O Pin: 40 mA

(vii) Flash Memory: 16 KB (of which 2 KB used by boot loader)

(viii) SRAM: 1 KB

(ix) EEPROM: 512 bytes

(x) Clock Speed: 8 MHz (3.3V model) or 16 MHz (5V model)

Pin Out

Each of the 14 digital pins on the Pro Mini can be used as an input or output, using pin Mode(), digital Write(), and digital Read() functions. They operate at 3.3 or 5 volts (depending on the model). Each pin can provide or receive a maximum of 40 mA and has an internal pull-up resistor (disconnected by default) of 20-50 kOhms. In addition, some pins have specialized functions:

- Serial: 0 (RX) and 1 (TX). Used to receive (RX) and transmit (TX) TTL serial data. These pins are connected to the TX-0 and RX-1 pins of the six pin header.
- External Interrupts: 2 and 3. These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value. See the attachInterrupt() function for details.
- PWM: 3, 5, 6, 9, 10, and 11. Provide 8-bit PWM output with the analogWrite() function.
- SPI: 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK). These pins support SPI communication, which, although provided by the underlying hardware, is not currently included in the Arduino language.
- LED: 13. There is a built-in LED connected to digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off.

  The Pro Mini has 6 analog inputs, each of which provide 10 bits of resolution (i.e. 1024 different values). Four of them are on the headers on the edge of the board; two (inputs 4 and 5) on holes in the interior of the board. The analog inputs measure from ground to VCC. Additionally, some pins have specialized functionality:
- I2C: 4 (SDA) and 5 (SCL). Support I2C (TWI) communication using the Wire library.

There is another pin on the board:

- Reset. Bring this line LOW to reset the micro controller. Typically used to add a reset button to shields which block the one on the board.

  See also the mapping between Arduino pins and ATmega168 ports.

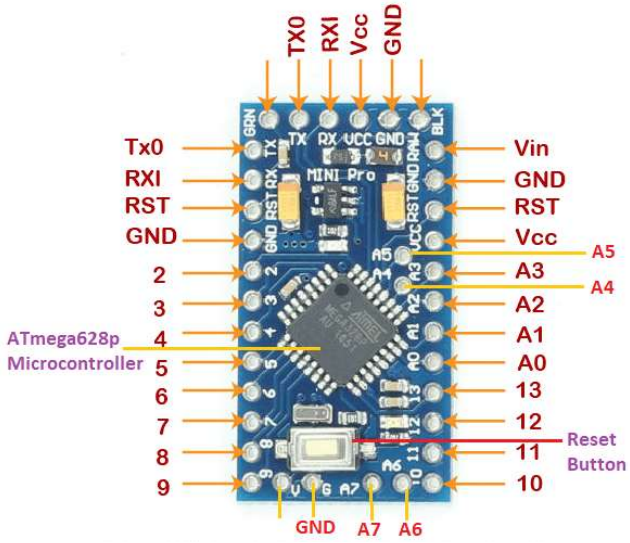

Figure 3.3: Arduino Pro Mini Pin Out

Micro controller IC ATmega328p

Figure 3.4: Micro controller IC AT Mega 328p

The high-performance Microchip Pico Power 8-bit AVR RISC-based micro controller combines 32KB ISP flash memory with read-while-write capabilities, 1024B EEPROM, 2KB SRAM, 23 general purpose I/O lines, 32 general purpose working registers, three flexible timer/counters with compare modes, internal and external interrupts, serial programmable USART, a byte-oriented 2-wire serial interface, SPI serial port, a 6-channel 10-bit A/D converter (8-channels in TQFP and QFN/MLF packages), programmable watchdog timer with internal oscillator, and five software selectable power saving modes. The device operates between 1.8-5.5 volts. By executing powerful instructions in a single clock cycle, the device achieves throughputs approaching 1 MIPS per MHz, balancing power consumption and processing speed.

3.3 Solar Panel

A solar panel is a set of solar photovoltaic modules electrically connected and mounted on a supporting structure. A photovoltaic module is a packaged, connected assembly of solar cells. The solar panel can be used as a component of a larger photovoltaic system to generate and supply electricity in commercial and residential applications. Each module is rated by its DC output power under standard test conditions (STC).

Figure 3.5 : Solar Panel

The efficiency of a module determines the area of a module given the same rated output - an 8% efficient 230 watt module will have twice the area of a 16% efficient 230 watt module. A single solar module can produce only a limited amount of power; most installations contain multiple modules. A photovoltaic system typically includes a panel or an array of solar modules, an inverter, and sometimes a battery and/or solar tracker and interconnection wiring. Solar cell modules produce electricity only when the sun is shining. They do not store energy, therefore to ensure flow of electricity when the sun is not shinning, it is necessary to store some of the energy produced. The most obvious solution is to use batteries, which chemically store electric energy. Batteries are groups of electro chemical cells (devices that convert chemical energy to electrical energy) connected in series. Battery cells are composed of two electrodes immersed in electrolyte solution which produce an electric current when a circuit is formed between them. The current is caused by reversible chemical reactions between the electrodes and the electrolyte within the cell. Batteries that are re-chargeable are called secondary or accumulator batteries. As the battery is being charged, electric energy is stored as chemical energy in the cells. When being discharged, the stored chemical energy is being removed from the battery and converted to electrical energy. In East-Africa, the most common type of secondary battery is the Lead-acid battery. [13]

Specifications of Solar Panel

(i) Size: 4.4" x 5.4" / 110mm x 140mm
(ii) Weight: 3 ounces / 90 grams
(iii) Cell type: Monocrystalline
(iv) Cell efficiency: 19%+
(v) 2.27 Watts Peak Power
(vi) Technical drawing

Dimensions:

- Length: 111.86mm/4.40in
- Width: 135.83mm/5.34in
- Thickness (without screws): 4.72mm/0.18in
- Thickness (with screws): 9.82mm/0.38in

3.4 Solar Charger Controller

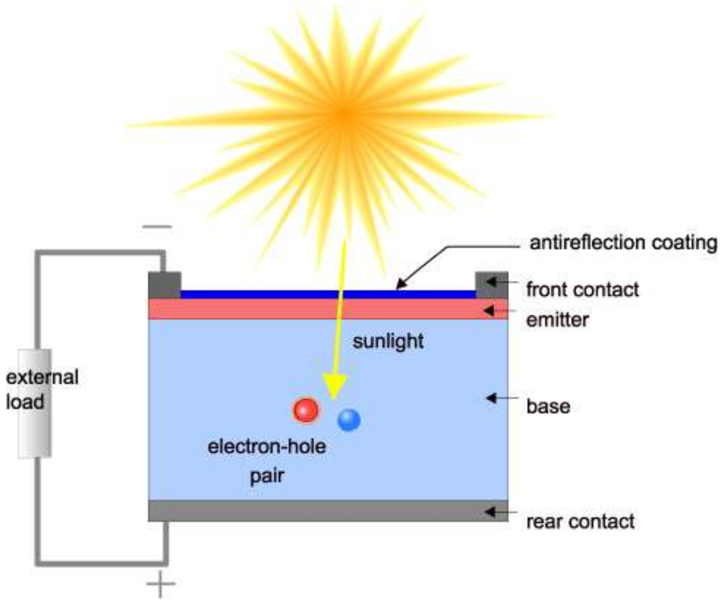

Figure 3.6: Solar Panel Schema Diagram

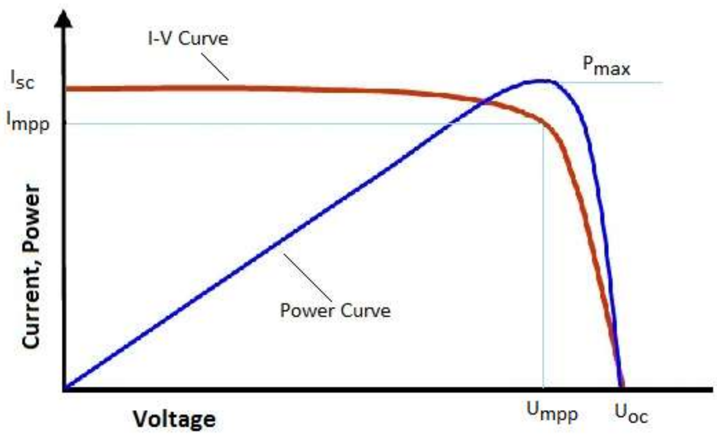

Figure 3.7: Solar Cell System Curve

Here is a solar charger circuit that is used to charge Lead Acid or Ni-Cd batteries using the solar energy power. The circuit harvests solar energy to charge a 6 volt 4.5 Ah rechargeable battery for various applications. The charger has voltage and current regulation and over voltage cut-off facilities.

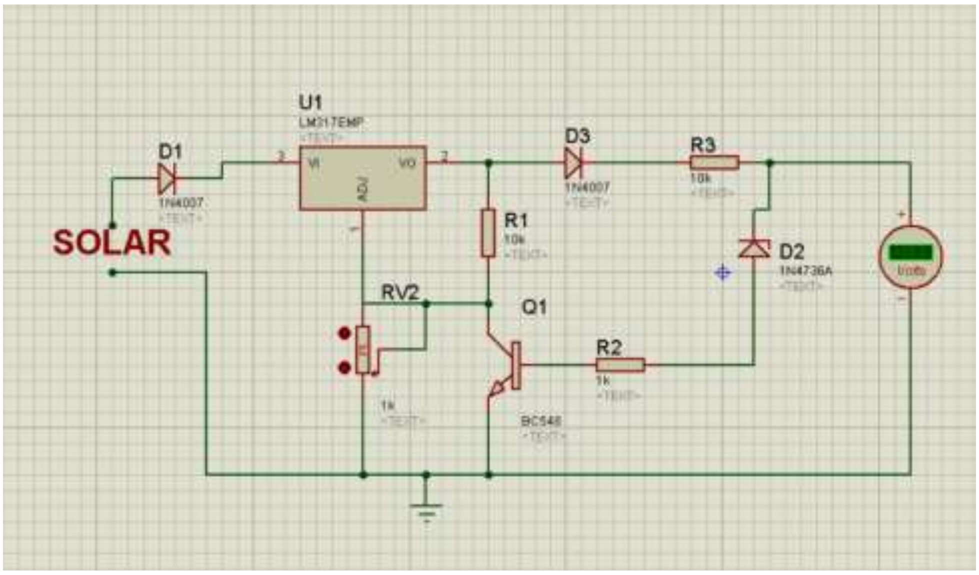

Figure 3.8: Solar Charger Controller Circuit

The circuit uses a 12 volt solar panel and a variable voltage regulator IC LM 317. The solar panel consists of solar cells each rated at 1.2 volts. 12 volt DC is available from the panel to charge the battery. Charging current passes through D1 to the voltage regulator IC LM 317. By adjusting its Adjust pin, output voltage and current can be regulated. VR is placed between the adjust pin and ground to provide an output voltage of 9 volts to the battery. Resistor R3 Restrict the charging current and diode D2 prevents discharge of current from the battery.

Transistor T1 and Zener diode ZD act as a cutoff switch when the battery is full. Normally T1 is off and battery gets charging current. When the terminal voltage of the battery rises above 6.8 volts, Zener conducts and provides base current to T1. It then turns on grounding the output of LM317 to stop charging.

3.5 Pump Motor

This is a low cost, small size Submersible Pump Motor which can be operated from a 2.5 ~ 6V power supply. It can take up to 120 liters per hour with very low current consumption of 220mA. Just connect tube pipe to the motor outlet, submerge it in water and power it. Make sure that the water level is always higher than the motor. Dry run may damage the motor due to heating and it will also produce noise.

Figure 3.9:Pump Motor

Feature:

(i) Operating Current : 130 ~ 220mA

(ii) Flow Rate : 80 ~ 120 L/H

(iii) Maximum Lift : 40 ~ 110 mm

(iv) Continuous Working Life : 500 hours

(v) Driving Mode : DC, Magnetic Driving

(vi) Material : Engineering Plastic

(vii) Outlet Outside Diameter : 7.5 mm

(viii) Outlet Inside Diameter : 5 mm

3.6 Soil Moisture Sensor

This soil moisture sensor module is used to detect the moisture of the soil. It measures the volumetric content of water inside the soil and gives us the moisture level as output. The module has both digital and analog outputs and a potentiometer to adjust the threshold level.

Moisture Sensor Module Pin out Configuration

Pin Name	**Description**
VCC	The Vcc pin powers the module, typically with +5V
GND	Power Supply Ground
DO	Digital Out Pin for Digital Output.
AO	Analog Out Pin for Analog Output

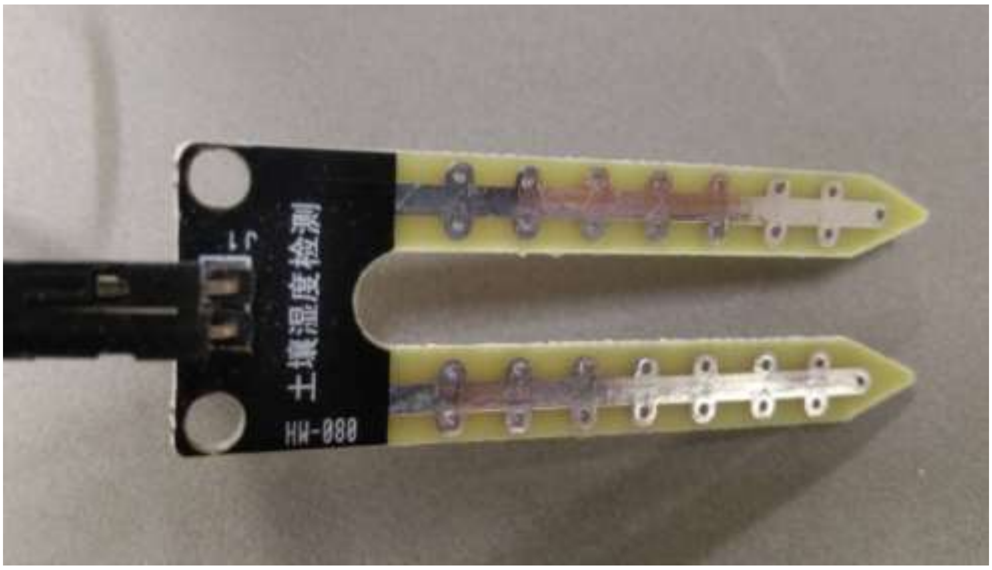

Figure 3.10: Soil Moisture Sensor.

Moisture Sensor Module Features & Specifications

(i) Operating Voltage: 3.3V to 5V DC
(ii) Operating Current: 15mA
(iii) Output Digital - 0V to 5V, Adjustable trigger level from preset
(iv) Output Analog - 0V to 5V based on infrared radiation from fire flame falling on the sensor
(v) LEDs indicating output and power
(vi) PCB Size: 3.2cm x 1.4cm

(vii) LM393 based design

(viii) Easy to use with Micro controllers or even with normal Digital/Analog IC

(ix) Small, cheap and easily available

3.7 Relay

A relay is an electrically operated switch. Many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid-state relays. Relays are used where it is necessary to control a circuit by a separate low-power signal, or where several circuits must be controlled by one signal. The first relays were used in long distance telegraph circuits as amplifiers: they repeated the signal coming in from one circuit and re-transmitted it on another circuit. Relays were used extensively in telephone exchanges and early computers to perform logical operations.

Figure 3.11: Relay

A type of relay that can handle the high power required to directly control an electric motor or other loads is called a contactor. Solid-state relays control power circuits with no moving parts, instead using a semiconductor device to perform switching. Relays with calibrated operating characteristics and sometimes multiple operating coils are used to protect electrical circuits from overload or faults; in modern electric power systems these functions are performed by digital instruments still called "protective relays". Magnetic latching relays require one pulse of coil power to move their contacts in one direction, and another, redirected pulse to move them back. Repeated pulses from the same input have no effect. Magnetic latching relays are useful in applications where interrupted power should not be able to transition the contacts.

Magnetic latching relays can have either single or dual coils. On a single coil device, the relay will operate in one direction when power is applied with one polarity, and will reset when the polarity is reversed. On a dual coil device, when polarized voltage is applied to the reset coil the contacts will transition. AC controlled magnetic latch relays have single coils that employ steering diodes to differentiate between operate and reset commands.

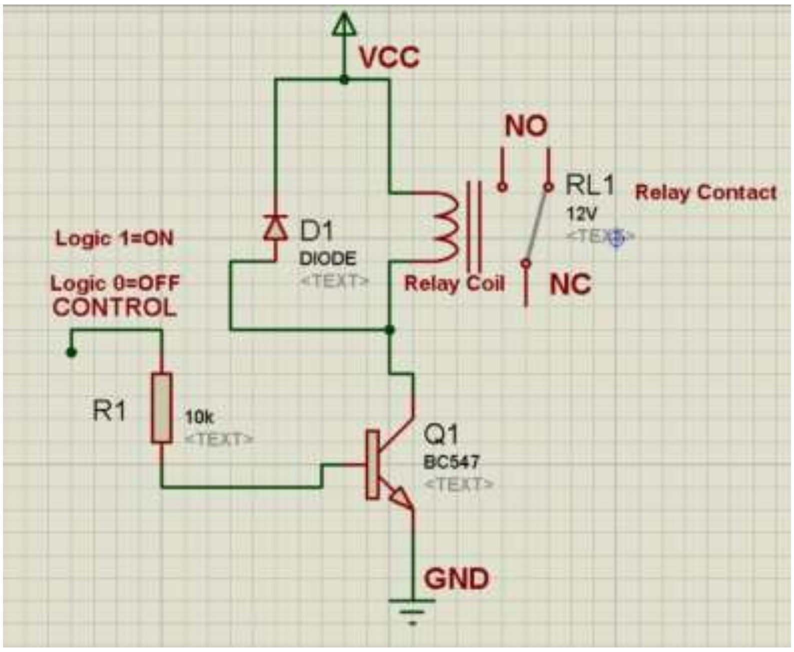

Figure 3.12: Transistor Switching Circuit.

The circuit above is called a low-side switch, because the switch – our transistor – is on the low (ground) side of the circuit. Alternatively, we can use a PNP transistor to create a high-side switch: Similar to the NPN circuit, the base is our input, and the emitter is tied to a constant voltage. A relay is an electrically operated switch of mains voltage. It means that it can be turned on or off, letting the current go through or not. Controlling a relay with the Arduino is as simple as controlling an output such as an LED. The relay module is the one in the figure below.

Figure 3.13: Relay Module.

This module has two channels (those blue cubes). There are other varieties with one, four and eight channels.

Mains voltage connections:

In relation to mains voltage, relays have 3 possible connections:

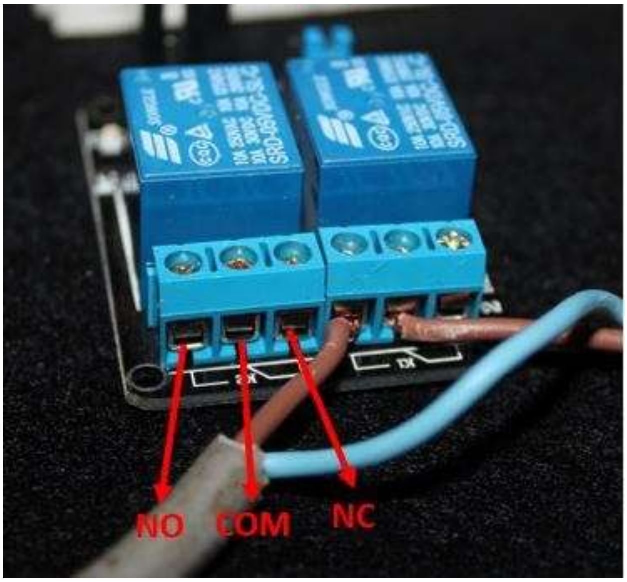

Figure 3.14: Pin diagram of Relay Module

COM: common pin

NO (Normally Open): there is no contact between the common pin and the normally open pin. So, when you trigger the relay, it connects to the COM pin and supply is provided to a load

NC (Normally Closed): there is contact between the common pin and the normally closed pin. There is always connection between the COM and NC pins, even when the relay is turned off. When you trigger the relay, the circuit is opened and there is no supply provided to a load.

Pin wiring:

The connections between the relay module and the Arduino are really simple:

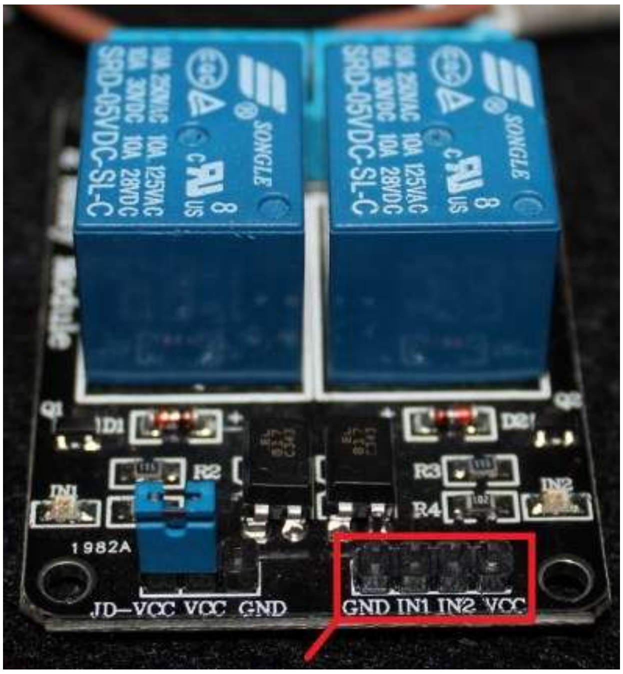

Figure 3.15: Main Voltage Connection

GND: goes to ground

IN1: controls the first relay (it will be connected to an Arduino digital pin)

IN2: controls the second relay (it should be connected to an Arduino digital pin if you are using this second relay. Otherwise, you don’t need to connect it)**VCC**: goes to 5V

3.8 Buck Converter

The converter (step-down converter) is a DC-to-DC converter that reduces the voltage from the input (supply) to the output (load). It is an intermittent power supply (SMPS) project that usually involves at least two semiconductors (including a diode and a transistor), a capacitor, an inductor or two. To reduce the voltage, filters made of capacitors (sometimes combined with inductors) are usually added to the output (single-pass filter) and input (supply-side filter) of such a converter.

Figure 3.16: DC -DC Buck Converter

DC-DC Buck Step Down Module LM2596 Power Supply is a 3-A load converter, capable of carrying a 3-A with a beautiful line and load pattern. These devices are available at an output voltage of 3.3 V, 5 V, 12 V, as well as a variable output voltage. The LM2596 system operates at a frequency change of 150kHz, thus allowing more precision filtering than would be required with high frequency converters.

Specifications of DC-DC Buck Converter Step Down Module LM2596 Power Supply :

(i) Conversion efficiency: 92% (highest)

(ii) Switching frequency: 150KHz

(iii) Output ripple: 30mA9max)

(iv) Load adjustment: ± 0.5%

(v) Voltage adjustment: ± 0.5%

(vi) Dynamic response rate: 5% 200 uS

(vii) Input voltage: 4.75-35V

(viii) Output voltage: 1.25-26 V (adjustable)

(ix) Output current: rated current 2A, maximum 3A (additional heat sink required)

(x) Conversion efficiency: up to 92% (higher output voltage, higher efficiency)

(xi) Switching frequency: 150KHz

(xii) Rectifier: Asynchronous straightening

(xiii) Module properties: non-isolated top-down module (fee)

(xiv) Short circuit protection: current limitation since recovery

(xv) Operating temperature: industrial grade (-40 to +85) (output power 10 W or less)

3.9 LDR Sensor

The LDR Sensor Module is used to detect the presence of light / measuring the intensity of light. The output of the module goes high in the presence of light and it becomes low in the absence of light. The sensitivity of the signal detection can be adjusted using potentiometer.

Features:

(i) Adjustable sensitivity (via blue digital potentiometer adjustment)

(ii) Operating voltage 3.3V-5V

(iii) Output Type: Analog voltage output -A0

(iv) Digital switching outputs (0 and 1) -D0

(v) With fixed bolt hole for easy installation

(vi) Small board PCB size: 3cm * 1.6cm

(vii) Power indicator (red) and the digital switch output indicator (green)

(viii) Using LM393 comparator chip, stable

Pin outs:

- External 3.3V-5V VCC
- External GND GND
- DO digital output interface, a small plate (0 and 1)
- AO small board analog output interface
- Can detect ambient brightness and light intensity

Figure 3.17: LDR Senor

3.10 Battery

Lithium batteries are primary batteries that have metallic lithium as an anode. These types of batteries are also referred to as lithium-metal batteries. They stand apart from other batteries in their high charge density and high cost per unit. Depending on the design and chemical compounds used, lithium cells can produce voltages from 1.5 V (comparable to a zinc–carbon or alkaline battery) to about 3.7 V.

Disposable primary lithium batteries must be distinguished from secondary lithium-ion or a lithium-polymer, which are rechargeable batteries. Lithium is especially useful, because its ions can be arranged to move between the anode and the cathode, using an intercalated lithium compound as the cathode material but without using lithium metal as the anode material. Pure lithium will instantly react with water, or even moisture in the air; the lithium in lithium ion batteries is in a less reactive compound. Lithium batteries are widely used in portable consumer electronic devices. The term "lithium battery" refers to a family of different lithium-metal chemistries, comprising many types of cathodes and electrolytes but all with metallic lithium as the anode. The battery requires from 0.15 to 0.3 kg of lithium per kWh. As designed these primary systems use a charged cathode, that being an electro-active material with crystallographic vacancies that are filled gradually during discharge.

Figure 3.18: 3.7V Battery

Product Specification

Voltage	3.7 V
Product Type	Lithium-Ion
Battery Capacity	2200mAh
Weight	45 g
Model Number	ICR 18650

3.11 5V Regulator IC

Voltage sources in a circuit may have fluctuations resulting in not providing fixed voltage outputs. A voltage regulator IC maintains the output voltage at a constant value. 7805 IC, a member of 78xx series of fixed linear voltage regulators used to maintain such fluctuations, is a popular voltage regulator integrated circuit (IC). The xx in 78xx indicates the output voltage it provides. 7805 IC provides +5 volts regulated power supply with provisions to add a heat sink.

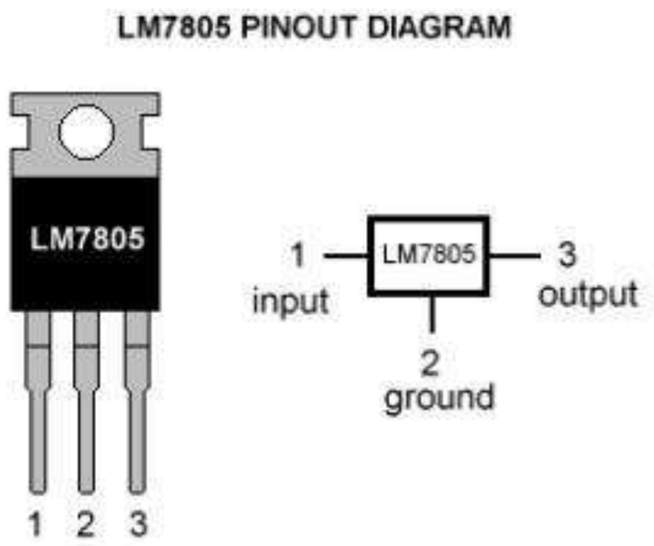

Figure 3.19: 5V Regulator IC

7805 IC Rating:

- Input voltage range 7V- 35V
- Current rating Ic = 1A
- Output voltage range V. Max=5.2V ,V. Min=4.8V

3.12 Servo Motor (SG90)

The **servomotor** is a closed-loop mechanism that incorporates positional feedback in order to control the rotational or linear speed and position. The **motor** is controlled with an electric signal, either analog or digital, which determines the amount of movement which represents the final command position for the shaft. **Servo motors** or "**servos**", as they are known, are electronic devices and rotary or linear actuators that rotate and push parts of a machine with precision. **Servos** are mainly used on angular or linear position and for specific velocity, and acceleration.

Figure 3.20: Servo Motor

Specification:

(i) High Quality Micro Servo
(ii) Torque: 1.8kg/cm (4.8V)
(iii) Operating Speed: 0.1sec/60degree (4.8V)
(iv) Operating Voltage: 4.8V
(v) Dead Band Width: 10usec
(vi) Temperature Range: 0-55^{o}C
(vii) Cable Length: 25.5cm
(viii) Servo Type: Analog Servo
(ix) Dimension: 23x12.2x29mm

3.13 Resistor

Resistors are electronic components which have a specific, never-changing electrical resistance. The resistor's resistance limits the flow of electrons through a circuit. They are passive components, meaning they only consume power (and can't generate it). Resistors are usually added to circuits where they complement active components like op-amps, microcontrollers, and other integrated circuits. Commonly resistors are used to limit current, divide voltages, and pull-up I/O lines.

The electrical resistance of a resistor is measured in ohms. The symbol for an ohm is the Greek capital-omega: Ω. The (somewhat roundabout) definition of 1Ω is the resistance between two points where 1 volt (1V) of applied potential energy will push 1 ampere (1A) of current. As SI units go, larger or smaller values of ohms can be matched with a prefix like kilo-, mega-, or giga-, to make large values easier to read. It's very common to see resistors in the kilohm (kΩ) and megaohm (MΩ) range (much less common to see milliohm (mΩ) resistors). For example, a 4,700Ω resistor is equivalent to a 4.7kΩ resistor, and a 5,600,000Ω resistor can be written as 5,600kΩ or (more commonly as) 5.6MΩ. All resistors have two terminals, one connection on each end of the resistor. When modeled on a schematic, a resistor will show up as one of these two symbols:

Figure 3.21: Two common resistor schematic symbols

3.14 Arduino IDE

The digital microcontroller unit named as Arduino Nano can be programmed with the Arduino software IDE. There is no any requirement for installing other software rather than Arduino. Firstly, Select "Arduino Nano from the Tools, Board menu (according to the microcontroller on our board). The IC used named as ATmega328 on the Arduino Nano comes pre burned with a boot loader that allows us to upload new code to it without the use of an external hardware programmer.

Communication is using the original STK500 protocol (reference, C header files). We can also bypass the boot loader and programs the microcontroller through the ICSP (In Circuit Serial Programming) header. The ATmega16U2 (or 8U2 in the rev1 and rev2 boards) firmware source code is available. The ATmega16U2/8U2 is loaded with a DFU boot loader, which can be activated by:

On Rev1 boards: connecting the solder jumper on the back of the board (near the map of Italy) and then resetting the 8U2. On Rev2 or later boards: there is a resistor that pulling the 8U2/16U2 HWB line to ground, making it easier to put into DFU mode.

The Arduino Nano is one of the latest digital microcontroller units and has a number of facilities for communicating with a computer, another Arduino, or other microcontrollers. The ATmega328 provides UART TTL at (5V) with serial communication, which is available on digital pins 0 -(RX) for receive the data and pin no.1 (TX) for transmit the data. An ATmega16U2 on the board channels this serial communication over USB and appears as a virtual com port to software on the computer. The '16U2 firmware uses the standard USB COM drivers, and no external driver is needed. However, on Windows, an .in file is required. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board.

Figure 3.22: Arduino Software Interface IDE

The RX and TX LEDs on the board will flash when data is being transmitted via the USB-to-serial chip and USB connection to the computer (but not for serial Communication on pins 0 and 1). A Software Serial library allows for serial communication on any of the Nano's digital pins. The ATmega328 also supports I2C (TWI) and SPI communication. The Arduino software includes a Wire library to simplify use of the I2C bus. Arduino programs are written in C or C++ and the program code written for Arduino is called sketch. The Arduino IDE uses the GNU tool chain and AVR Lab to compile programs, and for uploading the programs it uses argued. As the Arduino platform uses Atmel microcontrollers, Atmel's development environment, AVR Studio or the newer Atmel Studio, may also be used to develop software for the Arduino.

The Arduino Integrated Development Environment - or Arduino Software (IDE) - contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino and Genuino hardware to upload programs.

Writing Sketches

Programs written using Arduino Software (IDE) are called sketches. These sketches are written in the text editor and are saved with the file extension. ino. The editor has features for cutting/pasting and for searching/replacing text. The message area gives feedback while saving and exporting and also displays errors. The console displays text output by the Arduino Software (IDE), including complete error messages and other information. The bottom right-hand corner of the window displays the configured board and serial port. The toolbar buttons allow you to verify and upload programs, create, open, and save sketches, and open the serial monitor.

3.15 Proteus Software

The Proteus Design Suite is a proprietary software tool suite used primarily for electronic design automation. The software is used mainly by electronics design engineers and technicians to create schematics and electronics prints for manufacturing printed circuit boards.

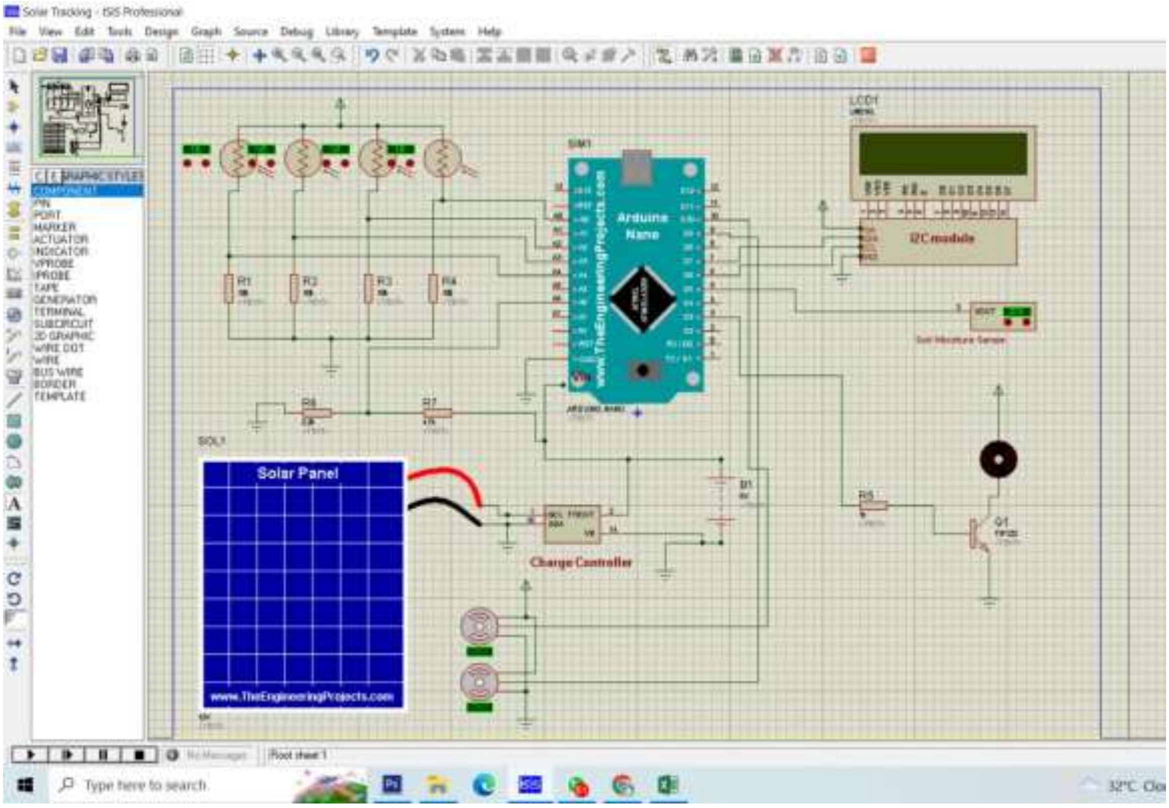

Figure 3.23: Proteus Software Interface

The first version of what is now the Proteus Design Suite was called PC-B and was written by the company chairman, John Jameson, for DOS in 1988. Schematic Capture support followed in 1990 with a port to the Windows environment shortly thereafter. Mixed mode SPICE Simulation was first integrated into Proteus in 1996 and microcontroller simulation then arrived in Proteus in 1998. Shape based auto routing was added in 2002 and 2006 saw another major product update with 3D Board Visualization. More recently, a dedicated IDE for simulation was added in 2011 and MCAD import/export was included in 2015. Support for high speed design was added in 2017. Feature led product releases are typically biannual, while maintenance-based service packs are released as required.

CHAPTER 4

METHODOLOGY

4.1 Our methodologies for the project

Our used methodology for the project:

- Creating an idea for the design and construction of Double Axis 360 Degree Sun Position Solar Tracking with Automatic Irrigation & Battery Charging System. And designing a block diagram & circuit diagram to know which components we need to construct it.
- Collecting all the components and programming the micro-controller to control our desired system.
- Setting up all the components in a PCB board & soldering. Then assembling all the blocks in a board and finally running the system to check if it actually works or not.

4.2 Block Diagram

The increase in energy consumption of portable electronic devices and the concept of harvesting renewable energy in human surrounding arouses a renewed interest. This book focuses on one such advanced method of energy harvesting using solar cell. The control circuit is implemented by the micro-controller.

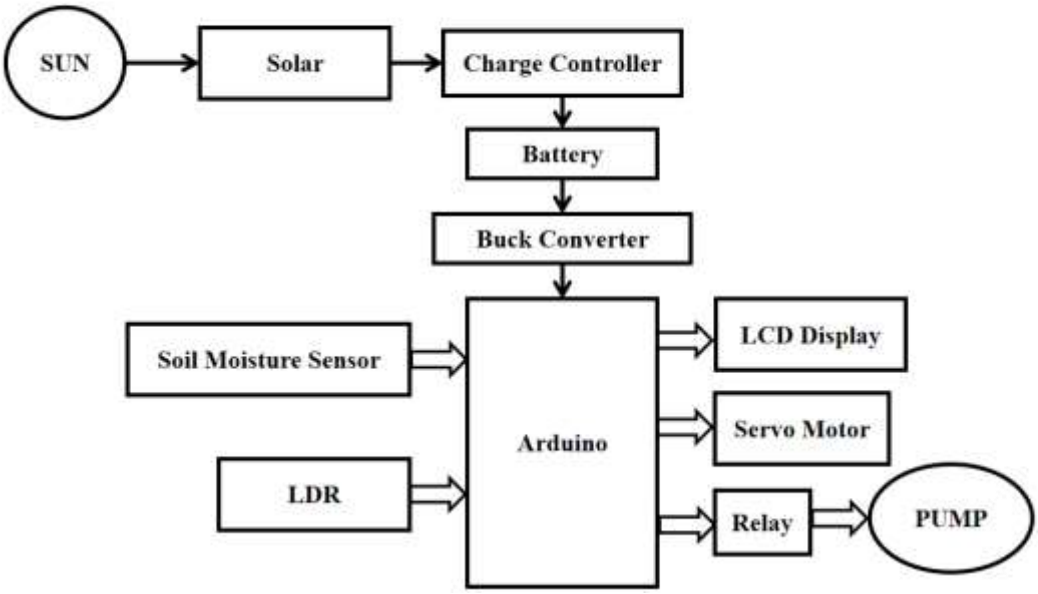

Figure 4.1: Block Diagram of Our System

4.3 Schematic Diagram

The schematic diagram here is representing the electrical circuit and the components of the project. Here we have used standardized symbols and lines.

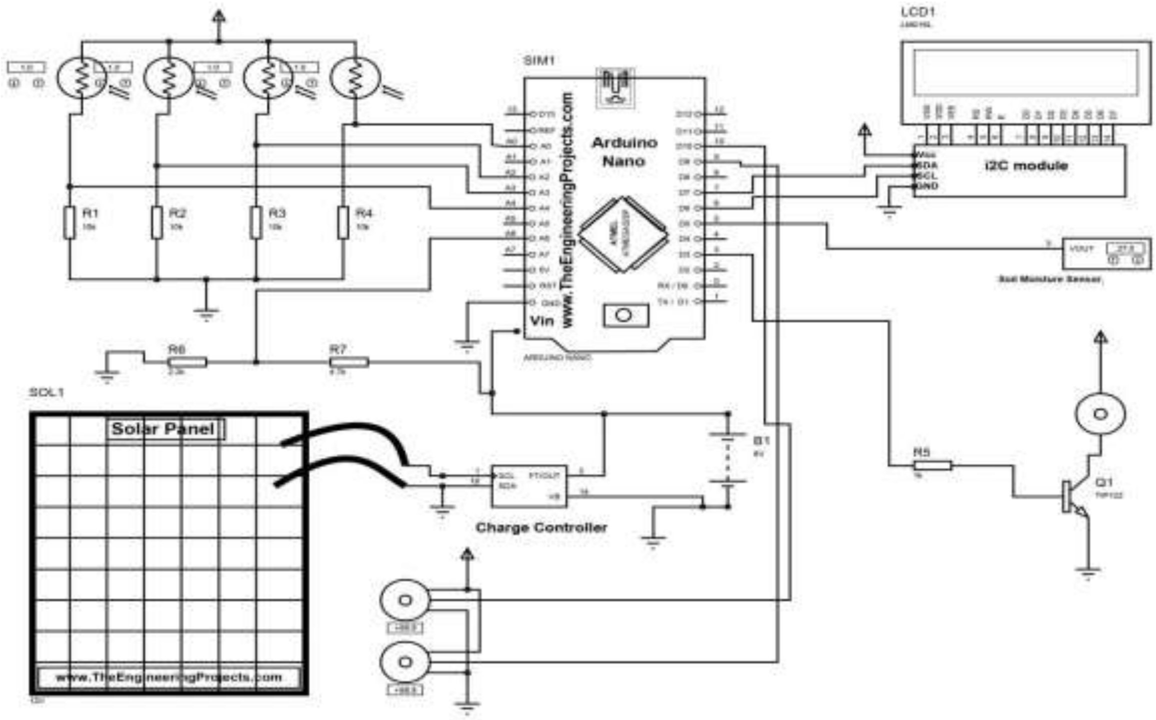

Figure 4.2: Schematic Diagram of the Project

4.4 Working Principle

Automation or automatic control is the use of various control systems for operating equipment such as machinery, processes in factories and other applications with minimal or reduced human . Automation system is so useful in our daily life . Solar panel is the best use for generate electricity and nowadays it makes a huge support of some electrical appliances . Sensor is an automated technique which is used for automation systems .

In this project we use a solar panel for primary power source . Here also use a micro-controller (Arduino Pro Mini) , Soil moisture sensor , Relay, LCD Display, Buck Converter, Solar Panel, Servo Motor, Battery and Pump motor . The main work of this project is when the sun reflects in this solar pane then it will charge and store it a battery. Sun light detect the LDR sensor and rotate the angle of light. Soil moisture sensor senses the soil condition . If soil is dry ,then the motor will on by the command of the micro controller and motor will on . After watering it will be off . LCD shows the condition of soil and battery voltage condition.

4.5 Our Final System view

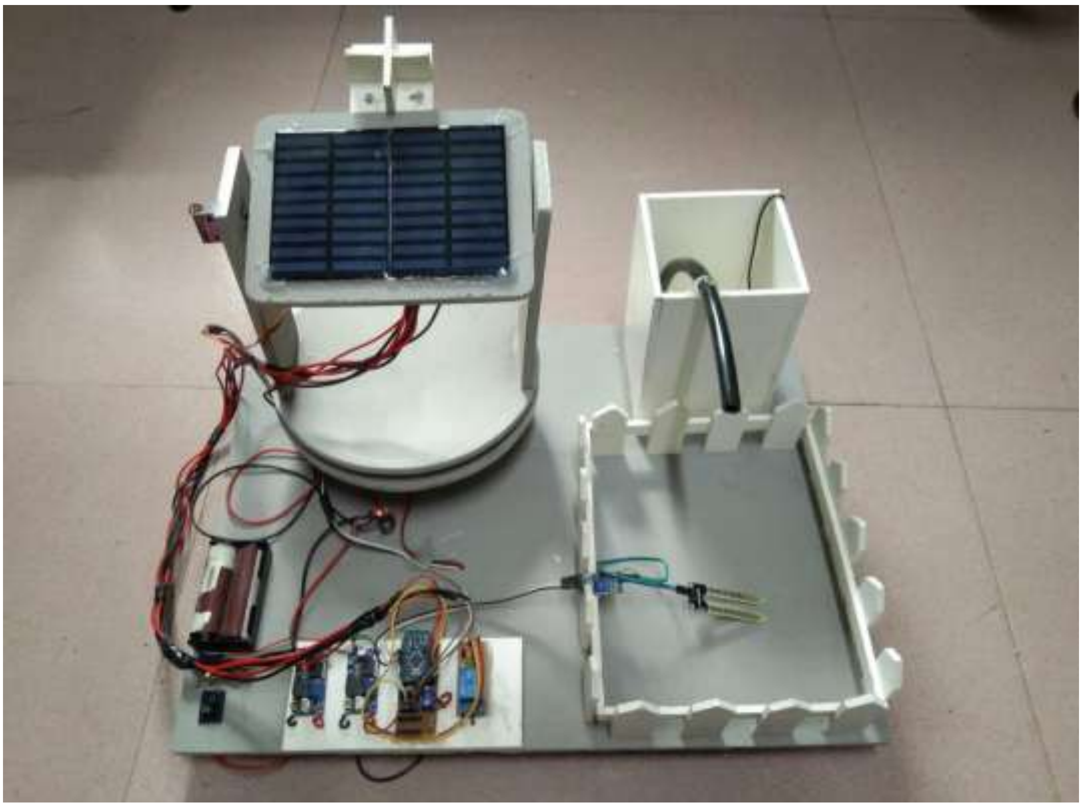

Figure 4.3: Our Final System Overview

CHAPTER 5
DISCUSSION, CALCULATION & RESULTS

5.1 Discussion

While working on our project, we did face some difficulties as it is a very complex system but the end results, we came up with were quite satisfactory. We have put the whole system through several tasks to validate our work and also have taken necessary notes for future improvements. Some future recommendations that we have involves improvement in system design and wiring, adding features for more efficient.

5.2 Calculation

Data Table:

SL.	Volume(m^3)	Time(S)	Discharge (m^3/s)	Average Dis.(m^3/s)	Efficiency (%)
01	0.3×10^{-3}	10	0.00003	0.00009325	6.19
02	0.5×10^{-3}	16	0.00003125		
03	0.8×10^{-3}	25	0.000032		

We take this data from our project

$h = 8\ Inch = 8 \times 0.0254 = 0.2032\ m$

$s_1 = 10\ sec$

$s_2 = 16\ sec$

$s_3 = 25\ sec$

$v_1 = 300\ ml = 0.3 \times 10^{-3} m^3$

$v_2 = 500\ ml = 0.5 \times 10^{-3} m^3$

$v_3 = 800\ ml = 0.8 \times 10^{-3} m^3$

$$\therefore Discharge\ Q = \frac{v}{t}$$

$$\therefore Q_1 = \frac{0.3 \times 10^{-3}}{10} = 0.00003\ m^3/s$$

$$\therefore Q_2 = \frac{0.5 \times 10^{-3}}{16} = 0.00003125\, m^3/s$$

$$\therefore Q_3 = \frac{0.8 \times 10^{-3}}{25} = 0.000032\, m^3/s$$

Average Discharge

$$Q = \frac{Q_1 + Q_2 + Q_3}{3}$$

$$\Rightarrow \frac{0.00003 + 0.00003125 + 0.000032}{3}$$

$$Q = 0.00009325\, m^3/s$$

Efficiency

$$\eta = \frac{\rho g Q h}{power(input), w}$$

$$\eta = \left(\frac{1000 \times 9.81 \times 0.00009325 \times 0.2032}{3}\right) \times\ 100\%$$

$$\eta = \frac{0.185883804}{3}\ \times 100\%$$

$$\eta = 0.061961268 \times 100\ \%$$

$$\eta = 6.19\%$$

5.3 Results

Now, it's time to talk about the results. We have written our commands using the Arduino IDE and the following things can happen:

- If the moisture sensor level goes down from a certain level then the information is sent to the Arduino Nano.
- The Arduino Nano puts current in the Base of the transistor taking it to active mode.
- The CE transistor takes the relay from normally closed to open condition.
- The relay finally turns on the pump to water the area.
- Sun detect in LDR sensor and rotate automatically.
- Battery voltage charging reading and pump condition show in LCD Display.

5.4 Advantage

There are certainly many advantages of our project and some of the major ones have been given below:

- The power sources are natural and the battery is rechargeable.
- Automatic Irrigation System.
- Less power consumption with best utilization.
- The project can be implemented on existing systems.
- The whole system is automatic and saves energy by detecting the presence of light
- The system is user friendly.
- The system is good for the environment as it utilizes renewable energy sources.

5.5 Limitations

Although our project has many applications and advantages but there are some limitations of the project as well and the good thing is that these limitations are minor and doesn't affect the efficiency of the system. Limitations are given below:

- The system needs to be more efficient to produce more energy.
- Due to using renewable energy sources, electrical energy production is less and most of the energy is not converted rather wasted.
- On rainy days, some problems may occur which can hamper energy production.

5.6 Application

Our project has many application areas and actually we need to use it in many places to verified the exact person which have the proper access. Some of the application areas of the project has been pointed out below:

- The system can be implemented to work on different projects such as on any roads requiring irrigation system.
- It can be implemented in area where power wastage takes place a lot.
- It can be implemented in areas where there's power shortage.
- The automatic system can be implemented in areas where security is necessary.
- It can be implemented in areas where there's no conventional power supply available.
- This system can work to power almost anything that runs on electricity

CHAPTER 6

CONCLUSION& RECOMMENDATION

6.1 Conclusion

In this study, we have investigated the feasibility of applying piezoelectricity to convert the mechanical vibrations of roadway to useful electricity. We have also investigated the practicability of employing solar panels to enhance the power of the sun light for our use to a considerable level. We hope that our proposal towards an efficient way to electrify the streets of all the city corporations under the prevailing, "Design and Construction Of A Double Axis 360 Degree Sun Position Solar Tracking with Automatic Irrigation System" project will help to more effectively implement the project within the budget and thereby reducing pressure on conventional power use and current generation.

6.2 Future Scope

We are thinking about adding many features to our project in the future to get more desirable outcomes. Some of the steps that we are thinking about taking are given below:

- In future, we are looking forward to improving our whole system design to make it more efficient.
- In future, we are thinking about adding more features to the system such as cc cameras.
- In future, we are thinking about making the system IoT enabled so that wirelessly the whole system can be observed.

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