International Journal of Science and Research Archive

eISSN: 2582-8185

Cross Ref DOI: 10.30574/ijsra

Journal homepage: https://ijsra.net/

(RESEARCH ARTICLE)

Check for updates

Implementation of smart irrigation system

G. Jayanthi *, K. Karthikeyan, M. Kadhiravan and P. Baranitharan

Department of Electrical and Electronics Engineering, Mahendra Engineering College, Namakkal, India.

International Journal of Science and Research Archive, 2024, 13(01), 1943–1951

Publication history: Received on 09 August 2024; revised on 23 September 2024; accepted on 26 September 2024

Article DOI: https://doi.org/10.30574/ijsra.2024.13.1.1758

Abstract

Current global technology significantly impacts agriculture, with automation playing a crucial role by executing procedures without assistance from any individual. This work aims to demonstrate how an individual can set up an affordable automatic irrigation system in a few hours by connecting various electronic components and materials. A sensor-based automated irrigation system has been designed and implemented, providing widespread use and significant advantages. This system aids daily activities by saving time and reducing labor. It makes use of a sensor technology in conjunction with a microcontroller, relay, DC motor, and battery. By measuring the moisture content of the soil and turning on irrigation as necessary, the device functions as an intelligent switch. The motor automatically turns on or off based on soil dryness. Sensor readings are transmitted to a computer for graph generation and analysis, allowing easy monitoring and control via a computer. Green roofs, nurseries, greenhouses, and gardens of all sizes can use this watering system.It conserves time, energy, reduces water wastage, and simplifies irrigation planning for farmers, enhancing their management of crops.

Keywords: Soil sensor; Irrigation; Automation; Microcontroller

1. Introduction

In the quickly changing technology environment of today, smart irrigation systems have revolutionized the agricultural sector by leveraging automation to efficiently manage water usage and maintain optimal soil moisture levels without constant human intervention. This innovation's central component is the Arduino microcontroller, a flexible and reasonably priced platform that enables accurate irrigation process management and monitoring. A smart irrigation system using Arduino integrates components like soil moisture sensors, relays, DC motors, and batteries. The soil moisture sensors continuously monitor the soil's water content, and when it drops below a preset threshold, the Arduino processes this data and activates the relay, which in turn powers the DC motor to run the water pump. This automated process ensures that plants are watered only when necessary, preventing over-irrigation and under-irrigation. It conserves water, reduces labor, saves time, and enhances agricultural efficiency. Additionally, it promotes sustainable farming by minimizing water wastage and ensuring crops receive adequate hydration. By adopting such a system, farmers can focus more on crop management and other essential tasks, thus improving productivity and yield.

2. Block diagram

In this block diagram, the moisture sensor provides an analog voltage output, which connects to the analog input pins of the Arduino UNO and is powered by the board. The Arduino UNO controls a relay, which in turn operates the motor or pump. The "NO" (Normally Open) terminal of the relay is linked to the circuit ground, and it is used to turn the motor ON or OFF. An energy supply or battery isrequired to run the entire system. The microcontroller, sensors, and motor all function with energy supplied from this source. When the sensors detect low moisture or dryness, they send data to the microcontroller (Arduino UNO), which then activates the motor via the relay. Once the sensors determine that the soil

*Corresponding author: G.Jayanthi

moisture level is adequate, They return data to the microcontroller, which turns off the motor using the same relay process. We can monitor the humidity level by using DHT 11 sensor.

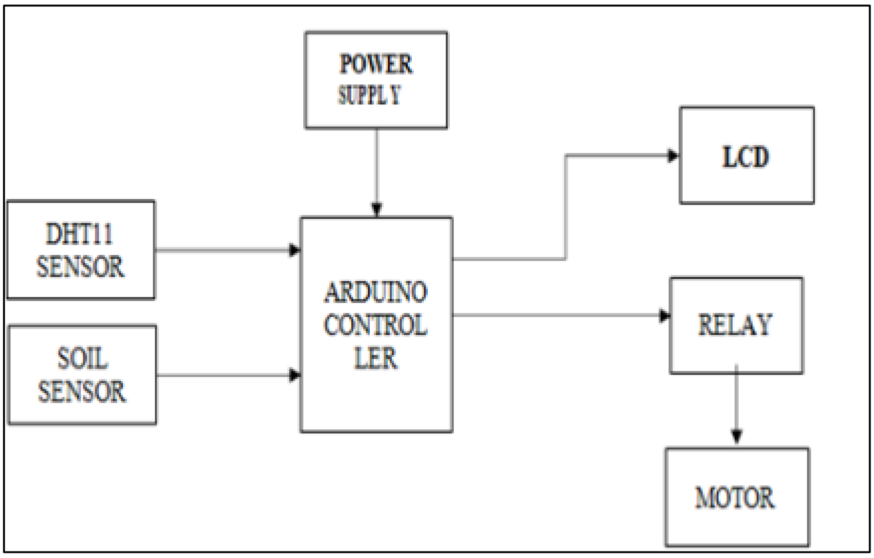

Figure 1 Block Diagram of Smart Irrigation System

3. Components description

3.1. DHT 11 sensor

The DHT-11 is a simple, very cheap digital sensor that measures temperature and humidity. It uses a capacitive humidity sensor and thermistor to measure the ambient air quality before sending a digital signal on the data pin (analog input pins are not needed). This sensor may be easily interfaced with any micro-controller, such as an Arduino, Raspberry Pi, or other device, to quickly measure temperature and humidity. For the DHT11 sensor, there are two options: a sensor and a module. This sensor can be identified from the module by its pull-up resistor and power-on LED. DHT 11 sensor has a thermistor to sense the surrounding air temperature in addition to a capacitive humidity sensor.

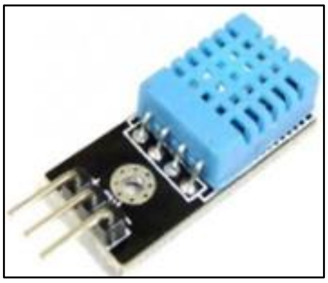

Figure 2 DHT 11 Sensor

3.2. Soil sensor

A soil moisture sensor is an electronic device designed for determining the soil's water content, crucial for optimizing irrigation in agriculture and horticulture. These sensors typically use probes or electrodes inserted into the soil to detect moisture levels by measuring electrical resistance or capacitance, which changes with the soil's water content. The sensor connects to a microcontroller, such as an Arduino, to process and convert this data into readable moisture levels. There are two primary types of soil moisture sensors: resistive, which measure electrical resistance, and capacitive, which measure changes in dielectric permittivity. By providing real-time soil moisture data, these sensors facilitate efficient water use, promoting healthier plant growth and higher yields while preventing over-irrigation. They are widely used in applications from large-scale farming to home gardening and environmental monitoring, offering a cost-effective and user-friendly way to maintain optimal soil moisture levels.

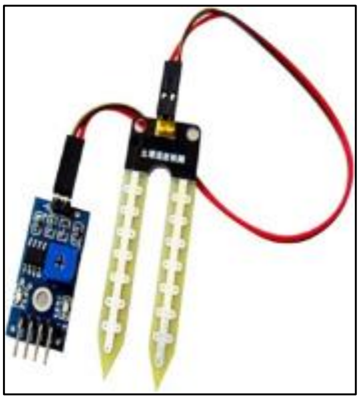

Figure 3 Soil Sensor

3.3. Arduino UNO

A well-known microcontroller board based on the ATmega328P chip is the Arduino Uno. It is a member of the Arduino family, which is known for its open-source hardware and software. It provides an easy-to-use platform for developing interactive electronic projects, featuring digital input/output pins, analog inputs, PWM outputs, and moreTheArduino IDE (Integrated Development Environment) makes programming the board easier by streamlining the authoring and uploading of code. An detachable dual-inline-package (DIP) ATmega328 AVR microcontroller, six analog inputs, a 16 MHz crystal oscillator, fourteen digital input/output pins (six of which can be used as PWM outputs), a USB port, a power jack, an ICSP header, and a reset button are all included in the most recent version, the Arduino Uno R3. All necessary components for microcontroller support are included, allowing for USB connection to a computer, battery, or AC-to-DC converter powering. Unlike previous boards, the Uno does not use the FTDI USB-to-serial driver chip. For those new to embedded electronics, the Arduino Uno is a great choice because of its large support network.

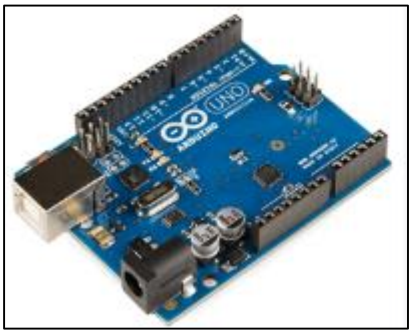

Figure 4 Arduino UNO

3.4. Relay

A relay is a switch operated electrically, allowing a low-power signal to command a circuit with high power. It comprises an electromagnet, armature, contacts, spring, and enclosure. When the electromagnet is energized by the control signal, the armature moves, opening and closing the circuit contacts. Different types of relays include electromechanical, solid-state, reed, time-delay, and polarized variants. They are utilized in automotive systems, telecommunications, industrial automation, home appliances, and power systems. Relays offer a reliable means to control high-power devices safely and efficiently, playing a vital role in enabling remote control, automation, and circuit protection.

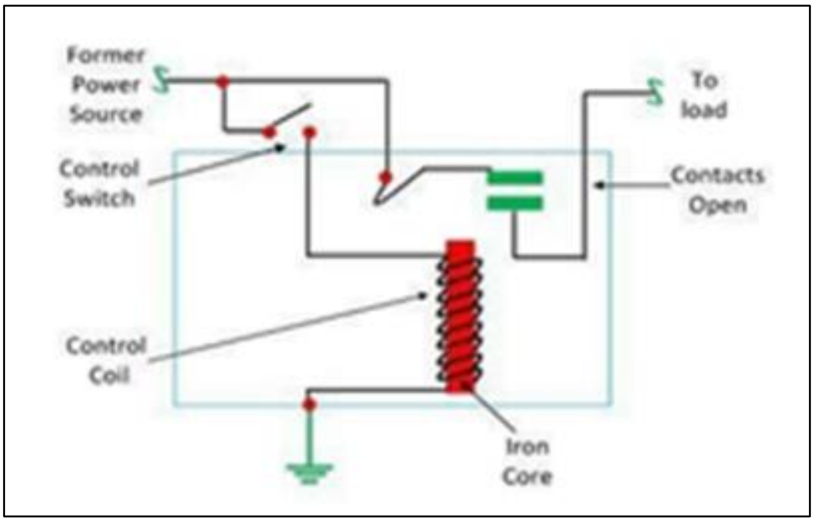

Figure 5 Relay Circuit

3.5. Water pump

A submersible pump is designed to operate underwater, wells, boreholes, or reservoirs to raise the water's surface through pumping. These pumps are often used to get water from underground sources, such as groundwater wells or storage tanks. They are characterized by hermetically sealed motor enclosures, allowing them to function efficiently and safely while fully submerged. Submersible pumps are commonly employed in residential, commercial, agricultural, and industrial settings for various purposes, including the availability of water, irrigation, drainage, and wastewater treatment.

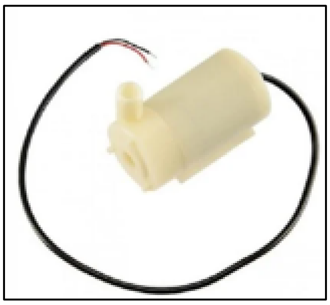

Figure 6 Submersible Pump

4. Design and implementation

The Arduino board receives a signal from the detector when the soil begins to dry out, and it uses that signal to activate the pump. Once the required moisture content of the soil is reached, the Arduino turns off the pump. The soil moisture detector functions as a variable resistor, meaning its resistance changes based on the conductivity between its two probes. The conductivity of these probes changes with the moisture content of the soil when they are inserted. Resistance is high and conductivity is low in dry soil, while resistance is low and conductivity is high in humid soil.

Therefore, the resistance of the sensor and soil moisture have an inverse relationship. This shift in resistance can be compared to the output voltage. The analog output voltage falls with increasing soil moisture content and vice versa. Analog input for the Arduino is provided by the output voltage of the sensor. From 0% to 100%, the Arduino determines the soil's moisture content by converting this input into a digital value. The Arduino utilizes a transistor to initiate the pump using a relay when the moisture level falls below a preset threshold, like 10 or 20%. The earth gets wetter as the pump runs. The moisture content of the soil is continuously monitored by the Arduino. Upon reaching the targeted moisture level (such as 90 or 95%), the Arduino deactivates the relay, so stopping the pump. Repetition of this cycle guarantees that the plant receives water whenever the soil dries out.

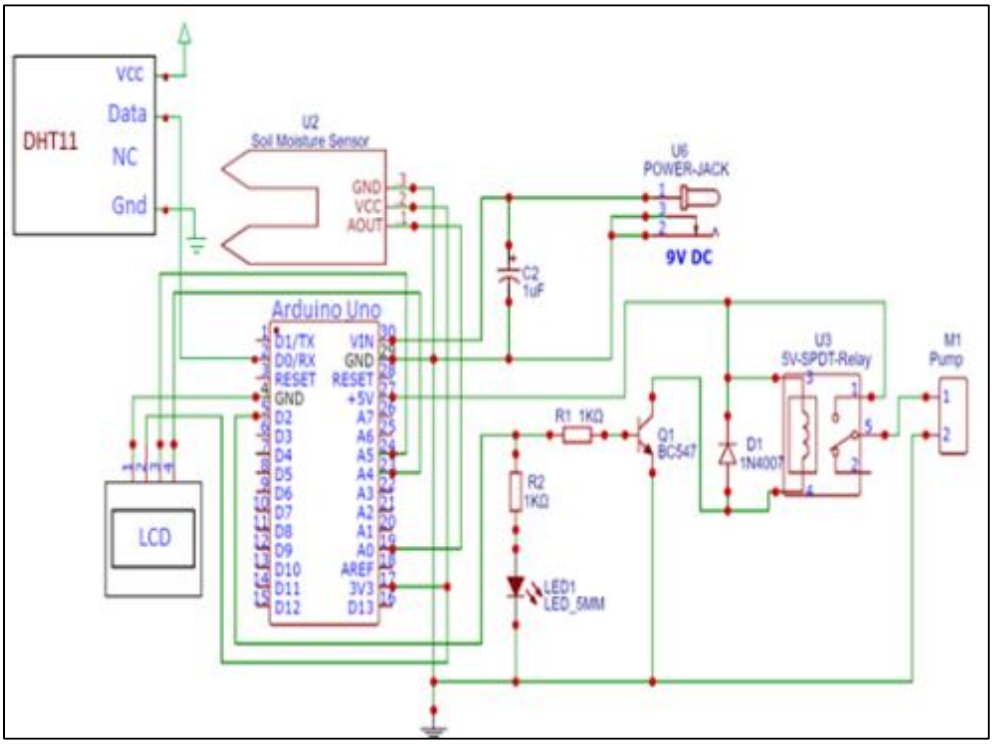

Figure 7 Circuit Diagram

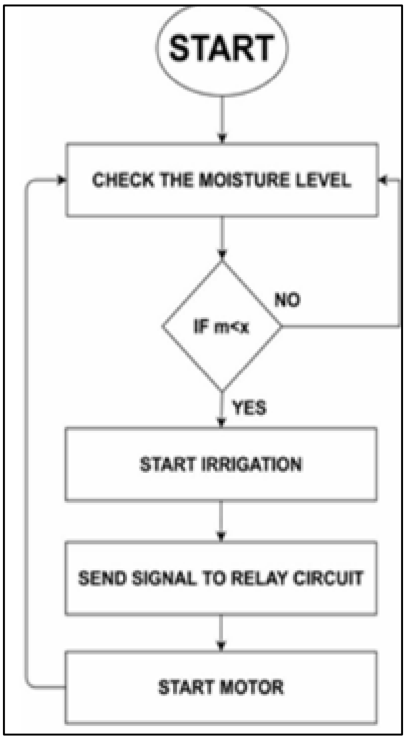

Figure 8 Flow Chart

4.1. Simulation Settings

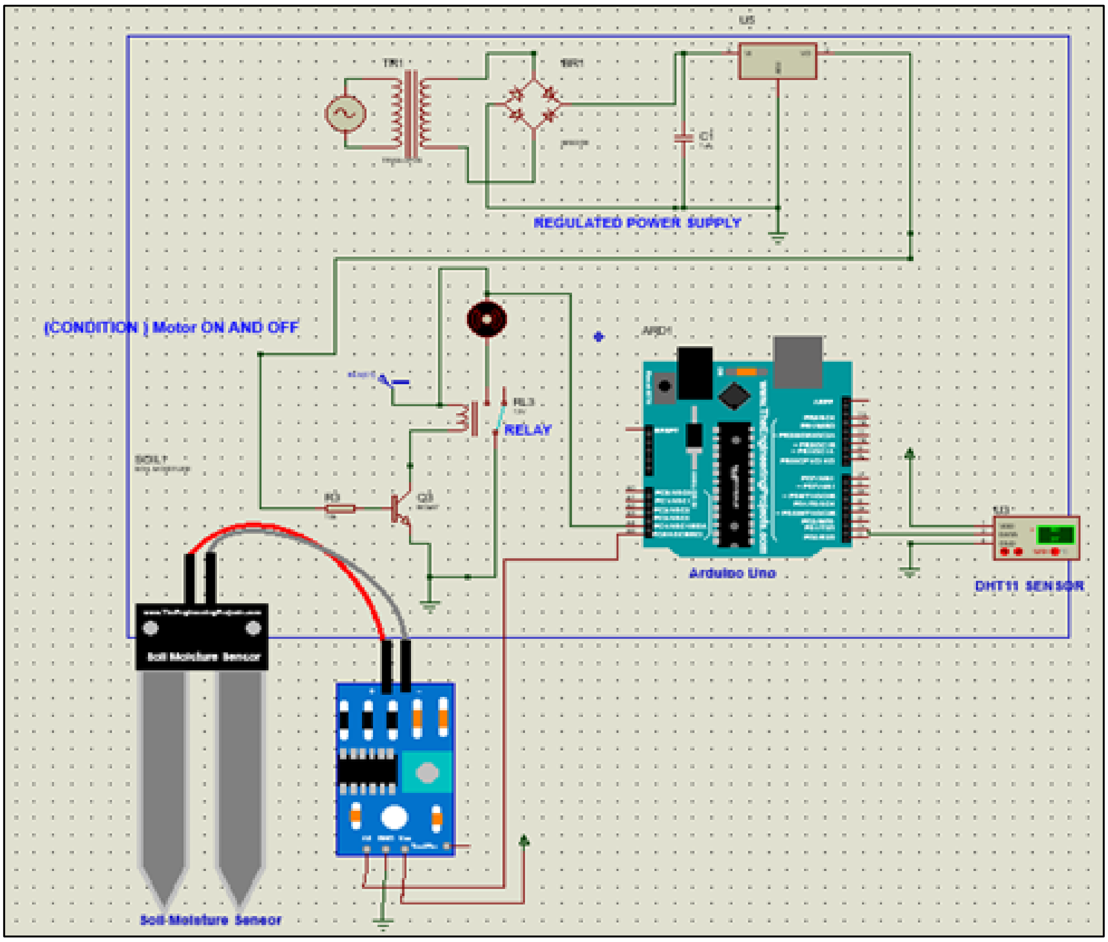

Figure 9 Simulation Diagram

4.2. Arduino Code

```
#include <LiquidCrystal.h>
#include <Adafruit_Sensor.h>
#include <DHT.h>
#include <DHT_U.h>
#define DHTTYPE    DHT11     // DHT 11
#define DHTPIN 8
DHT_Unified dht(DHTPIN, DHTTYPE);
uint32_t delayMS;
uint8_t relay = 10;
// initialize the library by associating any needed LCD interface pin
// with the arduino pin number it is connected to
const int rs = 7, en = 6, d4 = 5, d5 = 4, d6 = 3, d7 = 2;
LiquidCrystal lcd(rs, en, d4, d5, d6, d7);

void setup() {
  // set up the LCD's number of columns and rows:
  Serial.begin(9600);
dht.begin();
sensor_t sensor;
delayMS = sensor.min_delay / 1000;
pinMode(relay,OUTPUT);
  lcd.begin(16, 2);
  lcd.print("SMART");
  lcd.setCursor(0, 1);
  lcd.print("IRRIGATION");
}
```

```
  void loop() {

 relay_function();
    }
 void Dht_sensor()
 {
  sensors_event_t event;
  dht.temperature().getEvent(&event);
  Serial.print(F("Temperature: "));
  Serial.print(event.temperature);
  Serial.println(F("°C"));

  lcd.begin(16, 2);
  lcd.print(F("°C"));
  dht.humidity().getEvent(&event);
  Serial.print(F("Humidity: "));
  Serial.print(event.relative_humidity);
  Serial.println(F("%"));
  delay(500);
 }
 void relay_function(){
  digitalWrite(relay,HIGH);
  delay(1000);
  digitalWrite(relay,LOW);
  delay(1000);
 }
```

5. Result

The smart irrigation system demonstrated significant improvements in water management efficiency compared to traditional methods. Through continuous monitoring of soil moisture levels,weather conditions, the system effectively optimized irrigation schedules to meet the specific needs of crops. Data analysis revealed substantial water savings, less waste of water, and enhanced crop quality and output. The results highlight the effectiveness of the smart irrigation system in conserving water resources while enhancing agricultural productivity. The automated and real-time monitoring features of the system reduce the reliance on manual labor and minimize human error in irrigation management. Considerations for scalability, cost-effectiveness, and compatibility with existing agricultural practices are addressed to facilitate the adoption of smart irrigation technology in real-world settings. In conclusion, the smart irrigation system project demonstrated the possibilities for technologies based on microcontrollers to revolutionize water management in agriculture, improving agricultural output, preserving resources, and maintaining the environment.Further research and collaboration are needed to address remaining challenges and accelerate the adoption of smart irrigation systems that help farmers, communities, and the planet.

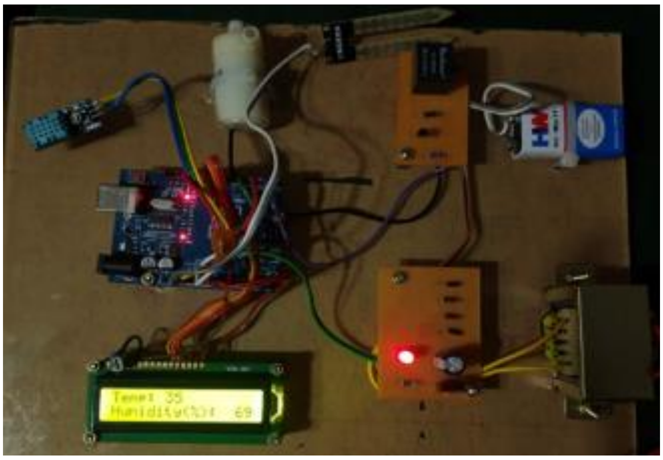

Figure 10 Hardware Output

6. Conclusion

In summary, the utilization of Arduino UNO in the Smart Irrigation System signifies a significant leap in agricultural technology, providing an effective and automated method for managing water resources. Through the integration of diverse components such as moisture sensors, relays, and pumps with the Arduino UNO microcontroller, this system guarantees precise and timely watering for plants based on real-time soil moisture readings. The automation facilitated by Arduino UNO reduces human involvement, resulting in water conservation and decreased labor expenses. Moreover, by preventing both excessive and inadequate watering, the system encourages sustainable farming methods, thereby aiding environmental preservation efforts. The affordability and user-friendly interface of the Arduino-based system render it accessible to a wide spectrum of users, ranging from small-scale farmers to large agricultural enterprises. Ultimately, the Smart Irrigation System employing Arduino UNO emerges as a pivotal instrument for enhancing crop yields, curbing water wastage, and propelling the adoption of sustainable agricultural practices within the swiftly evolving technological field.

References

[1] SANTOSHKUMAR; UDAYKUMAR; R.Y., "Development of WSN system for precision agriculture", EMBEDED AND COMMUNICATION SYSTEM, 2015

[2] ASSOCIATE PROF.B.T.SALOKHE, MISS SHILPA G. GADEKAR, "A wireless application of drip irrigation automation supported by soil moisture sensors",INTERNATIONAL JOURNALOFADVANCEDRESEARCHIN COMPUTERANDCOMMUNICATION ENGINEERING,APRIL2015.

[3] TAMEEM AHMAD, SHAMIM AHMAD, MOHAMMED JAMSHED, "A knowledge based Indian agriculture: with cloud ERP arrangement"2015 IEEE.

[4] PRABHA, TANUJABAI J.M, S. KRUPESH, "Real-time atomization of agricultural environment for social modernization of Indian agricultural system using arm 7". INTERNATIONALJOURNAL OF ADVANCED RESEARCH IN ELECTRICAL, ELECTRONICS AND INSTRUMENTATION ENGINEERING (ANISO 3297: 2007 CERTIFIED ORGANIZATION) VOL. 3, ISSUE 6, JUNE 2014.

[5] VENKATA NARAYANA ELURI, K. MADHUSUDHANA RAO, A. SRINAG, "Wireless solution for water saving in agriculture using embedded system", INTERNATIONAL JOURNAL OF COMPUTER SCIENCE AND BUSINESS INFORMATICS, ISSN: 1694-2108 — VOL. 2, NO. 1. JUNE 2013.

[6] J. BROEDERS, D. CROUX, M. PEETERS, T. BEYENS, S. DUCHATEAU, T. J.CLEIJ,P.WAGNER, R. THOELEN, AND W. DE CEUNINCK, "Mobile application for impedance-based bio mimetic sensor readout," IEEE SENSORS J.,VOL.13, NO. 7, PP. 2659- 2665, JULY 2013.

[7] XIHAI ZHANG, JUNLONG FANG, XIAO YU 2010 "Design and implementation of codes based on for the agricultural information wireless monitoring", IEEE.

[8] X. WANG, W. YANG, A. WHEATON, N. COOLEY, AND B. MORAN, "E_cientregistration of optical and IR images for automatic plant water stress assessment", COMPUT.ELECTRON.AGRICULTURE.VOL.74,NO. 2,year,2016.

[9] MR.M.A.MURTAZA,MR.MRAGANKSHARMA,"Microcontrollersolarpoweredautomatic irrigation system" INTERNATIONAL JOURNAL, VOLUME 7, ISSUE NO.4,YEAR,2017.

[10] V R.BALAJI, M.SUDHA, "Solar powered auto irrigation system". INTERNATIONAL JOURNAL, VOLUME, 20. ISSUE, 2. YEAR, 2016.

[11] S. DARSHNA, T.SANAGAVI, SHEENA MOHAN, A. SOUNDHARYA, SUKANYA DESIGAN, "Smart Irrigation System", INTERNATIONAL ORGANIZATION OF SCIENTIFIC RESEARCH, YEAR, 2015.

[12] PRAKHAR SRIVASTAVA, MOHIT BAJAJ, ANKUR SINGH RANA, "Overview of ESP8266 Wi-Fi module based Smart Irrigation System using IOT", IEEE, YEAR, 2018.

[13] TRIFUN SAVIĆ, MILUTIN RADONJIĆ, "WSN Architecture for Smart Irrigation System", IEEE, YEAR, 2018.

[14] S. VAISHALI, S. SURAJ,G. VIGNESH, S. DHIVYA, S. UDHAYAKUMAR, "Mobile Integrated Smart Irrigation Management and Monitoring System Using IOT", IEEE, YEAR, 2018.

[15] SANDEEP KUMAR,P. RAJA,G. BHARGAVI, "A Comparative Study on Modern Smart Irrigation System and Monitoring the Field by using IOT", INTERNATIONAL CONFERENCE ON COMPUTING, POWER AND COMMUNICATION TECHNOLOGIES, YEAR, 2018.

[16] IRFAN ARDIANSAH, AWANG BONO, RONI KASTANI, EDY SURYADI, YANTI RUBYANTI, “A Study of Irrigation Management in Smart Farming and IOT for Greenhouse Tomato Production”, JOURNAL OF ELECTRICAL SYSTEMS, YEAR, 2024.

[17] KENN MIGAN VINCENT GUMONAN,PHOEBE RUTH ALITHES BACOTOT SUDARIA, REGIE BINAYAO, PAUL VINCENT MANTUA, HOLY ROSE MAY NAMOCATCAT, JADE KACHEL KLIENT SEROY, SHIELA MAE OROZCO, “Smart Water Irrigation for Rice Farming Through the Internet Of Things”, INTERNATIONAL JOURNAL OF COMPUTING SCIENCES RESEARCH, YEAR, 2024.

[18] I.O.OLADIPO, P.O AJEWOLE, “A Smart Irrigation Water Application System Based on Arduino Platform”, ASIAN JOURNAL OF AGRICULTURAL AND HORTICULTURAL RESEARCH, YEAR, 2024.

[19] NITESH YADAV, “IOT Based Smart Irrigation System Using Weather Forecasting”, INTERNATIONAL JOURNAL OF SCIENCE AND RESEARCH (IJSR), YEAR, 2024.

[20] SAPNA JHA, ADITYA TRIVEDI, K.K. PAATANAIK, HIMANSHU GAUTTAM, PAOLO BELLAVISTA, “Efficient data harvesting from boundary nodes for smart irrigation”, PEER-TO-PEER NETWORKING AND APPLICATIONS, YEAR, 2023.