AMRUTVAHINI COLLEGE OF ENGINEERING, SANGAMNER-422608

A

PROJECT REPORT

ON

"SOLAR POWERED RAIN ROOFING SYSTEM FOR CROPS WITH SMART WATERING"

Submitted by,

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Year: 2023-24

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This is to certify that the Project entitled

"Solar Powered Rain Roofing System For Crops With Smart Watering"

has satisfactorily completed by,

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In partial fulfilment of term work for final year of E&TC engineering In Savitribai Phule Pune University for academic year 2023 - 2024.

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ABSTRACT

The "Solar powered Smart Farming Project with a Rain Roofing System for Crop Protection" represents a visionary approach to modernizing agriculture by integrating renewable energy, cutting-edge technology, and precision farming methods. This project introduces an intelligent rain roofing system designed to safeguard crops from heavy rainfall. Leveraging Internet of Things (IoT) technology, the system continuously monitors soil moisture levels, automatically triggers irrigation when needed, and tracks environmental factors such as temperature, humidity, and water pH. All data is securely stored and analyzed in a cloud-based platform, empowering farmers with real-timeinsights and remote control over their farming operations.

By combining solar power, automated rain protection, IoT capabilities, and cloud-based data analysis, this project aims to revolutionize agriculture, fostering sustainability, increasing crop yields, and equipping farmers with data-driven tools to navigate a changing agricultural landscape. The endeavor exemplifies a commitment to more efficient, productive, and environmentally responsible farming practices, contributing to a smarter and sustainable future for agriculture.

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CHAPTER 1
INTRODUCTION

1.1 OVERVIEW

In today's rapidly changing world, where concerns about sustainability, resource efficiency, and environmental conservation are paramount, innovative projects that harness the power of technology and renewable energy sources are becoming increasingly relevant. This project introduces a groundbreaking initiative focused on creating a Solar-Powered Rain Roofing System for Crop Cultivation with integrated Smart Watering capabilities. This innovative system combines the strengths of solar energy generation, rainwater harvesting, and precision agriculture to address the pressing challenges of water resource management and sustainable farming practices.

The primary goal of this project is to develop a holistic solution that not only optimizes the use of water for crop irrigation but also provides a resilient response to unpredictable weather patterns. By harnessing the sun's energy, collecting and storing rainwater, and employing advanced monitoring and control mechanisms, this system seeks to revolutionize agricultural practices, making them more eco-friendly and economically viable. The Solar powered IoT Smart Farming project with a rain roofing system for crop protection is a groundbreaking initiative that brings together renewable energy, advanced technology, and innovative farming practices. By harnessing solar powered implementing IoT devices, the farm becomes "smart"enabling real-time monitoring and control of crucial farm parameters.

The rain roofing system further enhances crop protection by regulating rainwater acidity, ensuring optimal soil pH and healthier plant growth. Key components of this project encompass solar panels for clean energy production, a specially designed rain roofing system for rainwater collection, cutting-edge weather sensors for real-time climate data, a sophisticated microcontroller-based control system for intelligent decision-making, and a crop irrigation system connected to a rainwater reservoir. Moreover, the project offers the possibility of creating an accessible user interface for remote system monitoring and manual control. This project embodies the spirit of innovation and environmental consciousness, showcasing how modern technology can contribute to addressing global challenges while advancing sustainable and efficient agricultural practices. In the following system, we will delve deeper into the intricate design, component details, step-by-step implementation, and potential enhancements of this Solar-Powered Rain Roofing System for Crop Cultivation with Smart Watering capabilities.

1.2 NEED OF PROJECT

The project is needed to promote sustainable agriculture, optimize resource efficiency, protect crops from excessive rainwater, increase yields, adopt advanced technologies, and contribute to environmental conservation and food security. Heavy rain reduces the plant growth in turn reduces yield and also harm the crops[1].

The farmers Commit Suicides After their crops got destroyed due to natural weather Calamities. Only Weather Updates or alert are given to formers through Media. But there is no exact time alert or there is no system which can protect farmer Crops [2].

An Intelligent System is designed to protect farmer crops over rains. A movable Panel is designed to protect agriculture field. During rains and other sudden weather changes the sensor connected in the land detects and intimation will be sent to Farmer Using IOT technology [3]. Farmer can move panel According to his crop requirement. If the Farmer doesn’t reply the system works in automatic Mode Such that the moisture Sensor Connected in Land Detects the Moisture Levels in Land and Initiates the appropriate Action required increasing the crop yields [4].

1.3 AIM OF THE PROJECT

The aim of this project is to design an automated roofing system triggered by heavy rain detection and to monitor the real time parameters of farm with automatic water irrigation.

1.4 OBJECTIVES OF THE PROJECT

- To collect the real time data on soil moisture, temperature, humidity and pH level in soil
- To send the sensed data from the sensors to the microcontroller and show parameters on 16*2 LCD display.
- To create a centralized system that remotely monitors the farm conditions from anywhere any time.
- To control opening and closing of roof system during heavy rain detected by rain sensor.

CHAPTER 2
BACKGROUND AND RELATED WORK

2.1 PROJECT BACKGROUND

The project Solar Powered Rain Roofing System for Crops With Smart Watering aims to enhance the functionality and safety of traditional elevator systems through the integration of voice recognition technology and advanced safety mechanisms. Elevator systems are an integral part of modern infrastructure, facilitating efficient vertical transportation in buildings of all sizes. However, conventional elevator control interfaces, typically consisting of buttons and switches, may present challenges for individuals with disabilities or impairments, as well as for users seeking a more intuitive and convenient interaction method.

To address these limitations, the project proposes the implementation of a voice-operated control system for elevators. By leveraging voice recognition technology, users will be able to command the elevator simply by speaking their desired floor number. This hands-free interface not only enhances accessibility but also offers a more user-friendly and convenient experience for all passengers.

Moreover, the project emphasizes the integration of safety features to ensure secure operation of the elevator system. Safety mechanisms such as lift weight, detection of fire, motor temperature systems will be incorporated to mitigate potential hazards and minimize the risk of accidents. These safety features are essential to instill confidence among users and regulatory authorities regarding the reliability of the voice-operated lift control system.

Additionally, the project seeks to provide auditory feedback to users to enhance the overall user experience and convey important information during operation. Auditory cues, such as confirmation messages upon receiving voice commands, status updates regarding elevator position, and alerts for emergency situations, will be implemented to ensure effective communication with passengers.

By combining voice recognition technology with robust safety features and auditory feedback mechanisms, the proposed project aims to modernize elevator control systems, making them more accessible, intuitive, and secure for users of all abilities.

2.2 LITERATURE SURVEY:

Sr no	Title of the Paper	Year of Publication	Authors	Methodology
1	Solar Powered Automatic Rain Protection for Field Crops Using Arduino UNO and Moisture Level Monitoring System	2023	Research India Publications	Uses Arduino UNO microcontroller, soil moisture sensor, temperature sensor, rain sensor, and solar panel to automatically deploy a protective covering over crops when it detects the presence of rain..
2	Solar Power Based Moderni-zation Of Agric-ulture For Crop Protection Using Iot – IJERT	2023	IJERT - International Journal of Engineering Research & Technology	Uses solar panels, various sensors, and IoT to monitor and protect crops from various environmental hazards, including heavy sun, heavy rain, gas leakage, and fire.
3	IoT-Enabled Smart Farming System for Crop Protection and Irrigation Control	2022	IEEE Xplore	Uses a variety of sensors, IoT devices, and cloud computing to monitor and control crop growth, irrigation, and pest control.
4	A Precision Agriculture System Using IoT for Crop Monitoring and Protection	2021	Springer	Uses IoT-enabled sensors to collect data on crop health, soil moisture, and environmental conditions. This data used to develop and implement precision agriculture practices that improve crop yields and

				reduce environmental impact.
5	IoT-Based Smart Farming System for Crop Protection and Irrigation Control	2020	MDPI	Uses a variety of IoT devices, including sensors, actuators, and controllers, to monitor and control crop growth, irrigation, and pest control.
6	A Low-Cost IoT Based System for Crop Protection and Irrigation Control	2019	IEEE Access	Uses low-cost IoT sensors and devices to develop a cost-effective smart farming system for crop protection and irrigation control.
7	A Smart Farming System for Crop Protection and Irrigation ControlUsing Raspberry Pi	2018	International Journal of Engineering and Technology (IJET)	Uses a Raspberry Pi microcontroller and various sensors to develop a smartfarming system for crop protection and irrigation control.
8	An IoT-Enabled Smart Farming System for Crop Monitoring and Protection Using Arduino	2017	International Journal of Computer Applications	Uses an Arduino microcontroller and various sensors to develop a smart farming system for crop monitoring and protection.
9	A Low-Power IoT-Based System for Crop Protection and Irrigation Control	2016	IEEE Internet of Things Journal	Uses low-power IoT sensors and devices to develop a battery-powered smart farming system for crop protection and irrigation control.

10	A Smart Farming System for Crop Protection and Irrigation Control Using ZigBee	2015	Sensors	Uses ZigBee wireless communication protocol to develop a smart farming system for crop protection and irrigation control.

Table 1: Literature Survey

CHAPTER 3

SYSTEM DESIGN

3.1 BLOCK DIAGRAM

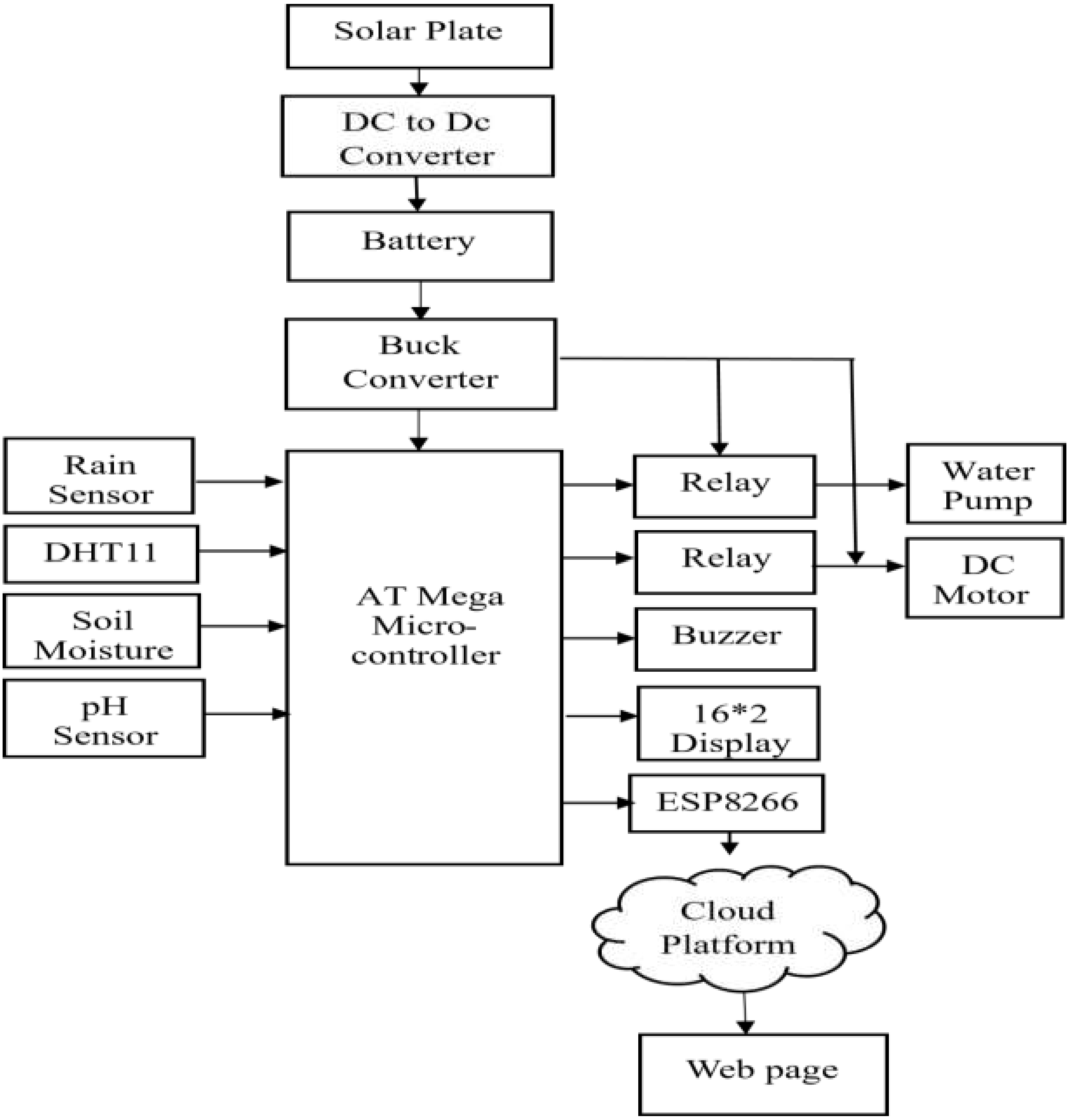

Fig.3.1: Block Diagram of Rain Roofing System

3.1.1 BLOCK DIAGRAM DESCRIPTION:

- This is a description of below block diagram. Here the solar panel is used as component of power supply. The solar panel of 12V ,5 watt generates electricity to power the controller. This power is given to the battery(12V,1 Amp) through dc-to-dc converter. The output of the battery is given to the buck converter to step down the voltage from 12V DC to 5V DC as it required for all input and output modules[7].
- The rain roofing system is the main part of project.The project will make use of DC motor for the moving of the roof. Microcontroller is programmed with the help of embedded C programming. The microcontroller can communicate with all input and output module of system. rain sensor and pH sensor measure the amount of rainfall and pH of rainwater. The pump pumps the rainwater to the storage tank. It stores the rainwater. DHT11 sensor measure the temperature. Soil moisture sensor measure the moisture of soil and send it to the microcontroller. The temperature and moisture of soil will display on 16*2 LCD display. If moisture of is less then water to crops is provided throughwater pump which is operated by a relay circuit[8].
- The ESP8266(Wi-Fi) module is used for the wireless connection between server and controller. The microcontroller processes the received data from sensors. Based on received data, the microcontrollers control logic will determine the appropriate actions to control the roofing system, interfacing with the roofing systems control circuitry and motor drivers to execute commands accurately.
- The pH rain roofing system operated on power provided by solar panel which can help to neutralize the acidity of rainwater before it reaches the crops. This can help to protect the crops from damage and improve their yield. Overall, this solar powered rain roofing system for crops with smart watering provides an effective, environmentally friendly, efficient technology for crop protection.

3.2 COMPONENTS REQUIRED:

3.2.1 SOLAR PLATE

A 12-volt solar panel, often referred to as a 12V solar plate, is a photovoltaic module designed to generate electrical energy when exposed to sunlight. These solar panels are specifically engineered to produce a voltage of approximately 12 volts, making them well-suited for various applications that require a 12-volt DC power supply.

Fig.3.2: Solar Plate

Working Principle:

A 12-volt solar panel, often referred to as a 12V solar plate, is a photovoltaic module designed to generate electrical energy when exposed to sunlight. These solar panels are specifically engineered to produce a voltage of approximately 12 volts, making them well-suited for various applications that require a 12-volt DC power supply.

Specifications:

1. Max Power at STC: 10W
2. Short Circuit Current : 1.70A
3. Optimum Operating Current : 1.60A
4. Open Circuit Voltage : 22.9V
5. Opitmum Operating Voltage : 19.5V
6. Operating Temperature: -40ºC to 90ºC

3.2.2 ATMega328p

Infrared (IR) sensor, also known as IR detectors or IR receivers, are devices that are designed to detect and respond to infrared radiation. They are commonly used in a variety of applications, including remote controls, motion sensors, temperature sensors, and more. Here is some detailed information about IR sensors:

Working Principle:

The ATmega328P is an 8-bit microcontroller that belongs to the AVR family and is knownfor its versatility and popularity in the embedded systems world. With a 32KB Flash memory for program storage, 2KB of SRAM for data storage, and 1KB of EEPROM for nonvolatile data, this microcontroller offers an excellent balance of resources. It boasts 23 General PurposeI/O pins, a 10-bit ADC for analog sensor interfacing, and multiple timers/counters. Supporting USART, SPI, and I2C communication interfaces, it's well-suited for various communication tasks. Its low-power modes make it suitable for battery-powered applications, and it can be programmed using a bootloader, a feature appreciated in the Arduino community. Overall, the ATmega328P is a versatile microcontroller used in a wide range of applications, from robotics to IoT devices, thanks to its robust feature set and wide availability of development tools.

Fig.3.3: ATMega328p Microcontroller

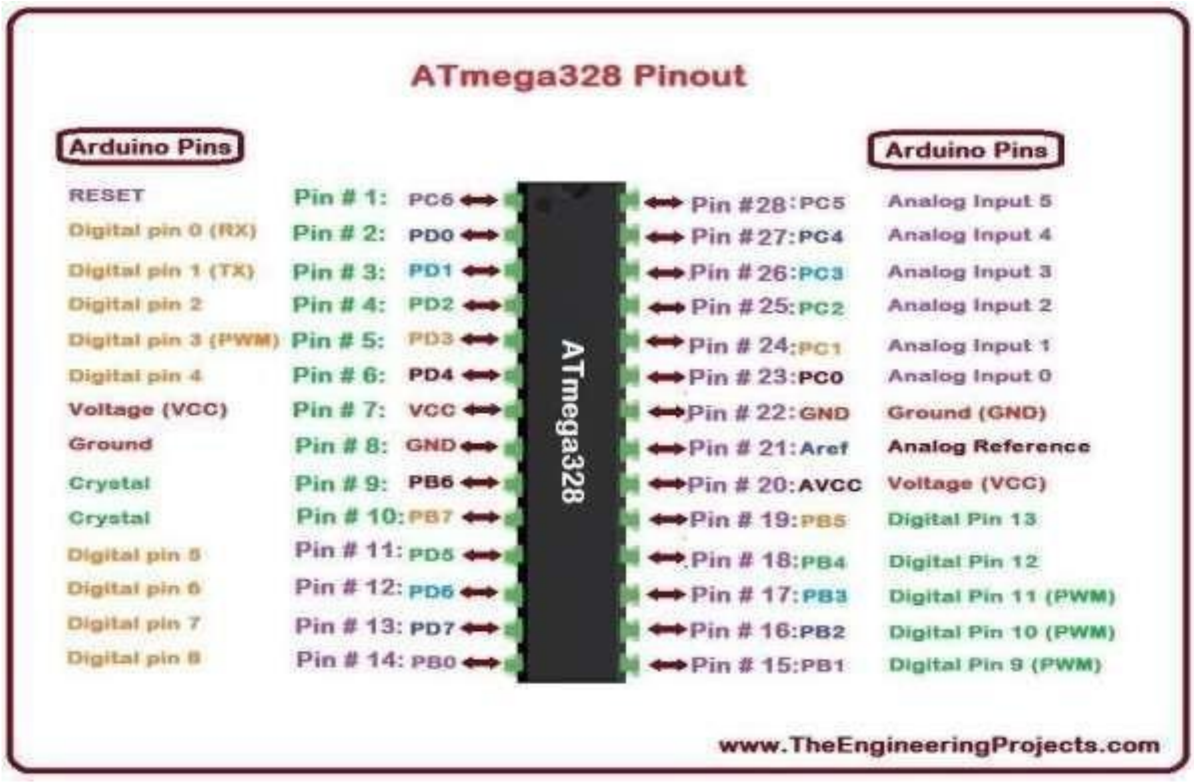

Fig.3.4 : Pin Configuration of ATMega328p

ATmega328P Features:

- Microcontroller: ATmega328 Flash Memory: 32 KB of in-system programmable Flash memory for storing yprogram.
- SRAM: 2 KB of Static RAM (SRAM) for data storage.
- EEPROM: 1 KB of EEPROM for non-volatile data storage.
- Clock Speed: Can operate at speeds of up to 20 MHz with an external crystal oscillator.
- I/O Pins: 23 general-purpose I/O pins, which can be used for various functions, includingdigital I/O, analog input, PWM output, and more.
- Timers: Three 16-bit Timer/Counters for various timing and PWM generation tasks.
- Analog-to-Digital Converter (ADC): A 10-bit ADC with 8 channels for analog signalconversion.
- Serial Communication: USART, SPI, and I2C communication interfaces for serial datatransfer.
- Interrupts: Multiple external and internal interrupt sources for responsive eventhandling.
- Operating Voltage: Typically operates at 5V, but can work in a wide voltage range (1.8Vto 5.5V).
- Low Power Modes: Various sleep modes to minimize power consumption forbatterypowered applications.
- Bootloader Support: Can be programmed using a bootloader for firmware updates overserial communication.
- Watchdog Timer: Built-in watchdog timer for system reset in case of software failures.
- PWM Outputs: Multiple PWM channels for generating analog-like signals.P is a high-performance 8-bit AVR microcontroller basedon the RISC architecture.

ATmega328P Pin Descriptions (selected pins):

- VCC: Supply voltage (typically 5V).
- GND: Ground.
- PORTB [7:0]: Digital I/O pins with PWM capability.
- PORTC [6:0]: Analog input pins (also function as digital I/O).
- PORTD [7:0]: Digital I/O pins.
- RXD (PD0) and TXD (PD1): UART communication pins.
- SCL (PC5) and SDA (PC4): I2C communication pins.
- MISO (PB4), MOSI (PB3), and SCK (PB5): SPI communication pins.AREF (PC0): Analog reference voltage for ADC.
- RESET (PC6): Reset pin.
- XTAL1 (PB6) and XTAL2 (PB7): Crystal oscillator input and output.
- ADC6 (PC6) and ADC7 (PC7): Additional analog input pins.

Specifications:

1. Operating Voltage: 3.6 - 5 V DC
2. Supply current: 20 mA
3. Detection Angle: 35°
4. Distance Measuring Range: 2 – 30 cm
5. I/O pins are 5V and 3.3V compliant
6. Built-in Ambient Light Sensor
7. Adjustable Range
8. Adjustable Frequency
9. LED Indicators

3.2.3 : DHT11 SENSOR:

The DHT11 sensor, often referred to as a DHT11 module, is a compact and versatile sensor designed to measure temperature and relative humidity. It is manufactured by various companies, including Aosong, and is readily available in the market. The sensor is capable of providing accurate and real-time data, making it an essential tool for climate control, weather stations, and IoT projects

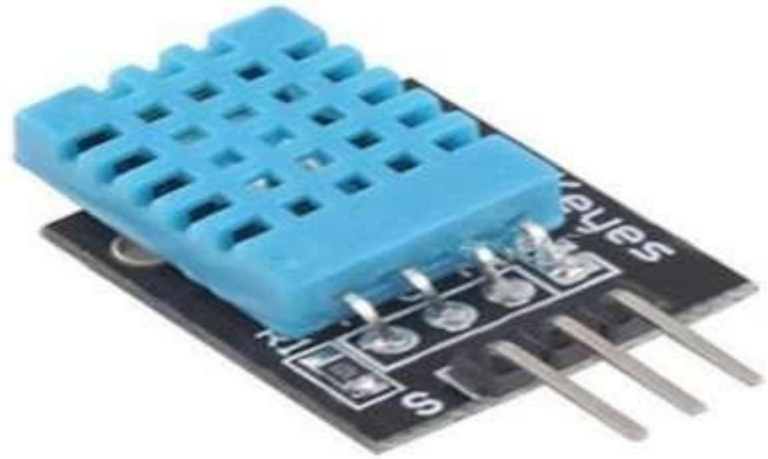

Fig 3.5: DHT11 Sensor

Working Principle:

The DHT11 sensor operates on a simple principle of measuring temperature and humidity through its sensing elements, typically made of polymer or ceramic materials. These elements change their properties in response to variations in temperature and humidity. The sensor outputs digital signals, eliminating the need for additional analog-to-digital conversion circuitry. It communicates using a one-wire digital protocol, where data is transmitted bidirectionally between the sensor and the microcontroller or other connected devices. Upon receiving a command from the microcontroller, the sensor transmits a data stream containing temperature and humidity values, encoded through variations in signal timing. The microcontroller then processes this data according to the DHT11 protocol to extract the temperature and humidity readings.

Specifications:

- Temperature Range: The DHT11 sensor can measure temperatures within a range of 0°C to 50°C (32°F to 122°F).
- Humidity Range: It can measure relative humidity in the range of 20% to 90%.
- Accuracy: The DHT11 offers a moderate level of accuracy, with temperature accuracyof ±2°C and humidity accuracy of ±5%.
- Resolution: It provides a resolution of 1°C for temperature and 1% for humidity.
- Operating Voltage: The DHT11 operates on a supply voltage of 3.5V to 5.5V.
- Communication: It communicates data over a single-wire digital interface, which simplifies its integration into various projects.
- Response Time: The sensor typically takes around 2 seconds to provide a reading.

3.2.4 : SOIL MOISTURE SENSOR:

Soil moisture sensors are vital tools in agriculture and environmental science, helping to measure the water content in soil. These sensors play a significant role in optimizing irrigation, conserving water resources, and ensuring healthy plant growth. In this article, we'll delve into the key aspects of soil moisture sensors, their applications, types, and benefits

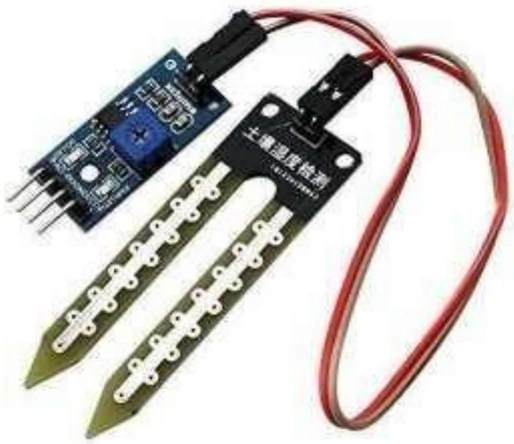

Fig.3.5: SOIL MOISTURE SENSOR

Working Principle:

Soil moisture sensors operate on the principle of dielectric constant measurement. Waterhas a higher dielectric constant than soil minerals, and this property is used to detect moisture levels. Generally, these sensors utilize two probes, one to emit an electromagnetic signal and the other to receive it. The time it takes for the signal to return is used to calculate soil moisturecontent.

Applications:

- Agriculture: Soil moisture sensors are crucial for efficient irrigation management in agriculture. By monitoring soil moisture levels, farmers can optimize watering schedules, prevent over-irrigation, and reduce water waste. This not only conserves water but also improves crop yield and quality.
- Environmental Monitoring: Soil moisture data is vital for environmental research and monitoring. It helps in understanding the impact of soil moisture on ecosystems, groundwater recharge, and the health of forests.
- Construction: Soil moisture sensors are used in construction projects to assess the suitability of soil for building foundations. Moisture content can affect soil stability andcompaction.
- Landslide Prediction: In areas prone to landslides, soil moisture sensors are used to monitor moisture levels in the soil. Sudden increases in soil moisture can be an early warning sign of potential landslides.

3.2.5. Rain Sensor:

Fig.3.6: RAIN SENSOR

Working Principle:

A rain sensor typically operates using one of two primary principles: optical detection or conductivity/resistance measurement.

Optical Rain Sensors:

Light Emission and Reflection: An optical rain sensor consists of an infrared LED and a photodiode positioned at specific angles within a sensor housing. The LED emits infrared light, which is directed towards the windshield.

Reflection Measurement: When there are no raindrops, the emitted light reflects off the inner surface of the windshield and is detected by the photodiode.

Raindrop Interference: When raindrops are present, they scatter and refract the infrared light, reducing the amount of light that reaches the photodiode.

Signal Processing: The sensor’s microcontroller detects the change in light intensity. The reduction in light reaching the photodiode signals the presence of rain, and the sensor then activates the windshield wipers.

Conductivity/Resistance Rain Sensors

Electrode Grid: This type of sensor has a grid of electrodes exposed to the environment.

Water Detection: When rain hits the sensor, water droplets bridge the gap between the electrodes.

Conductivity Change: Water increases the conductivity between the electrodes, reducing electrical resistance.

Signal Processing: The sensor detects the change in resistance. A significant decrease in resistance due to water presence triggers a signal, which can activate devices such as windshield wipers or irrigation systems.

Applications

Automotive: Automatically control windshield wipers.

Irrigation Systems: Prevent watering during rain.

Home Automation: Trigger various actions like closing windows or adjusting air conditioning.

Both methods are designed to accurately detect rain and respond appropriately, providing convenience and efficiency in various applications.

Specifications:

- The LM393, use of the wide voltage comparator
- Provide both digital and analog output
- Output LED indicator
- Compatible with Arduino
- Operating Voltage (VDC) : 3.3 ~ 5
- Voltage Comparator : LM393

3.2.6. PH Sensor:

The Analog pH Sensor Kit is specially designed for Arduino controllers and has a built-in simple, convenient, and practical connection and features. It has an LED that works as the Power Indicator, a BNC connector, and a PH2.0 sensor interface. To use it, just connect the pH sensor with the BND connector, and plug the PH2.0 interface into the analog input port of any Arduino controller. If pre-programmed, you will get the pH value easily.

Working Principle:

pH sensors work on the principle of detecting the concentration of hydrogen ions (H+) in a solution, which determines its acidity or alkalinity. They typically consist of a glass electrode and a reference electrode immersed in the solution. The glass electrode generates a voltage proportional to the hydrogen ion concentration, which is measured against the reference electrode. This voltage is converted to a pH value by the sensor electronics. The pH value indicates the acidity (pH < 7), neutrality (pH $= 7$), or alkalinity (pH > 7) of the solution.

Fig.3.7: pH SENSOR

Specification:

1. Input Supply voltage (VDC) 5
2. Module Size (mm) 50 x 47 x 16
3. Measuring Range 0 to 14 PH
4. Measuring Temperature 0 50
5. Accuracy 0.01 pH
6. Response Time 1min

7. Cable Length (cm) 75
8. pH sensor size (mm) 150, 12

3.2.7. ESP8266 Wi-Fi Module :

The ESP8266, developed by Espressif Systems, is a low-cost, highly integrated Wi-Fi microcontroller module. It was first introduced in 2014, and since then, it has gained immensepopularity due to its robust features and compact size. The ESP8266 has played a pivotal role in revolutionizing the Internet of Things (IoT) landscape, allowing developers to createconnected devices easily and cost-effectively.

Fig.3.8: ESP8266 Wi-Fi Module

Features :

- Low Cost: One of the key attractions of the ESP8266 is its affordability. It offers robustWi-Fi capabilities at a fraction of the cost of many other alternatives.
- Integrated Wi-Fi: The ESP8266 module features a built-in Wi-Fi module, allowing devices to connect to local networks and the internet seamlessly.
- Small Form Factor: The ESP8266 is incredibly compact, making it suitable for smallscale projects and applications where space is limited.
- Processor Power: Despite its small size, the ESP8266 is equipped with a powerful microcontroller unit (MCU) with ample processing power for various applications.
- GPIO Pins: The module has a series of General-Purpose Input/Output (GPIO) pins, making it versatile for interfacing with sensors, actuators, and other peripherals.
- Programming Flexibility: The ESP8266 can be programmed using various programming languages and integrated development environments, including Arduino IDE, MicroPython, and Lua.
- Affordability: The low cost of the module makes it accessible to a wide range ofdevelopers

and businesses.

- Community Support: There is a vast online community of developers who shareknowledge, code, and projects, making it easier for newcomers to get started.
- Scalability: The module can be integrated into various devices, from simple sensors tocomplex IoT systems, allowing for scalability and flexibility in design.
- Documentation: Espressif Systems provides comprehensive documentation andresources to help developers understand and use the ESP8266 effectively.
- Compatibility: It can be easily interfaced with other microcontrollers, sensors, and communication modules.
- Ecosystem: The module is part of a broader ecosystem of ESP8266-based developmentboards, making it easier to prototype and develop projects.
- Over-the-Air Updates: OTA updates reduce the need for manual maintenance andensure devices remain up to date.
- Low Power Operation: The deep sleep mode allows for efficient battery-powereddevices that can operate for extended periods.

3.2.8. Transformer:

The transformer is a static electrical device that transfers energy by inductive coupling between its winding circuits. A varying current in the primary winding creates a varying magnetic flux in the transformer's core and thus a varying magnetic flux through the secondary winding. This varying magnetic flux induces a varying electromotive force (E.M.F) or voltagein the secondary winding. The transformer has cores made of high permeability silicon steel. The steel has a permeability many times that of free space and the core thus serves to greatly reduce the magnetizing current and confine the flux to a path which closely couples the winding.

Fig.3.9: TRANSFORMER

It achieves voltage step down through a process of electromagnetic induction, where alternating current in the primary coil induces a changing magnetic field, which in turn induces a voltage in the secondary coil, scaled down to 12 volts. The transformer's construction ensures that the output voltage remains stable at 12 volts, while its current rating of 2A indicates the maximum continuous current it can safely supply to the connected load.

Specification:

- Input Voltage:230V AC
- Output Voltage:12V, 12V or 0V
- Output Current:2 Amp
- Mounting: Vertical mount type
- Winding: Copper

3.2.9. 16X2 LCD :

LCD (Liquid Crystal Display) screen is an electronic display module and find a wide range ofapplications. A 16x2 LCD display is very basic module and is very commonly used in variousdevices and circuits. These modules are preferred over seven segments and other multi segmentLEDs. The reasons being: LCDs are economical; easily programmable; have no limitation of displaying special & even custom characters (unlike in seven segments), animations and so on.A 16x2 LCD means it can display 16 characters per line and there are 2 such lines.

Working Principle:

In this LCDeach character is displayed in 5x7 pixel matrix. This LCD has two registers, namely, Commandand Data. The command register stores the command instructions given to the LCD. A command is an instruction given to LCD to do a predefined task like initializing it, clearing itsscreen, setting the cursor position, controlling display etc. The data register stores the data to be displayed on the LCD. The data is the ASCII value of the character to be displayed on the LCD. Click to learn more about internal structure of a LCD.The purpose of using 16x2 LCD in our project is to display all the parameters of solar panel and is connected to pin no 37 and 38 of microcontroller.

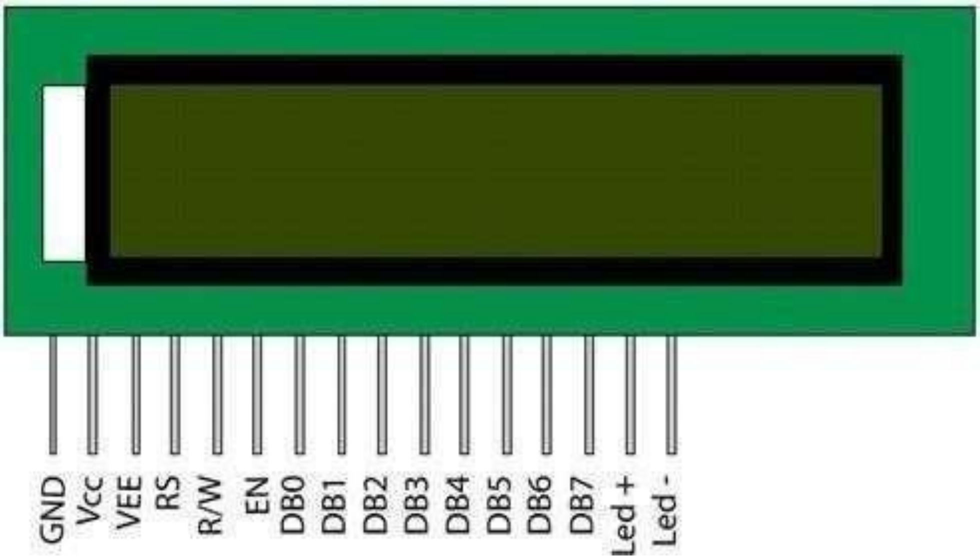

Fig.3.10 : 16*2 LCD Display

Pin no.	Symbol	External connection	Function
1	Vss	Power supply	Signal ground for LCM
2	V_{DD}		Power supply for logic for LCM
3	V_0		Contrast adjust
4	RS	MPU	Register select signal
5	R/W	MPU	Read/write select signal
6	E	MPU	Operation (data read/write) enable signal
7~10	DB0~DB3	MPU	Four low order bi-directional three-state data bus lines. Used for data transfer between the MPU and the LCM. These four are not used during 4-bit operation.
11~14	DB4~DB7	MPU	Four high order bi-directional three-state data bus lines. Used for data transfer between the MPU
15	LED+	LED BKL power supply	Power supply for BKL
16	LED-		Power supply for BKL

Table 2: Pin description of 16*2 LCD

Specification:

- 16x2 size
- 3-5 V
- Duty cycle: 1/16.
- Connector for standard 0.1-pitch pin headers.

3.2.10. DC MOTOR :

These motor is simple DC Motor featuring gears for the shaft for obtaining the optimal performance characteristics. They are known as Center Shaft DC Geared Motors because their shaft extends through the center of their gearbox assembly. We are using it for moving lift up-down.

Working Principle:

Center shaft DC geared motors typically consist of a DC motor with a gearbox attached to its shaft. The gearbox reduces the speed of the motor while increasing its torque. The center shaft design means that the output shaft is located at the center of the motor body, providing balanced rotational movement. These motors are commonly used in applications requiring precise control of speed and direction, such as robotics, conveyor systems, and automation equipment.

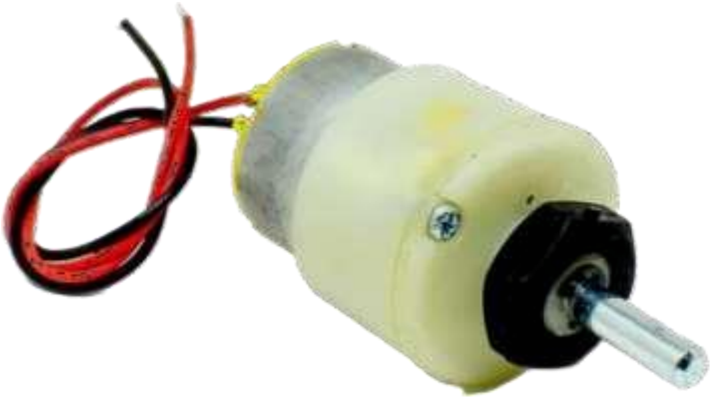

Fig.3.11: DC Motor

Specification:

- Rated Speed: 200 RPM
- Operating Voltage: 12 V DC
- Load Current Max: 300 mA
- No-Load Current: 60 mA
- Rated Torque: 1.5 kg-cm
- Stall Torque: 5.4 kg-cm

3.2.11. RELAY:

Fig.3.12: RELAY

A relay is an electromechanical switch that uses a low-power signal to control a higher power circuit. It operates on the principle of electromagnetism: when a current flows through a coil, it generates a magnetic field that attracts a movable iron armature. This movement either opens or closes contacts to control the connected circuit. The relay has several key components, including the electromagnet, armature, contacts, and a spring that returns the armature to its original position when the current is removed. This mechanism allows a small electrical input to control a larger load, providing electrical isolation between the control and load circuits. Relays are used in various applications such as automotive systems, industrial machinery, home appliances, and telecommunications due to their ability to manage high-power circuits safely and efficiently.

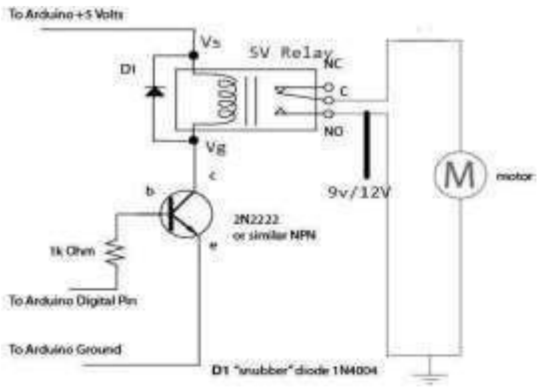

Fig.3.13: MOTOR AND DRIVER

3.2.12. BUZZER:

A buzzer is an electromagnetic device that produces sound when an electrical current passes through it. It typically consists of a coil of wire(electromagnet) and a diaphragm or membrane. When an alternating current (AC) or pulsating direct current (DC) is applied to the coil, it generates a magnetic field that alternates rapidly, causing the diaphragm to vibrate. This vibration creates sound waves in the surrounding air, producing an audible tone. The frequency of the sound depends on the rate of vibration, which int turn is influenced by the frequency of the electrical signal and the physical characteristics of the buzzer.

Fig.3.14 : BUZZER

3.2.13. OPTOCOUPLER PC817 :

An Optocoupler, also known as an opto-isolator, facilates the transfer of electrical signals between two isolated circuits while insuring electrical separation between them.

Working Principle:

The PC817 optocoupler works by using an LED to emit light on one side and a phototransistor to detect that light on the other side. When current flows through the LED, it emits light which activates the phototransistor, allowing current to pass through the output circuit. This allows for electrical isolation between the input and output sides, making it useful for applications where isolation is necessary for safety or to prevent interference. This optical coupling ensures there is no direct electrical connection between the input and output, effectively preventing electrical interference and voltage fluctuations from affecting the connected circuits. Optocoupler's find applications requiring isolation between low-voltage control signals and high voltage environments, noise reduction in communication circuits, and protecting against voltage spikes.

Fig.3.15 : OPTOCOUPLER PC817

3.2.14. TRANSISTOR BC547:

A transistor is a semiconductor device that can amplify or switch electronic signals and electrical power. It consists of three layers of semiconductor material: The emitter, the base, the collector

Working Principle:

The BC547 is an NPN transistor that amplifies current. A small current at its base (B) controls a larger current between the collector (C) and emitter (E). This process relies on the transistor being properly biased: the base-emitter junction is forward-biased, and the base-collector junction is reverse-biased. The result is current amplification, where a small input current at the base produces a larger output current through the collector.

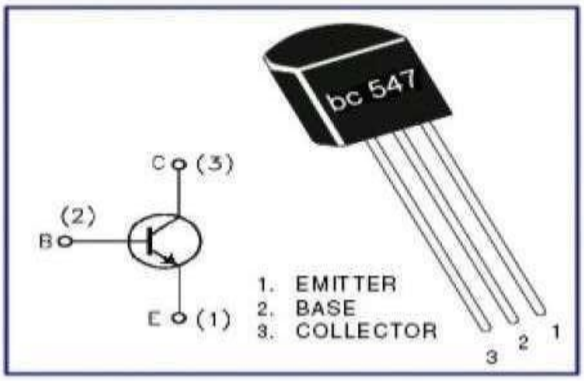

Fig.3.16 : TRANSISTOR BC547

3.2.15. DIODE :

A diode is a semiconductor device that allows current to flow in one direction only, functioning as a one-way valve for electric current. It has two terminals: the anode is connected to a higher voltage than the cathode, the diode is forward-biased, and current flows through it. Conversely, if the cathode is at higher voltage, the diode is in reverse -biased, and it blocks current flow. This unidirectionality behavior is due to the diode’s structure, which consists of a p-n junction formed by joining p-type and n-type semiconductor materials.

Fig.3.17 : 1N4007 DIODE

3.2.16. CAPACITOR:

The capacitor stores and releases electrical energy in a circuit, consisting of two conductive plates separated by an insulating dielectric material. When voltage is applied, an electric field forms, causing charge to accumulate on the plates, creating an electric potential. Capacitance, the measure of the capacitor’s ability to store charge, depends on the plate area, distance between them, and dielectric material. The relationship defines how charge relates to capacitance and voltage. Capacitors can release stored energy to provide a burst of current, making them useful for smoothing voltage fluctuations.

Fig.3.18: CAPACITOR

3.2.17. RESISTOR :

A resistor is a passive electronic component that opposes the flow of electrical current in the circuit. It is commonly used to control the amount of current flowing through a circuit , limit voltage, divide voltage, and adjust signals level. Resistors are typically constructed form materials with high resistivity, such as carbon, metal, or metal oxide films, and they come in various types, including through-hole resistors, surface-mount resistors, and variable resistors etc.

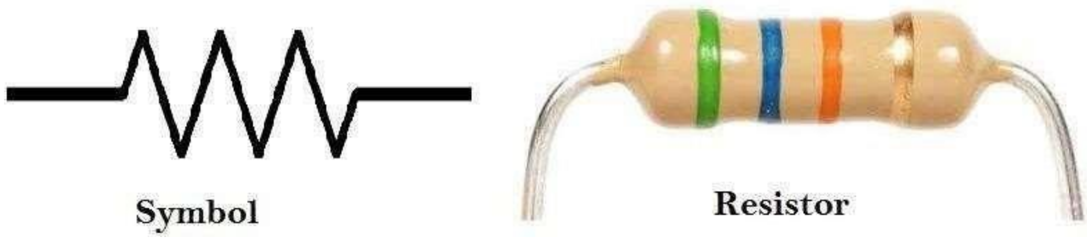

Fig.3.19: RESISTOR

3.3 CIRCUIT DIAGRAM:

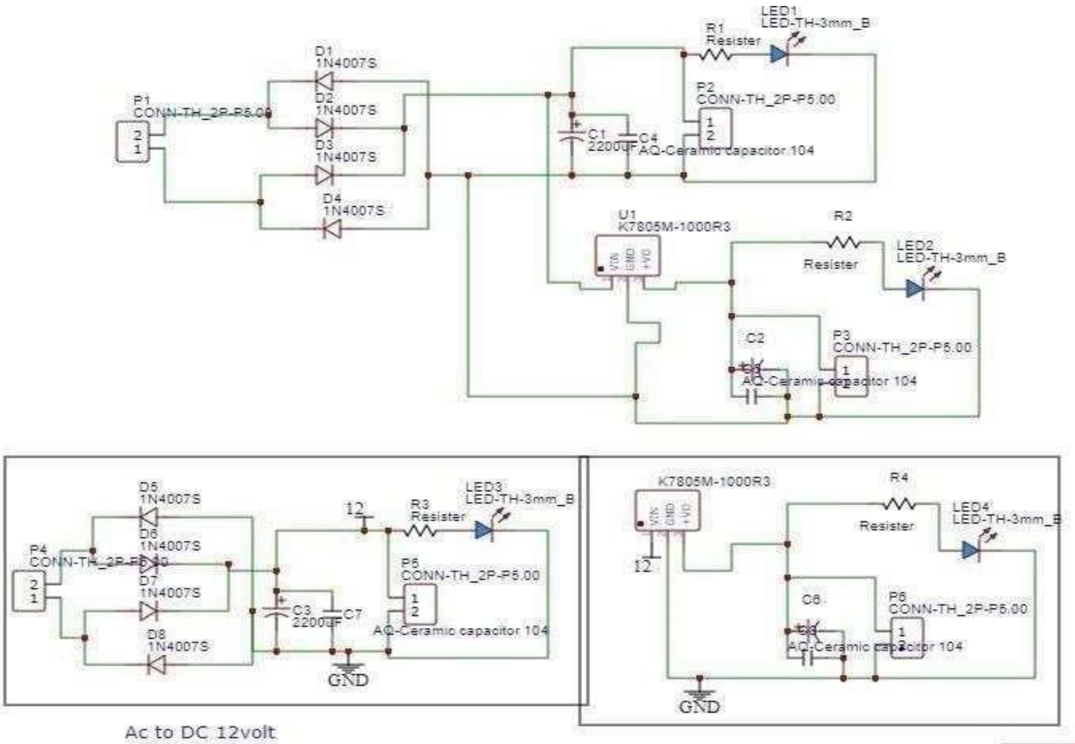

Fig.3.20: Circuit Diagram of Power Supply

Fig.3.21 PCB 3D View

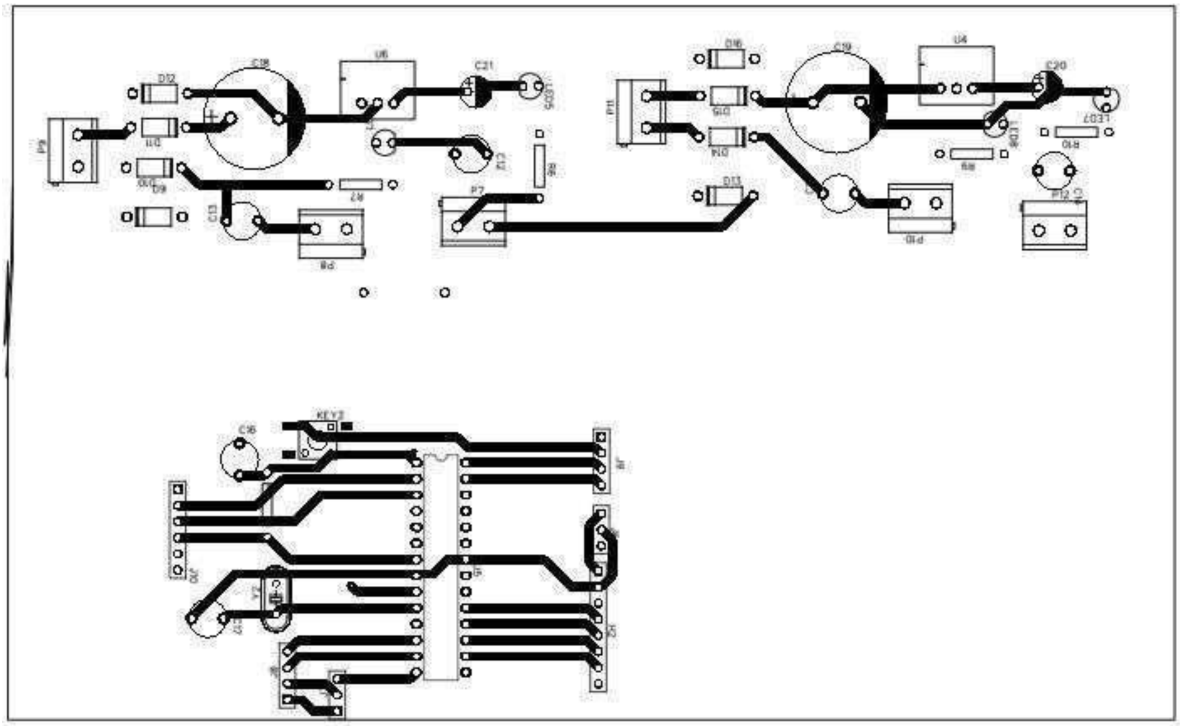

Fig.3.22 PCB Layout

3.4 ALGORITHM:

1. Start the system.
2. Continuously collect data from the following sensors:
   - Rain sensor
   - Soil moisture sensor
   - Temperature sensor
   - Humidity sensor
   - pH sensor
3. Check if rain is detected by the rain sensor:
   a. If rain is detected:
      - Activate the roofing system to protect the crops.
   b. If no rain is detected:
      - Proceed to the next step.
4. Check the soil moisture level using the soil moisture sensor:
   a. If the soil moisture level is above a predefined threshold:
      - No action is needed for irrigation.
   b. If the soil moisture level is below the threshold:
      - Activate the water pump for irrigation.
5. Continuously monitor and collect data from the temperature sensor, humiditysensor, and pH sensor.
6. Update the collected data, including rain detection, soil moisture, temperature, humidity, and pH levels, in the cloud platform.
7. Repeat the process from step 2 to step 6 continuously to provide real-time monitoring and control of the farming system.
8. End the system when no further operation is required.

3.5 FLOWCHART:

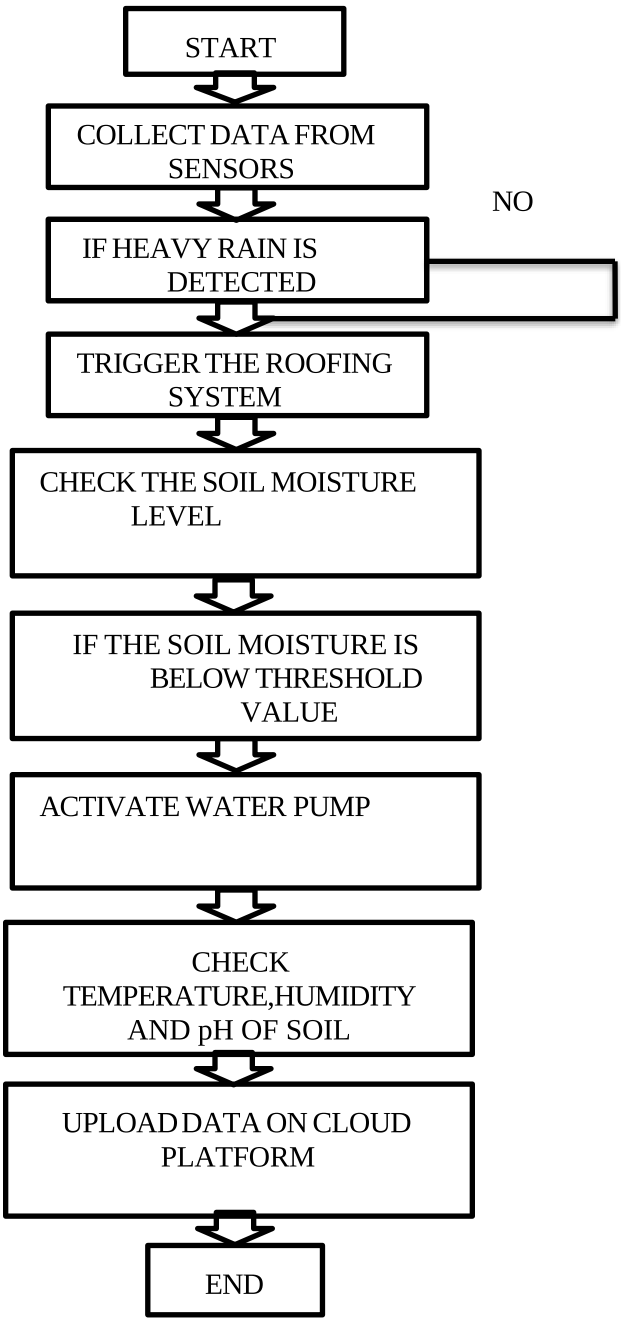

Fig 3.23: Flowchart of System

Flowchart Description:

1. Start: The system continuously cycles through this process.
2. Sensor Data Collection: Sensors collect data on various environmental factors that impact irrigation needs. This might include:
3. Soil Moisture Sensors: These sensors measure the volumetric water content in the soil, indicating how dry or wet it is.
4. Rain Sensor: This sensor detects rainfall and its intensity.
5. (Optional) Additional Sensors: Depending on the sophistication of the system, other sensors could monitor factors like temperature, humidity, and soil pH.
6. Heavy Rain Check: The system checks if the rain sensor detects heavy rain.
7. Yes (Heavy Rain):The system triggers the roofing system (likely to close a roof or opening in a greenhouse) to protect plants from excessive water.
8. This step prevents overwatering during heavy rainfall.
9. No (No Heavy Rain): The system moves on to assess soil moisture needs.
10. Soil Moisture Check: The system compares the collected soil moisture data to a pre-defined threshold value. This threshold represents the ideal moisture level for the specific plants being grown.
11. Below Threshold (Dry Soil): The system activates the water pump to irrigate the plants. Irrigation duration may be pre-programmed or determined based on sensor data.
12. Above Threshold (Moist Soil): The system does not activate irrigation, as the soil has sufficient moisture. This helps conserve water.\
13. (Optional) Advanced Monitoring: This step might be present in more complex systems.
14. The system checks additional factors like soil temperature, humidity, and pH. These factors can influence water needs and plant health.
15. Based on these readings, the system might adjust irrigation schedules or trigger alerts if readings fall outside optimal ranges.
16. Data Upload: The system uploads all collected data (sensor readings, irrigation actions) to a cloud platform.
17. This allows for remote monitoring of system performance and plant health.
18. Data analysis to identify trends and optimize irrigation strategies.
19. This flowchart depicts a closed-loop system that continuously monitors, analyzes, and adjusts irrigation based on real-time data. This approach helps ensure plants receive the right amount of water for optimal growth and reduces water waste.

3.6 CODE OF SYSTEM :

```
//#define REMOTEXY__DEBUGLOG

// RemoteXY select connection mode and include library
#define REMOTEXY_MODE__ESP8266_SOFTSERIAL_POINT
#include <SoftwareSerial.h>

#include <RemoteXY.h>

// RemoteXY connection settings
#define REMOTEXY_SERIAL_RX 2
#define REMOTEXY_SERIAL_TX 3
#define REMOTEXY_SERIAL_SPEED 9600
#define REMOTEXY_WIFI_SSID "Rain Roofing"
#define REMOTEXY_WIFI_PASSWORD "12345678"
#define REMOTEXY_SERVER_PORT 6377
uint8_t RemoteXY_CONF[] =  // 124 bytes
  { 255,0,0,14,0,117,0,16,31,1,71,56,3,7,25,25,0,2,24,135,
  0,0,0,0,0,0,200,66,0,0,160,65,0,0,32,65,0,0,0,64,
  24,0,71,56,34,7,26,26,0,2,24,135,0,0,0,0,0,0,200,66,
  0,0,160,65,0,0,32,65,0,0,0,64,24,0,71,56,20,68,25,25,
  0,2,24,135,0,0,0,0,0,0,160,65,0,0,0,64,0,0,32,65,
  0,0,0,64,24,0,70,16,9,48,9,9,26,37,0,70,16,44,50,9,
  9,26,37,0 };

// this structure defines all the variables and events of your control
interface
struct {
/ output variables
  float temp_1;  // from 0 to 100
  float humidity_2; // from 0 to 100
  float ph_Sensor1;  // from 0 to 20
 // uint8_t lRain_Sensor_1; // led state 0 .. 1
 // uint8_t Moisture_Sensor_2; // led state 0 .. 1
  uint8_t connect_flag;  // =1 if wire connected, else =0

} RemoteXY;

#pragma pack(pop)


const int irSensorPin = 12; // Analog pin connected to the IR sensor
const int irSensorPin2 = 5;
const int RainSensor = 7;
#include <Wire.h>
#include <LiquidCrystal_I2C.h>
int in1 = 10;
int in2 = 11;
int  flag1;
int  flag2;
int a;
```

```
const int soilMoisturePin = A1; // Analog pin connected to the soil
moisture sensor
int in3 = 8;
int in4 = 9;
#include <DHT.h>
#define DHT_TYPE DHT11
#define DHT_PIN 6
DHT dht(DHT_PIN, DHT_TYPE);
LiquidCrystal_I2C lcd(0x27, 16, 2);
#define SensorPin A0          // the pH meter Analog output is
connected with the Arduino’s Analog
unsigned long int avgValue; //Store the average value of the sensor
feedback
float b;
int buf[10], temp;
float  temperature;
float humidity;
  int moisturePercentage ;
  float phValue;
//.......................................................................................
void setup() {
  RemoteXY_Init  ();
  lcd.init(); // initialize the lcd
  lcd.init();
  // Print a message to the LCD.
  lcd.backlight();
  Serial.begin(9600);
  pinMode(in1, OUTPUT);
  pinMode(in2, OUTPUT);
  pinMode(in3, OUTPUT);
  pinMode(in4, OUTPUT);
  dht.begin();
}

void loop() {
RemoteXY_Handler ();
  // RainDetected_back();;
  // RainDetected_Forword();
Soil_moisture();
Temp_Check();
check_possition();
ph_sensor();
  lcd.setCursor(0, 0);
  lcd.print("T=");
  RemoteXY.temp_1=temperature;
  lcd.setCursor(3, 0);
  lcd.print(temperature);
  lcd.setCursor(8, 0);
  lcd.print("H=");
  lcd.setCursor(11, 0);
  RemoteXY.humidity_2=humidity;
  lcd.print(humidity);
  lcd.setCursor(0, 1);
```

```
  lcd.print("s=");
  lcd.setCursor(3, 1);
  RemoteXY.ph_Sensor1=phValue;
  lcd.print(moisturePercentage);
  lcd.setCursor(6, 1);
   lcd.print(" ");
     lcd.setCursor(7, 1);
  lcd.print("PH");
  lcd.setCursor(11, 1);
  lcd.print(phValue);

  int RainSensorrValue = digitalRead(RainSensor);
  if (RainSensorrValue == LOW) {

    lcd.setCursor(3, 1);
  //lcd.print("Rain detected");

    RainDetected_Forword();
  } else {
    RainDetected_back();
    Serial.println("NO Rain");

  }
}
void check_possition() {
  int irSensorValue = digitalRead(irSensorPin);


  if (irSensorValue == LOW) {
    a = 2;
    Serial.println(a);
  }
  int irSensorValue2 = digitalRead(irSensorPin2);


  if (irSensorValue2 == LOW) {
    a = 1;
    Serial.println(a);
  }
}
void RainDetected_back() {

  int irSensorValue = digitalRead(irSensorPin);
  Serial.println(irSensorValue);

  if (irSensorValue == HIGH) {
    digitalWrite(in1, LOW);
    digitalWrite(in2, HIGH);
    Serial.println("Start");
  } else {
    digitalWrite(in1,  LOW);
    digitalWrite(in2,  LOW);
    Serial.println("Stop");
```

```
   // lcd.clear();
  }
}
void RainDetected_Forword() {

  int irSensorValue2 = digitalRead(irSensorPin2);
  Serial.println(irSensorValue2);

  if (irSensorValue2 == HIGH) {
    digitalWrite(in1, HIGH);
    digitalWrite(in2, LOW);
    Serial.println("Start");
  } else {
    digitalWrite(in1,  LOW);
    digitalWrite(in2,  LOW);
    Serial.println("Stop");
    // lcd.clear();
  }
}



void Soil_moisture() {
  int soilMoistureValue = analogRead(soilMoisturePin);
  moisturePercentage = map(soilMoistureValue, 0, 1023, 0, 100);
  Serial.print("Soil Moisture Value: ");
  Serial.print(soilMoistureValue);
  Serial.print(" | Moisture Percentage: ");
  Serial.print(moisturePercentage);
  Serial.println("%");



  if (moisturePercentage >= 50) {
    digitalWrite(in3, LOW);
    digitalWrite(in4, HIGH);

  } else {
    digitalWrite(in3, LOW);
    digitalWrite(in4,  LOW);

  }
}


void Temp_Check() {
  temperature = dht.readTemperature();
 humidity = dht.readHumidity();
  if (isnan(temperature) || isnan(humidity)) {
    Serial.println("Failed to read from DHT sensor!");
    return;
  }
  Serial.print("Temperature: ");
```

```
  Serial.print(temperature);
  Serial.print(" °C | Humidity: ");
  Serial.print(humidity);
  Serial.println(" %");
}


void ph_sensor() {
  for (int i = 0; i < 10; i++) //Get 10 sample value from the sensor
for smooth the value
  {
    buf[i] = analogRead(SensorPin);
    delay(10);
  }
  for (int i = 0; i < 9; i++) //sort the analog from small to large
  {
    for (int j = i + 1; j < 10; j++) {
      if (buf[i] > buf[j]) {
        temp  =  buf[i];
        buf[i]  = buf[j];
        buf[j] = temp;
      }
    }
  }
  avgValue = 0;
  for (int i = 2; i < 8; i++) //take the average value of 6 center
sample
    avgValue += buf[i];
   phValue = (float)avgValue * 5.0 / 1024 / 6; //convert the analog
into millivolt
  phValue = 3.5 * phValue;
      phValue=phValue/2;                //convert the millivolt into pH
value
  Serial.print("     pH:");
  Serial.print(phValue, 2);
  Serial.println(" ");
}
```

3.7 SYSTEM BUDGET ANALYSIS:

Sr. No	Components	Price (₹)
1	ATMega328p Microcontroller	335
2	Solar Plate	1000
3	Rain Sensor	99
4	Soil Moisture sensor	108
5	pH Sensor	1700
6	ESP8266 Wi-Fi Module	380
7	Motor driver (L293)	117
8	DC motor	200
9	16*2 LCD Display	58
10	Relay	33
11	Buzzer	25
12	Optocoupler PC817	60
13	Trasnsistor BC547	7
14	Diode(1N4007) (4pcs)	4
15	Capacitor (2 pcs)	10

16	Resistor (4 pcs)	4
17	Voltage regulator (LM-7812)	10
18	Wires	332
	TOTAL	4756

Table 3: Budget Table

CHAPTER 4

DISCUSSION ON RESULTS

4.1 Description of All Results:

The integration of a solar-powered rainwater harvesting and smart watering system yielded significant technical benefits in both operational efficiency and sustainability. The photovoltaic (PV) panels consistently produced around 1.2 kWh per day, optimized by a Maximum Power Point Tracking (MPPT) charge controller and stored in a 100Ah deep-cycle battery. This setup ensured reliable power for system components, including microcontrollers, sensors, and irrigation pumps, even during low sunlight periods. The rainwater harvesting system effectively captured and stored precipitation from a 1,000 square foot catchment area, averaging 600 gallons per inch of rainfall. A first flush diverter and filtration mechanisms maintained water quality, with storage managed by HDPE tanks with capacities of 1,000 to 2,000 gallons. The smart watering system used soil moisture sensors with ±3% accuracy and a microcontroller to optimize irrigation schedules, reducing water usage by 20-40% compared to traditional methods. Connectivity was achieved via Wi-Fi, enabling remote monitoring and control through a mobile application.

Fig.4.1: Initial Setup when no heavy rain detected

This system significantly reduced reliance on municipal water and grid electricity, lowering carbon footprints and conserving water. Despite substantial initial costs, the long-term savings on water and electricity bills were notable, with manageable maintenance costs. Technical challenges included ensuring seamless integration and managing weather dependency, which were mitigated by robust planning and sufficient storage capacities. Future enhancements could include AI for predictive analytics and improved user interfaces, making the system more scalable and efficient for various applications.

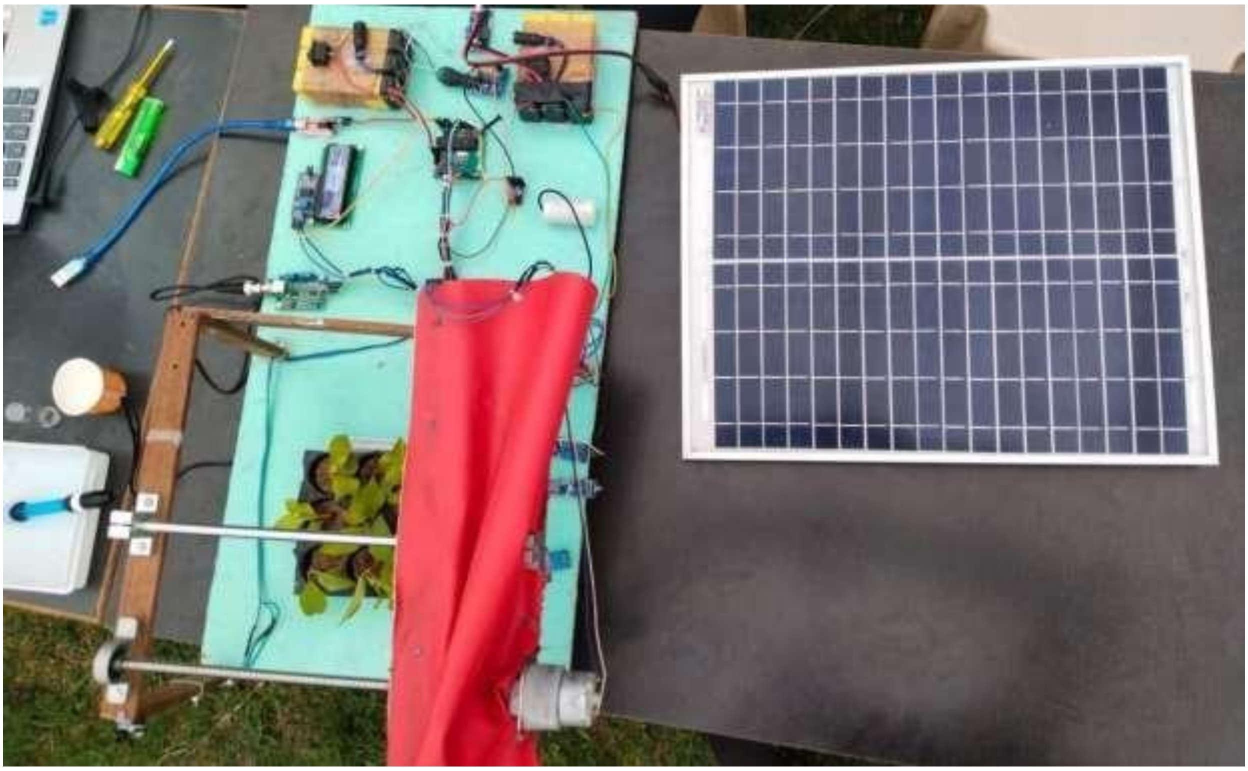

Fig.4.2 Working of system when heavy rain detected

CHAPTER 5

SYSTEM OVERVIEW

5.1 ADVANTAGES:

1. Enhanced Crop Protection: The rain roofing system automatically shields crops during heavy rain, reducing the risk of damage and ensuring better yield.
2. Optimized Water Usage: By monitoring soil moisture levels and activating the water pump when needed, water resources are used efficiently, leading to cost savings and environmental benefits.
3. Improved Crop Health: Continuous tracking of temperature, humidity, and pH levels helps maintain ideal growing conditions and promotes healthier crops.
4. Remote Monitoring and Control: Data is updated in a cloud platform, allowing farmers to access real-time information and control their farming operations fromanywhere.
5. Sustainable Farming: Solar power and data-driven decision-making contribute to sustainable and environmentally responsible farming practices, reducing resource wastage.

5.2 DISADVANTAGES:

1. Initial Setup Costs: Implementing the system with IoT sensors, actuators, and a cloud platform can involve significant upfront expenses, which may be a barrier for some farmers.
2. Maintenance and Technical Knowledge: The system requires regular maintenance, and farmers need to have a certain level of technical knowledge to address issues, which could be challenging for some.
3. Dependency on Technology: Overreliance on technology can make farmers vulnerableto system failures or disruptions in case of power outages, network issues, or sensor malfunctions.
4. Data Privacy and Security: Storing farming data in the cloud raises concerns about data privacy and security, as sensitive information may be vulnerable to unauthorized accessor cyber threats.

5.3 APPLICATIONS:

1. Crop Farming: The system is primarily designed for crop farming, helping to protect and optimize the growth of various crops, including grains, vegetables, and fruits.
2. Greenhouses: It can be used in greenhouses to maintain controlled environmental conditions, ensuring the growth of high-value and sensitive crops.
3. Vineyards and Orchards: The system is beneficial for vineyards and orchards, where precise monitoring and irrigation are crucial for crop quality.
4. Nurseries: It can be applied in plant nurseries to ensure optimal conditions for seedlings and young plants.
5. Smart Irrigation: Beyond rain protection, the system can be used for smart irrigation in agriculture, helping to manage water resources efficiently.
6. Aquaponics and Hydroponics: The system can be integrated into aquaponic and hydroponic setups, providing consistent water supply and protection from harsh weather conditions for soilless crop cultivation.
7. Vertical Farming: In vertical farming systems, where crops are grown in stacked layers, the rain roofing system can ensure uniform watering and protection for crops at different levels.
8. Specialty Crop Cultivation: For specialty crops such as herbs, spices, or medicinal plants, precise watering and environmental control are essential, making the rain roofing system invaluable for their cultivation.
9. Urban Agriculture: In urban farming initiatives, where space is limited and environmental factors are often challenging, the system can enable efficient crop production on rooftops or in small plots, maximizing yield in constrained areas.
10. Remote Agriculture: In remote or off-grid agricultural settings, where access to electricity and water may be limited, the solar-powered rain roofing system provides a sustainable solution for crop cultivation by harnessing renewable energy and optimizing water usage.

CHAPTER 6
CONCLUSION AND FUTURE SCOPE

6.1 Conclusion:

The "Solar powered IoT Smart Farming Project with a Rain Roofing System for Crop Protection" is a revolutionary advancement in modern agriculture. By utilizing solar power, it provides a sustainable and renewable energy source, significantly reducing the carbon footprint. The incorporation of IoT technology allows for real-time monitoring and precise control of farming processes, while cloud-based data analytics offer valuable insights for optimizing resource use and improving crop yields. The rain roofing system protects crops from adverse weather, minimizing the risk of damage and loss. This integrated approach not only promotes eco-friendly practices but also enhances agricultural productivity and resilience. By empowering farmers with advanced tools and data-driven insights, this project paves the way for a smarter, more sustainable, and future-ready farming industry.

6.2 Future Scope:

The future scope of the "Solar Powered Rain Roofing System For Crops With Smart Watering" project is extensive and holds great potential to revolutionize modern agriculture. Firstly, the development of advanced rain roofing systems that offer protection not only against rain but also against extreme weather conditions such as hail, frost, and excessive sunlight can significantly enhance crop safety and quality. By integrating more efficient solar panels and robust energy storage solutions, the system's energy efficiency and sustainability can be greatly improved, ensuring continuous operation even during prolonged periods of low sunlight.

Incorporating cutting-edge IoT sensors and sophisticated machine learning algorithms will enable highly precise monitoring and control of environmental conditions. Real-time data analytics will provide deeper insights into crop health, soil moisture levels, nutrient content, and weather patterns, empowering farmers with actionable information to make better-informed decisions. This can lead to optimized resource usage, such as water and fertilizers, and ultimately, higher crop yields.

Further advancements in automation, driven by artificial intelligence, can transform the system into a fully autonomous solution for precision agriculture. Automated watering systems that adjust based on real-time soil and weather data can ensure crops receive the optimal amount of water, preventing both under and over-irrigation. Additionally, the ability to implement variable rate irrigation and nutrient management tailored to specific crop needs can enhance e

efficiency and productivity.

The system's scalability and customization are also crucial for its broader application. It can be adapted to various farming scales, from small family-run farms to extensive commercial agricultural operations, with customizable features that address specific crop requirements and local climatic conditions. This flexibility ensures that the benefits of the system can be universally applied, regardless of farm size or location,

Lastly, enhanced connectivity through cloud-based platforms will enable remote monitoring and management of the farming systems. Farmers will be able to access real-time data and control the system from anywhere, using smartphones or computers. This capability will allow for timely interventions and adjustments, reducing labor costs and improving overall farm management efficiency. By integrating these advanced technologies, the project paves the way for a smarter, more resilient, and eco-friendly future in agriculture, ultimately contributing to global food security and sustainability.

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APPENDICES

Components Datasheet

1. ATMega328P Microcontroller

Pin	Function	Type	Description
1	Reset	Reset	Restart the microcontroller operation
2	Digital pin 0(TX)	Digital	Digital I/O or UART receive data
3	Digital pin 1	Digital	Digital I/O or UART transmit data
4	Digital pin 2	Digital	Digital I/O or external interrupt 0
5	Digital pin 3(PWM)	Digital	Digital I/O or external interrupt 1
6	Digital pin 4	Digital	Digital I/O or Timer/Counter 0 external counter input
7	VCC	Power	Digital Supply Voltage
8	GND	Power	Ground
9	XTAL1	Crystal	Input to inverting oscillator amplifier
10	XTAL2	Crystal	Output from inverting oscillator amplifier
11	Digital pin 5	Digital	Digital I/O or timer counter 1 external counter input
12	Digital pin 6	Digital	Digital I/O or analog comparator positive input
13	Digital pin 7	Digital	Digital I/O or analog comparator negative input
14	Digita pin 8	Digital	Digital I/O or timer counter 1 input capture pin
15	Digital pin 9	Digital	Digital I/O or Timer Counter 1 output compare match A
16	Digital pin 10	Digital	Digital I/O or SPI slave select
17	Digital pin 11	Digital	Digital I/O
18	Digital pin 12	Digital	Digital I/O
19	Digital pin 13	Digital	Digital I/O or SPI clock
20	VCC	Power	Supply voltage for the ADC
21	Aref	Analog	Reference voltage for ADC
22	GND	Power	Ground
23	Analog pin 0	Analog	Digital I/O or ADC channel 0
24	Analog pin 1	Analog	Digital I/O or ADC channel 1
25	Analog pin 2	Analog	Digital I/O or ADC channel 2
26	Analog pin 3	Analog	Digital I/O or ADC channel 3
27	Analog pin 4	Analog	Digital I/O , ADC channel 4 or I2C data line
28	Analog pin 5	Analog	Digital I/O , ADC channel 5 or I2C clock line

2. Soil Moisture Sensor

Datasheet of Soil Moisture Sensor

Pin No	Pin Name	Function name
1	VCC	5 Vdc Supply Input
2	GND	Ground Input
3	AO	Analog output pin

3. Rain Sensor

Datasheet of Rain Sensor

Pin No	Pin Name	Function name
1	VCC	5 Vdc Supply Input
2	GND	Ground Input
3	AO	Analog output pin

4. pH Sensor

Datasheet of pH Sensor

Pin No	Pin Name	Function name
1	VCC	5 Vdc Supply Input
2	GND	Ground Input
3	AO	Analog output pin
4	RE	Reference Electrode
5	Temp Sensor(optional)	To measure Temp

5. ESP8266 Wi-Fi Module

Datasheet of ESP8266 Wi-Fi Module

Pin No	Pin Name	Function name
1	TXD	Transmit Data
2	RXD	Receive Data
3	GPIO0	General Purpose I/O
4	GPIO2	General Purpose I/O
5	GND	Ground
6	VCC	Power
7	CH_PD	Chip Power Down
8	RST	Reset

6. 16X2 LCD

Datasheet of 16X2 LCD

Pin no.	Symbol	External connection	Function
1	Vss	Power supply	Signal ground for LCM
2	V_{DD}		Power supply for logic for LCM
3	V_0		Contrast adjust
4	RS	MPU	Register select signal
5	R/W	MPU	Read/write select signal
6	E	MPU	Operation (data read/write) enable signal
7~10	DB0~DB3	MPU	Four low order bi-directional three-state data bus lines. Used for data transfer between the MPU and the LCM. These four are not used during 4-bit operation.
11~14	DB4~DB7	MPU	Four high order bi-directional three-state data bus lines. Used for data transfer between the MPU
15	LED+	LED BKL power supply	Power supply for BKL
16	LED-		Power supply for BKL

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