

AUTOMATIC SOLAR SUBMERSIBLE PUMP CONTROL FOR IRRIGATION USING IOT

Submitted in partial fulfillment of the requirements for the award of
Bachelor of Engineering degree in Computer Science and Engineering

By

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SCHOOL OF COMPUTING**

SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY

(DEEMED TO BE UNIVERSITY)

CATEGORY -1 UNIVERSITY BY UGC

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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the Bonafide work of **PATHI VENKATESWARLU (40110919)** and **PYDI NITISH KUMAR (40111013)** who carried out the project entitled "**AUTOMATIC SOLAR SUBMERSIBLE PUMP CONTROL FOR IRRIGATION USING IOT**" under my supervision from November 2023 to April 2024.


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I, **PYDI NITISH KUMAR (40111013)** hereby declare that the Project Report entitled **AUTOMATIC SOLAR SUBMERSIBLE PUMP CONTROL FOR IRRIGATION USING IOT** done by me under the guidance of **Ms. R. ANANDHA SREE, M.E.** is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering degree in **Computer Science and Engineering**.

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ABSTRACT

The Internet of Things (IoT) and automation are pivotal in the evolution of both engineering and non-engineering companies. As a standard in today's market, internet connectivity is embedded into products, not as an extra feature but as an integral component. Our team is dedicated to agricultural automation, integrating IoT to facilitate remote control and monitoring of irrigation processes. This is especially beneficial for remote farms lacking access to the electric grid, as the system utilizes solar energy, converting it into electrical power through photovoltaic panels and storing it in batteries for subsequent use. It also includes a solar tracking system to maximize efficiency from sunlight.

Our project is structured around the conversion of sunlight to electrical power by the photovoltaic panel, which then powers the charging circuit to charge the system's battery. A regulator ensures the output voltage remains at a steady 5 volts, suitable for the system's requirements, while a power analyzer monitors and reports the power transfer to the Arduino controller. The solar tracking system, guided by light-dependent resistors, directs the solar cell towards the maximum sunlight, aided by a motor. The irrigation system's sensor measures soil moisture and relays the data to the controller, which commands the water pump accordingly. Communication between the user and the system is enabled through the IoT cloud on a WIFI network. The mobile application enhances user experience by displaying cell voltage, harvested power, and soil moisture levels on dedicated gauges. It also allows users to set desired soil moisture levels and control the water pump through an intuitive interface, ensuring the system's ease of use and accessibility for managing irrigation from any location.

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CHAPTER1

INTRODUCTION

As we know that Indian economy is one of the largest developing economies of the world. The agricultural sector has its largest contribution in the Indian economy. To achieve maximum utilization of man power and to obtain maximum profit in a given stipulated time there is a need in the up gradation of various engineering techniques that are being used today. Thus maintaining proper amount of water level in the soil is one of the necessary requirements to harvest a good crop that can be a source of various types of nutrients whether micro or macro for their proper growth. If we talk about Indian farmers, they are worst hit by the famines that occurs due to failure of crops depending upon various drought factors. Rain plays the key role in deciding the future of these crops as well as the farmers every year. The over utilization of ground water has drastically reduced the ground water level in the last 15 years

So it is the need of hour to utilise each and every drop of water wisely so that it can also be used by our coming generations also. Also we should develop some new methods that use the renewable sources of energy. The development of these new techniques are going to reach our goal of sustainable development as well as to cut off the emission of greenhouse gases to a minimum level. As the name of our project that is automation irrigation system with the help of the Solar power is a step to utilise some new engineering techniques. This technique will be a very good option for the small and medium farmers who suffer every year just because of failure of crops that took place every year. The implementation of this technology has a wide scope in the nearby future.

1.1 OBJECTIVE

The main objective of this project was to design a small scale irrigated system that would use water in more well-organized way in order to prevent excess water loss and minimize the cost of labour. The following aspects were considered in the choice of design solution

- Installation cost Water saving

- Human intervention
- Reliability
- Power consumption
- Maintenance
- Expandability

CHAPTER 2 LITERATURE SURVEY

In this chapter, we will show a thorough knowledge of the project and provide resources to support our study focus. The goal of this chapter is to delineate various theoretical positions. From these resources we develop a conceptual framework for generation of hypotheses and preparing the research question.

2.1 HISTORICAL BACKGROUND

Adoption of internet of Things (IoT) has increased noticeably in every aspect of our life. From connected devices, health-care and fitness, home-automation, and logistics, to smart cities and industrial or agricultural sector, IoT is a must. Farming has faced a variety of technological transformations within last decades, and it has become industrialized or technology-driven. By utilizing several smart agriculture tools, farmers have gained a control over methods of raising livestock and growing crops, making farming-process more predictable and efficient. Because of the growing demands of consumers for agriculture produce, there has been a pressure on agricultural companies to adopt and increase proliferation of smart farming technologies worldwide. In 2020, the market share for IoT in agriculture reached \$5.6 billion.

- **The Benefits of smart farming**
- Better control over the internal processes and, as a result, lower production risks
- Cost management and waste reduction thanks to the increased control over the production.
- Increased business efficiency through process automation.
- Enhanced product quality and volumes.

2.2 IoT Based Smart Agriculture

Farming is one in every of the most significant sections of the Indian economy where 18% of its's Gross Domestic Product (GDP) is relying on farming and is accountable in providing employment to 1/2 the nation's personnel. In fact, productivity in agriculture sector suggests that India is a productive Asian country. As a result,

plays a main role in order to reach that level agricultural productivity. Therefore, smart agriculture could be an innovative solution within the agricultural business that helps to guide actions needed to change the situation. There is a mass need for reorienting agricultural systems in order to effectively support needs and guarantee food security throughout a dynamical climate. Agriculture policy of 2014/2020 has given new objectives. The first goal of this policy is minimizing usage of artificial manure in farming and learning what is efficient for agricultural vitality, and this may be achieved by implementing IoT tools in agriculture sector. Authors of this research were able to get completely different characteristics of applying IoT in agriculture such as reducing labor-price, obtaining details of the state of the soil, preserving amounts of water, and keeping the temperature of the greenhouses suitable for agriculture. Thus, by getting the advantages of implementing IoT tools on farming users will be impressed after considering non-presence of solid or entrenched and complete answer-system during this field. Authors had a tendency to propose beneficial agricultural system. It will play a role as a deeply labile on-line stage for empowering massive scale data handling, programmed thinking relying on progress of streams of knowledge returning from sensors and controlled processors.

2.2.1 The Architecture Design

One way to cope with the agricultural troubles or its growth of complication and quantity of agricultural production is by using of smart sensors to make smart farms and these sensors will lead in the end to precision agriculture. Authors made the module that senses humidity, temperature, and moisture of soil, rain frequency and light-intensity. Through a graphical user interface, it indicates to the farmer what is the best seed for the farm. The architecture of their design includes sensors like humidity, moisture and temperature sensors, a Wi-Fi module. The software program includes an IoT platform that incorporates installation of the profile for irrigation, based on seasons, on day by day, or weekly mode. The software sends notification that is called Main Module to switch on/off controllers. Sensors sense physical parameters and convert the analog input to digital output. Humidity and temperature sensors are applied to anticipate humidity and temperature respectively on agricultural field where soil moisture sensor

immersed inside the soil has the capacitive feature to read analog inputs, and is used to value the moisture level of the soil. Furthermore, module was combined for obtaining records in real time from the sensors. This serial and real-time data is then transmitted to the IoT gateway that transmits the facts to the IoT platform (Cloud) by the most important component in this part, which is Wi-Fi modem. The cloud within the device has a database that will maintain the data received from the IoT gateway. Composed data are analyzed by applying Decision Trees as described by Jun Wu, Anastasiya Olesnikova, and Chi-Hwa Song on their research The Development and Application of Decision Tree for Agricultural Data.

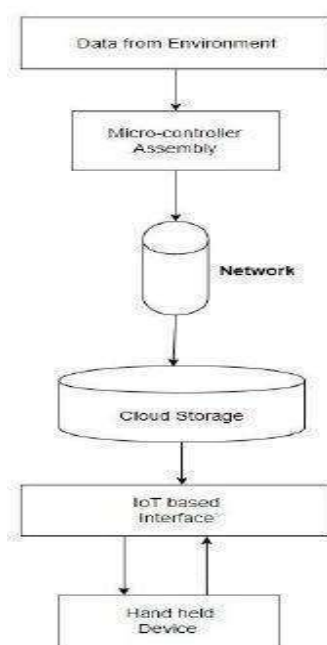


Figure 2.1: Diagram of IoT based Smart Agriculture system

2.2.2 Data from Environment

The moisture from the soil is detected by FC-28 soil moisture sensor and moisture level of the soil will be measured in percent where humidity and temperature are detected by DHT11 sensor in percentage and Celsius degree respectively. The light-intensity is measured by LM393 sensor in candela, and rain frequency is detected by FC-37 sensor in millimeters.[6]

2.2.3 Micro-controller assembly

Figure 2.2 is diagram of microcontroller assembly in the proposed design, this microcontroller is the hardware part of the model. It controls the information acquisition through sensors. Microcontroller process is to connect with cloud storage and has an embedded Wi-Fi modem that has the Wi-Fi range as much as three hundred meters. This range helps propagating data via system network.

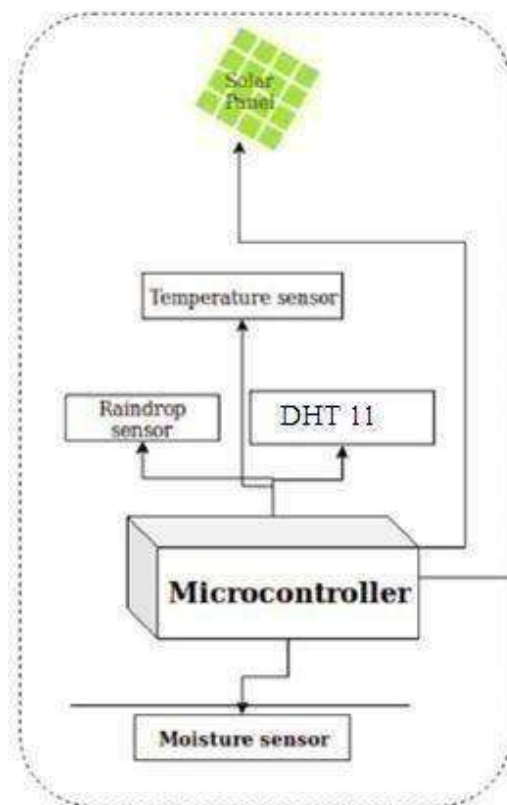


Figure 2.2: Microcontroller Assembly

A. ny light-emitting diode) or OLED (Organic-Light-Emitting Diode) to display data records. [6]Network and Cloud storage

Network plays a pivotal role for propagating data to storage of the cloud. It analyzes and performs calculations with sensor data records that is acquired in the shape of raw data and shows it on the IoT graphical user interface.

Communication among hardware components to the cloud is set up in two ways, either it is able to be through MQTT agents using the MQTT protocol, or via HTTP module utilizing the HTTP protocol. MQTT is preferred over HTTP, as it is message driven and HTTP is document pushed, so MQTT can be more trustworthy.

A. IoT based interface

IoT combination is involved with API or Application Programming Interface. APIs communicates with each IoT component by using logical connectors. APIs show data that allow those devices to transmit facts to application interface and it acts as an information interface. Also, they also allow application interface to control device and act as a function interface.[6]

B. Hand held Device

The monitoring of serial data may be finished in web based or phone application. In fact, data acquired from the sensor are displayed in these phone applications that play the role of user interface. These phone Apps are operated in portable device like mobile phones that has the feature of LCD (Liquid Crystal Display using ti

2.3 Remote Water Pump Controller for Agriculture Using GSM

India is an agriculture-orientated country. Nowadays farmers are dealing with problems related to irrigation of land. The reason behind this is that it is related to either dearth of energy supply or not be able to get the required supply on-time. Actually, the required power from the 3-phase substation that is needed to run the system is usually delivered to run the irrigation motor at night time in many villages where it is very infrequently to have energy at day time. As a result, a person has to visit the site of system and turn on generator supply. Keeping this in mind, authors came up with the idea called "Remote Water Pump Controller for Agriculture Using GSM". This can be used to remotely turn the motor on/off. [7]

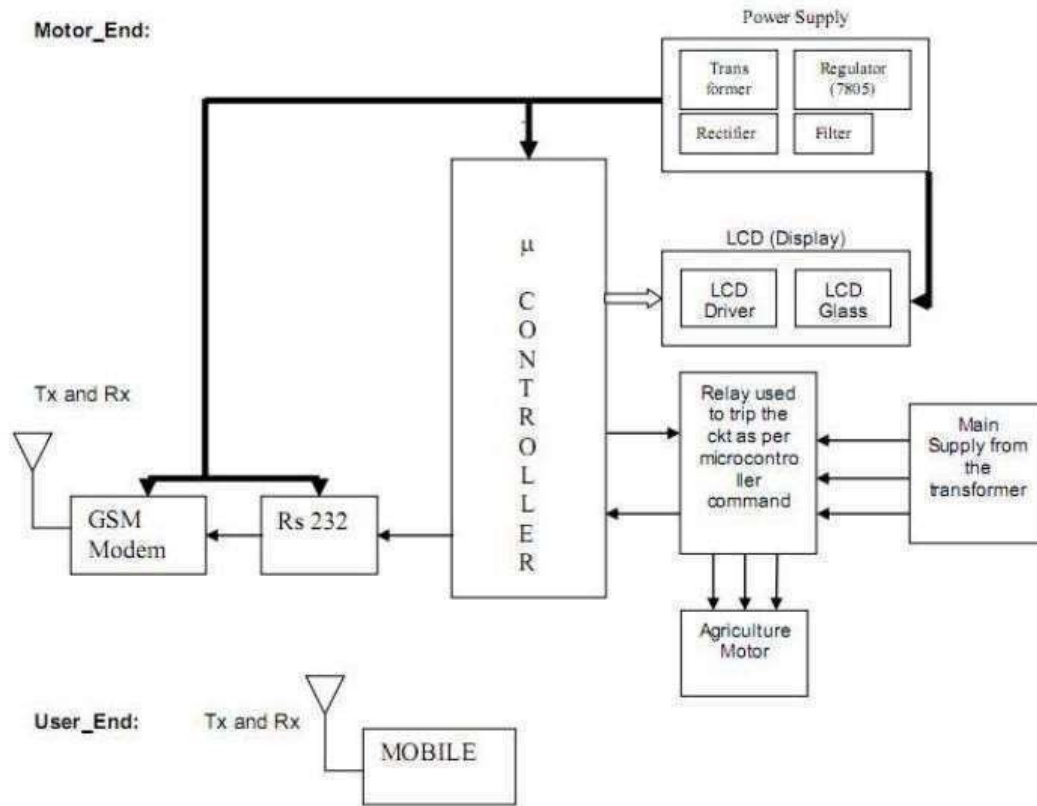


Figure 2.3: The block diagram of the Automated Irrigation System.[7]

2.4 Smart Farming System Android APP

Internet of Things (IoT) leads to an era that will drastically change industrial or agricultural sector and pass towards higher efficiency. Agriculture is an important source of income for many countries like for example India. Consequently, there is an insisting need to enter the world of internet of things. In fact, authors modeled smart farming system in order to increase production of plants. Their system specializes in 3 major parts, and they are sensors, microcontrollers and machineries. In this paper, authors focused more on control part such as watering and shooting pictures based totally on statistical information gathered from sensor system together with temperature, humidity moisture, and light intensity sensors. Sensed data aresometimes not correct due to some external noises, so authors apply Kalman filtering to precisely gather information before using an input in finding control range of error. For decision-making, authors do not only take into

consideration sensed data but also they additionally consider the weather condition. Decision tree model is generated to forecast weather circumstance. Then, a decision will be made based on information records of weather condition. Actually, this step is developed automatically to let the system whether or not watering and light system to be on or off. Authors also provide a feature to manually control the watering and light system through mobile application [8]

2.4.1 Architecture Design

In Figure 2.4, shows the proposed device architecture where user can login with mobileApp if the user has an existing account. In any other case, user will do registration and login into phone App. Then, this App will use mobile digital camera to capture the image on business card, and the data from the digital camera is given to the text detection module and translates the original photo that applies methods that are discussed in and to detect regions of interest in a photo [8]

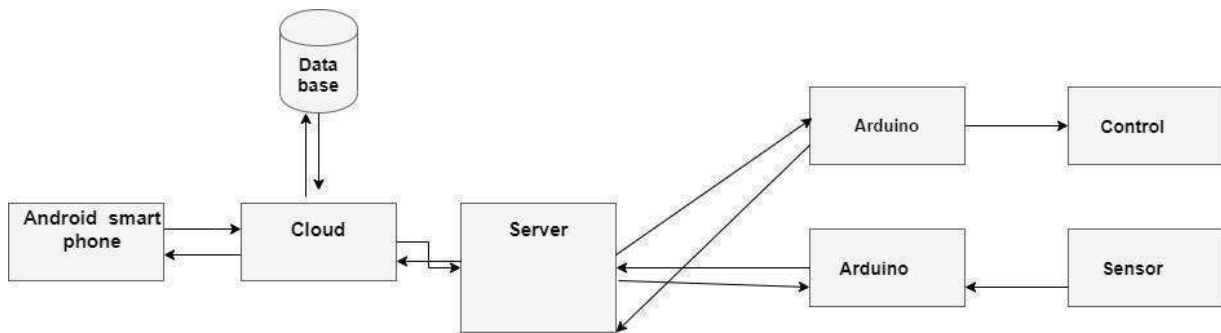


Figure 2.4: Smart Farming System Android APP architecture. [8]

2.4.2 Internet of things (IoT)

Internet of things is a machine of interrelated or a tissue of computing devices, mechanical and digital machines that are provided with unique identifiers (UIDs). And, IoT provides a potential to transfer data over a system without requiring human-to-human or human- to-computer communication or interaction. Actually, it is an ecosystem that consists of web- enabled smart devices, which use embedded systems

like processors, sensors and hardware to collect, send, and act on data they acquire from their environments. IoT-based devices proportion sensed data they gather by connecting to an IoT gateway where serial data is either sent to the cloud to be analyzed or analyzed locally. Sometimes, those smart devices communicate with other related devices and act on collected data they get from one another. In fact, smart devices do most of the work without human intervention, even though human beings can interact with these devices to set them up, give them instructions or get an access to the data.[9]

Connectivity, networking and verbal exchange protocols used with these web-enabled devices largely depend upon the unique IoT applications deployed. Also, IoT can be part of artificial intelligence (AI) to let the system more dynamic.[9]

CHAPTER 3

AIM AND SCOPE OF THE PROJECT

3.1 OBJECTIVE

The idea of this project is to model, design, and implement a hardware and software based on Arduino microcontroller in order to harvest the solar energy and properly store it in a rechargeable battery, which will be used later to energize the irrigation process in faraway farms. The system has an internet connectivity that will allow the user to monitor the harvested energy from the sun using the solar cells, and also to control the irrigation process in two modes: automatically where the irrigation will be started automatically on low soil moisture levels from real-time feedback, or manually where the user can start or stop the irrigation from the mobile app based on user's preferences. This will be available for the user using a smart application installed on his mobile phone that can be run on mobile operating systems like iOS or android, from any place on the earth as long as there is Internet connection.

The motivation of choosing this project is to achieve a system that will handle the irrigation process and make it very easy for users, regardless of their agricultural knowledge.

The user can use his mobile application to monitor the following values:

- Real time soil moisture level.
- Real time cell voltage.
- Real time transferred power from cell to system battery.

Also the user can control the following aspects in the system:

- Water pump on/off.

- Operation mode by setting the system in automatic mode to start and stop the irrigation automatically depending on the soil moisture or manual mode to wait for user commands to start or stop irrigation process.

3.2 SCOPE

Contributions of renewable energy to remote control are currently considered as key factors in the standard of progress of societies in terms of reducing sources of energy polluting environment and increasing technological advancement of human control. And, these contributions in the world of energy are equally pleased societies as emergence of recent developments. Renewable energy prices have fallen considerably over the past years, especially wind and solar energy, and it is expected to become the world's largest source of new power generation capacity - 700 GW in the next five years. In fact, the IEA (International Energy Agency) does not anticipate the fall of oil prices to affect renewable energy growth. Also, it expects electricity sector to continue to lead the transformation of global energy, and it estimates that the proportion of electricity generation from modern renewable energy (including hydropower) will increase from 22 percent in 2013 to 26 percent in 2020. Despite of significant reduction in the cost of solar and wind power over the past decade, essential innovations on energy storage should be pushed to increase supply invariability, increase the efficiency of utility operation, and improve the market segments to increase the spread of renewable energy in unified networks.

CHAPTER 4

REQUIREMENT ANALYSIS

4.1 FEASIBILITY STUDIES/RISK ANALYSIS OF THE PROJECT

Here in this project an experimental scale within rural areas where there is an enormous disposition of irrigation system which is executed using arm controller and wireless communication. The main of this implementation was to demonstrate that the automatic irrigation system can be used to optimize /reduce water usage. It can also be a photovoltaic irrigation system which consists of a solar powered that is the soil moisture sensor and temperature sensor placed under the soil where plants roots are reached which is a distributed network. The system has a water level sensor which will indicate the presence of water level in tank. A software application was advanced by programming the verge values of soil moisture water level that was automated into a microcontroller.

4.2 SYSTEM REQUIREMENTS

4.2.1 HARDWARE REQUIREMENTS

- Solar panel
- DC-DC converter
- Battery
- Filter circuit
- Soil moisture sensor
- LDR sensor
- Water level sensor
- Node MCU
- Wi-Fi Module
- PC
- L293D Driver Board
- Water Motor

4.2.2 SOFTWARE REQUIREMENTS

- Arduino IDE
- Embedded C
- Java

4.3 RESEARCH DESIGN

Our design is outlined in several blocks. The first block is solar tracking and sensing, and the second one is Wi-Fi interfacing. Then, there is solar power monitoring and battery charging. After that soil moisture monitoring and pump controlling. The following are components of our project.

4.3.1 ARDUINO UNO

Arduino is the leading open-source hardware and software brand that offers a range of software tools, hardware platforms and documentation. It enables almost its users to be creative by steps of easy-to-follow kind. Arduino is a popular tool for developing IoT-based prototypes as well as one of the most successful tools for STEM (science, technology, engineering and math) /STEAM(science, technology, engineering, arts and math) education systems. Hundreds of thousands of designers, engineers, students, developers and makers around the world are using Arduino to innovate in music, games, toys, smart homes, farming, autonomous vehicles, and more. It is set up to build a community that could help spreading uses of its tools and benefit from contributions from hundreds of people who help by debugging the code, writing examples, creating tutorials, supporting other users on the forums and build thousands of groups around the globe. Arduino has several features that are Microcontroller Microchip ATmega328P, Operating Voltage 5V, Flash Memory 32 KB, SRAM 2 KB, EEPROM 1 KB, and Clock Speed 16 MHz



Figure 4.1: The Arduino UNO.

4.3.2 SOLAR CELL

Solar panels have been on the market for many years, and there are several way using sun's power. Historically, most people generally used to have a black container that they fill with water and leave it under the sun to have a hot water. In fact, this is a cheap way of using solar power and is replicated in more sophisticated installations for houses. However, solar power from photovoltaic (PV) panels probably plays a more important role in our lives. For example, sun's energy is converted into electricity, and by this way it can be stored in a leisure battery and released again when we turn on an appliance [11]. Solar Cell has several features that are Maximum Power (P_{max}):4 Wp, Voltage at Maximum Power (V_{mpp}):8.79 V, Current at Maximum Power (I_{mpp}):0.46 A, Open Circuit Voltage (V_{oc}):10.19 V, and Short Circuit Current (I_{sc}):0.49 A



Figure 4.2: The solar cell.

4.3.3 ESP8266

ESP8266 is a highly integrated chip designed for the needs of a new connected world and offers a complete and self-contained Wi-Fi networking solution, allowing it to either host the application or to offload all Wi-Fi networking functions from another application processor. ESP8266 has several features that are Built-in Micro-USB (with flash and reset switches, easy to program), Full I/O port and Wireless 802.11 supported (direct download no need to reset), and Arduino compatible (works great with the latest Arduino IDE/Mongoose IoT/Micropython)

Figure 4.3: The ESP8266.



4.3.4 Boost converter MT3608

MT3608 has a constant frequency, 6-pin SOT23 current mode step-up converter intended for small and low power applications. MT3608 switches at 1.2MHz and allows the use of tiny and low-cost capacitors and inductors 2mm or less in height. It has several features like automatic shifting to pulse frequency modulation mode at light loads, and it includes under-voltage lockout, current limiting, and thermal overload protection to prevent damage in the event of an output overload [14]. It also has other features like Input voltage: 2V - 24V, Output voltage: 5V - 28V, Output current: max. 2A, and Efficiency: > 93%

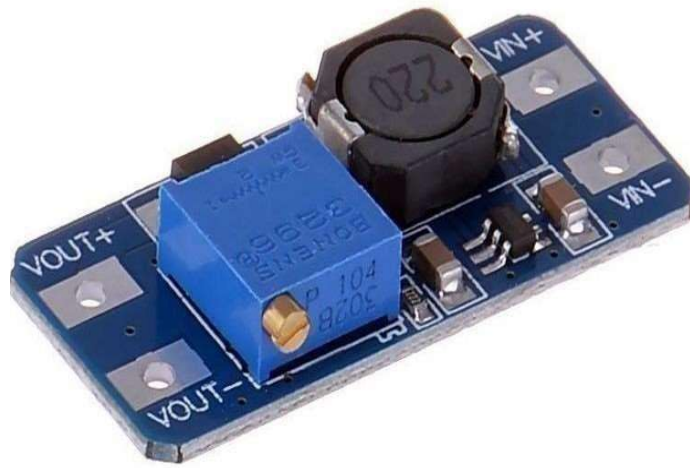


Figure 4.4: The boost converter MT3608

4.3.5 Lithium battery 18650

18650 Cell is a Li-ion type battery that is applied in many fields. For example, it is found on portable electronics like torch lights and electric vehicles/Cars like Tesla and much more. The main reason for this battery to be successful is its properties compared to other brands. These properties include current carrying capability, voltage, cycle life, storage life, safety, and operating temperature and much more. Also, it has Nominal Voltage: 3.7V, Nominal Capacity: 2,850 mAh, Minimum Discharge Voltage: 3V, Maximum Discharge current: 1C, Charging Voltage: 4.2V (maximum), and Charging current: 0.5C



Figure 4.5: The Lithium battery 18650.

4.3.6 Buck converter lm2596

LM2596 series of regulators are monolithic integrated circuits that provide all the active functions for a step-down (buck) switching regulator, capable of driving a 3-A load with excellent line and load regulation. These devices are available in fixed output voltages of 3.3 V, 5 V, 12 V, and an adjustable output version. Requiring a minimum number of external components, these regulators are simple to use and include internal frequency compensation, and a fixed frequency oscillator. LM2596 series operates at a switching frequency of 150 kHz, thus allowing smaller sized filter components than what would be required with lower frequency switching regulators. So, it has 3.3-V, 5-V, 12-V, and adjustable output versions. And other features like it is available in TO-220 and TO-263 packages, 3-A output load current, and input voltage range up to 40 V



Figure 4.6: The buck converter lm2596

4.3.7 Soil humidity sensor

This soil humidity detection component is equipped with potentiometer and soil moisture thresholds. It can automatically measure volumetric water content in soil. In fact, direct gravimetric measurement of free soil moisture requires removing, drying, and weighing of a sample, soil moisture sensors measure the volumetric water content indirectly by using some other property of the soil, such as electrical resistance, dielectric constant, or interaction with neutrons, as a proxy for the moisture content. It has several features like VCC: External 3.3 V to 5 V, GND: External GND, DO: Digital output interface (0 and 1), and AO: Analog output interface (this interface is generally not do application)

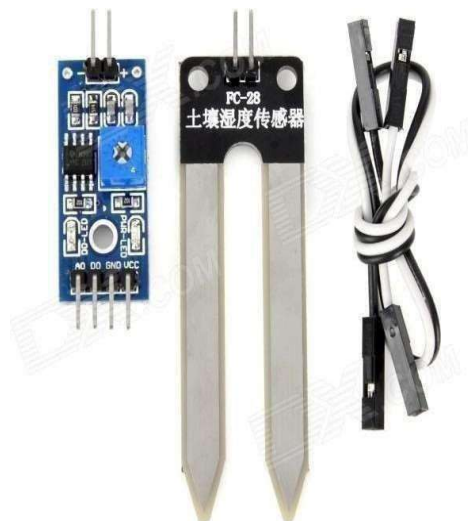


Figure 4.7: The soil humidity sensor

4.3.8 IRF520 MOSFET

In a field-effect transistor (FET), the width of a conducting channel in a semiconductor and, therefore, its current-carrying capability, is varied by the application of an electric field (thus, the name field-effect transistor). As such, a FET is a “voltage-controlled” device. The most widely used FETs are Metal-Oxide-Semiconductor FETs (or MOSFET) [22]. But, IRF520 MOSFET module is designed to switch heavy DC loads from a single digital pin of the microcontroller, and its main purpose is to provide a low-cost way. Actually, screw terminals are provided to interface to your load and external power source. An LED indicator provides a visual indication of when your load is being switched. It has several features that are Voltage: 3.3V, 5V, Ports: Digital Level, Output load voltage: 0-24V, Output load current: <5A (1A above need to add heatsink), Platform: Arduino, MCU, ARM, raspberry pie, Using original IRF520 Power MOS output PWM can be adjusted and driven up to 24V that allows the load such as LED lights, DC motors, miniature pumps, solenoid valves PWM dimming LED can be used to achieve stepless dimming, variable speed motor.

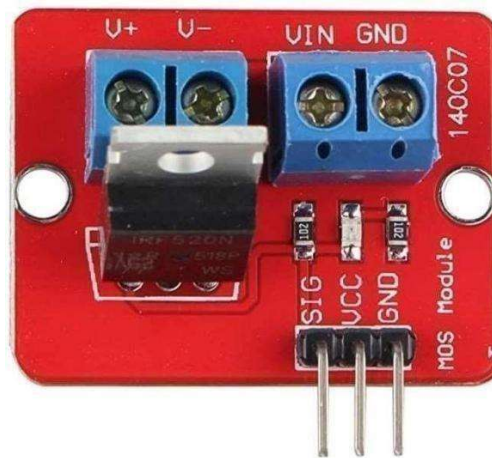


Figure 4.8: IRF520 MOSFET

4.3.9 Light Dependent Resistor (LDR)

Two cadmium sulphide (cds) photoconductive cells with spectral responses similar to that of the human eye. The cell resistance falls with increasing light intensity [24]. It is a highly used component especially for tracking light systems, and features such as Maximum voltage: 150 Volt DC, Spectral peak: 540 nm, Maximum wattage: 100 mW, Light resistance (10 Lux): 50-100 Kohm, and Operating temperature: - 30 ~ + 70 degree Celsius



Figure 4.9: The LDR

4.3.10 Charge Controller

Lithium battery protection board is used to protect the battery to prevent the battery from being over-discharged or over-charged during use and resulting to battery damage [26]. It has features like Voltage: 7.4 V/ 8.4 V, and Working current: 3 A [27].



Figure 4.10: The charge controller.

4.3.11 Power analyzer INA219

INA219 is a current shunt and power monitor with an I2C- or SMBUS-compatible interface. It monitors both shunt voltage-drop and bus supply voltage, with programmable conversion times and filtering. A programmable calibration value, combined with an internal multiplier, enables direct readouts of current in amperes. It has features like Senses Bus Voltages from 0 to 26 V, Reports Current, Voltage, and Power, 16 Programmable Addresses, and High Accuracy: 0.5% (Maximum) Over Temperature (INA219B) [28].

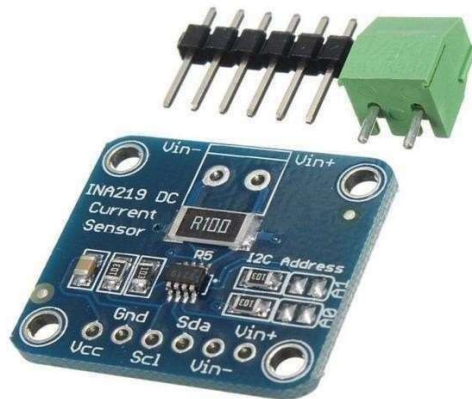


Figure 4.11: INA219 power analyzer.

4.3.12 Water Pump

This automated water-pump has become extremely popular since it automatically waters plants according to the monitored soil moisture in a very efficient way [31]. It has several features like Voltage range (V): DC 2.5-6V, Rated voltage: DC 3V or 4.5V, No load of water discharge capacity: 100L / H, and Load rated current: 0.18A [30].



Figure 4.12: The water pump.

4.3.13 Servo Motor

This metal gear servo has a torque of as large as 13.5KG. It rotates from 0-180 degrees. You can control its gear to rotate to a certain degree by program. The connection cable is 30cm long; the orange wire is the signal wire, brown, the ground, and red, the power. The servo works under the voltage of 4.8~6V. [32]



Figure 4.13: The servo motor.

CHAPTER 5

DESCRIPTION OF PROPOSED SYSTEM

5.1 EXISTING SYSTEM

System is making an irrigation automatic and also giving an option to control it manually via GSM (Phones) from anywhere. Data transmission takes place via XBEE which transmits signals as the characters through small chip. Limitation is that the communication can be established with the user and system is via GSM or XBEE. XBEE is not suitable for long range and GSM is not worked for only signal available areas.

5.2 Proposed System

Sensor data acquisition: The sensor is interface with Node MCU such as Soil moisture, LDR and water level sensor is used. **Wireless data transmission:** The data acquired from sensors are transmitted to the web server using wireless transmission (WIFI module ESP8266). **Data processing and Decision making:** The data processing is the task of checking various sensors data received from the field with the already fixed threshold values. The motor will be switched ON automatically if the soil moisture value falls below the threshold and vice-versa. The farmer can even switch ON the Motor from mobile using mobile application. **Automation and irrigation system:** The irrigation system automated once the control received from the Controller. The Motor driver are used to pass control from ESP8266 to the L293D Driver. **Web application:** The web application will be designed to monitor the field and crops from anywhere using internet connection. To control the Node MCU processing IDE is used, the webpage can be communicated using the processing IDE. **Mobile Application:** The mobile application will be developed in android. The mobile application helps to monitor field from anywhere.

5.3 PROPOSED METHODOLOGY

Sensor data acquisition: The sensor is interface with Node MCU such as Soil moisture, LDR and water level sensor is used.

Wireless data transmission: The data acquired from sensors are transmitted to the web server using wireless transmission (WIFI module ESP8266).

Data processing and Decision making: The data processing is the task of checking various

sensorsdata received from the field with the already fixed threshold values. The motor will be switched ON
Error CS0234: The type or namespace name 'UI' does not exist in the namespace 'System.Web' (are you missing an

assembly reference?) [D:\PROJECT\PROJECT.csproj] automatically if the soil moisture value falls below the threshold and vice- versa. The farmer can even switch ON the Motor from mobile using mobile application.

Automation and irrigation system: The irrigation system automated once the control received fromthe Controller. The Motor driver are used to pass control form ESP8266 to the L293D Driver.

Web application: The web application will be designed to monitor the field and crops from anywhereusing internet connection. To control the Node MCU processing IDE is used, the webpage can be communicated using the processing IDE.

Mobile Application: The mobile application will be developed in android. The mobile application helpsto monitor filed from anywhere.

5.4 SYSTEM ARCHITECTURE

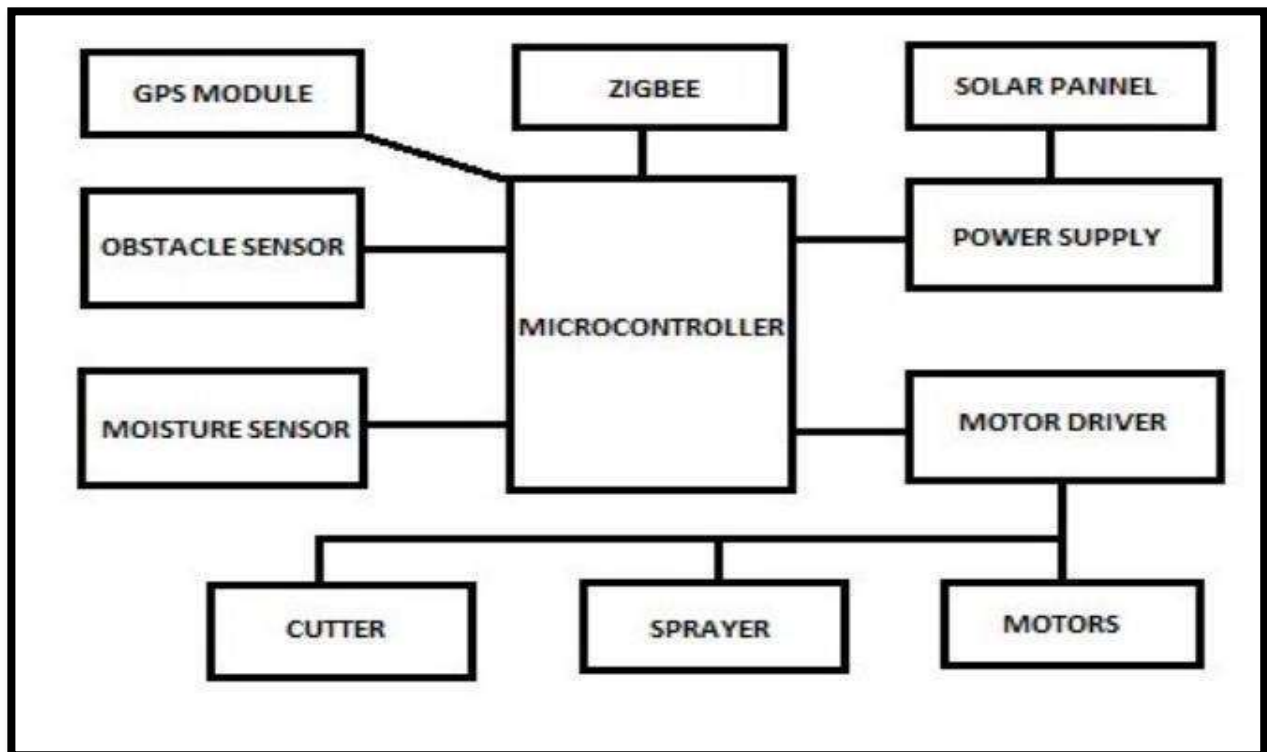


Figure 2.7: The block diagram of the GPS based vehicle

CHAPTER 6

IMPLEMENTATION DETAILS

6.1 HARDWARE IMPLEMENTATION

6.1.1 Solar Sensing and Control Circuit

Arduino board can sense the maximum sun light direction using a set of three LDR(light dependent resistors), each resistor is facing to different side. The middle LDR is perpendicular to the solar cell itself, and the other two LDRs are either to the right or to the left of the middle LDR. As a result, the controller will read the voltage from each LDR, and higher voltage means higher received light. Figure 4.1 below shows the solar sensing and control circuit. So, in short, a set of three LDR (light dependent resistors) are used to make the brain of Arduino Uno able to sense the maximum sun light direction. A set of this resistor one by one is facing to different side with the middle LDR is perpendicular to the solar cell itself, The voltage from LDR will be read by using the controller of the Arduino, and when the controller reach to the maximum voltage read it means that the LDR have a higher received light. In the control circuit, the servo motor is connected with the Arduino digital pins.

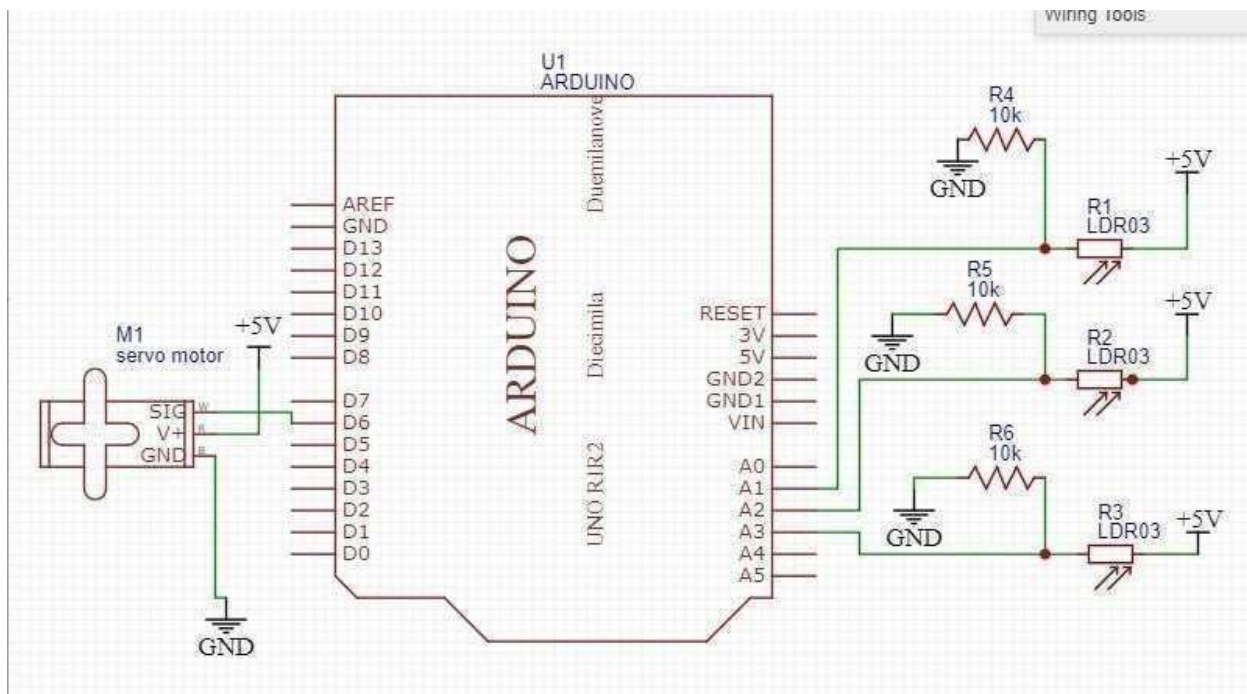


Figure 6.1: solar sensing and control circuit

Servo motor is connected to the Arduino digital pin where the Arduino can control the servo to rotate right or left depending on the received voltage from the light dependent resistor. For

example, if the right LDR voltage is higher than the center LDR voltage this means the sun is coming from right so the controller will keep rotating right the solar cell using the servo motor until the center LDR reads a higher voltage. At this point, the sun is perpendicular to the cell. Arduino has 6 analog pins from A0 to A5 where LDRs are connected and it also has 14 digital pins and we connected servo motor to one of digital pins that is D6. It is known that LDR resistor has low resistivity when it is exposed to the light, so it converts amount of light to a resistance. In addition to the LDRs, there are 3 10 K resistors connected between LDRs and ground to make voltage divider. Once a LDR has low resistivity from high amount of light, the voltage on 10 K resistor will be 5 V. As a result, the controller Arduino will read which resistor has higher voltage. All of LDRs are put inside black tubes or light-guides to prevent errors of reading resistance or tracking from solar light especially when it is perpendicular to the power cell. LDRs have 2 wires each, one wire of them should be connected to 5 V on Arduino, and the other wire that is for voltage divider and 10 K with ground and the other wire of them are on A1, A2, and A3 respectively on Arduino. Servo motor has 3 wires and two of them connected to buck converter and the last one is connected to D6 on Arduino. Above servo motor there are 2 wires from solar cell to the main terminal of the project which connected to boost converter.

6.1.2 Wi-Fi Interfacing Circuit

Arduino Uno doesn't have a Wi-Fi modem, which is required for connection to the IoT cloud, so the need for Wi-Fi modem with serial interface appears. ESP8266 as mentioned earlier in this report has a good Wi-Fi connectivity with low power consumption and serial interface, the connection is TX from ESP8266 to Rx of the Arduino and Rx from ESP8266 to TX from Arduino. Figure 4.2 below shows the Wi-Fi interfacing circuit

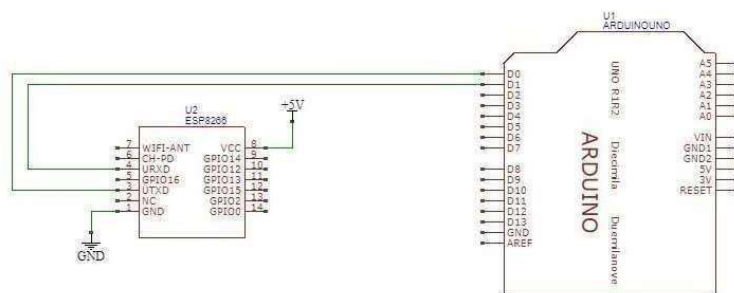


Figure 6.2:Wi-Fi interfacing circuit

6.1.3 Solar Power Monitoring and Battery Charging Circuits

The output from the solar cell is fed to step-up or boost converter to increase the voltage to 8.4 volts which is the needed voltage to charge the two cell batteries, the power analyzer chip INA219 will monitor the current and volt. Then, it will calculate the power. All readings will be sent to the Arduino board using I2C protocol using the two pins (SCL serial clock, SDA serial data) are connected to A4 and A5 respectively. Figure 4.3 below shows the solar power monitoring and battery charging circuits.

Firstly, solar cell gives a DC output so it is a DC source and it has the same symbol but the only difference is it receives light. It should charge the two lithium batteries that have best storage capacity and have light weight, and in normal conditions they are 3.7 V but their full limit is 4.2 V so the total is 8.4 V. But they have disadvantages overcharge is forbidden because it will be bloated or even worse than that it will be exploded. Another disadvantage is it is forbidden to let voltage be less than 3 V, so the normal range for batteries is from 6 to 8.4 V. Practically speaking, solar cell will not give us 8.4 exactly since we have times during the day like sunset and sunrise or sometimes a dusty or cloudy or foggy climate or may be other reasons. This is why we used boost converter to increase level of output voltage of solar cell by adjusting its potentiometer.

Protection board or charge controller will keep the voltage of batteries within normal range 6 to 8.4 that will enter the buck or set down converter because the whole project needs 5V. And INA219 will help us to know voltage and power that come from solar cell. The output from + pin of solar cell is going through INA219 from + pin and output of INA219 is going to + pin of boost converter. Whereas ground of solar cell is directly going to boost converter. In fact, we added a forward diode from + pin of boost converter to protection board not to the opposite direction because if we don't have enough voltage from solar cell, the batteries will feed the boost converter back, so we put forward diode that dissipates 0.7 V to prevent current moving based on this condition. As a result, the potentiometer of boost converter should be adjusted to 9.1 V in order to have 8.4 V to charge batteries ($9.1\text{ V} - 0.7\text{ V} = 8.4\text{ V}$).

On protection board, there are two terminals of power coming from boost converter P- and P+ (from diode side). Also, there are 3 terminals on protection board and they are B+ (from positive side of battery), B- (from negative side of battery), and BM or battery-middle and it is connected to middle of batteries through short-circuit of batteries. In fact, lithium batteries are set in series, positive side of the battery is connected to negative side of the other battery, and the protection board is called 2-S-charge controller for two series battery. P+ pin of protection board is also

connected to the on/off manual switch of our project that is connected to the main feeder of the project pin N+, which is buck converter 5 V where P- of the protection board is directly connected to N- pin of buck converter.

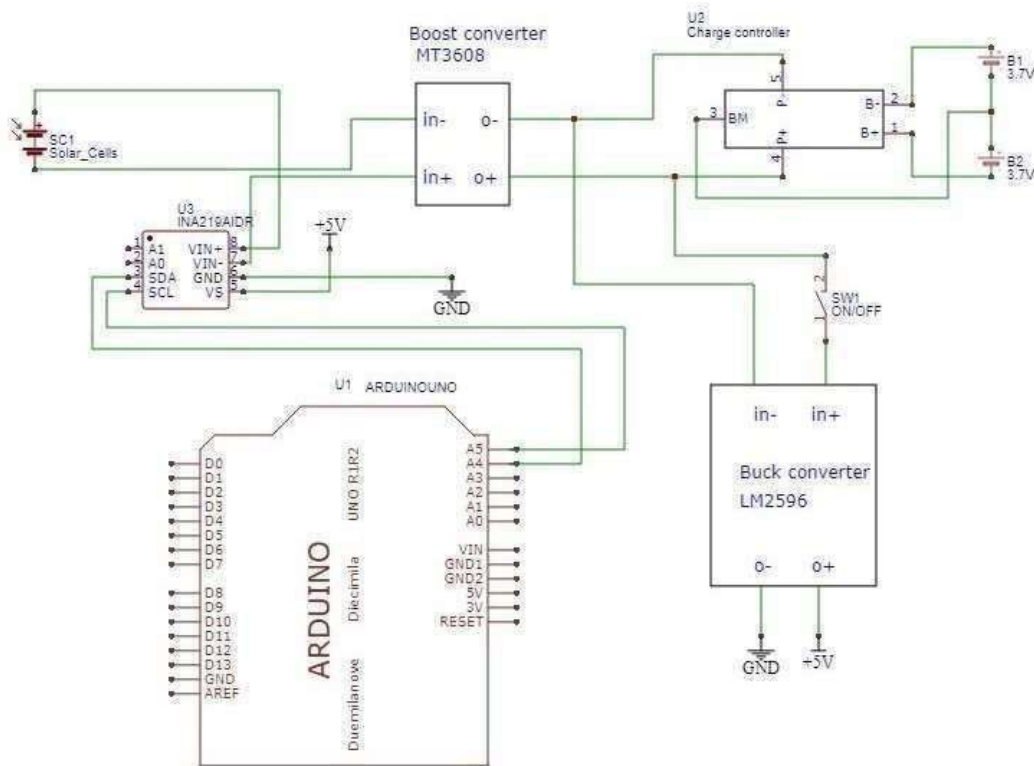


Figure 6.3: solar power monitoring and battery charging

6.1.4 Soil Moisture Monitoring and Pump Controlling Circuit

To measure the soil moisture level a special board for this purpose was used, this board depends on the soil conductivity to measure the amount of water inside the soil. The output from the sensor is analog and connected to one of the analog inputs on Arduino board. The controller will start or stop water pumping depends on the code, but the output power from the controller is insufficient to operate the water pump. For this reason, IRF520 is used to drive the water pump as shown in figure

4.4 below

Soil moisture sensor has 5 wires two of them from buck converter and the third one is connected to A0 on Arduino. The last two wires are for the probe to read soil level. And

IRF520 has 5 wires, and 2 of them are from buck converter. The other 2 connected to submersible water pump. The last one pin called signal on IRF520 is connected to D5 on Arduino. The reason why we used IRF520 is that Arduino gives 30 mA and by this current we can not power the water pump because it needs 600 mA. By using IRF520 as an amplifier switch, we can give water pump its needed current from buck converter that already has 3 A.

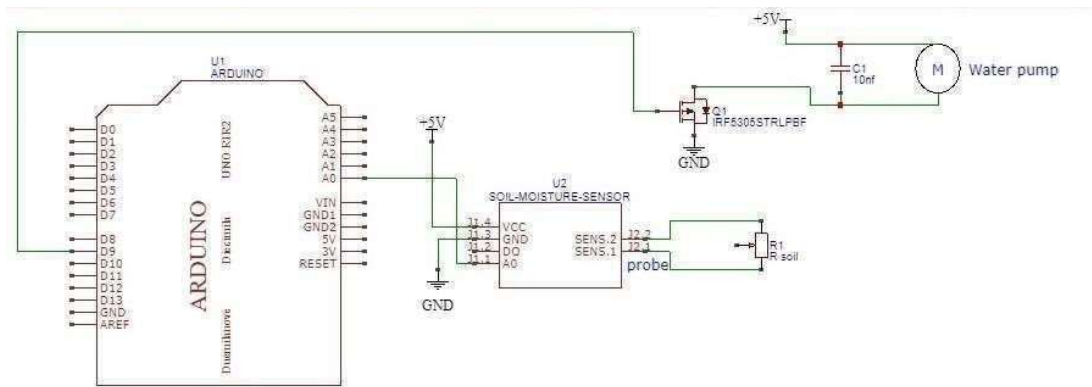


Figure 6.4: Soil moisture monitor and pump controlling circuit

6.2 SOFTWARE IMPLEMENTATION

In this section, documentation of Arduino programming will be explained including the used program for writing the code and the flowchart and finally the IoT server used for this project

6.2.1 Arduino IDE

Programming has always been seen as a complicated process since early dates of manufacturing computers. In fact, codes or languages of programming have not been available like nowadays as files called libraries. It used to take years of studying how to make a bridge- language between software and machines languages or to get even the most basic concepts down. Also, it's difficult to apply these codes on real-work devices. However, this is not happening nowadays because knowing how to code and program is a very useful skill to have or most of the time files of codes are available almost everywhere on Internet. Arduino IDE is a coding software, which makes the programming process more accessible to beginners with its simple interface and community-driven system [34].

Arduino Integrated Development Environment (IDE) is a cross-platform application (for Windows, macOS, Linux), which is written in a famous programming language called Java. It

is used to write and upload programs to Arduino compatible boards. The source code for the IDE is released under the GNU or General Public License, version 2. Actually, Arduino IDE supports languages like C and C++ using special rules of code-structuring. Also, Arduino IDE supplies a software library from the wiring project that provides many common input and output procedures. Furthermore, User-written code only requires two basic functions, for starting the sketch and the main program loop that are compiled and linked with a program stub called `main()` into an executable cyclic executive program with the GNU tool chain, and also included with the IDE distribution. Arduino IDE utilizes the program Avrdude in order to convert an executable code into a text file in hexadecimal encoding, which is loaded into the Arduino board by a loader program in the board's firmware [35].

Arduino IDE is incredibly minimalistic. Yet, it provides a near-complete environment for most Arduino-based projects. The top menu bar has the standard options including File (for new, load, save, etc.), Edit (for font, copy, paste, etc.), Sketch (for compiling and programming), Tools (for testing projects), and Help. The middle section of the IDE is a simple text editor, and it is the place where user can enter the program code whereas the bottom section of the IDE is dedicated to an output window, which is used to see the status of the compilation, used capacity of the memory, any errors that were found in the program, and various other useful messages.

Projects, that are made by using the Arduino, are called sketches, and such sketches are usually written in a cut-down version of C++ and a number of C++ features are not included. Because programming a microcontroller is somewhat different from programming a computer, there are a number of device-specific libraries (e.g., changing pin modes, output data on pins, reading analog values, and timers). As a result, this sometimes confuses users who think Arduino is programmed in an Arduino language. However, the Arduino is, in fact, programmed in C++. It just uses unique libraries for the device [36].

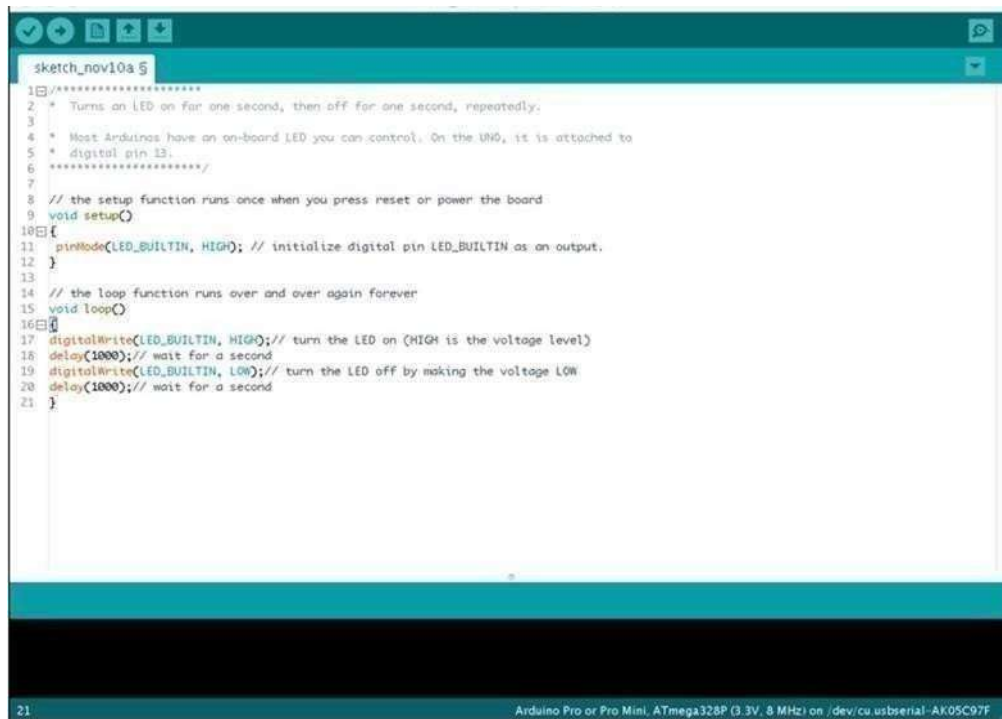


Figure 6.5: The Arduino IDE.

6.2.2 System Flow Chart

Figure 4.6 below shows the Arduino code flow chart, after starting the controller it will go in automatic mode directly which means it will read the soil moisture and start water pumping if the real soil moisture below the desired soil moisture. Also, the controller will keep reading from the serial port to change the mode from automatic to manual mode and vice versa. If the mode is manual then the controller will read serial port to switch on/off the water pump. In all time, the controller will read the cell voltage and current from the power analyzer and send it serially to Wi-Fi modem.

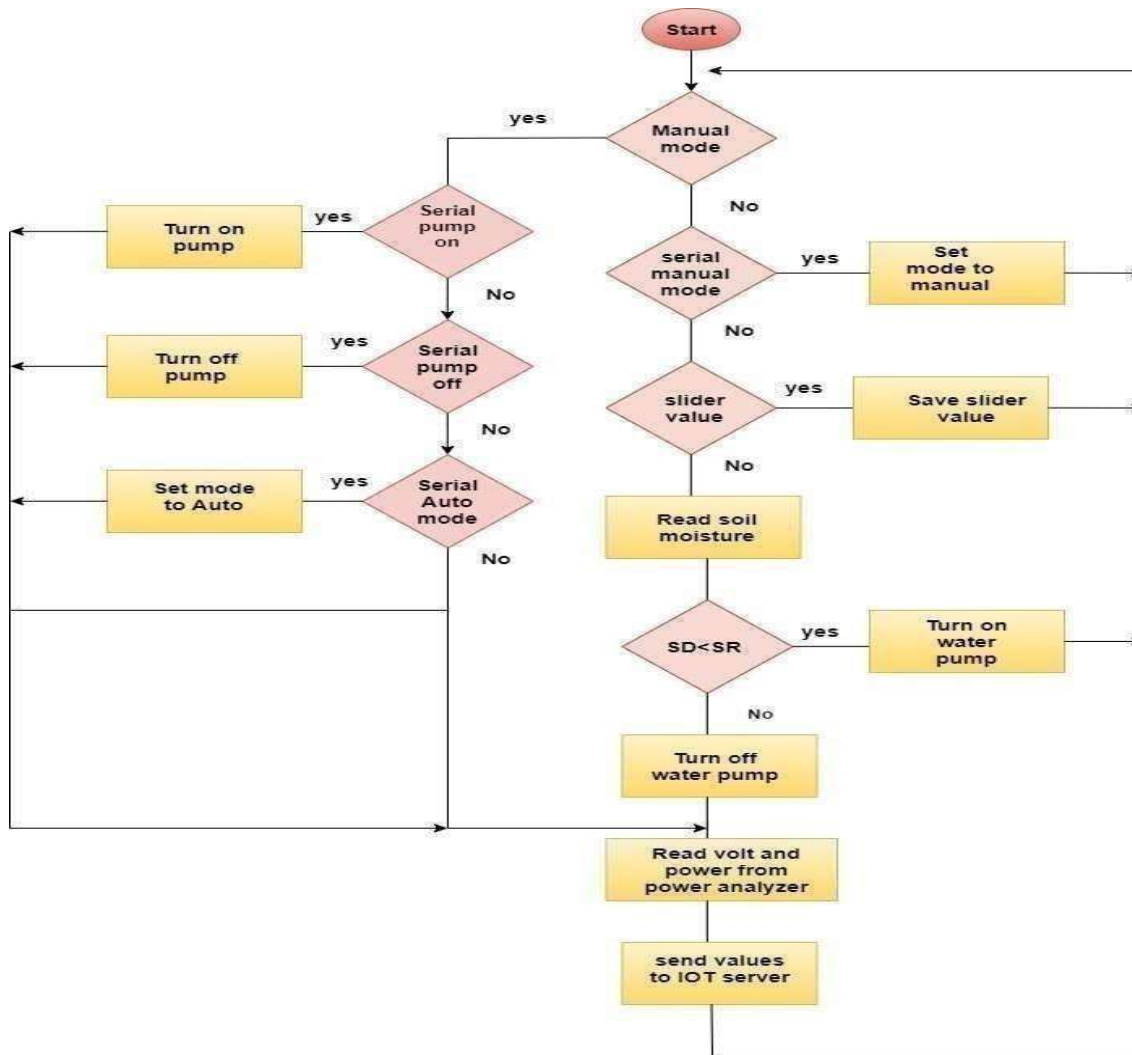


Figure 6.6: system flow chart

6.2.3 SYSTEM GUI

Figure 4.7 below shows the real graphical user interface, the first part on the top is the monitoring part, there are three gauges for monitoring a real time values, the cell voltage and the cell power and the soil moisture level. Then the desired soil moisture can be selected using a slider where the user can set any desired level from 0 to 99 and the system will keep this value true as long as the mode is automatic. The mode button is a touch-button, which will flip from automatic to manual mode on each press. Also, the water pump motor can be controlled on or off depending on the selected mode, and will just operate if the selected mode is manual.

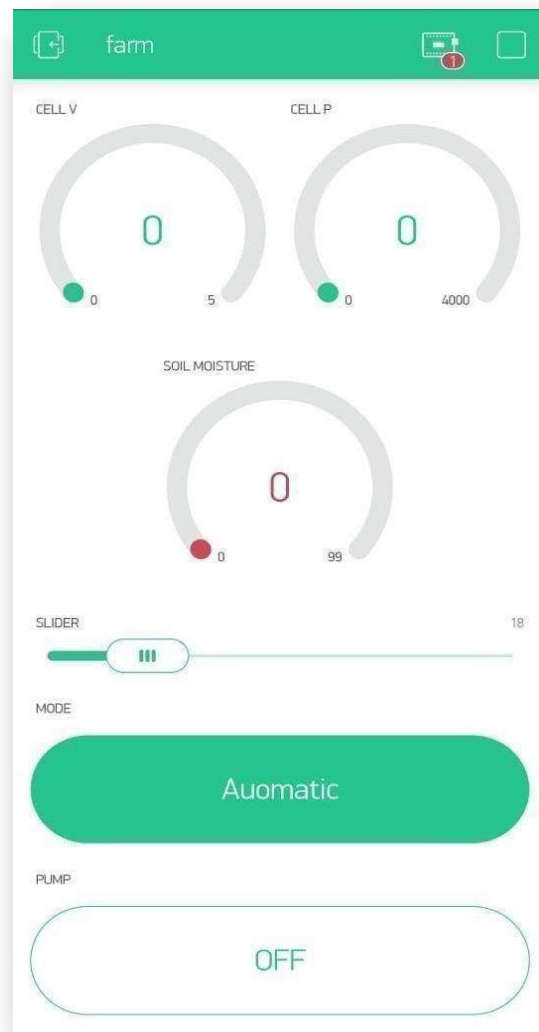


Figure 6.7:blynk GUI

6.2.4 IOT CLOUD

Blynk is a platform where it is available on iOS and Android apps to control Arduino, ESP8266, Raspberry Pi and many components over the Internet. User can easily build graphic interfaces for all projects by simply dragging and dropping widgets. Figure 4.7 below shows Blynk application. The following is a list of some microcontroller boards that can be coupled with Blynk:

- Espressif (ESP8266, ESP32, NodeMCU, WeMos D1, Adafruit HUZZAH, SparkFun Blynk Board, SparkFun ESP8266 Thing)
- Linux (C++) (Raspberry Pi, Ubuntu).

- Arduino.

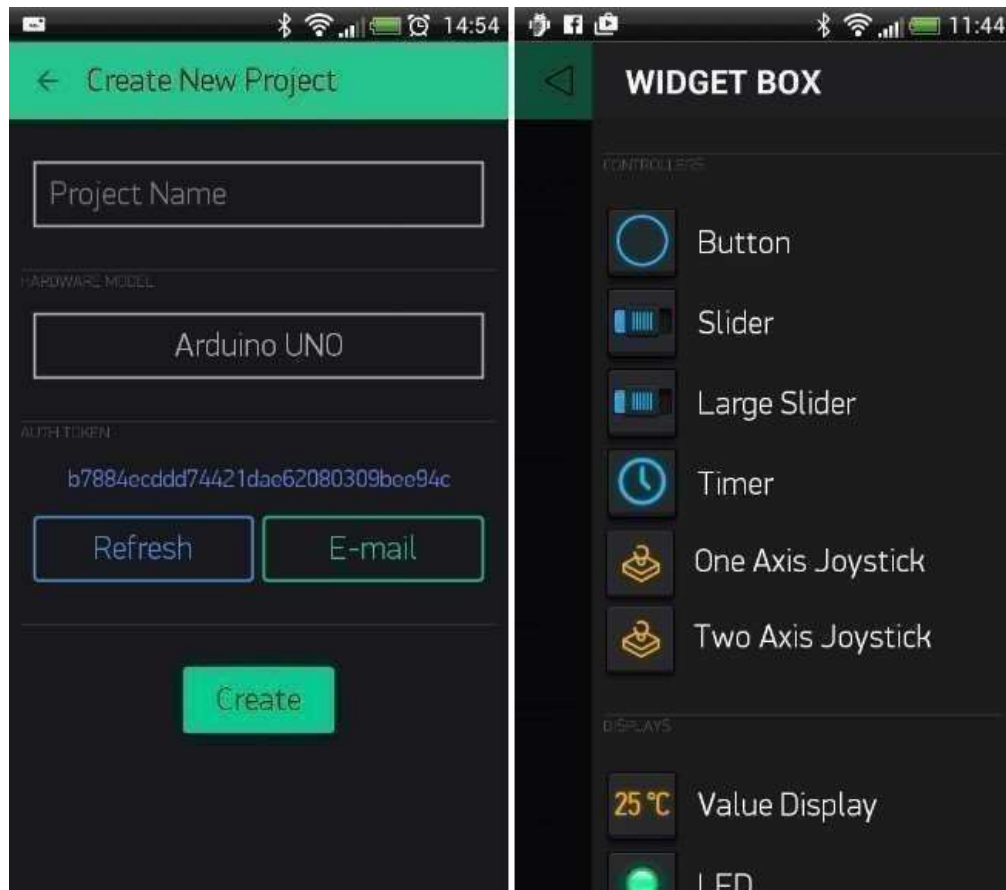


Figure 6.8: Blynk application

CHAPTER 7

RESULTS AND DISCUSSION

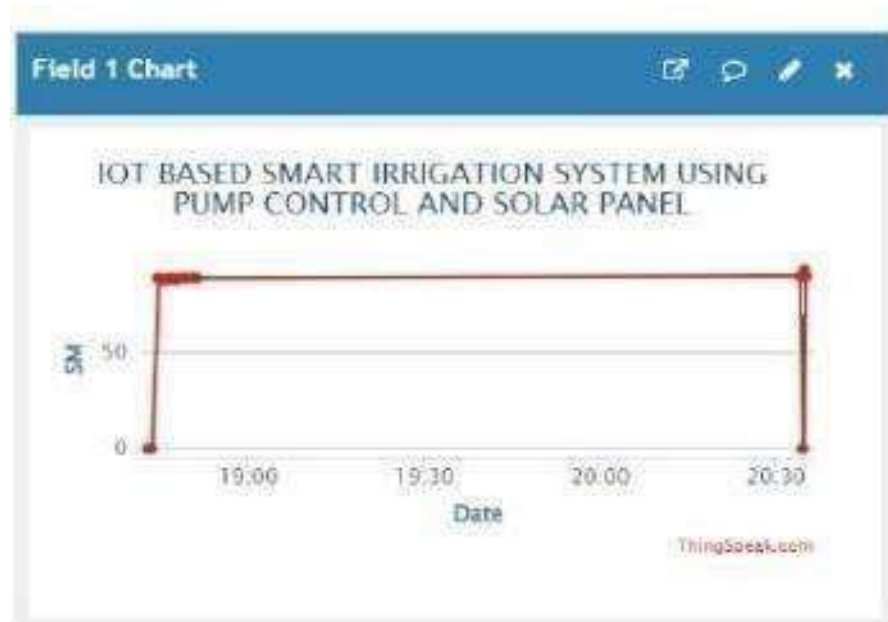


Fig : IotWater Level

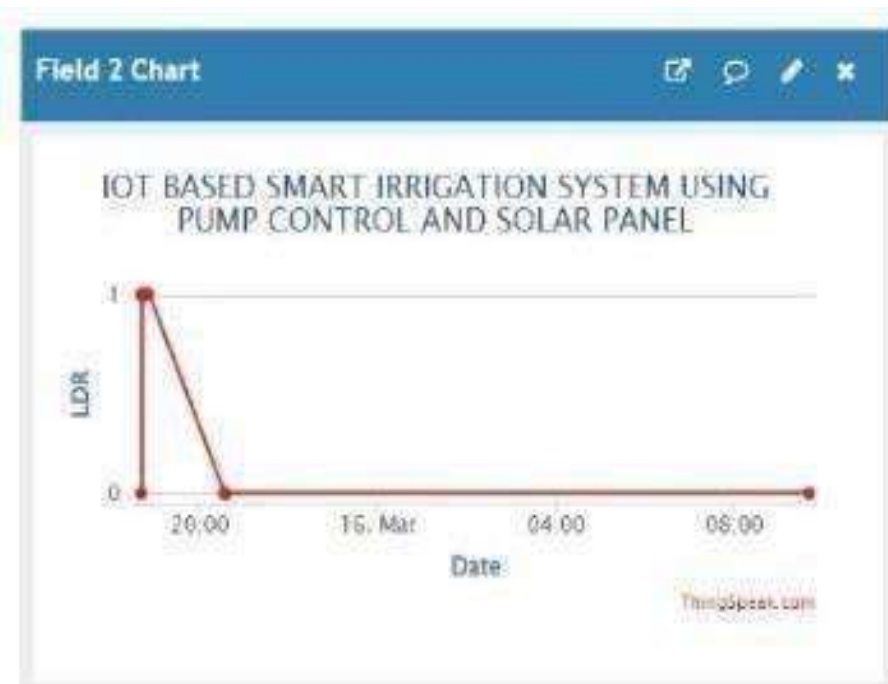


Fig : Iot Temperature Level

CHAPTER 8

CONCLUSION

- Using Arduino board makes the work more effective since all the time needed in this project was consumed on programming and debugging the system not learning how to start with microcontrollers.
- The maximum power that can be taken from the solar cell is when the sunlight is perpendicular to the cell, and the output voltage is going low when high current being drained.
- ESP8266 is used as Wi-Fi modem in our system but it has very strong and high-speed CPU with large memory size, the only drawback for this controller is no analog input
- In some cases when the water tank is empty the system will keep working and no indication for empty tank; to solve this problem we have two options; either measure the pump current and if the current is high it means a dry run or the second option to add a water level sensor to the system.

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APPENDIX

A. SOURCE CODE

```
#include <ESP8266WiFi.h>

#include "DHT.h" // DHT11 temperature and humidity sensor
Predefined library#define DHTTYPE DHT11 // DHT 11

#define dht_dpın 0//GPIO-0 D3 pin of nodemcu

int Raw = A0; //Analog channel A0 as used to measure temperature

int threshold = 16; //Nodemcu digital pin water sensor read-GPIO16---D0 of
NodeMCUint Solenoid = 13; // GPIO13---D7 of NodeMCU--Motorconnection

const char* ssid = "Your SSID";

const char* password = "Your Wifi
Password";    DHT    dht(dht_dpın,
DHTTYPE);

WiFiServer server(80);

void setup(void)

{
    dht.begin();
    Serial.begin(96
00);delay(10);

    pinMode(threshold,INPUT_PULLUP); //Pin#13 as output-Activate
pullup at pin 13pinMode(Solenoid, OUTPUT);    //D7 as output

    digitalWrite(Solenoid, LOW); //Deactivate Solenoid

// Connect to WiFi
network Serial.println();
```

```

Serial.print("Connecting
to ");Serial.println(ssid);

WiFi.begin(ssid, password); //Begin WiFi

while (WiFi.status() != WL_CONNECTED) {delay(500);

    Serial.print(".");

}

Serial.println("");
Serial.println("WiFi
connected");
// Start the server
server.begin();
Serial.println("Server
started");

// Print the IP address on serial monitor
Serial.print("Use this URL to connect: ");

Serial.print("http://"); //URL IP to be typed in mobile/desktop browser

Serial.print(WiFi.localIP()
);Serial.println("/");

}

void loop() {

// Check if a client has
connected WiFiClient client =
server.available();if (!client) {

    return;
}

// Wait until the client sends some data
Serial.println("new          client");

```

```

while(!client.available()){

    delay(1);
}

// Read the first line of the request

String
request=client.readStringUntil('\r');
Serial.println(request);
client.flush();

float h =0.0; //Humidity level

float t =0.0; //Temperature in
celcius float f =0.0; //Temperature
in fahrenheit

float percentage = 0.0; // Calculating percentage of moisture

float reading= 0.0; //Analog channel moisture read

// Match the requestint value = LOW;

if (request.indexOf("/Up=ON") != -1) {

    h = dht.readHumidity();      //Read humidity level

    t = dht.readTemperature(); //Read temperature in celcius

    f = (h * 1.8) + 32;    //Temperature converted to Fahrenheit

    reading = analogRead(Raw); //Analog pin reading output voltage by water
    moisture rain sensor percentage = (reading/1024) * 100; //Converting the raw
    value in percentage
    if (reading<=110){ // If less mositure in soil start the motor otherwise stop
    digitalWrite(Solenoid, HIGH);

    value = HIGH;

    else {

```

```

digitalWrite(Solenoid,
LOW);value = LOW;

}

}

if (request.indexOf("/Solenoid=ON") != -1) { //Motor ON
digitalWrite(Solenoid, HIGH);

value = HIGH;
}

if (request.indexOf("/Solenoid=OFF") != -1) { //Motor OFF
digitalWrite(Solenoid, LOW);

value = LOW;
}

// Return the response
client.println("HTTP/1.1 200 OK");
client.println("Content-Type:
text/html"); client.println(""); // do
not forget this one
client.println("<!DOCTYPE
HTML>"); client.println("<html>");

client.println("<h1 align=center>Smart Garden - Weather
Station</h1><br><br>");client.print("Temperature in Celsius =");
client.println(t); client.println("<br>");

client.print("Temperature in Fahrenheit =");client.println(f);

client.println("<br>");
client.print("Humidity
="); client.println(h);
client.print(" %");
client.println("<br>");
client.println();

client.print("Moisture Level Percentage=");

```

```

client.print(percentage);

client.print("%");

if(digitalRead(threshold)==HIGH){ // Read digital output of soil sensor

client.println("Threshold Reached = Rain detected / Moisture exceeded / Water
detected");

}

client.println("<br><br>");
if(value == HIGH)

client.println("Motor/Pump
Operational");else

client.print("Motor/Pump at Halt");

client.println("<br><br>");

client.println("<a href='\"/Up=ON\"'><button>Update = Temperature Humidity
MoistureValues</button></a><br />");

client.println("<a href='\"/Solenoid=ON\"'><button>Motor Pump On
</button></a>"); client.println("<a href='\"/Solenoid=OFF\"'><button>Motor
Pump Off </button></a><br />");client.println("</html>");

delay(1);

Serial.println("Client
disonnected");
Serial.println("");

}

if(digitalRead(threshold)==HIGH){ // Read digital output of soil sensor
client.println("Threshold Reached = Rain detected / Moisture exceeded / Water
detected");

}

```

B. SCREENSHOTS

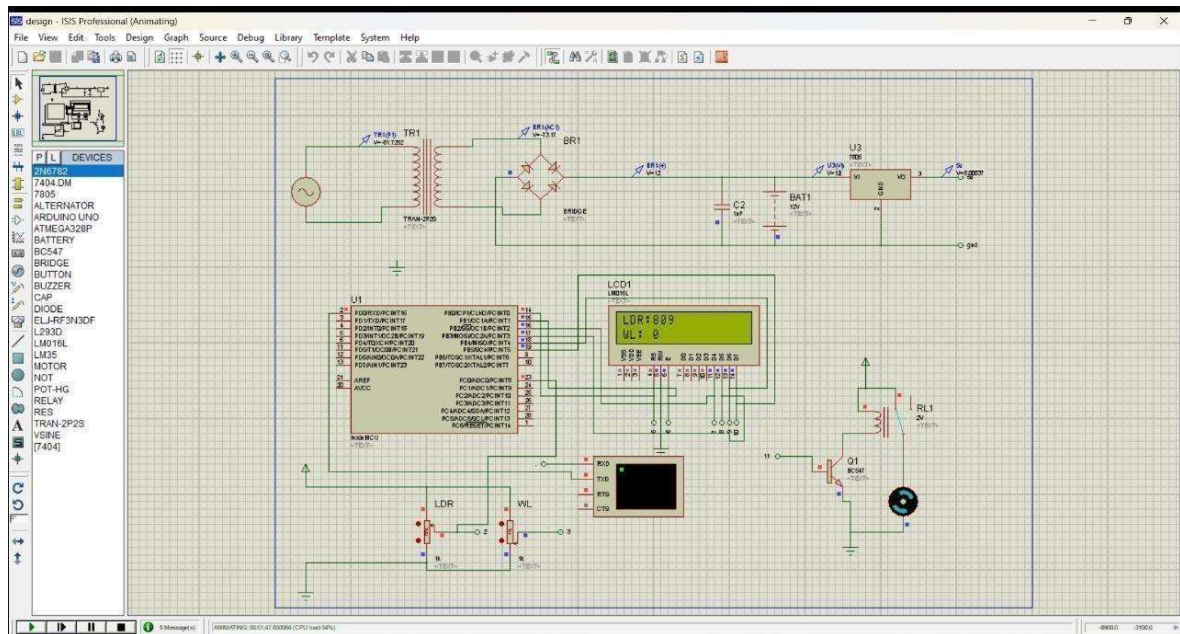


Fig B.1

AUTOMATIC SOLAR SUBMERSIBLE PUMP CONTROL FOR IRRIGATION USING IOT

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ABSTRACT

In this paper, we offer an embedded system that automates watering by utilizing a LDR sensor, a solar power source, and a ESP8266 module. Solar power is the method to use for irrigation to overcome energy issues. Solar panels capture sunlight and convert it into power, which is then stored in a battery. Solar-powered automatic irrigation, when applied appropriately, can significantly improve water management. Well-planned irrigation increases the fertility rate of the field and improves water management throughout critical plant growth stages, resulting in larger yields and higher-quality crops. Solar-powered, controlled irrigation systems that draw on soil moisture have two advantages: faster plant development and constant watering. Effective water management is able to eliminate water scarcity. The WI-FI module sends an alert to the registered cloud when the pump turns on or off. When the automated system fails, the pump can be manually turned on and off. For those who prefer to operate the gadget by hand, there is a manual switching option. Another advantage of manually controlling the pump is that it can be used for reasons other than watering the field. The water level sensor can measure soil resistivity, also known as volumetric water content, in voltage terms.

Index's: LDR sensor, microcontroller, pump, solar panel, manual switch, and battery.

1. INTRODUCTION

Agriculture is critical to the development of a country. The bulk of the world's arable land is underutilized, either because people lack the requisite expertise or because water is scarce. Many locations rely on monsoon rain, and when it does not arrive when it should, crops either do not grow or dry up. Farmers pay a lot more when they can't rely on

rainwater for irrigation or water sources, which drives up output prices [1]. High investment during production yields no profits during harvest or market sale since, as is widely known, agricultural products have an insufficient market. Unless we want to start raising food prices, Water is not a concern in some locations, but crops are withering or becoming overflooded as a result of inadequate water management, reducing crop yields and soil fertility [2]. Soil moisture sensors in solar-powered automatic irrigation systems assure an appropriate supply of water at regular intervals, reducing both water scarcity and waste. Many technological advances have resulted in a multitude of irrigation system types and approaches aimed at resolving the water issue [3]. However, the demand for fossil fuels is rapidly increasing in the modern world and will soon be depleted. not to mention the blackout. These technologies are harming farmers rather than benefiting them.

To solve the issue of energy shortages and power outages, a solar-powered irrigation system is being developed.

This solar-powered technology achieves automatic irrigation by sensing the moisture content of the soil in the field. The water Level sensor measures the soil resistivity, or volumetric water content, in this situation. If the soil's moisture level is low or dry, the pump will activate and provide water once more. Because the microcontroller is in charge of all system control, it is referred to as the system's "heart" [4]. Any changes to the motor or field status are reported to the assigned register number by the WI-FI node [5]. In the case that the automatic system fails, the farmer can manually engage the pump via a switch to continue the irrigation system; however, the farmer will need to physically visit the field to inspect it. Different applications for the pump include manually providing water for different reasons [6]. In

this model, we created an autonomous watering system that runs on solar power and makes use of a soil moisture sensor.

1.1. THE STATEMENT OF THE PROBLEM

Many new technologies are aimed at enhancing self-watering systems, yet these systems are not without hazards. As a result, both an automatic system and a manual operation are required. The manual system will supply water in the event that the automated system fails due to a short circuit. Because the irrigation system should not interfere with our productivity targets, we can irrigate the land manually. The irrigation pump can only irrigate the land where the sensor is placed. Instead of being worthless, we may build a manual switch and use the pump to supply water for other reasons. The primary power source or an adopter must be present for the system to function effectively; otherwise, the system will not function. As a result, we recommend a choice of power sources.

2. LITERATURE SURVEY

The Internet of Things has many current applications, including smart cities, healthcare, and agricultural innovation. In addition, as IoT technologies such as LoRaWAN, SIGFOX, ZigBee, and others expand, the industry is switching its old systems to IoT systems in order to improve performance. Smart agriculture is one of the most difficult issues for an IoT system application due to the significant energy and water consumption required to produce the required agricultural production. Numerous similar projects in various nations have worked to address this challenge in order to increase agricultural output while conserving water usage during irrigation. Using AI and deep learning, we projected crop output and soil parameters required for best performance with least power use [7]. Convolutional neural networks were also used to detect agricultural deficiencies required for real-time monitoring. The simulation findings show that the proposed model outperforms prior studies in the sector and will greatly improve efficiency and effectiveness while lowering expenses.

The smart agriculture system we are now developing is based on LoRa technology and is composed of three layers: a sensing layer, a fog layer, and a cloud layer. This [8] examines the design and implementation of it. In this context, our attention is directed towards a particular approach through which traditional farmland in rural India is being converted into an intelligent agricultural system. Utilizing LoRa's advantageous traits—such as its low power consumption, limited data transmission capacity, and wide coverage range—enables this. We evaluate the efficacy of our prototype by comparing it to the current cutting-edge smart agriculture system framework, utilizing metrics such as latency, distance, and cost.

In this [9], we develop an Internet of Things (IoT) system for intelligent agriculture using unmanned aerial vehicles (UAVs). We want to address the previously

expressed issues by completing the selection process for unmanned aerial vehicles (UAVs) used in agricultural activities such as plant protection and mapping. Intelligent sensing, transmission, application, and execution layers can collect, process, and evaluate data about soil moisture, weather, total solar radiation, photosynthetically active radiation, insects, and total solar radiation all at the same time. Consequently, a sophisticated agricultural Internet of Things (IoT) system utilizing unmanned aerial vehicles (UAVs) has been created. Ultimately, the findings from the trials demonstrate that this system is capable of satisfying the requirements of its users with a relatively minor margin of error in data accuracy.

The technology assesses the farm's condition in real time, distinguishing between normal and abnormal states. It independently controls the irrigation and cooling systems and wirelessly provides the gathered data to the farmer. In addition, the agent-based system was employed to model the behavior of the system, which includes the changing conditions of the agricultural field and how an anomalous reading causes a shift in the system's behavior from normal to abnormal. The [10], designed to monitor the current condition of the farm, showcases its real-time performance and triggers an immediate reaction in case of any aberrant readings. It underwent testing and was subsequently deployed on a small-scale farm. Based on the data, the implementation of this technique resulted in a notable enhancement in farm productivity and an overall improvement in quality.

The objective of this [11] is to examine and contrast different strategies for reducing data in order to achieve the most efficient transmission of IoT data in the field of smart agriculture. These solutions aim to minimize the size or quantity of data samples transmitted in order to decrease network congestion, preserve storage and processing capacity, and lower energy usage. The data reduction techniques that were taken into account include quantization, deduplication, and sampling. The efficacy of these methods was assessed using a real-time dataset specifically designed for smart agriculture systems. The dataset comprises five distinct variables: soil temperature, soil moisture, soil pH, soil moisture levels, and ambient air moisture. The methodologies were evaluated using three metrics, considering the size of each sample: information loss, computational cost, and energy use. The three data reduction methodologies were implemented using the Python programming language.

This [12] shows promise in offering widely available smart agriculture infrastructure with the publication of a fog-based model that adds further support from the Internet of Things. The fog platform brings computation and data storage as close to the network's periphery as possible in order to provide reliable data processing of information provided by Internet of Things (IoT) devices used in linked agriculture. The results suggest leveraging the Web of Science database's literature search feature to improve the IoT-Fog training set for the development of smart agricultural

production. The suggested approach outperforms existing Internet of Things (IoT)-based agricultural solutions when implemented appropriately. The results reveal that the proposed system significantly reduces system performance, processing efficiency, and statistical significance while geometrically enhancing the accuracy of the same existing systems.

3. METHODOLOGY

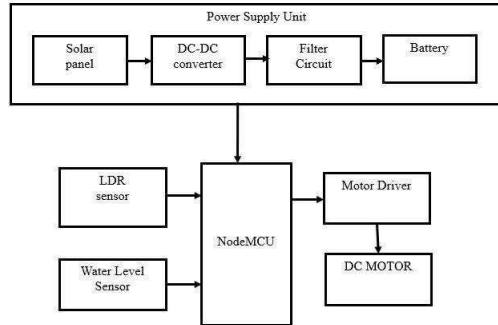


Fig 3.1: depicts a block diagram.

The block diagram helps to clarify the complete system. The charging apparatus will use the solar panels to transform sunlight into power, which it will then store in a battery. The battery is responsible for powering the entire system, including the automation and irrigation components. The microcontroller is in charge of the complete automation system's regulation and control. Field-mounted components such as the soil moisture sensor, WI-FI module and relay drive are connected to the microcontroller via the microcontroller board. The relays will start to drive once the pump and power source are connected to the microcontroller. A switch also enables manual operation by connecting the power supply to the pump.

4. MODEL OVERVIEW

The model's components are detailed below:

4.1 SOURCE OF ENERGY

4.1.1 PHOTOVOLTAIC CELLS

Solar panels absorb sunlight and convert it into useful electricity to power homes and businesses with renewable energy. While most people associate solar panels with rooftop installations, they can also be used to charge personal electronics and even automotive batteries. Individual photovoltaic (PV) cells, often known as solar cells, are the building blocks of solar panels that convert sunlight into electricity. A "module" or panel is a collection of linked cells arranged in a specific pattern; an array is a collection of two or more panels.

A solar panel for a home or business typically has roughly 40 cells, and a residential array typically has 10–20 panels.

4.1.2 POWER SUPPLY MODULE

It is used to connect the negative and positive terminals of a system (adopter) in a system with three power sources—a solar panel, a battery, and the mains. Unfortunately, even when the solar panel is connected to it for charging, the battery will not charge while using the converter. Diodes, which also prevent charge from flowing backwards, turn the system on and off to accomplish this.

4.1.3 BATTERY

Electric batteries, composed of electrochemical cells that can be linked to external devices, find application in flashlights, smartphones, and electric vehicles. When a battery is linked to an external circuit, the electrolytes inside it move as ions, carrying out chemical reactions at the terminals and providing energy to the circuit. The migration of ions within a battery is the fundamental mechanism that enables the flow of electric current and facilitates the conduction of work. Originally, the term "battery" denoted a device comprising numerous cells, but it has now been broadened to encompass devices consisting of just a single cell. It conserves charge and utilizes a 12V DC battery to supply power to the system as required.

4.2. ESP8266 MICROCONTROLLER

A microcontroller is used in an automation system to control all of the necessary tasks. The sensor reads the soil and provides the microcontroller with a binary value (0x01). A value of 1 indicates dry soil, and a value of 0 indicates moist soil, depending on the sensor used. In response to the soil state, the controller will interact with the relay drive via the WI-FI module. The ESP8266 microcontroller from the LoRa series is used in this application. The controller board connects the microcontroller to the power source and other components.

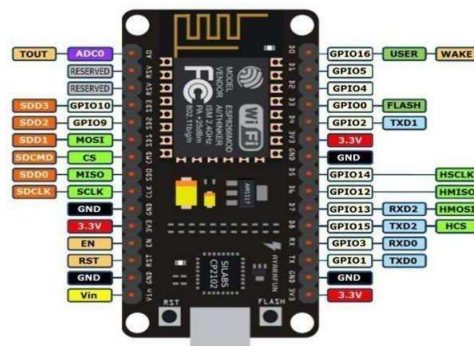


Fig 1: ESP8266 Chip Info

4.3. PUMP

Any mechanical device that moves fluids from one area to another is referred to as a pump. Pumps use energy and operate via a mechanism to move fluid and perform mechanical work. Pumps can be powered by a range of sources, including human power, electricity, engines, or wind

turbines, ranging from small pumps used in medical applications to enormous industrial pumps. Mechanical pumps are used in a variety of applications, including well water, irrigation, fuel, and cooling towers.

Irrigation pumps are self-priming electrical centrifugal pumps. This type of pump is completely immersed in order to pump liquids from a reservoir or bore hole. The pump transports fluid from the supply reservoir to the desired field. The distance pumped is related to the pumping head. This model makes use of a 5V DC pump with a 0.5 m head.

4.4. LDR SENSOR

A light-dependent resistor (LDR) is an electronic component that exhibits a changing resistance in response to changes in light intensity. Consequently, they can be utilized in circuits designed for light-sensing purposes. Resistance has an inverse relationship with light intensity, whereby an increase in light intensity leads to a decrease in resistance. This phenomenon is commonly referred to as photoconductivity. An LDR is beneficial in circuits that switch on or off based on the presence or absence of light, as well as circuits that detect and respond to light. An LDR is fabricated using a semiconductor with high resistance. The resistance of an LDR can range from several million ohms (M) in the absence of light to a few hundred ohms when exposed to light. When the frequency of light incident on a Light Dependent Resistor (LDR) surpasses a certain threshold, photons provide sufficient energy to bound electrons, causing them to transition into the conduction band. The subsequent liberated electrons facilitate the flow of electric current, resulting in a decrease in resistance. The resistance range and sensitivity of a light-dependent resistor (LDR) can exhibit significant variations among different devices.

4.5. WATER LEVEL SENSOR

A water level sensor is a device that detects if a liquid in a stationary vessel is at a high or low level. Liquid level measurement methods are classified into two types: contact and non-contact. An input water level transmitter is a contact measurement that turns the liquid level's height into an electrical signal. It is currently a popular water level transmitter.

5. RESULT AND DISCUSSIONS

The proposed solution allows us to keep tabs on plants through the use of image processing algorithms, with all of the data being recorded in the IoT. It is also possible to automate the process of checking the plants' precise status by using external sensors. Robots are smart enough to prevent field floods and can do more tasks overall. The Web of Things allows us to keep tabs. Because it holds the complete system program instructions, the ESP8266 microcontroller serves as the system's brain in this setup. Here, we use image processing and a moisture sensor to figure out whether the tree is wet, so the pump motor

can water it automatically. Water level sensor can detect when it's raining and turn off the pump motor; it can also check the water level at the ring and the tank to refill the tank automatically. It is possible to gauge the proportion of light intensity that plants absorb during photosynthesis using an LDR sensor. This data can then be shown on an Thingspeak screen. In order to manage or monitor the entire system's operation using IoT, all data is collected from sensors in the controller and sent to the cloud.

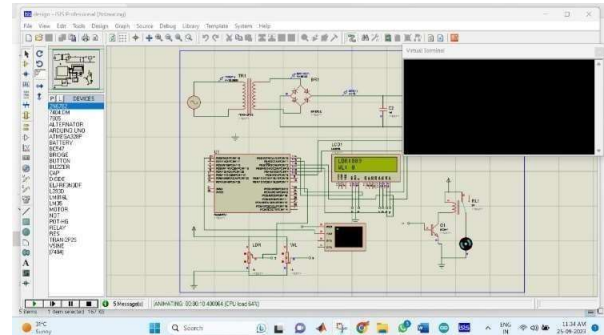


Fig 2. Simulation output

6. CONCLUSION

As a result, the autonomous irrigation system guarantees that crops are properly watered, resulting in maximum output. Irrigation is done on a regular basis to control the shortage or insufficiency of water in the field. By implementing manual switching, we may use the pump for more than just water supply. In addition to being used to fill the tank, the pump is also used for cultivating land. Furthermore, it aids in the operation of the irrigation system in the event of an automated system failure or short circuit. Solar panels are used to address the issue of energy scarcity. Adopters, on the other hand, act as a backup plan in case the battery is broken or there is insufficient sunlight to charge the battery.

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D. CERTIFICATE

