DESIGN AND IMPLEMENTATION OF SOLAR ENERGY BASED PUMPING SYSTEMS FOR IRRIGATION

A thesis

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SONARGAON UNIVERSITY (SU)

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Submitted to the
DEPARTMENT OF MECHANICAL ENGINEERING (ME)
SONARGAON UNIVERSITY (SU)
In partial fulfillment of the requirements for the award of the degree of Bachelor of Science in Mechanical Engineering

JANUARY 2024

Acknowledgement

The report titled as on "Design and Implementation of Solar Energy Based Pumping Systems for Irrigation" has been prepared to fulfill the requirement of our practicum program. In the process of doing and preparing our practicum report, we would like to pay our gratitude to some persons for their enormous help and vast co- operation. At first, we would like to show our gratitude to the University authority to permit us to do our practicum. Specially, we would like to thank to our honorable supervisor **Shahinur Rahman**, Lecturer & Course Coordinator, Department of, Mechanical Engineering, SU− Sonargaon University Dhaka, for his valuable and patient advice , sympathetic assistance, co- operation, contribution of new idea. Deep Theoretical and hardware knowledge & keen interest of our supervisor in this field influenced us to carry out this project. His endless patience, scholarly guidance, continual encouragement, constant and energetic supervision, constructive criticism, valuable advice, reading many inferior draft and correcting them at all stage have made it possible to complete this project.

The authors are also greatful to professor **Md. Mostofa hossain**, Head of the Department of Mechanical Engineering, Brig. Gen. (Retd) Prof. **Habibur Rahman Kamal** Dean, Science and Engineering Prof. **Shamim Ara Hassan**, Vice Chancellor and all respectful teachers of the Mechanical Engineering Department for their cooperation and significant help in completing this project work successfully.

Abstract

Agriculture is the source of living of majority Indians and it also has a countless influence on economy of the country. The objective of our project is to reduce this manual involvement by the farmer by using an automated irrigation system which purpose is to enhance water use for agricultural crops. The inspiration for this project came from the countries where economy is based on agriculture and the climatic conditions prime to shortage of rains & scarcity of water. The farmers working in the farm lands are only dependent on the rains and bore wells for irrigation of the land. Even if the farm land has a water-pump, manual involvement by farmers is required to turn the pump on/off when needed. The project is intended to cultivate an automatic irrigation system which controls the pump motor ON/OFF on sensing the moisture content of the soil. In the field of agriculture, use of appropriate technique of irrigation is essential. The advantage of using this technique is to reduce human intervention and still certify proper irrigation. A software application was developed by predetermining the threshold values of soil moisture, temperature and water level that was programmed into an arm controller. This paper presents the controlling and monitoring the level of water and detecting the soil moisture content.

The Solar Irrigation System (SIS) is a groundbreaking solution poised to redefine agricultural practices by harnessing solar energy for irrigation. By leveraging photovoltaic technology, the system eliminates dependence on conventional energy sources, offering farmers a sustainable and cost-effective alternative. The SIS ensures uninterrupted irrigation through advanced energy storage systems, addressing challenges posed by low solar exposure or nighttime conditions. Incorporating smart irrigation technology with sensors and data analytics, the system optimizes water usage based on real-time environmental factors, promoting water conservation and maximizing crop yields. The modular and scalable design of the SIS caters to diverse farm sizes and needs, making it adaptable to various agricultural landscapes. Beyond cost savings and environmental sustainability, the SIS empowers farmers with remote monitoring and control capabilities, enhancing operational efficiency. Positioned as a key driver of agricultural productivity, the Solar Irrigation System presents a transformative solution that aligns with the global shift towards sustainable and efficient farming practices.

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Chapter 01

Introduction

1.1 Introduction

Bangladesh's noteworthy wellspring of pay is from agribusiness zone. What's increasingly, 70% of farmers and general people depend upon the agribusiness. In Bangladesh by far most of the water framework structures are worked physically. These antiquated methodologies are superseded with semi-automated and motorized frameworks. His available customary techniques look like dump water framework, terraced water framework, spill water framework, sprinkler structure. The overall water framework circumstance is organized by extended enthusiasm for higher agrarian benefit, poor execution and lessened openness of water for Agribusiness. These issues can be fittingly corrected in case we use robotized structure for water framework. A. Need of Automatic Irrigation Simple and easy to present and organize. Saving essentialness and resources, with the objective that it will in general be utilized in real way and aggregate. Agriculturists would have the ability to spread the fitting proportion of water at the ideal time by means of modernizing property or nursery water framework. Dodging water framework at the wrong time of day, decrease overflow from over watering doused soils which will upgrade trim execution. Automated water framework structure uses valves to turn motor ON and OFF. Motors can be motorized viably by using controllers and no need of work to turn motor ON and OFF. It is correct strategy for water framework and a productive contraption for exact soil moistness control in exceedingly thought nursery vegetable age. It is productive, the human mix-up end in open soil suddenness levels.

The essential purpose of this endeavor was to offer water to the plants or developing normally using microcontroller (Arduino Uno). We can normally watering the plants when we are taking a break or don't we have to inconvenience my neighbors, Sometimes the neighbors do unnecessarily of watering and the plants end up kicking the container at any rate. There are check based contraptions open in India which waters the earth on set between time.They don't recognize the earth clamminess and the including temperature to know whether the soil very watering or not.

1.2 Background

The background of the Solar Irrigation System (SIS) lies in the intersection of agricultural challenges, environmental sustainability, and advancements in renewable energy technology. Traditional irrigation methods often rely on fossil fuels or grid-based electricity, contributing to high operational costs and environmental impact. In response to these challenges, the concept of harnessing solar energy for irrigation emerged as a viable and eco-friendly solution.

The development of solar irrigation systems gained momentum with the increasing global awareness of climate change and the need to reduce greenhouse gas emissions. Solar power, as a clean and renewable energy source, presented an opportunity to address the energy-intensive nature of irrigation in agriculture. The declining costs and improving efficiency of solar photovoltaic technology further fueled the feasibility of solar irrigation systems, making them more accessible to farmers worldwide.

As concerns over water scarcity and the sustainable use of natural resources grew, there was a heightened emphasis on optimizing irrigation practices. The integration of smart technologies, such as sensors and data analytics, became pivotal in ensuring precise and efficient water management. These technologies, coupled with solar power, formed the foundation of the Solar Irrigation System, enabling farmers to remotely monitor and control irrigation processes based on real-time data and environmental conditions.

The modularity and scalability of these systems were designed to cater to the diverse needs of farmers, accommodating variations in farm size, crop types, and geographical conditions. The background of the Solar Irrigation System is rooted in the collaborative efforts of agricultural experts, engineers, and environmentalists striving to address the challenges facing modern agriculture while promoting sustainable and resilient farming practices.

In summary, the evolution of the Solar Irrigation System is a response to the need for sustainable, cost-effective, and technologically advanced irrigation solutions that align with the growing global commitment to environmental stewardship and resource efficiency in agriculture. [1]

1.3 Objective

The goal or goals of which the arranged contraption is required to accomplish is to make a customized water control with modified water framework structure The standard objective of this endeavor was s to setup, create and test a customized water framework control system. Perceive the requirement for water sparing in water system frameworks.

- To control an irrigation system Using soil Moisture sensor
- Decrease the amount of work pressure in workplace
- To avert over laborers of the siphoning machine and keep it from getting terrible.
- To dodge loss of water.

1.4 Methodology

The methodology of a Solar Irrigation System (SIS) involves a multi-faceted approach, incorporating various technologies and processes to harness solar energy for efficient and sustainable irrigation. The key components of the methodology include:

1. **Solar Photovoltaic (PV) Technology:**
    - **Solar Panels Installation:** The core of the SIS involves the deployment of solar panels to capture sunlight and convert it into electricity. These panels are strategically installed in locations with optimal sunlight exposure.
    - **Inverter System:** The generated DC (direct current) electricity from the solar panels is converted into AC (alternating current) electricity using inverters. This conversion ensures compatibility with standard electrical systems.
2. **Energy Storage Systems:**
    - **Battery Technology:** To ensure continuous irrigation during periods of low solar exposure or at night, energy storage systems, typically based on advanced battery technologies, are integrated into the SIS. These batteries store excess energy generated during peak sunlight hours for later use.
3. **Smart Irrigation Technology:**

- **Sensor Integration:** The SIS incorporates a network of sensors to monitor key environmental factors such as soil moisture levels, weather conditions, and crop requirements. These sensors provide real-time data that informs irrigation decisions.

- **Data Analytics:** Advanced data analytics processes the information collected by sensors, enabling intelligent decision-making. Algorithms can optimize irrigation schedules based on the specific needs of crops and environmental conditions, thereby minimizing water wastage.

4. **Remote Monitoring and Control:**

    - **User Interface:** A user-friendly interface is provided, allowing farmers to remotely monitor and control the SIS. This interface often includes features for adjusting irrigation schedules, checking system status, and receiving alerts or notifications.

5. **Modularity and Scalability:**

    - **System Design:** The SIS is designed to be modular and scalable, accommodating variations in farm size, crop types, and water requirements. This flexibility allows for easy customization and expansion based on the specific needs of individual farmers.

6. **Installation and Maintenance:**

    - **Professional Installation:** Trained technicians install the SIS components, ensuring proper alignment and functionality of solar panels, inverters, batteries, and sensors.

    - **Routine Maintenance:** Regular maintenance is essential to keep the system in optimal condition. This includes cleaning solar panels, checking connections, and monitoring the performance of batteries and other components.

By integrating these components and processes, the methodology of a Solar Irrigation System aims to provide a reliable, sustainable, and technologically advanced solution for irrigation in agriculture. [2]

Chapter 02

Hardware Components

2.1 Introduction

The hardware components of a Solar Irrigation System (SIS) constitute a sophisticated ensemble designed to harness the abundant energy of the sun for sustainable and efficient agricultural irrigation. At the forefront are solar panels, strategically positioned to capture sunlight and convert it into electrical energy through photovoltaic technology. These panels are the primary energy generators, laying the foundation for a clean and renewable power source. Inverters play a pivotal role by converting the direct current (DC) electricity produced by solar panels into the alternating current (AC) required for irrigation equipment, ensuring a seamless integration of solar power into the system. Complementing this, advanced battery technologies serve as energy storage units, storing surplus electricity during peak sunlight hours and releasing it during low-light or nighttime conditions. Sensors, deployed to monitor essential environmental parameters like soil moisture and weather conditions, collect real-time data critical for informed decision-making. The data analytics system processes this information, utilizing algorithms to optimize irrigation schedules and minimize water wastage. A user-friendly remote monitoring and control interface empowers farmers to manage the system in real-time, facilitating timely adjustments. With a modular and scalable design, the SIS accommodates diverse agricultural landscapes, embodying a transformative solution that merges cutting-edge technology with sustainable farming practices. [3]

2.2 Hardware required

Water stream Controller uses a direct instrument to distinguish and keep up the water framework in an agricultural land or some other compartment by trading it on/off the motor normally when required. Here used soil soaked sensor. The sensor is keeping up the water stream in the soil by actuating and retriggering the clock IC. Here the check IC is acting in mono stable mode or one-shot mode. The list of required hardware are as:

- Battery
- Relay module

- Microcontroller (Arduino)
- Solar Panel
- Amplifier circuit as part of a soil moisture sensor
- Soil moisture probes
- Plant in the flowerpot
- Water pump
- Water container

2.3 Processing System

Notwithstanding the way that there are a couple of associations moving these systems made in various courses, there is a fundamental way by which one can build his/her very own plant watering structure in just a Barely any hours, if each required material are available nearby basic required data about devices. To assemble this system one ought to honestly interface following.

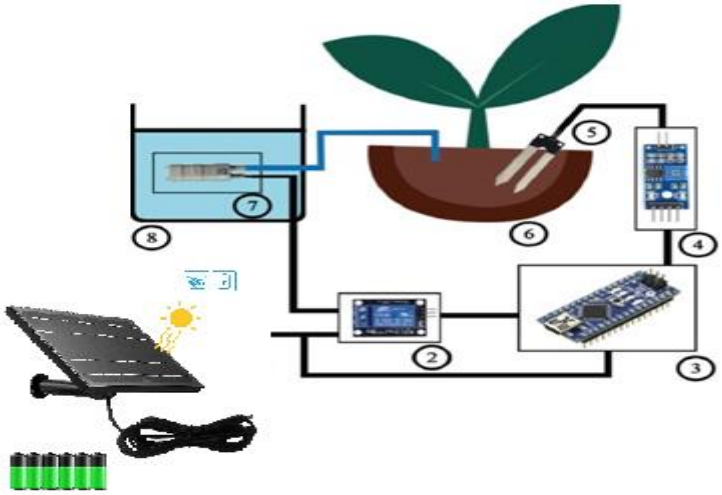

Fig 3.1: Processing system of Solar Irrigation System.

Ref: (https://www.researchgate.net/figure/All-materials-connected-into-one-system_fig1_319130612)

Figure 3.1 underneath shows the relationship of all recently referenced materials in the structure. (Figure 3.1)In our examination, definitely related each and every required material by us as showed up in Figure 1 above, in this state to test whether our system will work suitably or not. In like manner, the general lead and the nearness of our plant, that was subject of the examination.

2.4 NodeMCU

In this undertaking has utilized an NodeMCU in which microcontroller board dependent on the ATmega328. There are add up to 32 sticks in this ESP32 and 14 pins are advanced stick of them in the esp series. 6 stick can be utilized PWM yields, for simple information utilized 6 stick, fired resonator is 16 MHz it's called clock recurrence .it has one port USB association and one 12 volt control supply port by which supply the power another circuit, it has a reset catch which is reset the program. TXD and RXD both are computerized stick. TXD is sequentially transmitting and RDX is sequentially accepting port. Then again it has 6 simple sources of info 5v vcc stick, 3.3v vcc stick, ground stick (it has 3 ground stick however all simple stick), ROW input, RESET stick, and finally Analog reference stick. Presently another 6 pins are MOS-0, MOS-1, SS, SCK, SDA, and SCL, this six pins are called stick header. Two 8 bits microcontroller has utilized in this Arduino and other two pins are input/yield stick and just boot loader (its programming stacking framework). The microcontroller bolstered require all that it has contains; USB link or power utilized essentially interface it to a PC with an AC-to-DC connector or battery to begin The Uno varies from every former board in that it doesn't utilize the FTDI USB-to-sequential driver chip. [4]

Fig. 3.2: NodeMCU

Ref: (https://duino4projects.com/home-automation-using-nodemcu-esp8266-board/)

The power source is picked therefore. External (non-USB) power can come either from an AC-to-DC connector (divider mole) or battery The Arduino Uno can be energized by methods for the USB affiliation or with an outside power supply. 2.1mm center positive fitting into the board's ability jack associated by stopping with connector. Connector. By 6 to 20 volts can work the board an outside supply. On the off chance that supply voltage under 7V, in any case, under five volts by 5V stick and subsequently the board not stable. [5]

Table 3.1: NodeMCU Specifications

Feature	Specification
Microcontroller	Atmega328
Operating voltage	5v
Input voltage (recommended)	7-12v
Input voltage (limits)	6-20v
Digital I/O pins	14 (of which 6 provide PWM output)
Analog input pins	6
DC Current per I/O Pin	40mA
DC Current for 3.3v	50mA
Flash Memory	32KB(Atmega328) of which 0.5KB Used by boot loader
SRAM	2KB(Atmega328)
EEPROM	1KB(Atmega328)
Clock Speed	16 MHZ

2.4.1 Analysis of Programming

Utilizing Arduino programming chosen the program which is works in The Arduinouno " from the products of Arduino Uno > Board menu (as per the microcontroller on your board). See instructional exercises the and reference. For subtleties, it without the utilization of an outside equipment developer The ATmega328 on the Arduino Uno comes perjured with a boot loader that enables you to transfer new code to. Utilizing the first STK500 convention (reference, C header records) it conveys. the ICSP (In-Circuit Serial Programming) header; is sidestep in a microcontroller this is the boot loader and projects the through observe their information for details The DFU boot loader used to stack by ATmega16U2/8U2 , which can be actuated by: different microcontrollers and another Arduino likewise utilized PC for conveying Offices or UART TTL (5V) sequential communication used ATmega328 gives,

on advanced pins 0 (RX) and 1 (TX) are accessible in the Arduino. This sequential correspondence over USB and shows up as a virtual com port to programming on the PC AnATmega16U2 on the board channel. The '16U2 firmware utilizes the standard USB COM drivers, and no outside driver is required. In any case, on Windows, an .in document is required. The Arduino programming incorporates a sequential screen which enables straightforward printed information to be sent to and from the Arduino board. The RX and TX LEDs on the board will streak when information is being transmitted by means of the USB-to-sequential chip and USB association with the PC (yet not for sequential correspondence on pins 0 and 1). A Software Serial library takes into account sequential correspondence on any of the Uno's advanced pins. The ATmega328 likewise bolsters I2C (TWI) and SPI correspondence. The Arduino programming incorporates a Wire library to rearrange utilization of the I2C bud. [6]

2.4.2 Physical Characteristics

The Uno PCB are 2.7 and 2.1 inches separately are the most extreme length and width with the power jack and USB connector and reaching out past the previous measurement. The board to be joined to a surface or four screw gaps permit case. The computerized stick 7 and 8 is 160 mil (0.16"), remove between them not an even numerous of the 100 mil separating of alternate pins. [7]

2.4.3 Function of Different Pin

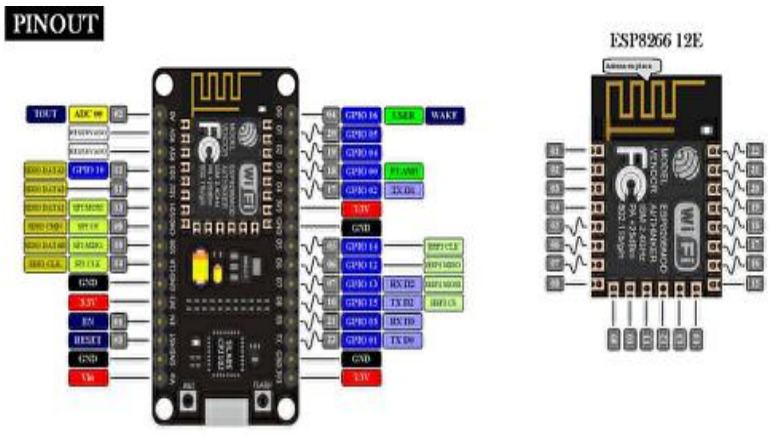

Fig.3.3: Function of Different Pin

Ref:(https://www.robotechbd.com/product/arduino/boards/esp8266-ch340-nodemcu-wifi-module-lua-v3/)

I) USB power port

Using the USB cable Arduino board can be got power from our PC. Connected USB link to the USB association you need to do.

II) Barrel Jack of power

By connecting it to the Barrel Jack (2). Arduino sheets can be controlled straightforwardly from the AC mains control supply.

III) Voltage Controller

The amount of voltage is required control the Arduino board and balance out the DC voltages discover by the different components and processor.
That's voltage control by the voltage regulator

IV) Arduino Crystal Oscillator

Arduino in managing time issues is helped by the precious stone oscillator. The Arduino ascertain the time by utilizing the gem oscillator. Best of the number printed of Arduino gem is 16.000H9H. It has the measure of recurrence is 16,000,000 Hertz or 16 MHz

V) 17 Reset pin of Arduino

Arduino board can be reset by anyone, that is, from the earliest starting point will be start begin your program. Two separate ways, you will be reset the UNO board. First way, by utilizing the reset catch (17) on the board. And 2nd way, the Arduino stick named RESET (5) can be associate an outer reset catch by you.

6,7,8,9 Pins (3.3v, 5v, GND, VIN)

- 6 pin is supply 3.3 output volt
- 7 number pin is 5 volt output supply
- Arduino board works fine most of the component with 3.3 volt and 5 volt.
- 8 number pin is GND (Ground) –in the Arduino has several GND pins, these are

used to ground our circuit.

- 9 number pin is Vin −by the Vin pin you can supply the power at Arduino board from an external power source, like the mains power supply of Ac.

X) Simple or (Analog) pins

There are five Analog sticks in the Arduino UNO board, as A0 through A5. Here the stickiness sensor and temperature sensor are simple sensor. At the point when any flag originate from simple sensor which is changed over into computerized value By These pins and read it by the chip. [3]

XI) Prime microcontroller

This is claim microcontroller (11) of Each Arduino board. You think the microcontroller is the cerebrum of an Arduino board. On the Arduino is marginally unique in relation to board to board by the principle IC (coordinated circuit).generally ATMEL Company makes the microcontrollers. You ought to perceive what IC your square has previously stacking another program from the Arduino IDE. This information is open on the most astounding purpose of the IC. To realize more bits of knowledge concerning the IC improvement and limits.

XII) ICSP pin

ICSP (12) is an AVR it is the most imperative piece of an Arduino, for the Arduino involving MISO, RESET, MOSI, VCC, SCK, and GND in an unobtrusive programming header. As a SPI (Serial Peripheral Interface)it is much of the time alluded and as an "advancement" of the yield it could be considered. Extremely, the yield substance to the ace of the SPI transport are unraveled by you.

XIII) Indicator as a Power LED

Power LED demonstrate the power when the power supply in the board.

When we interface the fitting with our Arduino into a power source to demonstrate that your block is fueled correctly. When the association will be something incorrectly then the light

portion not turn on.

XIV) The pin of TX and RX LEDs

This is another vital piece of Arduino board. There are two capacities: like for transmit is TX (transmit) and for getting is RX (receive).Appear these stick is first, pins 0 and 1 are computerized stick, by these stick indicate the sequential correspondence. Second, the RX and TX a drove (13). The TX drove flashes while sending the sequential information.

XV) Digital Input/output pin

There are add up to 14 advanced I/O sticks in this Arduino 0 to 13 stick are Digital stick. There are 6 PWM (beat Width Modulation) These pins can be masterminded to fill in as data mechanized pins to examine justification regards (0 or 1) or as cutting edge yield pins to drive assorted modules like LEDs, exchanges, etc. The pins named "~" can be used to create PWM. [4]

2.5 Battery

A battery is a device that converts chemical energy contained within its active materials directly into electric energy by means of an electrochemical oxidation-reduction (redox) reaction.

Fig 3.4: Battery

Ref:(https://www.lisocl2-battery.com/supplier-255660-lithium-ion-battery)

2.6 Solar Panels

A solar panel is a device that converts sunlight into electricity by using photovoltaic (PV) cells. PV cells are made of materials that generate electrons when exposed to light. The electrons flow through a circuit and produce direct current (DC) electricity, which can be

used to power various devices or stored in batteries. Solar panels are also known as solar cell panels, solar electric panels, or PV modules. Solar panels are usually arranged in groups called arrays or systems. A photovoltaic system consists of one or more solar panels, a inverter that converts DC electricity to alternate current (AC) electricity, and sometimes other components such as controllers, meters, and trackers. A photovoltaic system can be used to provide electricity for off-grid applications, such as remote homes or cabins, or to feed electricity back into the grid and earn credits or payments from the utility company. This is called a grid-connected photovoltaic system. [8]

Fig. 3.5: Solar Panel

Ref: (https://www.amazon.co.uk/sourcing-map-0-7425-Electric-Project/dp/B0BHY7R6L8)

2.7 Discussion about Microcontroller

In this area we will talk about ATmega328p Microcontroller the ATmega328P is a low-control CMOS 8-bit microcontroller reliant on the AVR redesigned RISC structure. By executing astonishing bearings in a single clock cycle, it has 2kb RAM Furthermore, 32 kb ROM in which 4kb is for reveres boot and other 28kb useable another capacity it has 16 MHz clock bring recurrence and task voltage 5v. There are 32 sticks in the ATmega328p microcontroller. It has 3 port and every port has 8 stick other then again it has 2 ground pins.2 Vcc pins, 2 precious stone pins and 1 reset stick and 1 simple reference the ATmega328P accomplishes throughputs progressing toward 1 MIPS for each MHz permitting the structure expected to streamline control use as opposed to arranging speed The ATmega328P gives the running with highlights: 4K/8K bytes of In-System Programmable Flash with Read-While- Write limits, 256/512/512/1K bytes EEPROM, 512/1K/1K/2K bytes SRAM, 23 for the most part accommodating I/O lines, 32 completely important working registers, three flexible Timer/Counters with look at modes, inward and outside freight boats in on, a back to back programmable USART, a byte-engineered 2- Wire serial interface, a SPI sequential port, a 6-channel 10-bit ADC (8 diverts in TQFP and QFN/MLF bundles), a programmable

watchdog timer inward oscillator, and five programming selectable power sparing modes. The idle mode stops the CPU while permitting the SRAM, Timer/Counters, USART, 2-wire serial interface, SPI port and interface with framework to keep working. The power down mode spares the enlist substance yet solidifies the oscillator, handicapping all other chip capacities until the point that the following hinder or equipment reset. In power-spare mode, the offbeat clock keep on running, enabling the client to keep up a clock base while whatever remains of the gadget is dozing. The ADC noise reduction mode stops the CPU and all I/O modules aside from no concurrent clock and ADC to limit exchange clamor amid ADC change. In standby mode, the precious stone/resonator oscillator is running while whatever is left of the gadget is dozing. This permits quick start-up joined with low power utilization. The AVR center combines a rich instruction set with 32 general purpose working registers. All the 32 registers are directly connected to the Arithmetic Logic Unit (ALU), allowing two independent registers to be accessed in one single instruction executed in one clock cycle. The idle mode stops the CPU while allowing the RAM, timer/counters, serial port and interrupt system to continue functioning. The power-down mode saves the RAM contents but freezes the oscillator, disabling all other chip function until the next interrupt or hardware reset. The device is manufactured using Atmel's high density non-volatile memory technology. The on-chip ISP flash allows the program conventional non-volatile memory programmer or by an On-chip boot program running on the AVR core. Regardless of the way that there are confined tending to plans and enhanced pick codes for select archive and I/O enroll get to, all can even now be tended to and controlled as if .They were in SRAM. In the ATMEGA variety, the working register archive isn't mapped into the data address space; everything thought of it as, is crazy to hope to treat any of the ATMEGA's working registers as though they were SRAM. Or maybe, the I/O registers are mapped into the data address space starting at the plain beginning of the area space. Likewise, the proportion of data convey space focused on I/O registers has grown essentially to 4096 bytes (000016–0FFF16). Likewise as with past ages, in any case, the speedy I/O control bearings can simply accomplish the underlying 64 I/O enroll regions (the underlying 32 zones for bitwise rules). In numerous varieties of the AVR structure, this inside EEPROM memory isn't mapped into the MCU's addressable memory space. It must be gotten to a comparative way an external periphery contraption is, using remarkable pointer registers and read/make bearings which makes EEPROM get to much slower than other inside RAM. [9]

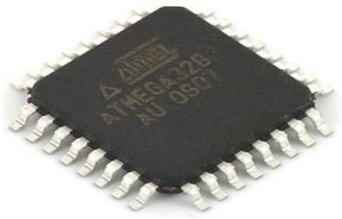

Fig 3.6: ATMEGA 328

Ref:(https://www.techbazar.com.bd/product/atmega3290a/)

2.7.1 Architecture block diagram Atmega328

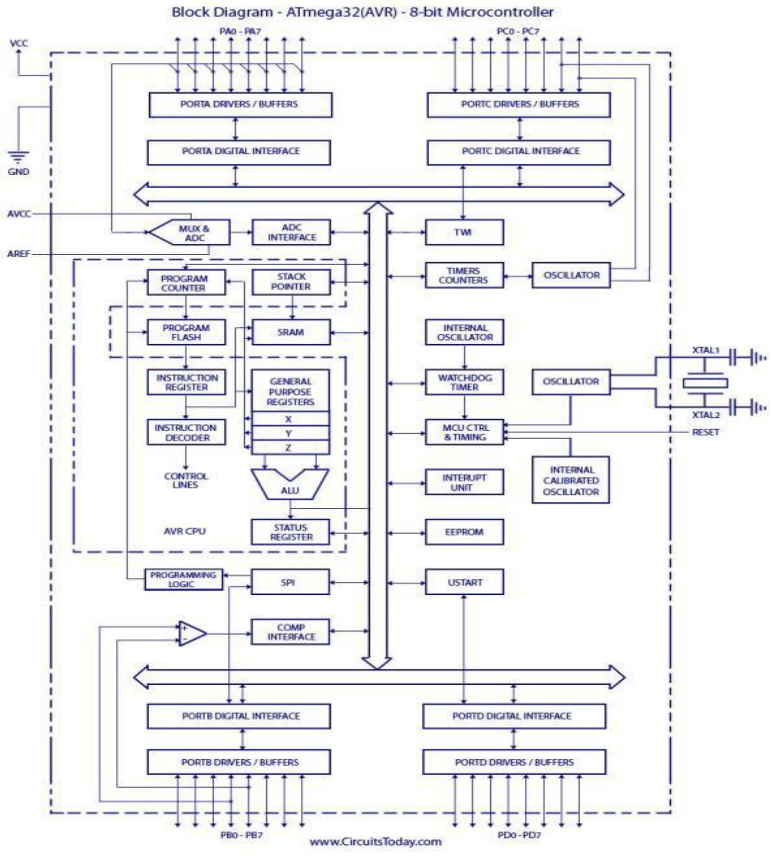

Fig 3.7: Pin configuration

Ref: (https://www.researchgate.net/figure/Block-diagram-of-AT-8535_fig5_327966459)

2.8 DC Water Pump

12v dc vehicle glass locally built model self-production arrangements, with a little siphon can moreover be changed over into various usages a little siphon, RS-360 Mini 4-12v water siphoning engine reversible rigging aquarium siphon RS-360 micro motors small pump. The radiating siphon is normally found inside a submersible wellspring siphon and some cooling units. As the impeller inside it turns, water is attracted one side of the siphon. It is then removed out the opposite end. The power and size of the impeller choose the measure of water stream. More water can be siphoned on the off chance that we have a vast impeller. As the impeller turns, it moves water from the gulf (which is situated close to the focal point of pivot of the impeller) along the surfaces of the impeller to the external bits of the volute by methods for outward power (in this manner, it's name radial siphon). As this water gathers in the external locales of the volute, it is coordinated to the outlet. The water leaving the outlet causes the water strain to drop at the bay. [10]

Fig: 3.8: Pump

Ref: (https://www.bdtronics.com/dc3-5v-mini-submersible-water-pump-100l-h-silent-aquarium-fish-tank-accessories.html)

To coordinate the rate with which water is leaving the outlet, the siphon sucks in new water at the gulf. These pumps must be prepared before beginning, which for this situation is now done as a result of its submerged application. Rating Voltage: 12v Dc. Current: 1 amps.

2.8.1 Specification:

Model : 360

Color : silver + white

Quantity : 1

Material :

Flow rate 0.5L per minute

Suitable voltage : Ac 4-12v

Standing voltage : 6v

Please avoid long time operation under 12v and longtime no-load testing

Absorption range: Water pump with air about 1m, over 3m without air

Raising range : 0.5

Power supply verify of Dc power adapter, such as high current battery, normal battery, the power of the router, the record power with 6v-9v and 0.8A current.

Great for DIY

2.9 Connecting Wires

Wire is typically encircled by outline the metal through an opening in a pass on or draw plate. A wire is a single, for the most part tube molded, versatile strand or post of metal. Wires are used to persevere through mechanical weights or power and media correspondences signals. The term wire is moreover used even more unreservedly to insinuate a pile of such strands, as in 'multi stranded wire', which is even more precisely named a wire rope in mechanics, or a connection in power. Wire measures come in different standard sizes, as conveyed the extent that a check number. [11]

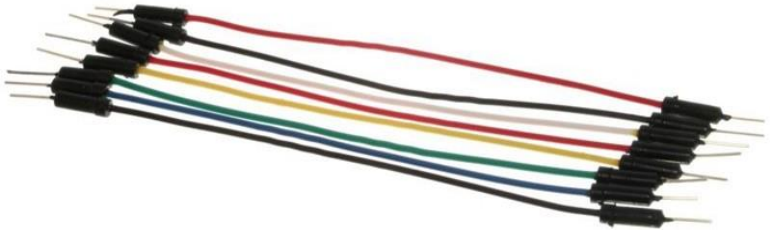

Fig. 3.9: connecting wire

Ref:(https://www.researchgate.net/figure/Fig-8-Jumper-wires-VIII-SOFTWARE-REQUIREMENT-A-ARDUINO-IDE_fig5_337184700)

2.10 Soil moisturize sensor

The volumetric water content in soil measure by the dampness sensors. Since the direct gravimetric estimation of free soil sogginess requires removing, weighting and drying of a model, measure the volumetric water content roundabout by using some other property of soil dampness sensors of the dirt, for example, dielectric steady, electrical opposition, as an intermediary for the dampness content. Or on the other hand communication with neutrons, soil dampness and the deliberate property must be adjusted between them. it is relying upon numerous worldwide parts like soil type, electric conductivity or temperature. The dirt dampness consequences for Reflecting microwave radiation. at Agricultural and hydrology framework is utilized remote detecting innovation. Ranchers or plant specialists can utilize Portable test instruments. By this sensor gauge volumetric water substance and Soil dampness sensors regularly allude to sensors. Measure another property of dampness in soils by another class of sensors called water potential; these sensors are regularly insinuated as soil water potential sensors and join sensitometers and gypsum squares. [12]

Fig 3.10: Soil moisturize sensor

Ref:(https://www.researchgate.net/figure/Figura-4-Sensor-de-tipo-resistivo-YL69-Fuente-https-wwwamazoncom_fig1_356254257)s

2.10.1 Identification of various part

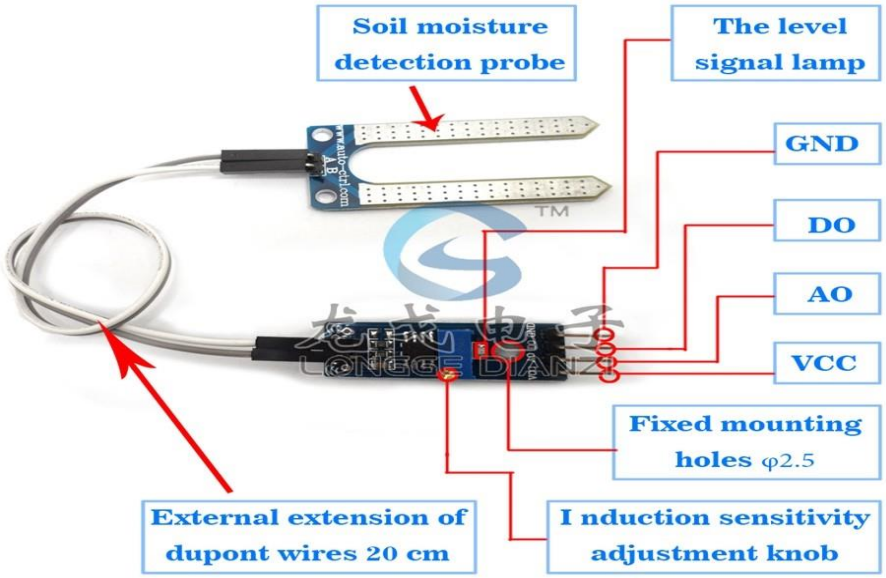

Fig 3.11: Identity Soil moisturize sensor

Ref:(https://www.ebay.com/itm/142319736918)

2.10.*2* Technology

Around the sensors certain volume components dielectric steady is gotten by estimating the swaying circuits working recurrence. Time Domain Reflectometry (TDR): The dielectric consistent of an express volume fragment around the sensor is acquired by evaluating the speed of affecting along an anchored transmission line.

Neutron dampness checks: to appraise soil dampness content between a source and finder test the properties of water as a mediator for neutrons are used.

Soil resistivity: To decide the dirt dampness content the steam of power between two cathodes can be utilized estimating how unequivocally the dirt stand up tp. [13]

2.11 Relay Module of 5v

5v 2-channel relay interface board is the low level relay. 15-20mA driver current is needed every channel. The Appliance and hardware which are drive extensive measure of current these apparatus and gear can be control the relay. This relay works under AC250v 10A or 1oA DC3ov with high current relay. A standard interface has in this transfer microcontroller can control. [14]

Fig: 3.12: Relay module.

Ref:(https://www.researchgate.net/figure/2-Channel-Relay-module-relay-is-inactive-It-is-also-called-FORM-B-contact-or-break_fig1_329557916)

2.11.1 Property

- AC 250v/10A,DC 30v/10A are the maximum output of this relay
- Opt coupler LOW Level Trigger development board with 2 Channel Relay Module is perfect with Arduino.
- Microcontroller can control directly standard interface (TTL logic.MSP430, ARM, DSP, PIC, AVR, 80510.
- SPDT relays is high quality loose music relay. One normally close terminal, one normally open terminal, and A common terminal.

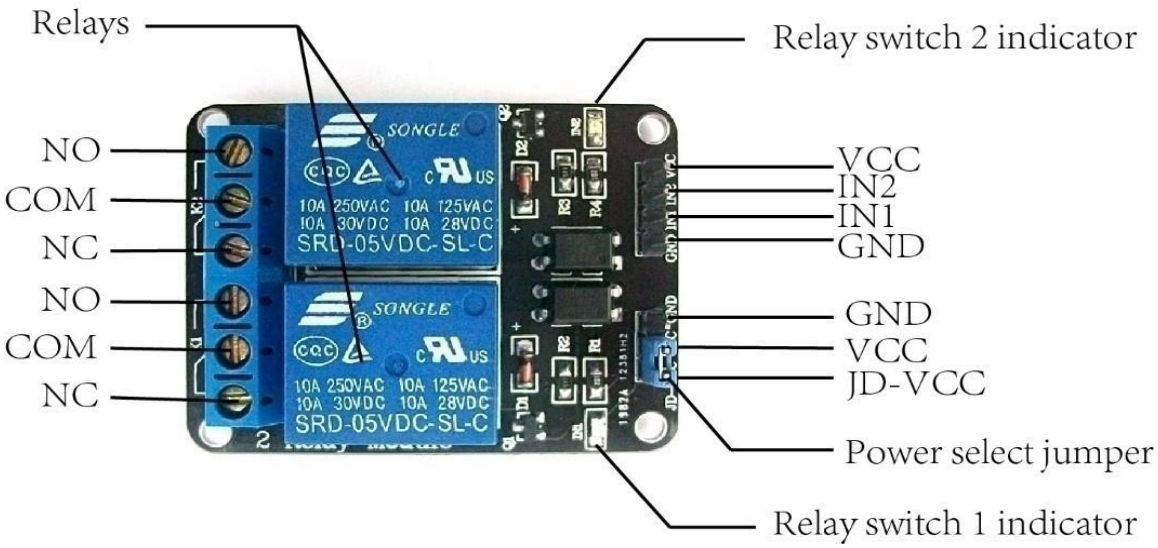

Fig: 3.13: Identity with relay pin

Ref:(https://www.researchgate.net/figure/2-Channel-Relay-module-relay-is-inactive-It-is-also-called-FORM-B-contact-or-break_fig1_329557916)

2.11.2 Designed

The power supply of the relay module are VCC and RY-VCC. When the large power load need to drive any machine, connect an extra power to RY-VCC to supply the relay and you can take the jumper cap off ; the MCU board to supply input signals is connected VCC to 5V. [15]

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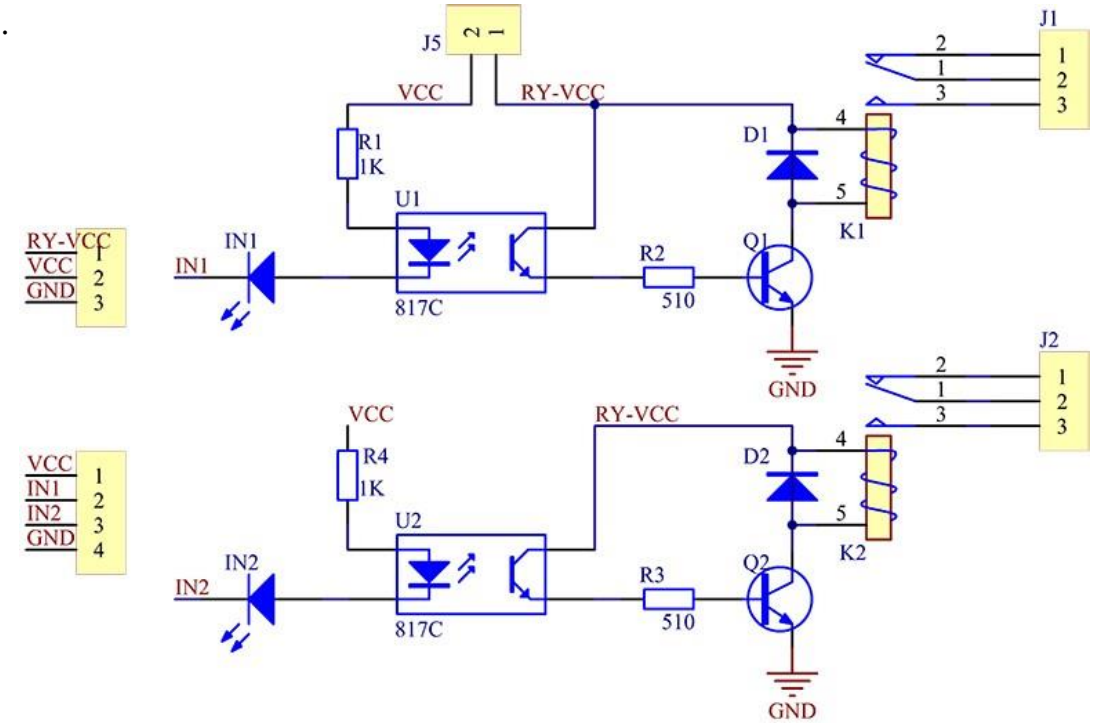

Fig 3.14: Relay schematic diagram

Ref:(https://www.researchgate.net/figure/Two-channel-relay-circuit_fig1_333447284)

Chapter 03

Design and Working Methodology

3.1 Introduction

This part will clarify about the development of three fundamental area of this project.

Power Supply Unit: Explain the development of a directed power supply. The Water irrigation control Unit: Explain the construction of water irrigation control system.

Main Circuit: Take the water saturate sensor motion as info, looked at them and hence control the pump ON/OFF condition.

3.2 Methodology

The methodology of a Solar Irrigation System (SIS) involves a systematic and integrated approach to harness solar energy for efficient and sustainable irrigation practices. Here is a comprehensive breakdown of the key steps and processes in the methodology:

1. Site Assessment:
    - Objective: Conduct a thorough assessment of the agricultural site to determine solar exposure, topography, water requirements, and other relevant factors.
    - Outcome: Informed decision-making on the optimal placement of solar panels and other system components.
2. Solar Panel Installation:
    - Process: Install solar panels in locations with maximum sunlight exposure, ensuring proper alignment and inclination for optimal energy capture.
    - Outcome: Establish a robust solar energy harvesting system as the primary power source for the irrigation system.
3. Inverter Integration:
    - Process: Integrate inverters to convert the generated direct current (DC) from solar panels into alternating current (AC) suitable for irrigation equipment.
    - Outcome: Enable seamless integration of solar-generated power into the irrigation system.

4. Energy Storage System Setup:
    - Process: Implement advanced battery technologies to store excess energy generated during peak sunlight hours.
    - Outcome: Ensure a continuous and reliable power supply during periods of low solar exposure or at night.
5. Sensor Deployment:
    - Process: Deploy sensors to monitor key environmental parameters, including soil moisture levels, temperature, and weather conditions.
    - Outcome: Collect real-time data to inform intelligent irrigation decisions based on specific crop needs and environmental conditions.
6. Data Analytics Implementation:
    - Process: Implement a data analytics system to process information collected by sensors, employing algorithms to analyze and optimize irrigation schedules.
    - Outcome: Maximize water efficiency, minimize wastage, and enhance overall crop yield through data-driven irrigation management.
7. Remote Monitoring and Control System:
    - Process: Develop a user-friendly interface for remote monitoring and control, allowing farmers to adjust irrigation schedules and receive real-time system status updates.
    - Outcome: Empower farmers with the ability to make informed decisions and optimize irrigation practices remotely.
8. Modular and Scalable Design Considerations:
    - Approach: Design the SIS with modularity and scalability, allowing for customization based on farm size, crop types, and water requirements.
    - Outcome: Provide flexibility for adaptation to diverse agricultural landscapes and varying irrigation needs.
9. Installation and Maintenance:
    - Process: Conduct professional installation of components, ensuring proper functioning and alignment.
    - Outcome: Establish a robust and well-maintained Solar Irrigation System for long-term efficiency.
10. Training and Support:
    - Approach: Provide training to farmers on system usage and maintenance.
    - Outcome: Enhance user capability for effective utilization

By following this comprehensive methodology, a Solar Irrigation System can effectively harness solar energy to optimize water usage, reduce environmental impact, and contribute to sustainable and efficient agricultural practices.

3.3 Block Diagram

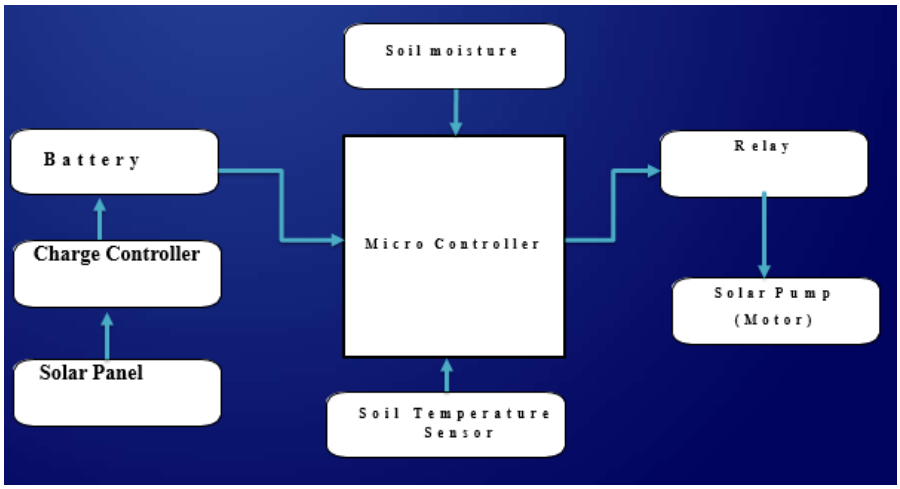

Fig 3.1: Block Diagram

3.4 Software configuration

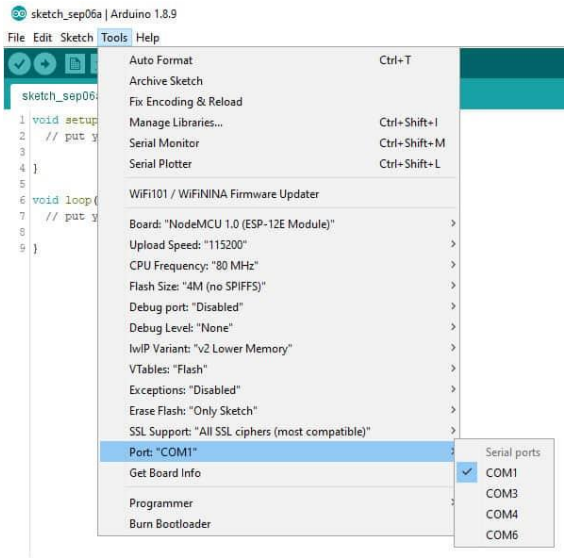

Fig 3.2: Software Configuration

Ref:(https://mp1993.de/mega-4808-and-optiboot-bootloader/)

3.5 Circuit Diagram

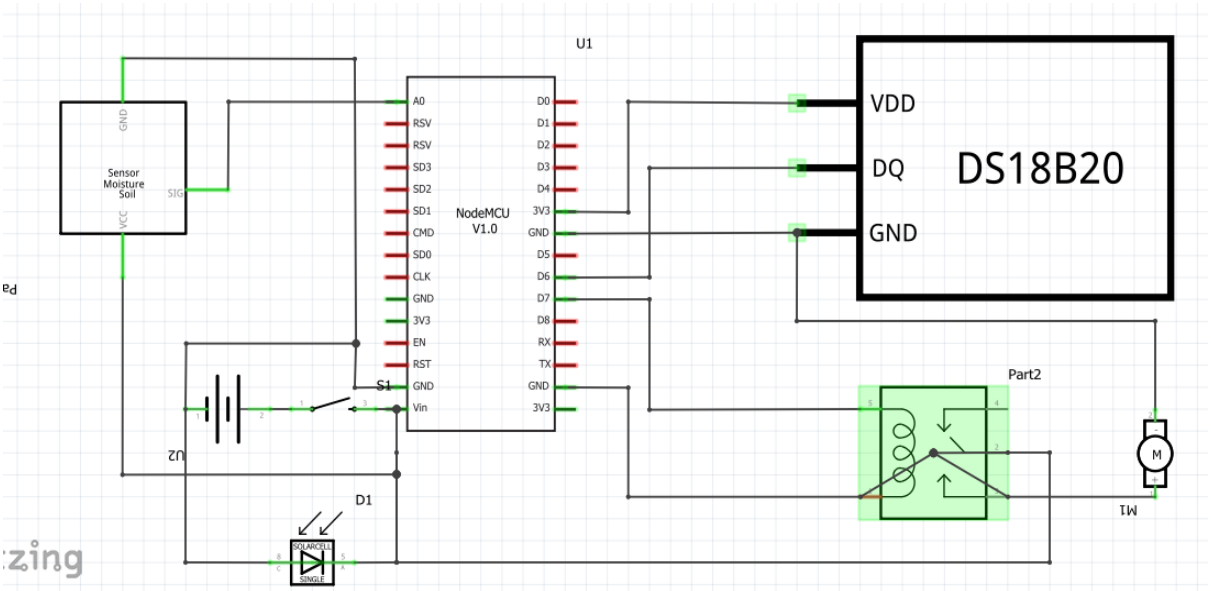

Fig: 3.3: circuit diagram

Ref:(https://link.springer.com/chapter/10.1007/978-3-030-05873-9_16)

In this project we use dampness sensor including amplifier circuit by which send a signal to Nodemcu as an input. One source used for power supply power to the Nodemcu and another supplies power to relay.

In this project is utilized two functional components. They are the engine/water pump and the dampness sensors. Following schematic chart associated with dampness sensor and engine driver with engine pump. The temperature dimension of dampness in the dirt measures by moisture sensor and on the off chance that watering is required, sends the signal to the Arduino. The plants until the point when the ideal dampness level is being come to by the motor/water siphon pump water.

3.6 Summarization

A circuit chart (electronic schematic, electrical outline, crucial design,) is a graphical portrayal of an electrical circuit. The introduction of the interconnections between circuit areas in the schematic chart does not using any and all means relate to the physical methodologies in the completed device. A pictorial circuit plot utilizes fundamental pictures of parts, while a schematic graph displays the segments and interconnections of the circuit utilizing managed emblematic delineations.

Chapter 04

Result

4.1 Introduction

In this section is discussed about results of works. We can see the flow chart the when the soil temperature has gone below then the pump only start the point and when the soil temperature has reach minimum to the point the pump will be stop. The system operate on using several possibilities and including power

4.2 Result

According to the circuit diagram the experimental model was made and the results were as prospective. When the OHT was about to go dry the motor pump switched ON and switched OFF when the OHT was about to overflow. We can see the figure 5.1 below this is based on the Arduino microcontroller and sensor technology. The system has been designed and tested successfully in a successful manner. Represents results of our experiment in the form of the overall representation of our tested automatic plant watering system. As it can be concluded from the picture below,

The system is also functionality, the overall behavior as well as of the plant, has been observed in the next 1 weeks as a results we have got expected and required results. As result of our observation we noticed that plant maintained its homeostasis in desired, without any deficiencies observed with Regular and health manner. When need the water the sensor sent a signal to microcontroller after that microcontroller sent a signal to the pump to until enough quantity of water was not delivered, Start watering the plant.

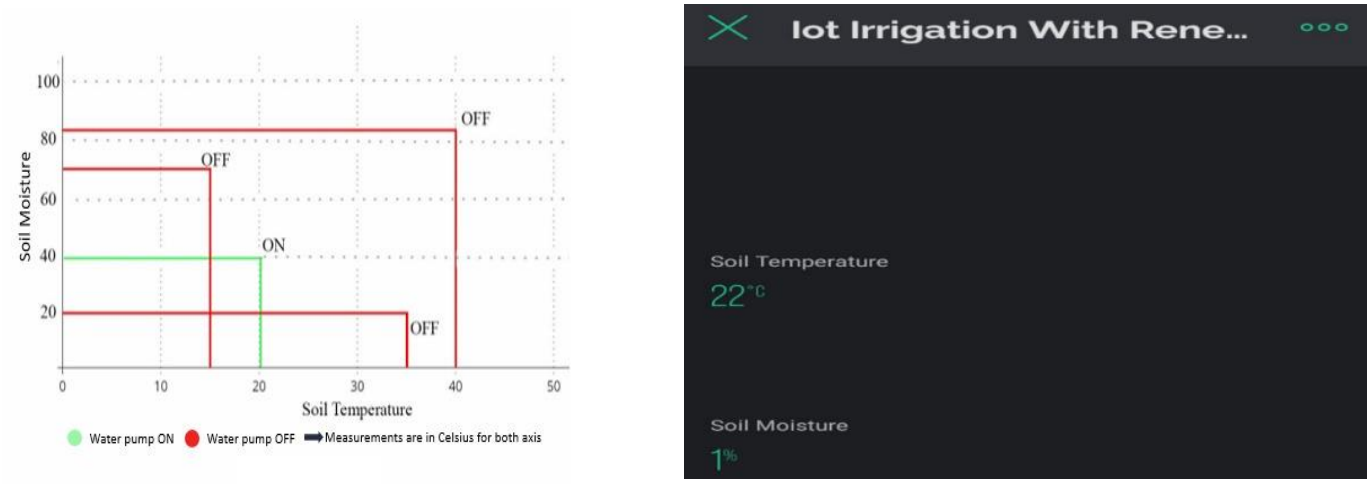

Fig 4.1: Output Result Graph and Mobile App Preview

Data Table for Result

SN	Soil (gm)	Water (ml)	Temperature (c)	Soil Moisture (%)
01	500	0	22	1
02	500	50	19	34
03	500	75	18	55
04	500	90	18	63
05	500	100	17	71

4.3 Project Prototype Image

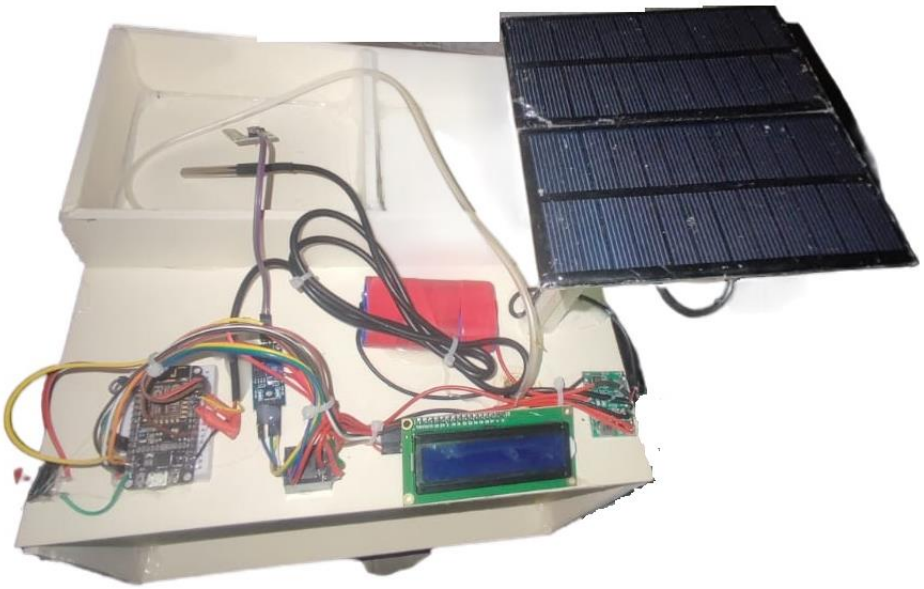

Fig 4.2: Project Outlook

Chapter 05

Discussion

5.1 Discussion

The adoption of Solar Irrigation Systems (SIS) represents a pivotal shift in agricultural practices, offering a sustainable and technologically advanced solution to address longstanding challenges. At its core, SIS leverages solar energy to power irrigation systems, providing a clean and renewable alternative to conventional energy sources. The system's reliance on solar panels, strategically positioned to capture sunlight, not only reduces operational costs but also aligns with global efforts to mitigate climate change. Incorporating smart irrigation technology with sensors and data analytics, SIS optimizes water usage by monitoring real-time environmental conditions, fostering water conservation and enhancing crop yields. The inclusion of energy storage systems ensures uninterrupted irrigation, overcoming the intermittent nature of solar energy production. The modularity and scalability of SIS cater to the diverse needs of farmers, allowing for customization based on farm size and requirements. Remote monitoring and control capabilities empower farmers to make informed decisions, improving operational efficiency. While the initial investment and environmental considerations warrant attention, the long-term benefits of reduced costs, enhanced productivity, and environmental sustainability position SIS as a transformative force in modern agriculture, aligning with the imperative for more resilient and eco-conscious farming practices.

5.2 Application

The application of Solar Irrigation Systems (SIS) spans a wide range of agricultural contexts, bringing about transformative benefits in resource efficiency, cost savings, and environmental sustainability. In regions grappling with water scarcity, particularly in arid and semi-arid areas, SIS becomes a critical tool for harnessing solar energy to power irrigation systems. These systems are invaluable in remote or off-grid locations where access to traditional energy sources is limited, providing a reliable and decentralized solution. Smallholder farmers, who often face financial constraints and rising energy costs, find SIS

to be a cost-effective alternative, enabling them to enhance productivity while minimizing operational expenses.

The modularity and scalability of SIS make it adaptable to various farm sizes and types of crops, allowing for customization based on specific agricultural needs. This versatility ensures that the technology can be effectively deployed in both large-scale commercial farming and small-scale subsistence agriculture. Additionally, SIS contributes to sustainable farming practices by incorporating smart irrigation technology. Through real-time monitoring of soil conditions, weather patterns, and crop water requirements, the system optimizes irrigation schedules, reducing water wastage and promoting efficient water use.

The environmental benefits of SIS are significant, as it reduces reliance on fossil fuels, minimizes greenhouse gas emissions, and aligns with global efforts to combat climate change. As a renewable energy solution, SIS not only addresses immediate agricultural challenges but also supports broader initiatives for creating resilient and environmentally conscious food production systems.

In summary, the application of Solar Irrigation Systems is multifaceted, providing a sustainable and accessible means of irrigation across diverse agricultural landscapes. By harnessing solar power, these systems contribute to increased farm productivity, reduced environmental impact, and improved livelihoods for farmers, making them a key player in the advancement of modern and sustainable agriculture. Extraordinary and expected aftereffects of our investigation were finished up from the way that our plant has effectively maintained a strategic distance from lack of hydration and continued developing with no issues. Furthermore, lacks, because of the sensor that is inserted inside the plant estimating the dirt dampness level and controlling the water siphon. The framework deals with the rule of estimating the dirt dampness level by methods for the sensor innovation which thus controls the water siphon by means of microcontroller with the end goal to give the plant enough measures of water when essential. Next couple of sections talk about the conceivable utilizations of this framework. Computerized plant watering framework can be utilized to understand numerous issues on the planet giving both restricted and wide applications and arrangements, where for the previous there is a case of robotized watering of plant at whatever point somebody takes some time off and disregards plants at home, which empowers the plants to get the correct measure of required water and counteracts

unpredictable watering which prompts mineral misfortune in the dirt; and for the last application, there is a case of utilizing this framework for restorative and rural purposes to take care of some greatest human-related issues like undernourishment, air contamination and event of respiratory illnesses. Being perfect for reasons for having huge patio nurseries, estates or explicit plants with possess watering needs, this framework can be extremely useful in agribusiness to keep vegetable plants watered for greater gather with negligible misfortune because of water vanishing and spillover.

5.3 Conclusion

Thus the "**Design and Implementation of Solar Energy Based Pumping Systems for Irrigation"** has been designed and tested successfully. The hardware components and of all integrated features has used to developed the system. All of the Presence of each module has been placed carefully and reasoned out, as the unit can contribute for best working. Thus, Watering System of the Arduino Based Automatic Plant as designed and tested successfully. Automatically tested the function of this system. The moisture level (water content) of the different plants measured by the moisture sensors. The moisture sensor sends the signal to the Arduino board when the moisture level is found to be below the desired level, and triggers the Water Pump to turn ON and supply the water to respective plant using the Rotating Platform/Sprinkler. At the point when the coveted dampness level is achieved, the framework ends without anyone else and the Water Pump is killed. Consequently, the usefulness of the whole framework has been tried altogether and it is said to work effectively.

REFERENCES

[1] Pruburaj, L., 2018. Role of agriculture in the economic development of a country. Shanlax International Journal of Commerce, 6(3), pp.1-5.

[2] Satyanarayana, A., Thiyagarajan, T.M. and Uphoff, N., 2007. Opportunities for water saving with higher yield from the system of rice intensification. Irrigation Science, 25(2), pp.99-115.

[3] Huang Y, Lan Y, Thomson SJ, Fang A, Hoffmann WC, Lacey RE. Development of soft computing and applications in agricultural and biological engineering. Computers and electronics in agriculture. 2010 May 1;71(2):107-27.

[4] Kamilaris A, Kartakoullis A, Prenafeta-Boldú FX. A review on the practice of big data analysis in agriculture. Computers and Electronics in Agriculture. 2017 Dec 1;143:23-37.

[5] TongKe, F., 2013. Smart agriculture based on cloud computing and IOT. Journal of Convergence Information Technology, 8(2), pp.210-216.

[6] Kansara, K., Zaveri, V., Shah, S., Delwadkar, S. and Jani, K., 2015. Sensor based automated irrigation system with IOT: A technical review. International Journal of Computer Science and Information Technologies, 6(6), pp.5331-5333.

[7] IACSIT, V.D.K., Akhouri, A., Kumar, C., Rishabh, R. and Bagla, R., 2013. A Real time implementation of a GSM based Automated Irrigation Control System using Drip Irrigation Methology. International Journal of Scientific & Engineering Research, 4(5).

[8] Suresh, R., Gopinath, S., Govindaraju, K., Devika, T. and Vanitha, N.S., 2014. GSM based automated irrigation control using raingun irrigation system. International Journal of Advanced Research in Computer and Communication Engineering, 3(2), pp.5654-5657.

[9] Gutiérrez, J., Villa-Medina, J.F., Nieto-Garibay, A. and Porta-Gándara, M.Á., 2013. Automated irrigation system using a wireless sensor network and GPRS module. IEEE transactions on instrumentation and measurement, 63(1), pp.166-176.

[10] Saraf, S.B. and Gawali, D.H., 2017, May. IoT based smart irrigation monitoring and controlling system. In 2017 2nd IEEE International Conference on Recent Trends in Electronics, Information & Communication Technology (RTEICT) (pp. 815-819). IEEE.

[11] Divani, D., Patil, P. and Punjabi, S.K., 2016, April. Automated plant Watering system. In 2016 International Conference on Computation of Power, Energy Information and Commuincation (ICCPEIC) (pp. 180-182). IEEE.

[12] Kruthika, K., Kumar, B.K. and Lakshminarayanan, S., 2016, October. Design and development of a robotic arm. In 2016 International Conference on Circuits, Controls, Communications and Computing (I4C) (pp. 1-4). IEEE.

[13] Meghana, M., Kumar, K., Verma, R. and Kiran, D., 2019, October. Design and Development of Real-Time Water Quality Monitoring System. In 2019 Global Conference for Advancement in Technology (GCAT) (pp. 1-6). IEEE.

[14] Jain, A., Balaji, V., Rohitha, R. and Kumar, K., 2019, August. Design and Development of Solar Powered Automatic Grain Dryer for Storage. In 2019 IEEE International Conference on Distributed Computing, VLSI, Electrical Circuits and Robotics (DISCOVER) (pp. 1-5). IEEE.

[15] Kiran Kumar B M, M S Indira, S NagarajaRaoPranupa S., 2020, Design and Development of Three DoF Solar Powered Smart Spraying Agricultural Robot. Test Engineering and Management, 83, pp. 5235-5242

APPENDIX

```
#define BLYNK_PRINT Serial
#include <SPI.h>
#include <ESP8266WiFi.h>
#include <BlynkSimpleEsp8266.h>
#include <OneWire.h>
#include <DallasTemperature.h>
#include<LiquidCrystal_I2C.h>
#define ONE_WIRE_BUS D2
LiquidCrystal_I2C lcd(0x27, 16, 2);
OneWire oneWire(ONE_WIRE_BUS);
DallasTemperature sensors(&oneWire);
char auth[] ="WlN2cekOLZOYUZQJq5koFGhC3VXA2_Tu";
char ssid[] = "iot";
char pass[] = "iot12345";
#define pump D7
BlynkTimer timer;


void setup()
{
   lcd.begin();
 lcd.backlight();


 pinMode(pump,OUTPUT);
 Serial.begin(115200);
  Blynk.begin(auth, ssid, pass, "blynk.cloud", 80);
```

```
  sensors.begin();
}
int sensor=0;
void sendTemps()
{
sensor=analogRead(A0);
int outputvalue=map(sensor,0,1023,0,100);
lcd.setCursor(0, 0);
   lcd.print("SM: ");
    lcd.print(outputvalue);



sensors.requestTemperatures();
float temp = (sensors.getTempCByIndex(0));
Serial.println(temp);
Serial.println(outputvalue);
lcd.setCursor(0, 1);
   lcd.print("ST: ");
    lcd.print(temp);

    if(outputvalue>70 && temp<40)
{digitalWrite(pump,HIGH);}
else{digitalWrite(pump,LOW);}

Blynk.virtualWrite(V0, temp);
```

```
Blynk.virtualWrite(V1,outputvalue);
delay(1000);
}
void loop()
{
Blynk.run();
timer.run();
sendTemps();
}-
```