SCHOOL OF MECHANICAL ENGINEERING AND BUILDING SCIENCES

Technical Answers For Real World Problems (MEE3999)

Automatic Irrigation System Using Hybrid System.

Submitted by

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1. Abstract

An automatic irrigation control system has been designed to facilitate the automatic supply of adequate of water from a reservoir to field or domestic crops in all agricultural seasons. One of the objectives of this work is to see how human control could be removed from irrigation and also to optimize the use of water in the process. The method employed is to continuously monitor the soil moisture level to decide whether irrigation is needed, and how much water is needed in the soil. A pumping mechanism is used to deliver the needed amount of water to the soil. The work can be grouped into four subsystems namely; power supply, sensing unit, control unit and pumping subsystems which make up the automatic irrigation control system. A moisture sensor was used to measure the electrical resistance of the soil; a regulated 12 volts power supply unit was constructed to power the system; the control circuit was implemented using a Node MCU and a relay switch; and the pumping subsystem consisting of a submersible low-noise micro water pump. System response tests were carried out.

2. Introduction

Micro Irrigation is an artificial supplying of water to the root of plant. Irrigation has been used to assist in the growing of agricultural crops, maintenance of landscapes, and re-vegetation of disturbed soils in dry areas and during periods of inadequate rainfall. The old method used for irrigation was the use of watering cans, water channels that have to be opened and closed manually or backpack sprinklers. In this case, a lot of water is wasted in the process. There is need for improvement on the existing or old forms of irrigation. An automated irrigation system needs to be developed to optimize water use for agricultural crops. An intelligent automatic irrigation system has to have all the components that autonomously monitor and control the level of water available to the plants without any failure or human intervention. The intelligent system should perform the following functions:

(1) Continuously monitor the amount of soil water available to plants (this is usually achieved using a sensing system).

(2) Determine if watering is required for the plants based on the information obtained from monitoring the soil water content.

(3) Supply exact (or approximate) amount of water required for the plants. This will be enhanced by how well it achieves requirement.

(4) Discontinue the water supply when the required amount has been delivered to the plants.

. The water supply needed by the system to perform its irrigation function can be from any source, i.e. well, river, stream, pond, lagoon, etc. However, it is most desirable if a constant source of water is available to the system in order to ensure continuity of operation. The most preferred arrangement will be a water reservoir which is constantly maintained at full capacity or a large source of fresh water which remains continually available irrespective of variations in weather or climatic conditions.

The method of monitoring the soil moisture is employed in this project work. By this method, the amount of water applied to the agricultural products is minimized and it reduces crop production cost. Irrigation methods, are based on the following; the experience of the farmer, the soil properties and environmental conditions. A better way to monitor the environmental conditions and effective use of water to avoid wastage is by the use of sensor network.

3. Literature Review

There are about four categories of methods, according to [9], proposed for scheduling irrigation effectively:

- Entirely empirical method and without any kind of on-going measurement

- Method based on monitoring soil moisture

- Method based on estimates of water use from weather data, and

- Method based on tracking the condition of the crop usually referred to as crop water stress.

For development of automated irrigation system, soil moisture content is more important parameter as compared to others as it has crucial role in plant growth mechanism and availability of water for irrigation is major concern for the farmers specially the ones who are dependent on rain. The researchers have used various techniques to measure moisture contents precisely. The electrical conductivity measurement is the most simple, cost effective and power efficient method of all. But it is not precise and its results vary over time. In spite of its disadvantages it is widely preferred by many researchers; they used this method to implement automated irrigation control system using drip irrigation methodology. To provide user interface GSM technique was employed and at the user end android based application was developed to display data and with that information user can decide what action to take. Workload for the farmer will reduce and also increase in the productivity of the farm was observed. Acoustic method has been used to measure water content of the soil on the fact that travel time of sound wave is different in dry and wet soil

4. Objective of the Project

I. To facilitate the automatic supply of adequate of water from a reservoir to field or domestic crops in all agricultural seasons.

II. To see how human control could be removed from irrigation.

III. To optimize the use of water in the process.

5. SWOC ANALYSIS

1. Strengths-

- Economized use of water
- Increased area of Cultivation
- Uniform water distribution
- Yield increase in crops
- Change of cropping pattern is easy.

ii. Weakness-

- Difficulty in intercultural operation
- Initial Investment
- Non-Suitability to all areas/ Soil Types.
- Difficulties in Layout and Maintenance

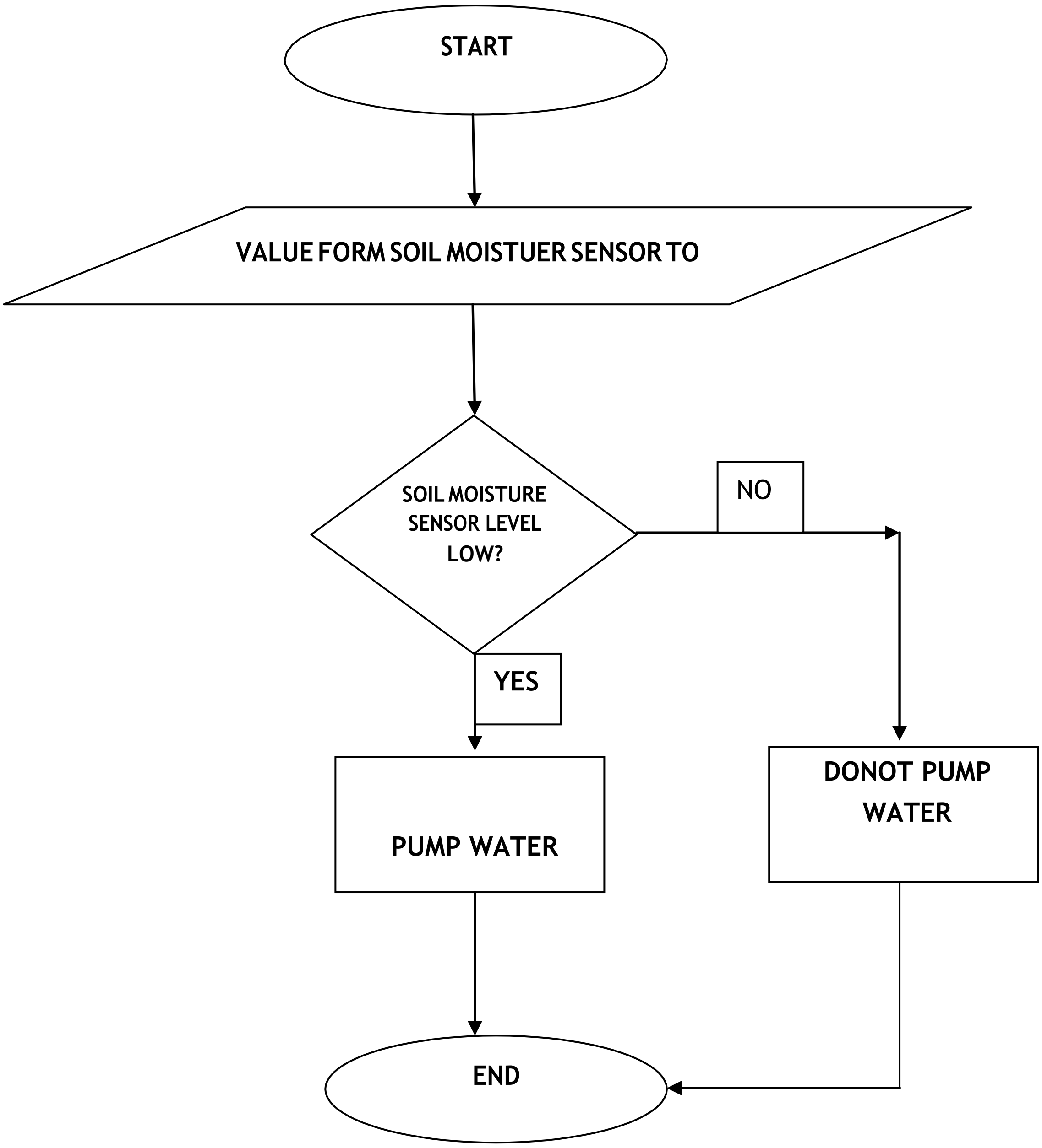
iii. Opportunities-

- Provision Of Bank loan
- Availability of Subsidy to farmers.
- One time Investment
- Involvement of private agencies in rural Development
- Technical advancement in agriculture helping in development of farmers and rural areas.

iv. Threats/ Challenges-

- Damage due to rats and rodents
- High initial investment
- Inadequate Availability of spare parts
- Pest and disease problem

6. Flow Chart


START
VALUE FORM SOIL MOISTUER SENSOR TO
SOIL MOISTURE SENSOR LEVEL LOW?
NO
YES
PUMP WATER
DONOT PUMP WATER
END

7. Modeling

7.1 Part Specifications

1) Soil Moisture Sensor- KITSGURU KG003

   The Soil Moisture Sensor uses capacitance to measure dielectric permittivity of the surrounding medium. In soil, dielectric permittivity is a function of the water content.

   - Working Voltage: 5V
   - Working Current: <20mA
   - Interface type: Analog
   - Working Temperature:10°C~30°C
   - Height**:** 4.3 inch (109 mm)
   - Width: 1.6 inch (41 mm)
   - Thickness: 0.44 inch (11 mm)
   - Weight: 17 g

2) Relay REES52 16220 4 CHANNEL 5V MODULE

   - High current relay, AC250V 10A, DC30V 10A
   - 2 LEDs to indicate when relays are on
   - Works with logic level signals from 3.3V or 5V devices
   - Opto isolation circuitry
   - PCB size: 50x45 mm

3) Node MCU

NodeMCU is a LUA based interactive firmware for ESP8622 Wi-Fi SoC, as well as open source hardware board that contrary to the Wi-Fi modules; includes a CP2102 TTL to USB chip for programming and debugging, is breadboard-friendly, and can simply be powered via its micro USB port. We are using an mobile application known as Blynk for the controlling of the system. This application provides user with the interface for internet of things.
Via this application the user can control the functioning of the pump.

- Wi-Fi Module – ESP-12E module similar to ESP-12 module but with 6 extra GPIOs.
- USB – micro USB port for power, programming and debugging
- Power – 5V via micro USB port
- Dimensions – 49 x 24.5 x 13mm

4.) **Submersible Pump**

18W Motor lifts water up to 1.6 meters

- Rust Proof and Durable quality
- Volume Flow rate = 1100 liters/hour
- Mass flow rate= ρ x volume flow rate = 0.306 kg/s
- ρ= Density of water=1000 kg/s

- Power = (mass flow rate x velocity^2) / 2 = 18 W
- Velocity of the Water at exit = 10.64 m/s
- Pressure of the water = P (atm.) + ρgh - (ρv^2)/2 = 0.308 bar

4) Jumper Wires

A jump wire is an electrical wire or group of them in a cable with a connector or pin at each end which is normally used to interconnect the components of a breadboard or other prototype or test circuit, internally or with other equipment or components, without soldering.

- Material- Tin plated soft Copper Wire
- Conductor Resistance- 0.54mΩ/cm
- Conductivity- Min. 96%
- Current Rating- 6 Amps at 70°C for 0.50mm

8 CAD Model with detailed part drawing

1. Relay
2. Node MCU
3. Submersible pump

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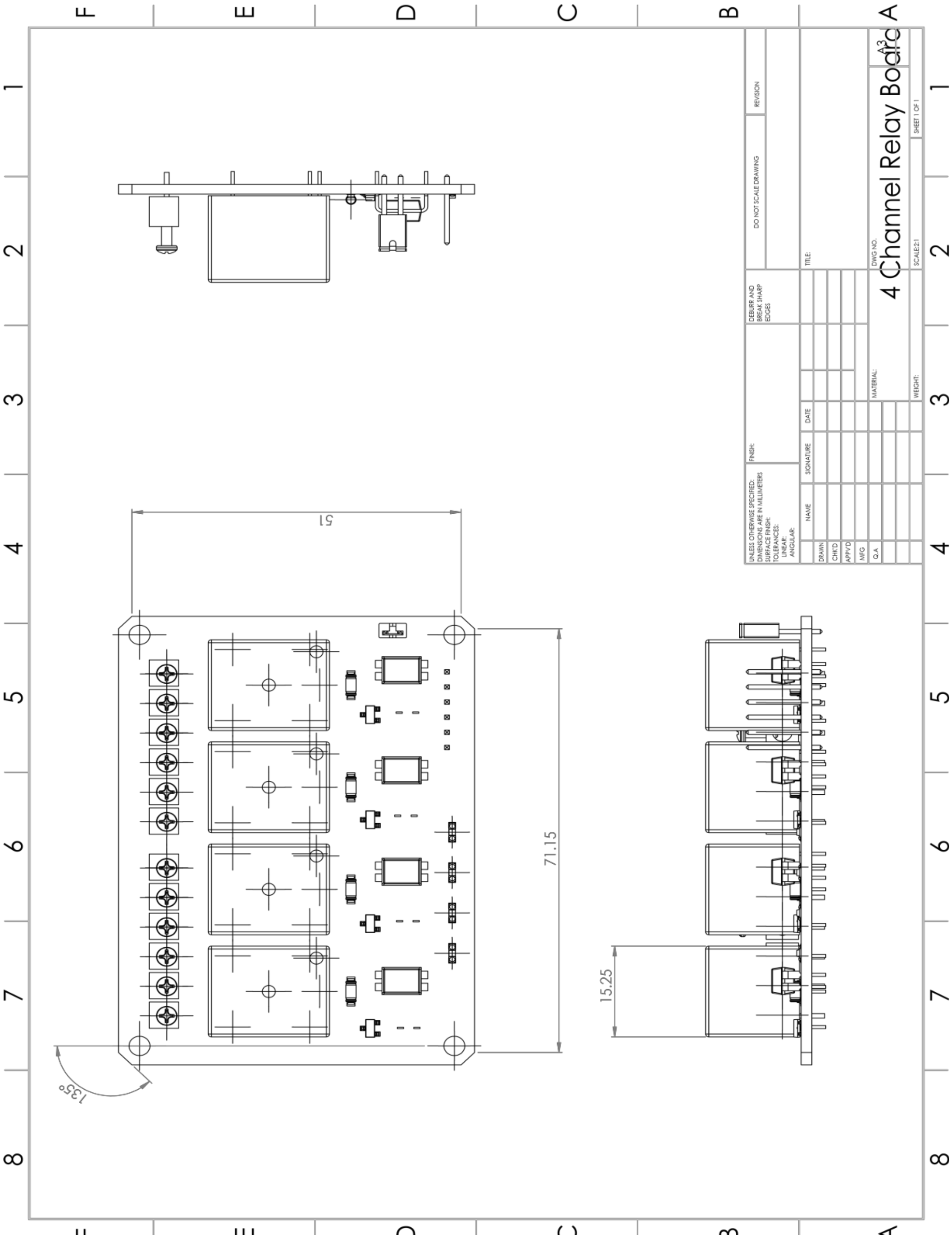

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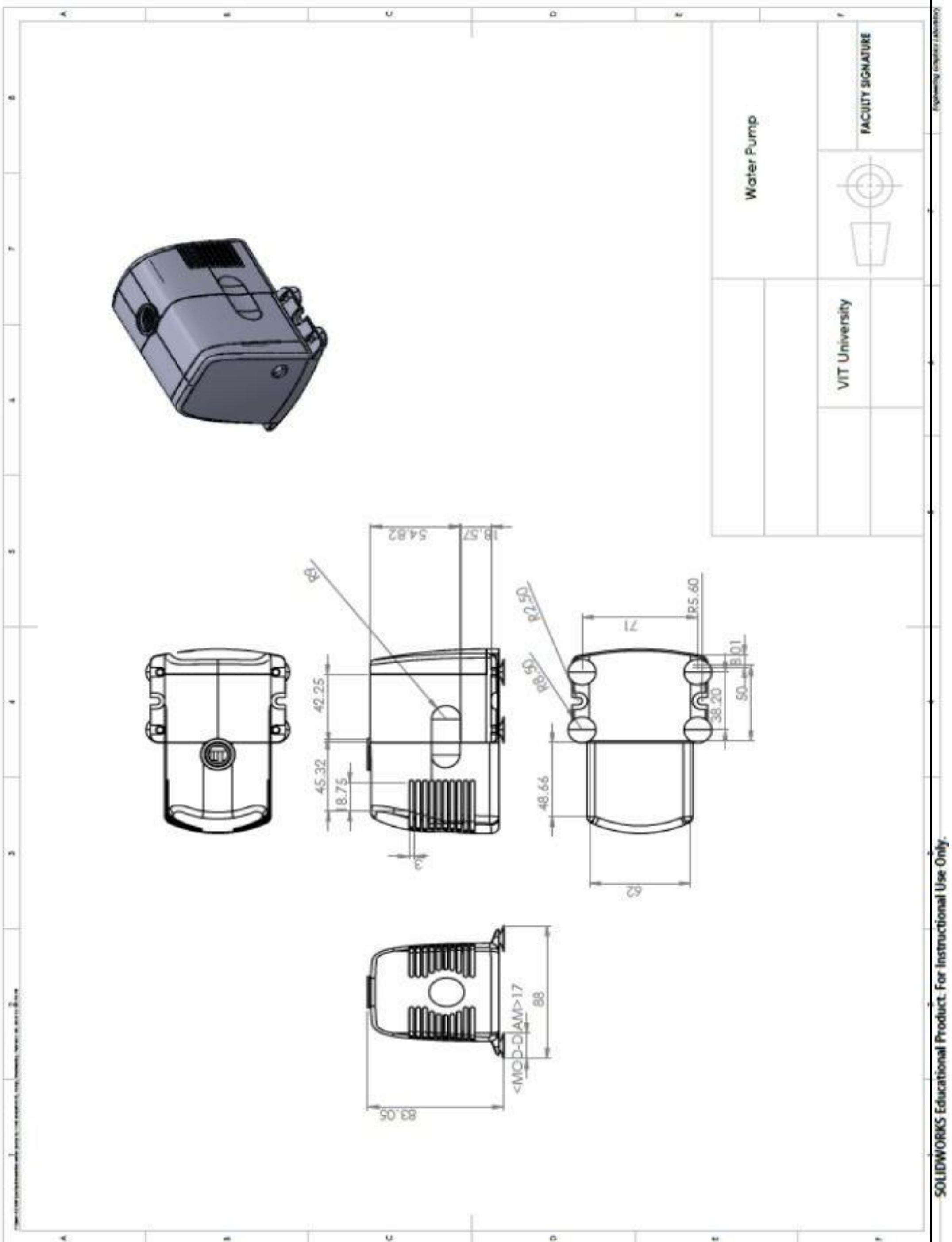

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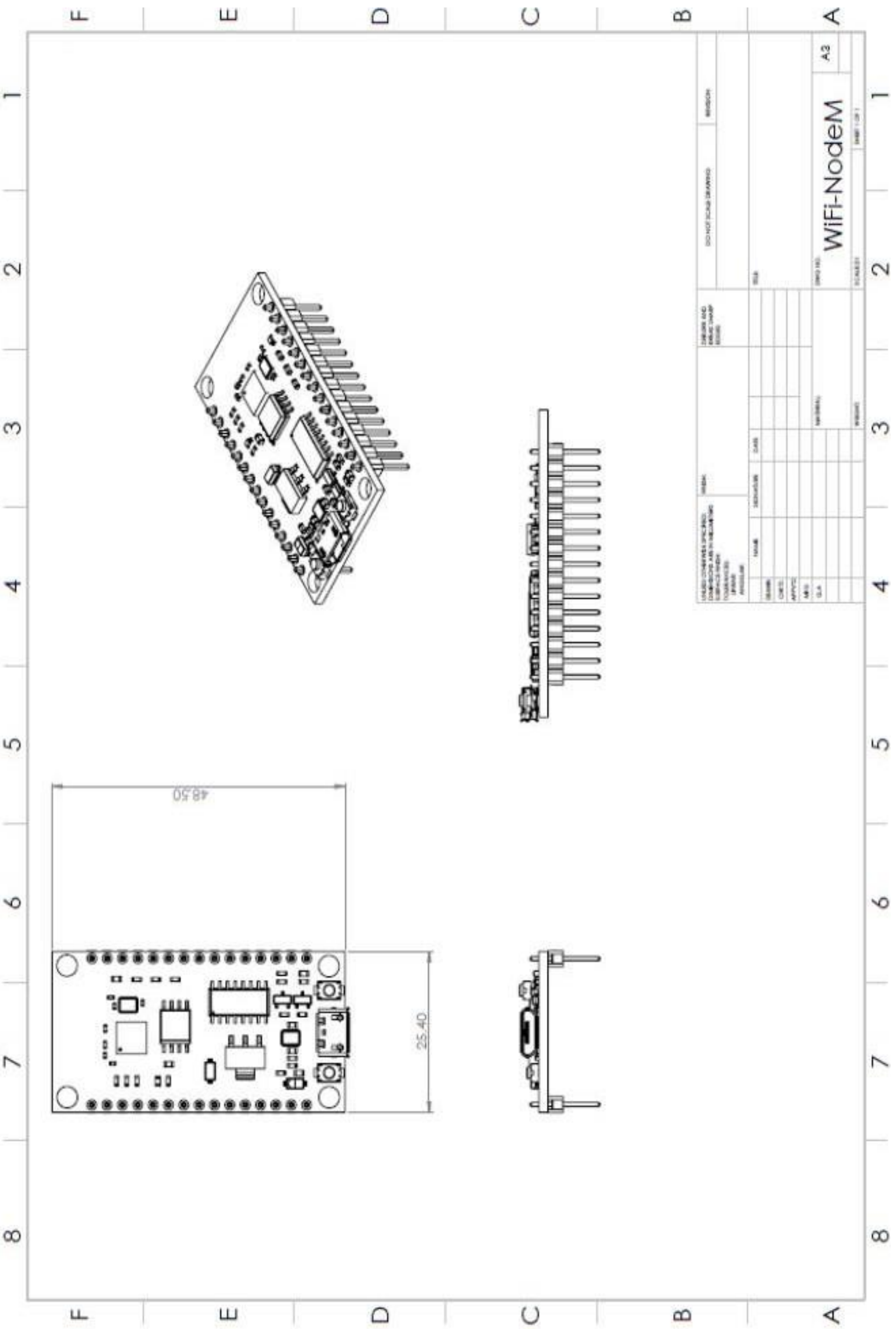

9. Codes:

9.1Boundary conditions

As per the research paper by McCouch'Research'Program, the relative humidity of the soil required for the plantation of rice is 55%

The sensor was calibrated by completely dipping the sensor in water for 100% moisture and placing the sensor in dry conditions for 0% moisture. To get the accurate result the sensor was mapped between these values as minimum and maximum points.

Code for Node MCU –

```
#define BLYNK_PRINT Serial     //including Blynk library
#include <ESP8266WiFi.h>       //including wifi (nodemcu ) library
#include <BlynkSimpleEsp8266.h>

int sensor_pin = A0;// moisture sensor pin
int output_value ;
int pump = 16;
char auth[] = "1dc16481c56048e1977f43d3920af096"; //authentication code for blynk
char ssid[] = "Xender_APf65e"; //wifi name
char pass[] = "0987654321"; //wifi password
static int pinValue;

void setup()
{
   Serial.begin(9600); //serial monitor begin at baud rate at 9600
   Serial.println("Reading From the Sensor ...");
   delay(2000);
   pinMode(pump, OUTPUT);
  Blynk.begin(auth, ssid, pass); //initiating blynk
```

```
}
BLYNK_WRITE(V2)
{
 pinValue = param.asInt(); // assigning incoming value from pin V1 to a variable
 }

void loop()
{
 Blynk.run();
 output_value= analogRead(sensor_pin);
  output_value =
  map(output_value,1024,630,0,100);
  Serial.print("Mositure : ");
  Serial.print(output_value);
  Serial.println("%");
  Blynk.virtualWrite(V0,output_v
  alue);
  delay(1000);

 if (pinValue == 1)
  {

  if (output_value > 55)
  {
     digitalWrite(pump,HIGH);
     Serial.println("PUMP IS OFF");
     Blynk.virtualWrite(V1, "PUMP IS
     OFF");
   }

  else
  {
     digitalWrite(pump,LOW);
     Serial.println("PUMP IS ON");
     Blynk.virtualWrite(V1, "PUMP IS
     ON");
   }

  }
 else if (pinValue == 0)
 {
     digitalWrite(pump,HIGH);
     Serial.println("PUMP IS OFF");
     Blynk.virtualWrite(V1, "PUMP IS
     OFF");
```

```
    }
    Serial.println(pinValue);
  }
```

Code for Arduino UNO:

```
#include <Servo.h>

Servo myservo;

int pos = 90;  // initial position
int sens1 = A0; // LDR 1 pin
int sens2 = A1; // LDR 2 pin
int tolerance = 0;


void setup()

{

  myservo.attach(9); // attaches the servo on pin 9 to the servo object
pinMode(sens1, INPUT); pinMode(sens2, INPUT);
myservo.write(pos);
  // a 2 seconds delay while we position the solar panel

}



void loop()

{

  int val1 = analogRead(sens1); // read the value of sensor 1
int val2 = analogRead(sens2); // read the value of sensor 2


  if((abs(val1 - val2) <= tolerance) || (abs(val2 - val1) <= tolerance))

   {
```

```
  //do nothing if the difference between values is within the tolerance limit
 }
 else
 {
  if(val1 > val2)
  {
    pos = ++pos;
    String stringOne = "right";
    Serial.println(stringOne);
  }
  if(val1 < val2)
  {
    pos = --pos;
    String stringtwo = "left";
    Serial.println(stringtwo);
  }
 }
 if(pos > 140)
 {
  pos = 140;
 } // reset to 180 if it goes higher if(pos < 40) { pos =40 ; } //
reset to 0 if it goes lower

 myservo.write(pos); // write the position to servo
delay(20);
}
```

9.2Equations Involved

Power of the Pump =P = 18 W

Maximum Height that can be sent by the Pump = 1.6m Volume Flow rate = 1100 litres/hour

Mass flow rate= ρ x volume flow rate

= 0.306 kg/s

Density of water= ρ= 1000 kg/s

Power = 18 w = (mass flow rate x velocity^2) / 2

Velocity of the Water = 10.64 m/s

Pressure of the water = P (atmosphere) + ρgh - (ρv^2)/2

= 0.308 bar

Calculations for single axis Solar tracking system:

Direct sunlight: -

Maximum current = 0.55mA Maximum voltage = 3.25 volt
Power Output = 1.7875mW

Indirect sunlight: -

Maximum current = 0.55mA Maximum voltage = 3.25 volt
Power Output = 1.7875mW

Figure: Single axis Solar Tracking System

11. Result Inference

- Amount of water pumped manually was more than the required value.
- Net water saved using sensor was 20%

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12. Model Layout:

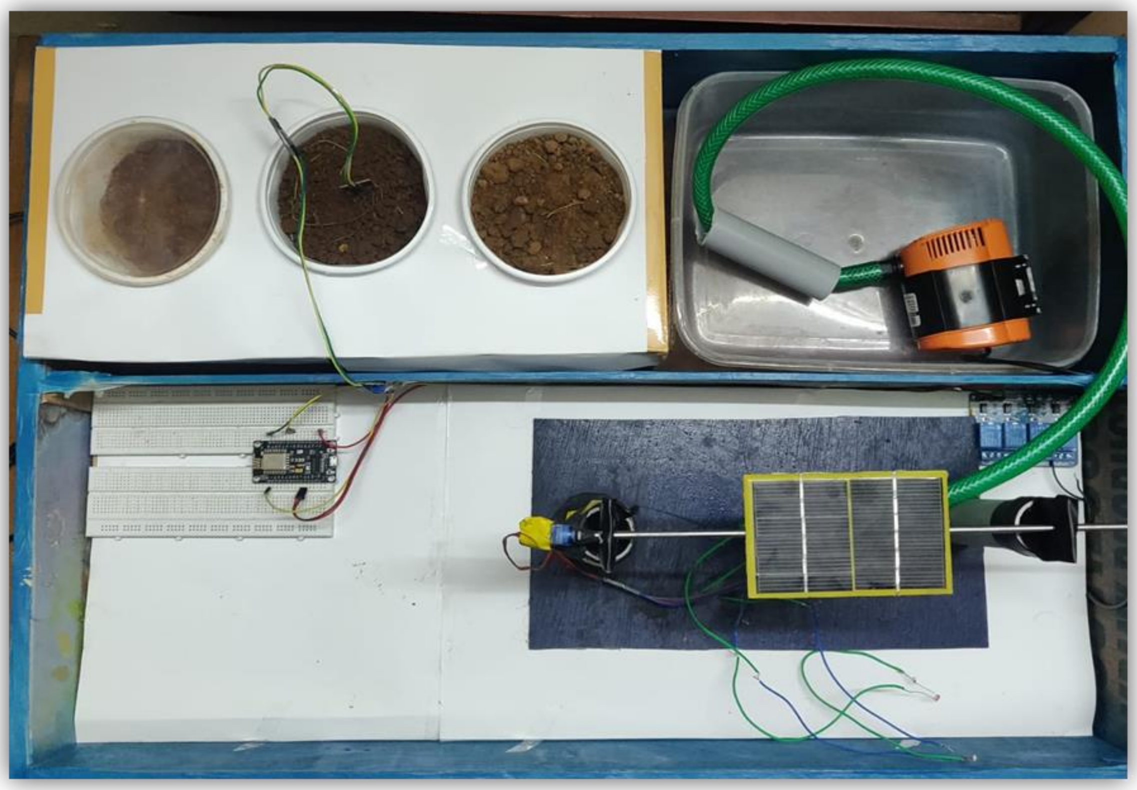

Fig 1: - Complete Assembly

Fig 2: - Soil Sensor Components

Fig 3: - Relay Module

Fig 4: - Submersible Pump

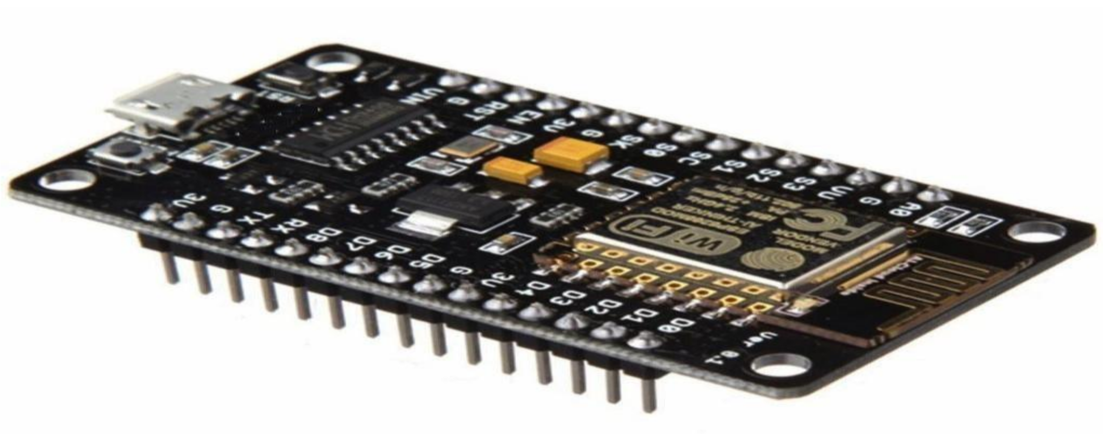

Fig 5: - Node MCU

13. Social, Economic, Environmental relevance

- Environmental Factors-

    i. As the system is automatic, water will be supplied as the moisture content decreases. So the soil will always remain moist.

    ii. No stagnant water ponds in the field abating the risk of mosquitoes.

    iii. Increased efficiency in water use.

- Economic Factors-

    iv. Irrigation process starts and stops exactly when required, thus optimizing energy requirements.

    v. Less damage of crops due to excess irrigation thus increasing productivity.

    vi. Reduced farm labor and thus decreasing production cost.

- Social Factors-

    vii. Implementing advanced technology in rural areas resulting rural community development.

    viii. Less human efforts resulting in less fatigue.

    ix. Adoption of advanced crop systems and new technologies, especially new crop systems that are complex and difficult to operate manually

14. Conclusion

- Automatic irrigation control system has been designed and constructed.
- The prototype of the system worked according to specification and quite satisfactorily.
- The system helps to eliminate the stress of manual irrigation and irrigation control while at the same time conserving the available water supply.
- Improving Irrigation efficiency can contribute greatly to reducing production costs of agricultural products, thereby making the industry to be more competitive and sustainable.
- For a large scale implementation a more powerful water pump can be used. Also a microcontroller should be used to accommodate more than one sensor input and also control different irrigation regimes independently. A wireless sensor and GPRS(General Packet Radio Service) based automated irrigation system can also be employed, which will help monitor the soil moisture and to control the application of water to the agricultural products thereby saving water.

15. REFERENCES-

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