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Internet of Things-based Agricultural Land Monitoring

Andrew[1)*], **Haryono**[2)]
[1)2)] Pradita University, Tangerang, Indonesia
[1)]andrew@student.pradita.ac.id, [2)]haryono@pradita.ac.id

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Abstract: Agriculture is an industrial sector that produces raw materials such as rice, corn, and agricultural products. In the current era, there should be no problem if there is a food shortage because society, industry, and education do not make a real contribution to supporting the agricultural industry. The state also needs good agricultural land, so that the state can fulfill the needs of its people. Without good agriculture, a country will not be able to meet the needs of its people. Modern society today is not or is rarely concerned with agriculture. Agriculture is carried out only by providing fertilizer, water, and land, paying attention to the quality of the agricultural land. One of the problems of declining agricultural production is crop failure. One of the reasons island for agriculture. Soil is the most important part of the world of agriculture. If the land is not cultivated then the land is difficult to become an ideal place for agriculture. The Internet of Things can be used as a solution to problems by tilling the soil and monitoring soil conditions. In conditions in the dry season, soil moisture needs to be done by water. In the rainy season, the land should not be flooded, let alone submerged and flooded. In order to maintain the balance of moisture and waterlogged soil, the Internet of Things is a solution for monitoring and managing agricultural land. Internet of Things is a device that can communicate with each other from one device to another, such as sensors and actuators. Good land cultivation makes agricultural land fertile. Agricultural land processing is maximized by adding a monitoring system for agricultural land using a micro-controller Arduino Uno, NodeMCU ESP8266, several sensors, and integrated devices. The purpose of this research is to make a prototype that is useful for monitoring agricultural land.

Keywords: Arduino Uno, NodeMCU ESP8266; Internet of Things; Agriculture; Monitoring Agricultural Land;

INTRODUCTION

Agriculture is currently also experiencing a fairly advanced development. Some modern equipment has been widely used by the community in managing their agriculture in order to get maximum results. Like agricultural tools in harvesting rice, nowadays many people use tractors to cut rice and directly process it into the grain. In addition, currently, many farms use the concept of integrated agriculture, growing crops with a variety of agricultural products. Farmers do not grow many similar crops but grow various kinds of agricultural crops.

Agricultural processing is inseparable from the problem of agricultural land (Raihan & Tuspekova, 2022). No matter how good agriculture is, if it doesn't do good land management, the results will make agriculture not produce good products. Plants do not grow optimally and the results also cannot be maximized. Some countries that do not have good agricultural land (Prayitno et al., 2021), have invaded by planting agricultural land in arid land or deserts. It doesn't matter whether the land is arid or desert, if optimal management is carried out, it causes agricultural products to increase agricultural products.

Drought on agricultural land can be overcome by giving water to agricultural land, if the agricultural land is very large, then the sprinkler on the land is not effective, which will waste a large cost and is very inefficient. Waterlogged land also cannot plant crops on agricultural land with wet land conditions. Therefore, the presence of internet of things technology is very much needed in monitoring and controlling so that internet of things devices make very good devices or devices in monitoring agricultural land (Butet et al., 2022), (Hu et al., 2019). It has become commonplace that agriculture requires innovation in agriculture like modern agriculture today. The use of technology such as drones to monitor agricultural crops has been widely practiced by farmers.

*name of corresponding author

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This study aims to create a prototype in monitoring agricultural land (Butet et al., 2022), (Pérez-Hoyos et al., 2020). This prototype will work in monitoring agricultural land, if it floods, the flood pump will turn on to dispose of water. If there is a shortage of water, the pump will provide water and there is no need for the soil to become very wet, it is enough to just moisten the soil, so that the plants can continue to produce according to the production period.

LITERATURE REVIEW

Previous studies that have discussed the Internet of Things to support agricultural activities. The following will be described in table 1.

Table. 1 Previous research on IoT-based agriculture

Author	Topic	Advantages	Disadvantages
(Saydi, 2021)	Monitoring of Rainfall and Soil Moisture in Agricultural Land Using Internet of Things (IoT) Based Sensors as the Basis for Precision Agriculture	Discussion about Internet of things devices for monitoring humidity and rainfall, using Arduino by using other sensors.	The drawback of this study is that it does not discuss flood prevention, because very heavy rains sometimes cause the land to be exposed to deep inundated water. This is detrimental to farmers.
(Syafiqoh et al., 2018)	Development of Internet of Things-Based Wireless Sensor Network for Agricultural Soil and Water Quality Monitoring System.	Discussion on soil monitoring in agriculture and water quality based on the Internet of Things. Soil temperature sensor, PH meter sensor.	The weakness of this study, if there is a flood on agricultural land. This causes damage to agricultural land. This research has not discussed about agricultural land submerged due to flooding.
(Ambarwari et al., 2021)	Environmental Condition Monitoring System for Food Crops with NodeMCU ESP8266 and IoT-Based Raspberry Pi	The discussion on the Internet of Things uses a DHT22 sensor (temperature and humidity), DS18B20 sensor (soil temperature), soil moisture sensor, BH1750 sensor (light intensity). Using the Message Queuing Telemetry Transport (MQTT) protocol and the data is sent to a gateway (Raspberry Pi).	The weakness of this study, if there is a flood on agricultural land. This causes damage to agricultural land. This research has not discussed about agricultural land submerged due to flooding.
(Waworundeng et al., 2018)	Automatic Watering System for Plants with IoT Monitoring and Notification	Discussions about monitoring systems for plants using Arduino microcontrollers and other sensors for agriculture have been able to solve problems in agriculture.	The weakness of the monitoring system is the problem of flooding on agricultural land, this also causes agricultural crops to die.

From table 1 regarding previous research, this research is to complement the weaknesses of previous research. State-of-the-art in this research is to use additional pumps to anticipate flooded agricultural land. With a pump that functions to drain the flood, the plants become healthy because their roots are not submerged in water. The purpose of this research is to monitor and maintain agricultural land to become fertile land for plants. Therefore, this research will make a prototype so that it can keep agricultural land fertile.

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METHOD

This research solves the problem of agricultural land using an Arduino microcontroller and agricultural soil detection sensors.

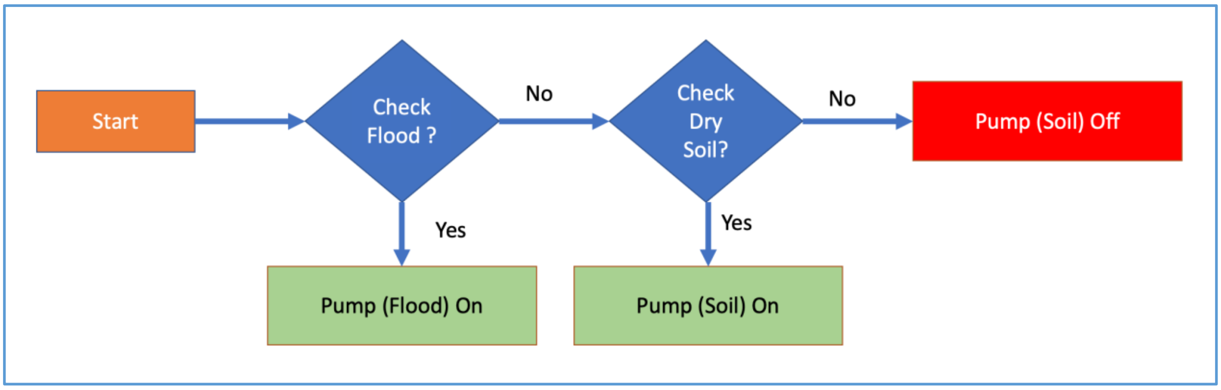

Figure. 1 Proposed method for solution of dry soil and flooded soil
Source : researcher property

Figure 1, is a proposed method for monitoring and controlling agricultural land by using detection sensors and pumps to water the land and to suck up flooding on agricultural land. Although it is not an ideal research method, it has been able to answer the problems in this research. The resulting prototype has limitations, where the limitation is a small prototype model. If it is applied to agricultural land, it is necessary to modify it first, such as a water pump with a larger capacity water pump.

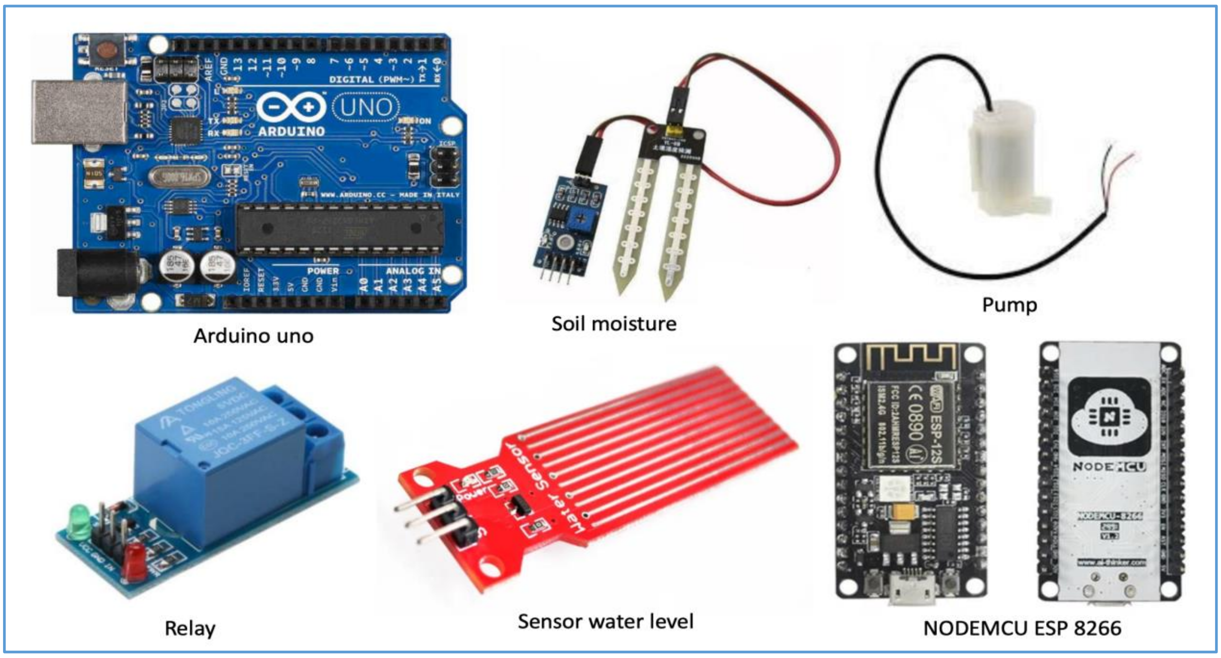

Figure. 2 Sensor and microcontroller monitoring dry soil and wet soil.
Source : researcher property

Sensor and Micro-controller

The sensors used to make the prototypes are the Arduino Uno microcontroller (Balogun et al., 2018), (Oltean, 2019) and the NodeMCU ESP 8266. The water level sensor (Kawakami et al., 2016), (Su & Ma, 2010) is useful for measuring flood water levels, then the sensor issues a signal to the micro-controller to give orders to the relay to turn on the flood pump so that it immediately turns on the pump. . The following are prototype equipment for agricultural land control (Nasir Ahmad et al., 2020): 1 pc Arduino Uno, 1 pc NodeMCU ESP8266, 2 pcs relays, 1 pc soil moisture sensor and 1 pc water level sensor.

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RESULT

The results of the proposed method for agricultural land cultivation can be seen in Figure 3 and Figure 4. The figure is a prototype made to solve the problems of this research. Farm soils are problematic if the soil is too dry, so the plant will die because there are no nutrients carried by the roots to the plant process. On the other hand, if the soil is too flooded and too wet, the roots will rot and eventually the plant will die. Therefore, the problems in the riser question are solved by the proposed research method. The result is a prototype like in figure 3 and figure 4.

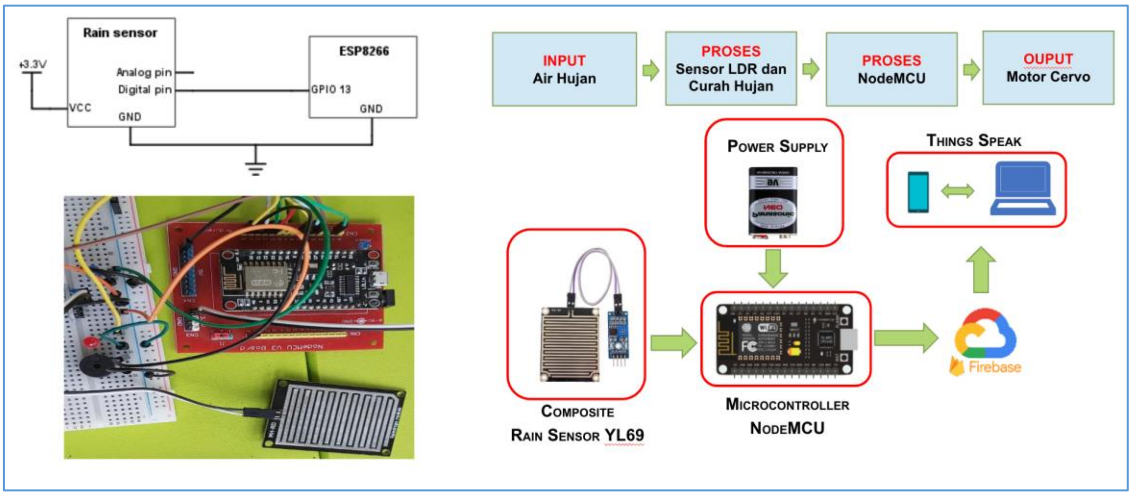

Figure. 3 Prototype monitoring dry soil and wet soil.
Source : researcher property

Figure 3, the monitoring prototype used is a prototype for checking rain. If it rains, the rain sensor will send a signal to the microcontroller to stop the water pumping into the agricultural land. The goal is that the soil is not too moist. This process is also integrated with each other, where if the soil sensor experiences moisture, the rain sensor will send a signal to the microcontroller to stop the pump so that the soil does not become moist. The soil sensor will send data to the cloud database or firebase for storage (Ohyver et al., 2019). The server can monitor the state of agricultural land.

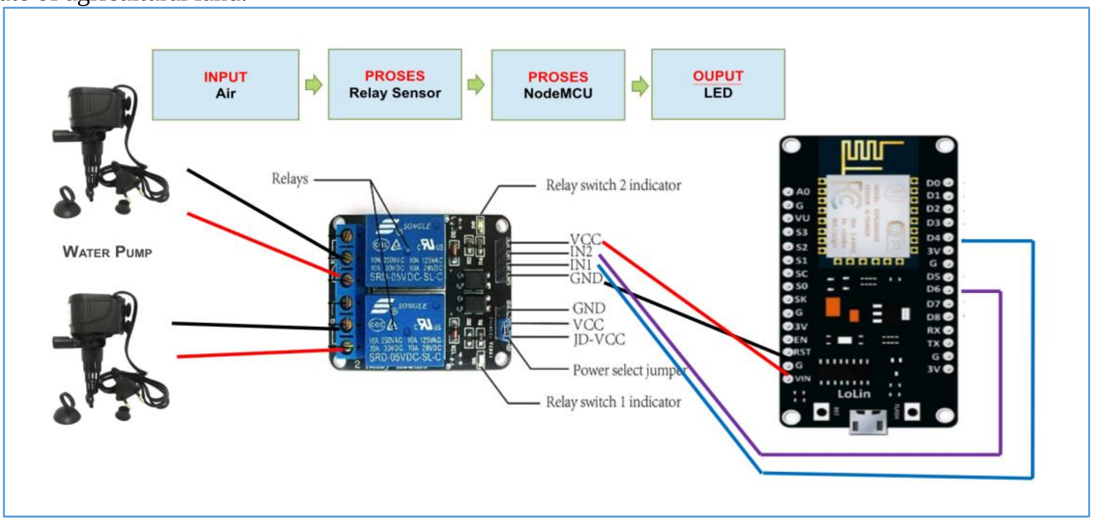

Figure. 4 Prototype pump.
Source : researcher property

Figure 4. is the prototype used to power the water pump. There are two pumps, the first pump is to extract agricultural ground water. The second pump does watering of agricultural land. Sensor water level menangkap ketinggian menggenang di lahan pertanian lebih dari 5 centimeter, maka sensor memberikan info ke micorcontroleer untuk menyala pompa banjir agar melakukan penyedotan air dan dibuang ke lahan yang lainnya. Lahan tersebut akan menjadi kering dan air yang tergenang

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DISCUSSIONS

Script for watering dry soil and extracting water from the soil if the soil conditions are flooded. Of course, the location is made of a dam to control flood water, but if the water stagnates in agricultural land, the flood pump will suck up the water, until the soil becomes dry, but the soil is still moist. Pump technology does not stand alone but uses a dam system to control agricultural groundwater.

Script for pump

```
void setup() {
    // put your setup code here, to run once:
    Serial.begin(9600);
    tank.initialize();
    reserve.initialize();
    pinMode(pumpPin, OUTPUT);
    digitalWrite(pumpPin, HIGH);
}

void loop() {
    // put your main code here, to run repeatedly:
    tank1 = tank.getDistance();
    reserve1 = reserve.getDistance();
    float tankLevel = 100.0 – ((tank1 / (tankEmpty + 0.0)) * 100);
    float reserveLevel = 100.0 – ((reserve1 / (reserveEmpty + 0.0)) * 100);

    if (tankLevel < (0 + 0.0)) {
        tankLevel = 0 + 0.0;
    }
    if (reserveLevel < (0 + 0.0)) {
        reserveLevel = 0 + 0.0;
    }

    if (tankLevel < (20 + 0.0)) {
        if(tankLevel<(3+0.0)){
            digitalWrite(pumpPin, LOW);
        }
        else if (reserveLevel < (20 + 0.0)) {
            //DON’T TURN ON PUMP
            digitalWrite(pumpPin, HIGH);
            lcd.clear();
            lcd.setCursor(0, 1);
            lcd.print(“RSRVE EMPTY”);
            delay(1000);
        }
        else {
            //------ TURN ON PUMP -------
            digitalWrite(pumpPin,LOW);
            lcd.clear();
            lcd.setCursor(0, 1);
            lcd.print(“PUMP ON”);
            delay(1000);
        }
    }

    if(reserveLevel < (20 + 0.0)){
        //------ DON’T TURN ON PUMP -----
        digitalWrite(pumpPin, HIGH);
        lcd.clear();
        lcd.setCursor(0, 1);
        lcd.print(“RSRVE EMPTY”);
        delay(1000);
    }
    if (tankLevel > (75 + 0.0)) {
        //------ TURN OFF PUMP ------
        digitalWrite(pumpPin, HIGH);
    }
}
```

Script Soil Watering

```
void Soil-Watering-sensor() {

    output_value = analogRead(sensor_pin);        //gets the value from the soil moisture sensor
```

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```
    output_value = map(output_value,550,0,0,100);   // this sets the percentage value
    Serial.print("Moisture : ");
    Serial.print(output_value);                     //print the percent of soil moisture - max is 33% if dipped in a cup of water
    Serial.println("%");
    delay(1000); //wait 1 second
    if (output_value < threshold)                   //if the soil is try then pump out water for 1 second
    {
        digitalWrite(pump, HIGH);
        Serial.println("pump on for 1 second");
        delay(1000);  //run pump for 1 second;
        digitalWrite(pump, LOW);
        Serial.println("pump off");
        delay(1000);                                //wait 1 second. This is for testing
    }
    else
    {
      digitalWrite(pump, LOW);
      Serial.println("do not turn on pump");
      delay(1000);                                  // wait 1 second. This is for testing
    }
}
```

CONCLUSION

From the results of research using the proposed method obtained prototypes such as in figure 3 and figure 4 to solve the problems that exist in the soil problem. Agricultural land with very dry conditions then pump 1 will water the agricultural land, while pump 2 is used to carry out suction on flooded agricultural land. The sensor for detection is used in figure 3, where the sensor can detect agricultural soil conditions.

SUGGESTION

This research can still be continued by adding other sensors, such as temperature and humidity sensors, or also being developed with other modern agriculture such as agrovoltaic, where agricultural land is installed with solar cells to capture sunlight into electricity. Agricultural crops sometimes do not need extreme sunlight but need moderate sunlight. The scorching heat of the sun can be used as electricity, to drive water pumps, as well as lighting agricultural land at night or it can be used for household purposes.

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