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Automated Irrigation System and Field Monitoring Using IoT

Suhitha S[1], Suganya K[1], Renuga S[1], Nivethitha V[1], P Sivakumar[2]

[1]*Department of Electronics and Communication Engineering, Dr.N.G.P. Institute of Technology, TamilNadu, India*

[2]*Professor, Department of Electronics and Communication Engineering, Dr.N.G.P. Institute of Technology, TamilNadu, India*

Emails: suhithasureshece@gmail.com, suganya493@gmail.com

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Abstract

Traditional agriculture is transforming into smart agriculture due to the prominence of the Internet of Things (IoT). Low-cost and low-power are the key factors to make any IoT network useful and acceptable to the farmers. In this paper, we have proposed a low-power, low-cost IoT network for smart agriculture. For monitoring the soil moisture content and detect the presence of human and animals by using an in-house developed sensor. In the proposed network, the node used to connect the system to our smart device, also controls the flow of water and also the timing intervals in between the irrigation cycles. It is easy to use for anyone with a Smartphone and doesn't require maintenance once set up.

1. Introduction

An Automated Irrigation System for Field Monitoring using IoT is a system that combines the power of Internet of Things (IoT) technology with modern irrigation practices to improve the efficiency and effectiveness of agriculture. The concept of this project is to allow the owners of fields to control and observe the growth of their plants in their farms. This is achieved by using a smart platform of IoT and solenoid valves to control the flow of water based on the moisture of the soil and gives real time surveillance to the owners who stay far away from the farms (Gupta and Arakere Ramachandran, Ramalakshmi, and Srinivasan). The most important advantage of contemporary drip irrigation systems is that water is approaching the root zone of plants, which helps to save water. But, in present, the farmers are using irrigation schemes manually to irrigate their lands at a consistent interval of time (Rani, N. Kumar, and Bhushan). If farmer fails to attend the irrigation, there is chance of wastage of water and electricity. Also, excess watering leads to soil damage. In order to control and monitor the irrigation process, smart and automated irrigation system is developed (Vaishali et al.). we have proposed a low- power, low-cost IoT network for smart agriculture (Jamroen et al. Asuwini et al.).IOT advancement aids in social affair information on conditions like atmosphere, temperature and productivity of soil, harvest web watching engages area of weed, level of water, bug acknowledgment, animal interference in to the field, alter improvement, cultivation (Rajendranath and Hency Asuwini et al.) . This system uses sensor to monitor soil moisture levels. water flow rates, presence of animals and humans and uses this information to control the irrigation process automatically. (Anusha et al.) The system can provide the right amount of water to crops at the right time, promoting healthy growth and improving crop yields (Rafiq et al. Aggarwal and A. Kumar). The system can monitor and controlled remotely, making it possible to monitor crop conditions and adjust the irrigation process from a remote location. The system is connected to the internet and can be monitored and controlled using a smartphone app[15]. In this paper we will be discussing all about the project as to how it is constructed and how it works.

1.1. Hardware Description:

FIGURE 1. **Soil Moisture Sensor**

The volumetric water content of the soil is measured by soil moisture sensors. As removing, drying, and weighing a sample of free-soil are necessary for the direct gravimetric measurement of its moisture using another characteristic of the soil, such as electrical resistance, the dielectric constant, or interaction with neutrons as a stand-in for the moisture content, soil moisture sensors estimate the volumetric water content indirectly.

1.2. PIR Sensor HC-SR501:

FIGURE 2. **PIR Sensor**

It is a simple, low-cost sensor that can identify movement by observing variations in infrared radiation levels. It is simple to operate and capable of detecting motion by observing variations in infrared radiation levels. The sensor's sensitivity can be changed to meet the particular needs of the application. The HC-SR501 is appropriate for a wide range of applications because to its detection range of up to 7 metres.

FIGURE 3. **Ultra-Sonic Sensor (HC-SR04)**

1.3. Ultra-Sonic Sensor:

Ultra-Sonic Sensor (figure 3) works by sending out a high frequency sound wave(ultrasound) and measuring the time it takes for the sound wave to bounce back after hitting an object.The module has four pins: VCC, GND, Trig, and Echo. The VCC and GND pins are used to power the module, while the Trig pin is used to trigger the ultrasonic pulse and the Echo pin is used to receive the reflected pulse.Around 2 cm (0.8 inches) to 3 metres can be measured precisely and without contact using an ultrasonic distance sensor (3.3 yards). With just one I/O pin, it is relatively simple to connect to BASIC Stamp® or Javelin Stamp microcontrollers. The PING sensor operates by transmitting a burst of ultrasonic sound that is much above the range of human hearing and then delivering an output pulse at a rate determined by how long it takes for the echo of the burst to return to the sensor. The target distance can be quickly determined by measuring the echo pulse width.

1.4. Relay:

FIGURE 4. **Relay**

Relay **(figure 4)** is an electrically operated switch. Current flowing through the coil of the relay creates a magnetic field which attracts a lever and changes the switch contacts. The coil current can be on or off so relays have two switch positions and they are double throw (changeover) switches. Relays allow one circuit to switch a second circuit which can be completely separate from the first. For example, a low voltage battery circuit can use a relay to switch a 230V AC mains circuit. There is no electrical connection inside the relay between the two circuits; the link is magnetic and mechanical. The coil of a relay passes a relatively large current, typically 30mA for a 12V relay, but it can be as much as 100mA for relays designed to operate from lower voltages. Most ICs (chips) cannot provide this current and a transistor is usually used to amplify the small IC current to the larger value required for the relay coil.

1.5. Pump:

FIGURE 5. **Pump**

Micro dc 3-6v micro submersible pump mini water pump for fountain garden mini water circulation system diy project dc 3v to 6v submersible pump micro mini submersible water pump 3v to 6vdc water pump for diy dc pump for hobby kit mini submersible pump motor this is a low cost, small size submersible pump motor which can be operated from a 2.5 ~ 6V power supply. It can take up to 120 litres per hour with very low current consumption of 220ma. Just connect tube pipe to the motor outlet, submerge it in water and power it. Make sure that the water level is always higher than the motor. The dry run may damage the motor due to heating and it will also produce noise.

1.6. Node MCU (ESP8266):

The Node MCU (ESP8266) is a low-cost, open-source microcontroller development board based

FIGURE 6. **Node MCU (ESP8266)**

on the ESP8266 Wi-Fi microcontroller. It provides a complete platform for building lot (Internet of Things) applications and includes an integrated Wi-Fi module for connecting to the Internet. The integrated Wi-Fi module allows the Node MCU (ESP8266) to connect to the Internet and send/receive data. The Node MCU board can be programmed using the Arduino Integrated. Development Environment (IDE) or other programming environments, making it easy to get started with lot projects.

1.7. LCD:

FIGURE 7. **16×2 Character LCD**

LCD (Liquid Crystal Display) screen is an electronic display module and find a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segmentsand other multi segment LEDs. The reasons being: LCDs are economical; easily programmable; have no limitation of displaying special & even custom characters (unlike in seven segments), animations and so on. A **16x2 LCD** means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. This LCD has two registers, namely, Command and Data. The command register stores the command instructions given to the LCD. A command is an instruction given to LCD to do a predefined task like initializing it, clearing its screen, setting the cursor position, controlling display etc. The data register stores the data to be displayed on the LCD. The data is the ASCII value of the character to be displayed on the LCD.

1.8. Pin Diagram:

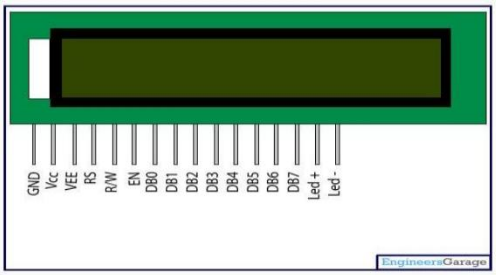


FIGURE 8. **Pin Diagram of 16x2 LCD**

1.9. Block Diagram:

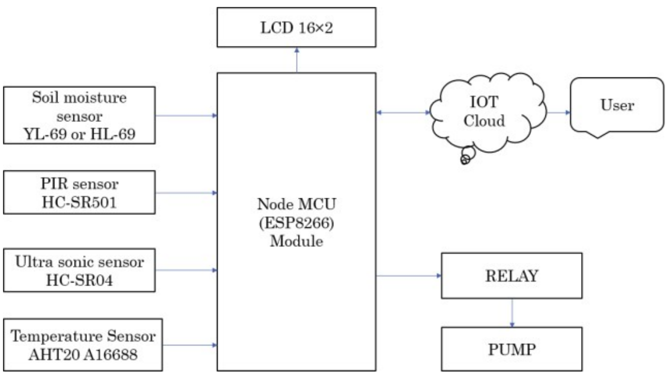


FIGURE 9. **Block Diagram**

2. Materials and Methods:

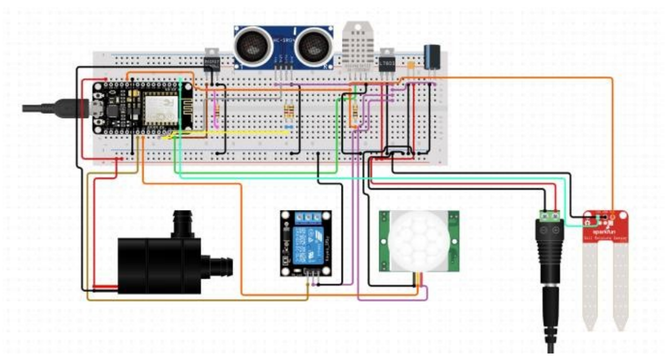


FIGURE 10. **Schematic diagram**

- a - Node MCU(ESP8266)
- b - PIR sensor (HC-SR501)
- c - Ultra sonic sensor (HC-SR04)
- d - Soil moisture sensor (YL-69 or HL-69)
- e - Solenoid valve
- f - Relay
- g – Pump

Connect the VCC pin of the PIR Sensor (Figure 2) to the 3.3V pin on the Node MCU (ESP8266) (Figure 6) module. Connect the GND pin of the PIR Sensor to the GND pin on the Node MCU (ESP8266) module Connect the OUT pin of the PIR Sensor to a digital input pin (e.g.D1) on the Node MCU (ESP8266) module (Figure 10). Connect the VCC pin of the ultrasonic sensor to the 3.3V pin on the Node MCU(ESP8266) module. Connect the GND pin of the ultrasonic sensor (Figure 3) to the GND pin on the Node MCU (ESP8266) module Connect the TRIG pin of the ultrasonic sensor to a digital output pin (e.g.D1) on the Node MCU (ESP8266) module Connect the ECHO pin of the ultrasonic sensor to a digital input pin (e.g.D2) on the Node MCU (ESP8266) module.

The Analog output of soil moisture sensor is processed using ADC. The moisture content in terms of percentage is displayed on the serial monitor. The output of the soil moisture sensor changes in the range of ADC value from 0 to 1023.

This can be represented as moisture value in terms of percentage using formula given below.

Analog Output = ADC Value / 1023

Moisture in percentage = 100 – (Analog output * 100)

Controlling Node MCU with smartphone and Blynk via internet:

Blynk allow us to create applications and then use it to control Node MCU connected to a PC with internet access, from anywhere in the world, (for instance, controlled, servos, receive data, etc.), with a smartphone. It is one of the most interesting actions! The connection can also be established by Bluetooth between smartphone and node MCU, but this will be not presented in this work. Blynk (Figure 11) can be download from Google play store (for Android) & app store (for apple), providing us the dashboard as well as the connectivity to node MCU, (it is a virtual connectivity). Programming Blynk is very simple, push and drag widgets form the tools bar and allocating them pins on node MCU. For such

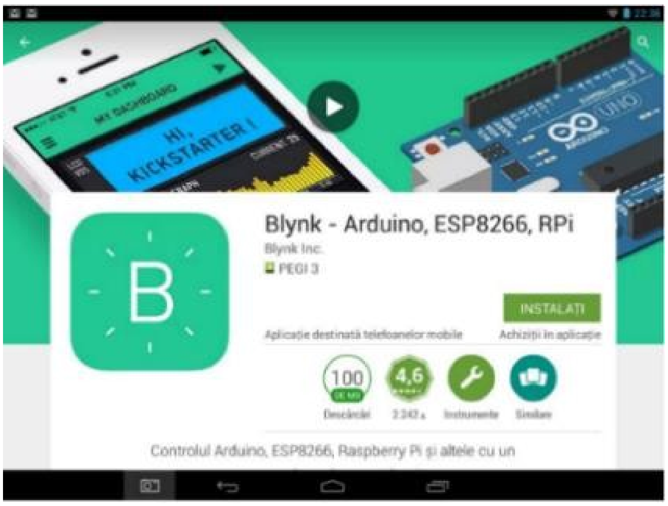


FIGURE 11. **Blynk v0.3.1**

project can be used an ordinary Node MCU, without internet shield, connected to a PC with internet access and a smartphone. The role of PC is to ensure the connectivity of the Arduino board

to the internet and to upload the Node MCU. For this purpose, it is necessarily to install Blynk library on the PC and made some settings.

we need to follows many steps.

• Install Blynk app on your smartphone and create your simplest application, for instance control one led.

• Download blynk v0.3.1 (Figure 11)library and install on your PC.

• Set the right port of the PC to communicate with the Arduino board, (very important), from the script of the Blynk library

• Upload the Arduino code, (from the examples presented in this work, or other).

• Run the Blynk on the smartphone.

Flow chart:

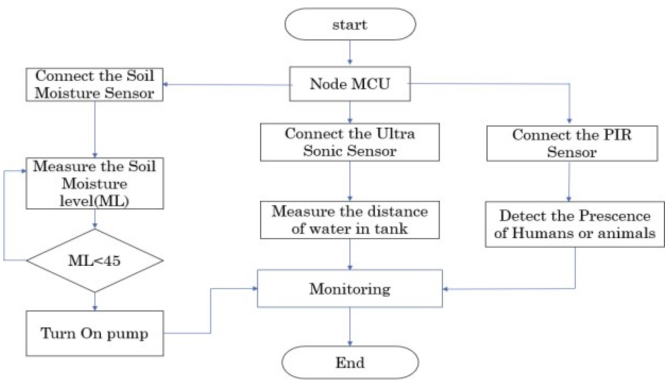


FIGURE 12. **Flow chart**

The Node MCU is connected with the soil moisture sensor (Figure 1). The soil moisture sensor measures the soil level and if the soil moisture level is below the set value the command send to the pump to turn on. If the soil moisture level is above the set value, then the command sends to the pump to turn off. Then the Node MCU is also connected with the ultra-sonic sensor and this sensor is used to measure the distance of the water in the tank. The Node MCU is connected with the pir sensor (Figure 2), which is used to detect the presence of human beings and animals. The process then repeats all over. The intention of this project is to provide the clients far away from the fields, a chance to keep an eye on their plants.4

3. Results and Discussion

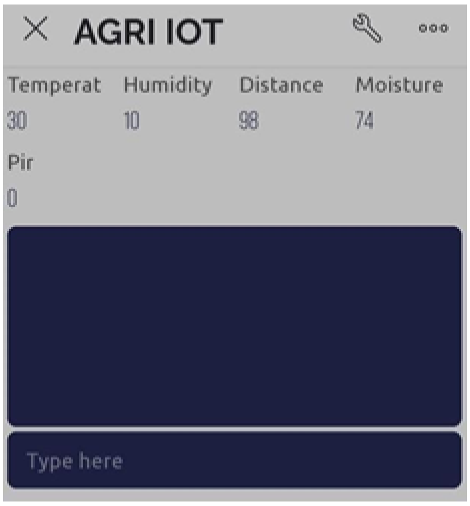
We have measured the results from two types of soil,1.red soil 2.clay soil.The soil mositure level of the red is maximum 75%and minimum 1%.The soil moisture level of the clay soil maximum is 79% and minimum at 1%.If the soil mositure level is maximum, then the pump will be off.If it is minimum then pump will be on.

CASE 1:

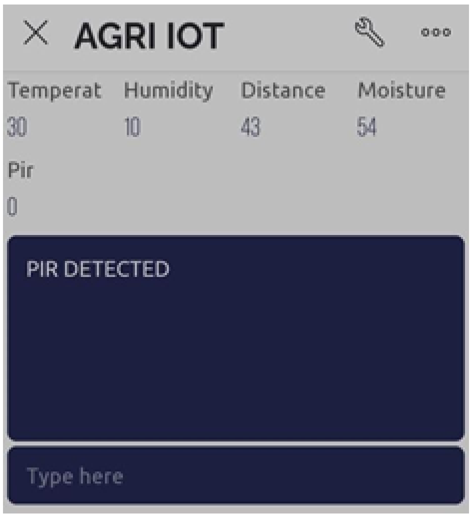
RED SOIL:

Moisture level low pump on:

Moisture level high pump off:

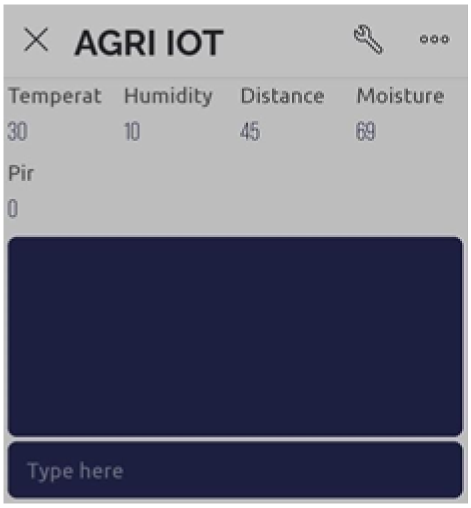


Moisture level low pump on PIR detected:



CASE 2:
CLAY SOIL:
Moisture level low pump on:

Moisture level high pump off:



4. Conclusion

By combining the data from these sensors, the Node MCU can provide valuable insights for various applications. For example, in an automated irrigation system, the moisture level in the soil can be used to determine the irrigation requirements of the crops, while the temperature data can be used to adjust the watering schedule based on the weather conditions. The motion detection can be used to activate the irrigation system only when there is no one in the field, saving water and energy. Similarly, in a security system, the motion detection can be used to trigger an alarm or notify the authorities if an intruder is detected.

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