J@WIM
International Journal of Wireless and Multimedia Communications
Vol. 2 No. 2 (2025), June 2025, pp. 6-10
ISSN: 3047-2172

Automatic Monitoring of Soil Conditions For Plants Based On The Internet of Things

Evan Adicandra[a], Aisyah Vianda Putri[b], Alif Bintang Al Ikhlas[c]

[abc]*Telecommunication Engineering, Politeknik Negeri Padang, Padang, 25166, Indonesia*

[a] *evanadcndra@gmail.com*, [b] *ap6881553@gmail.com*, [c] *alifintang14@gmail.com*

***Abstract*— The internet of things-based Automatic Monitoring of Soil to increase the efficiency and effectiveness of time management. In this way, user can find out about condition changes so that they can prevent unwanted things. By using ESP32 as the main component of the microcontroller, DHT22 as a sensor for measuring air temperature and humidity and soil moisture as a sensor for measuring soil conditions. then the parameter data measured on the two sensors will be sent to the ThingSpeak web using the WiFi module on the ESP32 module as an interface between software and hardware by entering channels and other things that have been determined. This tool can also be used as a medium for conveying information using wireless media. ThingSpeak has succeeded in calculating time according to real time where the DHT22 and ground sensors can work on time according to schedule. When both data are sent to ThingSpeak, the data can be displayed in the MIT App Inventor application which is an Android application so that monitoring can be done easily and efficiently.**

***Keywords* — ESP32, DHT22, module, ThingSpeak, Interface**

I. Introduction

The Internet of Things is a novel paradigm shift in the IT arena. The phrase "Internet of Things" which is also shortly well-known as IoT is coined from the two words i.e. the first word is "Internet" and the second word is "Things". The Internet is a global system of interconnected computer networks that use the standard Internet protocol suite (TCP/IP) to serve billions of users worldwide. It is a network of networks that consists of millions of private, public, academic, business, and government networks, of local to global scope, that are linked by a broad array of electronic, wireless and optical networking technologies[1]. IoT, which is integrated with Sensor Technology and Radio Frequency Technology, is the ubiquitous network based on the omnipresent hardware resources of Internet, is the Internet contents objects together. It is also a new wave of IT industry since the application of computing fields, communication network and global roaming technology had been applied. It involves in addition to sophisticated technologies of computer and communication network outside, still including many new supporting technologies of Internet of Things, such as collecting Information Technology, Remote Communication Technology, Remote Information Transmission Technology, Sea Measures Information Intelligence Analyzes and Controlling Technology etc. [2]. The Internet of Things allows complex networks to adapt and be adaptive to change and can connect "Things" to the internet through the use of standard communication protocols.

II. Methods And Materials

A. Methods

This research includes designing and testing an IoT-based automatic soil monitoring system which aims to maintain optimal soil moisture. This system is equipped with various hardware such as the ESP32 microcontroller which functions as a control center, a soil moisture sensor to detect soil moisture levels, DHT22 as a temperature and air humidity sensor, Soil Moisture as a soil moisture sensor and determines air levels in the soil. , and other devices.

Apart from hardware, the system is also integrated with the ThingSpeak application and which functions as a link between software and hardware, the Arduino IDE application as software that functions to create, edit and upload programs to the microcontroller board, and the MIT App Inventor application allows users to put together land conditions via smartphone in real-time. With the combination of this technology, the system is able to provide efficient and intelligent ground conditions without the need for manual monitoring, so that monitoring becomes more practical and targeted.

B. Materials

1. Arduino IDE

Arduino has become a platform as it has become the choice of many professionals. One of the reasons Arduino attracts so many people is because it is open source, both hardware and software. Arduino schematic is free for everyone. You are free to download images, buy components, make PCBs and assemble them yourself without paying the Arduino maker. Likewise, the Arduino IDE can be downloaded for free and installed on your computer. We need to thank the Arduino team for being so generous in sharing the luxury of hard work with everyone. Personally, I was pleasantly surprised by the high quality and advanced design of the Arduino hardware, programming language and IDE [3].

Fig. 1 Arduino Ide

2. ThingSpeak

The Thingspeak platform is an open tool or place for use in developing Internet of Things applications, apart from being open source, Thingspeak is also relatively easy to configure (7).

Fig. 2 ThingSpeak

3. MIT App Inventor

MIT App Inventor is a platform to facilitate the process of creating simple applications without having to learn or use too many programming languages. We can design Android applications as desired using various layouts and components available.

Fig. 3 MIT App Inventor

4. ESP32

The ESP32 is a microcontroller developed by Espressif Systems as the successor to the ESP8266. This microcontroller is equipped with WiFi and Bluetooth Low Energy (BLE) modules in a single chip, making it an ideal choice for Internet of Things (IoT) applications. Thanks to the integration of WiFi and Bluetooth modules with dual modes and power-saving features, the ESP32 offers flexibility and high efficiency for various IoT projects. The main advantages of the ESP32 lie in its cost-effective capabilities and low power consumption, making it a highly efficient solution [4].


Fig. 4 ESP32

5. DHT22

DHT22 is a digital sensor used to measure air temperature and humidity. This sensor uses a capacitive humidity sensor and a thermistor to measure the surrounding air and outputs a digital signal on the data pin (does not require an analog input pin). creation of a temperature and humidity monitoring system for air growth using sensors DHT22 [9]

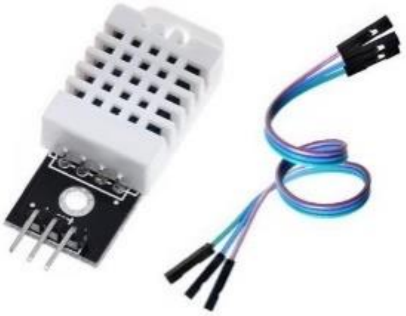

Fig. 5 DHT22

6. Soil Moisture

A Soil Moisture Sensor is a device designed to detect moisture levels in soil, as well as determine the presence of water in the vicinity. It functions as a probe that passes an electric current through the soil and measures its resistance to determine the moisture level. The more water in the soil, the easier it is for the electric current to flow, resulting in a low resistance, indicating that the soil is moist. Conversely, dry soil is difficult to conduct electric current, which means that the soil moisture is also low [5]. With this technology, we can easily monitor soil conditions and optimise plant care.

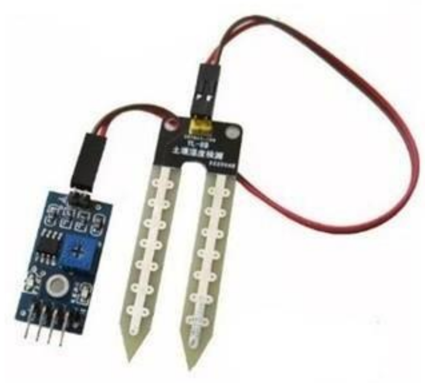

Fig. 6 Soil Moisture

C. Block Diagram

This research has a block diagram shown in the image Below :

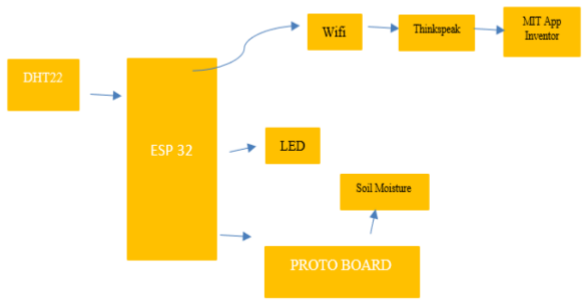

Fig. 7 Block Diagram

The block diagram above explains the design and construction of the system. This system uses a soil moisture sensor connected to ESP32 as a microcontroller. ESP32 is a microcontroller that has been equipped with a wifi module so that it is possible to send and receive data with ThingSpeak software that has been installed on devices.When the soil moisture sensor reads the soil moisture data, the data will appear on the ThingSpeak and will simultaneously be sent to the MIT App Inventor software. In the MIT App Inventor software, the soil moisture data can be seen and the necessary actions can be taken from anywhere.

D. Netwok Design

To give you a clearer picture of the automatic monitoring of Soil Condition system circuit, you can see the picture below.

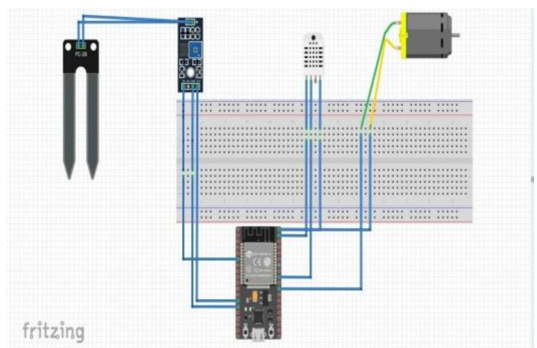

Fig. 8 Hardware Design

III. Result and Discussion.

A. Testing Device Connection With Internet

This device can connect to the internet via the ESP32 board. The connectivity process begins by entering the SSID and password of the available WiFi network or hotspot onto the ESP32 board. After that, the ESP32 will try to connect to the WiFi network. This process takes a little time, and once successfully connected, the ESP32 will receive the IP address assigned by the WiFi network. More details can be seen in the image below.

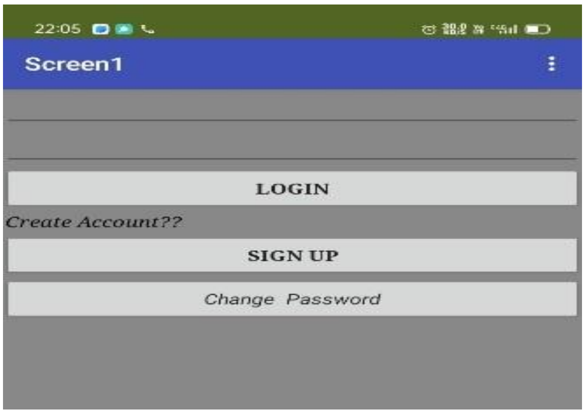

Fig. 9 Connection Device with Internet Network

B. Testing Data Delivery to IoT Platforms

This IoT platform test aims to collect, manage, and analyse the transmitted data, focusing on an IoT platform called ThingSpeak. In this testing process, data was successfully transmitted and displayed in real-time on the MIT App Inventor platform, demonstrating the effectiveness of its performance.

C. Soil Moisture Sensor Testing

Soil moisture sensor testing aims to determine the ability of the sensor to detect soil moisture and determine the soil moisture value. Soil moisture sensor testing is done by comparing 3 soil moisture sensors that are seen directly. Sensor testing is done attached to the circuit, when the sensor is plugged into the ground, the sensor will detect the moisture in the soil, this test can be seen directly on the LCD. Based on the results that have been tested. Soil moisture in this project is around 40% for normal soil and 60% for wet soil and for dry soil around 35%. Figure 10 shows how to test and Table 1 soil moisture sensor test results [6].

Fig. 10 Testing Soil Moisture Sensor

TABLE I
Soil Moisture Sensor Testing

No	Sensor	Results	Description
1	Soil moisture	0.9%	Wet soil
2	DHT22 Temperature	27%	Wet soil
3	DHT22 Humidity	86%	Wet soil

After testing the soil moisture, we get consistent results from all three sensors. This happened because the soil area tested had uniform moisture levels and conditions. These results show that the measurements obtained are very accurate and the sensors are working properly.

D. Prototype

Prototype testing marks the final stage of a series of important testing processes. To achieve success at this stage, the first step that must be taken is to assemble all the components carefully, then upload the prepared program into the ESP32 microcontroller and connect it to the ThingSpeak application. The testing process is carried out by operating the soil moisture sensor in two different conditions, namely dry and wet conditions. During testing, the values detected by the sensor will be monitored in real-time via the ThingSpeak application, which is then compared with the information displayed on the MIT App Inventor screen. This step aims to ensure the device system functions optimally and reliably. Therefore, we can continue testing this Internet of Things (IoT)-based automated Soil Monitoring system with confidence in its effective performance.

Fig. 11 Data In MIT App Inventor

TABLE 2
System Flow Monitoring

No	Tool Type	Action	Description
1	ESP32	Wifi on	Connects to the internet
2	DHT22	Read Air Data	High Or Low
3	Soil moisture	Read Soil Data	Dry or Wet Soil
4	ThingSpeak	Interface	Linked API
5	MIT App Inventor	Claim Data	Display Data

This system is designed to be able to carry out automatic soil monitoring which can be monitored remotely. This prototype is equipped with a soil moisture sensor that measures the soil moisture level around the plant. Monitoring can be done directly at the prototype location using ThingSpeak or remotely via a smartphone that has the MIT App Inventor application installed.

The ThingSpeak monitor functions the same as the app, but does not include a login control feature. The login function allows us to ensure that not everyone can access the system, and this is because the login capability can create security in the system. system development is used as a facility so that developers can easily model the software to be created [10].

IV. CONCLUSION

After going through the planning, manufacturing, testing and analysis stages, the following conclusions can be drawn regarding the Internet of Things (IoT) based automatic soil monitoring system:

1. An IoT-based automatic soil monitoring system was successfully designed and built using electronic components such as the ESP32 microcontroller, Soil Moisture Sensor, DHT22. This shows that this device has met the expected design aspects.

2. The system is capable of reading and sending real-time soil moisture data from the ESP32 microcontroller to the ThingSpeak application via a Wi-Fi network. In addition, users can monitor the quality of soil moisture detected by the sensor practically via the MIT App Inventor application and can monitor it remotely

3. The login system created in MIT App Inventor also helps so that not just anyone can access this automatic land monitoring system.

REFERENCES

[1] Nunberg, G. (2012) The Advent of the Internet: 12th April, Courses.

[2] Shao, W. and Li, L. (2009) Analysis of the Development Route of IoT in China. Perking: China Science and Technology Information, 24, 330-331.

[3] F. Djuandi, “Pengenalan Arduino,” E-book. tobuku, pp. 1–24, 2011

[4] Sylvia Rezky Auliany, Tika DW Lumbatoruan, Muhammad Rusdi, “ RANCANGAN BANGUN PENYIRAM TANAMAN OTOMATIS MENGGUNAKAN TIMER DENGAN SENSOR YL-69 BERBASIS INTERNET OF THINGS (IOT)”, konferensi Nasional Social dan Engineering Politeknik Negeri Medan Tahun 2023.

[5] Riska Jupita, Arjun Nuradin Tio, Arinda Rifaini, Sampurna Dadi R, “ RANCANG BANGUN PENYIRAM TANAMAN OTOMATIS MENGGUNAKAN SENSOR SOIL MOISTURE”, Vol. 2, No. 1, Juni 2021, page- page 94-102 E-ISSN: 2723-598X. DOI : https://doi.org/10.33365/jimel.v1i1

[6] Hendra Marcos, Husni Muzaki, "MONITORING SUHU UDARA DAN KELEMBABAN TANAH PADA BUDIDAYA TANAMAN PEPAYA",https://search.app/4JobpFaE4qa2zadd9

[7] Sahuleka B, Lim R, Santoso P. Sistem Data Logging Sederhana Berbasis Internet Of Things untuk Pemantauan Suhu Tubuh dan Detak Jantung. J Tek Elektro. 2018;11(1):29–35.

[8] Y. Zhou, Q. Zhou, Q. Kong, and W. Cai, ”Wireless temperature & humidity monitor and control system”, 2012 2nd Int. Conf. Consum. Electron. Commun. Networks, CECNet 2012 - Proc., pp. 2246-2250, 2012.

[9] C.G. Priya, M. Abishek Pandu, and B. Chandra, ”Automatic plant monitoring and controlling system over GSM using sensors”, Proc. - 2017 IEEE Technol. Innov. ICT Agric. Rural Dev. TIAR 2017, pp. 173-176, 2017

[10] T. A. Kurniawan and Aditia, "Penerapan Metode Prototype Dalam Pengembangan Sistem Untuk Perancangan Aplikasi Web Jasa Restorasi Pada PT. QUANTUM NUSATAMA," Jurnal Ilmiah Fakultas Teknik LIMIT’S, vol. 13, no. 1, pp. 1-8, 2017.