

UTILIZATION OF INTERNET OF THINGS FOR AUTOMATIC PLANT WATERING SYSTEM USING SOIL MOISTURE SENSOR

Iqlima Zahari¹, Wildan Mahmud², Bonifacius Vicky Indriyono³, Ichwan Setiarso⁴, Ivan Putra Gemilang⁵

^{1,2,3,5}Information Systems, Faculty of Computer Science, Dian Nuswantoro University

⁴Visual Communication Design, Faculty of Computer Science, Dian Nuswantoro University

¹iqlima.zahari@dsn.dinus.ac.id, ²wildan.mahmud@dsn.dinus.ac.id,

³bonifacius.vicky.indriyono@dsn.dinus.ac.id, ⁴ichwan.setiarso@dsn.dinus.ac.id,

⁵muhammadivanputragemilang@gmail.com

Abstract

The rapid development of technology has resulted in an increasing need for the benefits of technology in all aspects of human life. Technology is felt to be very helpful for humans in carrying out a series of daily activities, including the activities of farmers and chili plant business owners. Watering the plants every day makes the plants grow lush and healthy. However, sometimes these activities are neglected due to time constraints or other activities. To overcome this, it is necessary to build a system that can be used to assist automatic watering activities. This research discusses the use of Internet of Things technology to make automatic plant watering control devices using Android and Arduino UNO. The way this tool works is based on the soil moisture value and the testing temperature. The water pump will function when the soil moisture value is on a value scale of 75% with a temperature of 22 degrees Celsius and a water content ≥ 300 RH. By using soil moisture and temperature detection sensors, this tool will send a command signal to Arduino so that the relay driver is turned on so that the pump can distribute water as needed. From the tests carried out, it can be concluded that the tool made is able to carry out the function of watering plants automatically as expected. The water pump will automatically turn on if the temperature and soil moisture values match the settings in the system.

Keywords: internet of things, android, arduino UNO, soil moisture sensor FC-28.

1. Introduction

The development of the industrial world is currently known as the concept of Industry 4.0, which has the characteristics of technology that integrates with society and the human body such as sensors, robotics, 3D printing, the internet, to virtual and physical systems that can communicate with each other (Triyono, 2017). The industrial revolution 4.0 is the development of the third industrial revolution which combines several developments in the latest technologies, such as: cyber-physical systems, information and communication technology, Internet of Things and improved tools (Kinzel, 2016).

According to Schwab (2019), breakthroughs in the field of information technology such as artificial intelligence, internet of things and other information technology capabilities are signs or characteristics of the industrial revolution 4.0. From this explanation, the development of the industrial revolution 4.0 will create new, sophisticated technologies and can help existing jobs within the company, with the creation of this new technology, it will help human resources

in dealing with various types of work, as well as doing tasks faster, with new breakthroughs and new sophistication in technology, there will be many new things that must be learned in order to be able to apply them to the daily life of human resources. The rapid development of technology in the industrial revolution 4.0 has an impact on humans being increasingly pampered with information technology. Information technology is all tools that can help human activities in managing and transforming information using various communication media channels that are connected to software and hardware. One example of a part of information technology is the Internet of Things.

Internet of Things (IoT) is a term that can be defined as the process of using the internet on a larger scale, incorporating mobile computing and connectivity into everyday life (Behmann, 2015). According to Ashton (2017), the Internet of Things is defined as a set of sensors that are connected to the internet and act like the internet by forming an open series at any time, and transferring data freely so that computers are able to understand their surroundings and become part of life. man. The Internet of Things is a

concept that allows an object to have the ability to communicate via a network, such as a data transfer process that does not use human-to-human communication, data transfer from a human to a computer device or a controller (Abdullah, 2021). The concept of Internet of Things technology is ultimately able to make the performance of a system extend to a wider range and the processing and analysis of data on a system becomes very good. Susanto (2022) defines the Internet of Things as an embedded system that aims to expand the use of the internet network. The internet of things has many advantages such as being able to control data remotely, transfer data, energy resources and tools that are connected to sensors and connected to the network.

Plants are living things that need water for their development. Fertile soil is one of the conditions for plants to grow well. The level of fertility can be affected by the intensity of the water it contains (Darlis, 2012). For that temperature and soil moisture need to be maintained. Each plant has a different temperature and humidity. Especially chili plants in soil conditions, which require a soil temperature between 18o Celsius to 30o Celsius, and soil moisture in chili plants is around 60% to 80%.

However, the current obstacle is that farmers are still experiencing difficulties in terms of watering because it has to be done manually and they do not know the temperature and soil moisture levels needed by plants when watering plants. Agricultural production in the tropics is unstable, one of the reasons is that in the summer, the available rainwater reservoirs are not optimally utilized by farmers. This causes prolonged drought during the summer, with limited water for agricultural irrigation, resulting in unsatisfactory agricultural production, even the amount of production has decreased. Therefore, good water handling is needed for the tropics if you do not want to lose competitiveness with the quality of production in subtropical and other areas. Even though it should be, the tropics which have two seasons can take advantage of these seasons for maximum quality agricultural production, but the reality is the opposite. Therefore, we need a tool that can work automatically.

Arduino Uno is described as an ATmega328-based microcontroller board that has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog input/output pins, a clock speed of 16MHz, a USB connection, an ICSP header, and a reset button. This Arduino utilizes an electric current connected to a computer with a USB cable or an external current using a battery or with an AC-DC adapter. In general, Arduino has a function that facilitates use in various electronic fields such as making running LED applications, and many others. By using Arduino, making these applications becomes more practical, easy, and inexpensive. In a plant watering system, Arduino Uno has a function

as a controller or giving orders to water pumps according to the readings of soil temperature and humidity sensors. If the soil temperature is high and the soil moisture is dry, the water pump works to water the plants, and vice versa, if the soil temperature is low and the soil moisture is wet, the water pump stops working to water the plants. Another function of the arduino in this plant watering system is also to display the results of measuring the temperature and humidity values of the soil in wet or dry conditions connected to the LCD screen according to the readings of the soil temperature and humidity sensors.

Several previous studies have written about the use of Internet of Things technology, including research conducted by (Megawati, 2021) in a journal entitled Development of an Internet of Things Technology System that the Indonesian State Needs to Develop, explaining the results of a review of the application of IoT in human daily life, starting from education, health, economy, security, to transportation. The results of this study conclude that based on the literature study conducted in this study, valid information about IoT and research on IoT does not exceed 10% of the total research that has been reviewed. So increasing the development of IoT research is really needed, its development can be carried out starting from things that are directly related to human life. Then research conducted by (Sasmoko, 2017) in a journal entitled Implementation of the Application of the Internet of Things (IoT) in Infusion Monitoring Using Esp 8266 and the Web to Share Data explains how IoT technology can be used to monitor the amount of patient infusion via Web and Android connections. . The results of the study concluded that the test obtained an error rate of 2.46%, which means that the load cell sensor has a small error rate in detecting the infusion volume. Indriyono (2022) in an article entitled Automatic Lock Control System on Automatic Motorbikes Using an Android-Based Microcontroller explains how to take advantage of IoT technology through microcontrollers and Android to control motorbikes both turning on and off the engine. From the test results using three types of automatic motorbike variants, it was concluded that the results of the system testing and implementation carried out, it can be concluded that the use of the Arduino UNO-based android application can be used as a tool for the motorcycle control system both to turn on and turn off the engine with a distance - a certain distance as expected. Research conducted by (Prasetyo, 2017) which raises the topic of using IoT to control electrical loads, describes ways to control electrical loads using IoT through hardware in the form of NodeMCU ESP 8266 as the main controller. The results of this study indicate that the performance of Android-based aerodynamics learning media as a whole can run well according to planning. All

buttons on each view can function according to plan. Rusli (2021) in an article entitled Implementation of the IoT-Based Smart Farming Concept and its Benefits explains how IoT is utilized for smart farming systems. The test results conclude that implementing IOT-based smart farming can solve agricultural problems with solutions that are efficient and feasible to use. At this time, the Internet of things, with real time and accuracy, can provide changes to the agricultural supply chain and provide technology that makes agricultural logistics supply smooth.

2. Research Methodology

Research methodology is a technique for understanding something through investigative activities that arise in connection with the problem to be studied, which is carried out carefully so that a compatible solution is obtained (Ali, 2014), whereas according to Sugiono (2014), the research method is defined as a scientific method. in order to obtain data with a specific purpose, objective and function. The function of this research methodology is to provide an overview and assist researchers in making a research design that includes a complete series of procedures and stages of conducting research.

2.1 Research Methods

In this study the research method used is the research and development method. Research and development methods are defined as research techniques carried out to produce certain products, and test the effectiveness of products. The research stages of this method include:

- a. Formulation of The Problem : The initial idea of this study was the tendency of chili farmers or owners to be negligent in watering chili plants and a lack of understanding of soil moisture conditions.
- b. Information gathering: This stage is carried out through observation and literature study to find solutions to the problems faced. In this case looking for information from literature related to the use of Internet of Things technology.
- c. System design: The system to be designed is manifested in the form of charts or drawings so that it can be used as a basis for the manufacturing process. Design in the form of a system or tool needs to explain the procedure for use, how it works and what are the advantages and disadvantages of the system.
- d. System validation : System validation is the process of assessing the system design. Validation can be carried out by presenting several experienced personnel to assess the

newly designed product. Design validation is carried out in the discussion forum. Before the discussion begins, the research team can describe the research process until the design is found, along with its advantages.

- e. System Testing: System testing is done to get information whether the system design is more effective in overcoming the problem. Information is obtained from the conclusions given by the users of the tool.
- f. System Repair: After the system is tested, it will find some system weaknesses. From these findings, the system will then be repaired so that the system can return to normal.
- g. Follow-up testing: After the system is repaired, the repair results are tested again whether they are in accordance with the objectives or not.
- h. Final improvement: From the results of further testing it will be possible to find out whether the system is still not in accordance with the objectives or is it appropriate. If it is not appropriate, the system will be repaired again until no system deficiencies are found.

The research method used is shown in Figure 1 below.

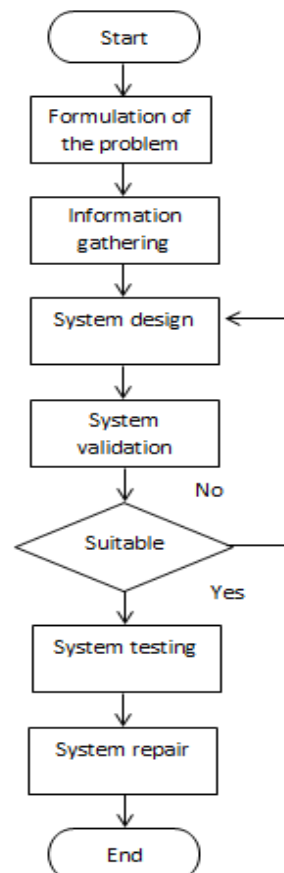


Figure 1. The flow of research methods

2.2 Method of Collecting Data

The data collection method used in this study is a secondary technique where the data obtained comes from library books, sources from the internet and journals, references or other sources that are still related to the use of IoT technology.

3. Literature Review

3.1 Internet of Thing (IoT)

Internet of Thing is defined as a set of tools that have the ability to be able to connect and exchange data through the internet network. IoT is a technology that can perform control, communication, collaboration with various hardware devices, data via the internet network (Hardyanto, 2017). The work process of IoT refers to the following principles:

- a. Analog Data: Analog data describes something natural in the human world, such as light, sound, temperature, vibration, speed, acceleration, time, location, and so on.
- b. Perpetual Connectivity : Internet of things will always be connected and always active. In other words, the connectivity is eternal. So, the device will be connected to the internet continuously. Thus, users can see accurate information on an ongoing basis.
- c. Real Time : Real time on the IoT concept doesn't work like anything else. IoT carries this real-time concept that starts operating from the moment the sensor acquires the data. For example for fire suppression equipment. Users certainly need information as soon as possible before the fire devours the house. Therefore, the tool will work in a split second after the smoke sensor and temperature sensor detect a flame.
- d. Spectrum of Insights: A spectrum of insights comes from IoT data. The data includes 5 phases of data flow, namely: real time, in motion, startup, at rest, and archive. The insight spectrum includes real-time data to determine the immediate response of control systems.
- e. Proximity Versus Depth: In this concept, "time for insight" is very important. That is, data analysis that has value or has value to support decision making. The Principle of Proximity Versus Depth means trading depth of information for speed of time-to-insight. With computers and internet of things solutions, we can already get Time-to-Insight" in basic analytics.

- f. The Next V: Experts usually call the characterization of big data with the term V's, namely: Volume, Velocity, Variety, and Value. The principle of The next V means, there is one V which is meant by Visibility. This means that when data is collected, data scientists around the world must have access so they can use it as needed.

3.2 Arduino IDE

Software written using the Arduino IDE (Integrated Development Environment) is known as sketch. Sketches are written using a text editor. Sketches are saved with the .ino extension. The message area provides information and error messages when we save or open a sketch. The console displays text output from the Arduino IDE and also displays an error message when we compile the sketch. On the lower right side of the Arduino IDE window shows the type of board and serial port that is being used (Safaat, 2015). The Arduino IDE display is shown in Figure 2 below.

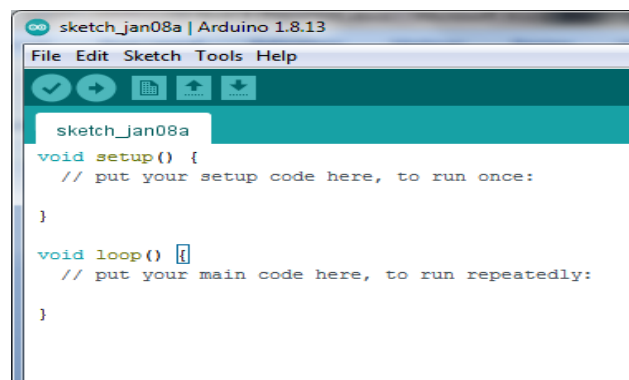




Figure 2. Arduino IDE window

In the Arduino IDE there are various command buttons. The command buttons can be seen in table 1 below.

Table 1. Arduino IDE Command Buttons

| No | Icon | Name | Functio |
|----|------|--------|--|
| 1 | | Verify | To check the program code errors that have been made |
| 2 | | Upload | Uploading the program to the Arduino board. |
| 3 | | New | To create a new sketch. |
| 4 | | Open | Open the saved sketch program. |

| No | Icon | Name | Functio |
|----|---|----------------|----------------------------------|
| 5 |  | Save | Save the created sketch program. |
| 6 |  | Serial Monitor | Opens the serial monitor screen |

3.3 Soil Moisture Sensor FC-28

Soil moisture sensor FC-28 is a special device capable of detecting soil moisture values. In general, actually this tool can be maximally used to detect soil moisture in city parks and water levels in yard plants. This tool has a component that functions as a bridge current through the ground. The soil moisture value is obtained from the resistance reading. A lot of water content will make the soil easier to conduct electricity (small resistance), while dry soil is very difficult to conduct electricity (large resistance). This sensor is very helpful for reminding moisture levels in plants or monitoring soil moisture (Isnawaty, 2016).

The special feature of this sensor is that this tool has an input voltage of 3.3 volts or 5 volts, an output voltage of 0 – 4.2 volts and a current of 35 mA.. FC-28 is able to directly detect soil moisture values which indicate the amount of water content in the soil through a combination with a microcontroller (Husdi, 2018). According to Nuraharjo (2020), a soil moisture sensor is a tool that can measure soil moisture and moisture content. The working principle of this tool is to flow current on the two plates where if the two plates are exposed to the conducting medium, the electrons will move from the + pole to the - pole so that a current will generate a voltage. The movement of electrons is used to detect whether there is water or not in the soil. If the soil is wet, it means that the soil contains a conducting medium, but if it is dry, it does not contain an electron-conducting medium. To control the soil moisture sensor, an Arduino microcontroller is needed to convert analog quantities into digital quantities. An example of the FC-28 Soil moisture sensor is shown in Figure 3 below



Figure 3. Soil moisture sensor FC-28

3.4 Arduino UNO R3

Arduino Uno R3 DIP is an arduino of the DIP (Dual In-Line Package) type in the form of the AT-Mega Microcontroller IC which can be removed

because it uses a socket and is not soldered. This type of Arduino is compatible with the Arduino IDE software, so there is no need to install drivers. The ESP32 module is the successor of the ESP8266 module which is quite popular for IoT applications. The ESP32 has a CPU core as well as faster Wi-Fi, more GPIO (General Purpose Input/Output), and supports Bluetooth Low Energy. The following is the Architecture and Block Diagram of ESP32. The Arduino UNO R3 – DIP model is shown in Figure 4 below



Figure 4. Arduino UNO R3 – DIP

3.5 Relay Module

The relay module is a device that operates based on electromagnetic principles to move the contactor to move the ON to OFF position or vice versa by utilizing electricity. Basically, the function of the relay module is as an electric switch. Where this tool will work automatically based on the given logic command. In general, a 5 volt DC relay is used to make projects where one of the components requires high voltage or which is usually AC (Alternating Current). The use of the relay more specifically is as follows:

1. Execute the logic functions of the Arduino microcontroller.
2. A means of controlling high voltages using only low voltages.
3. Minimizing the voltage drop.
4. Allows the use of the time delay function or the time delay function.
5. Protect other components from excess voltage that causes a short circuit.
6. Simplify the circuit to make it more concise.

In the relay module there are three pins that are used as output, the following is a description of the three pins that you really need to know:

1. COM (Common), is a pin that must be connected to one of the two ends of the cable to be used.
2. NO (Normally Open), is the pin where the other cable is connected if you want an open initial position or the electric current is cut off.
3. NC (Normally Close), is the pin where you connect the other cable if you want a closed

initial position or an electric current is connected.

Figure One channel relay module is shown in Figure 5 below.



Figure 5. One channel relay module

4. Results and Discussion

In the following, the results of the tests that have been carried out will be presented.

4.1 Soil Moisture Sensor Testing

This test is carried out to find out whether the Soil Moisture Sensor works well or not when used. The Soil Moisture Sensor pin component will be connected to components from Arduino then Arduino is connected to electricity using a charger cable.

After this tool is connected, the new sensor can be used. This sensor functions as input or detects soil moisture. Figure 6 below shows the soil moisture value when wet

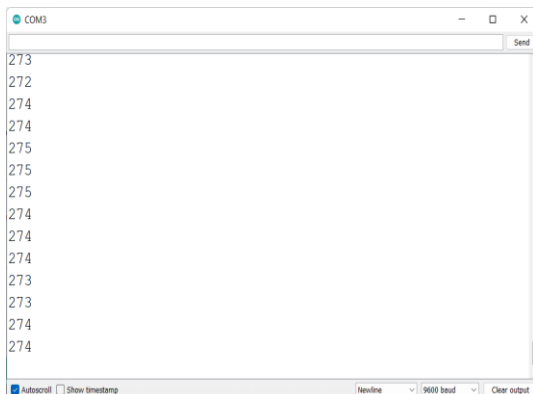


Figure 6. Soil moisture value when wet

To determine the sensitivity of the Soil Moisture Sensor, an experiment is carried out in the form of a periodic level of water content. The results are shown in table 2 below.

Table 2. Sensor Test Results for Soil Moisture Levels

| No | Moisture Content Value (Censored Based) | Experiment Results | | |
|----|---|--------------------|----------------------|-----|
| | | Land Status | Water Pump Condition | |
| | | | On | Off |
| 1 | ≥ 300 RH | Dry | Yes | No |
| 2 | ≤ 300 RH | Wet | No | Yes |

4.2 Hardware Requirements

To support the needs in making systems and tools, several hardware components are needed as presented in table 3.

Table 3. Hardware Requirements

| No | Device | Information |
|----|----------------------|--|
| 1 | Arduino UNO | The function of Arduino is to facilitate control of electronic components through other components such as relays, servos, modules and other types of sensors. |
| 2 | Jumper Cable | Jumper cable functions as a channel for digital data and as a power line that is used by all the hardware in this system. |
| 3 | Relay | The relay functions as an electronic switch that relies on digital data to turn on and off the switch, which is usually digital data in the form of HIGH and LOW, in this system the relay used functions as a connection and disconnecter for electricity from the battery to the pump. |
| 4 | Soil Moisture Sensor | Is a tool that is widely used to detect soil moisture values. |
| 5 | LCD Module | Used to display data displays through liquid crystals as a material for displaying data in the form of text or images. The function of the LCD Module in this design is to display the status of water humidity, where the data sent from the sensor is DRY and WET. |
| 6 | Breadboard | Breadboard is a board or board that functions to design a simple electronic circuit. The breadboard will later be prototyped or tested without having to solder. |
| 7 | Mini Water Pump | The mini water pump functions as a water diverter which will be flowed based on orders from the Relay. |
| 8 | 9V battery | The 9V battery functions to provide electric current to the pump so that the water pump will work properly. |

4.3 Software Requirements

The software used to create programs on the Arduino UNO board is Arduino. Table 4 below shows the requirements of the software

Table 4. Software Requirements

| No | Software | Explanation |
|----|-------------|--|
| 1 | Arduino IDE | The Arduino IDE software is used to type sketches and is used as a means of uploading ready-made sketches to the Arduino UNO hardware. |

3.1 Hardware Assembly

After all the hardware has been collected and ready to be assembled. first of all for assembly, attach the LCD Module to the Arduino UNO with the GND and VCC jumper cables on the breadboard section (-), then the SDA and SCL jumper cables are connected to sections A4 and A5 on the Arduino UNO, then the results can be seen as shown in figure 7.

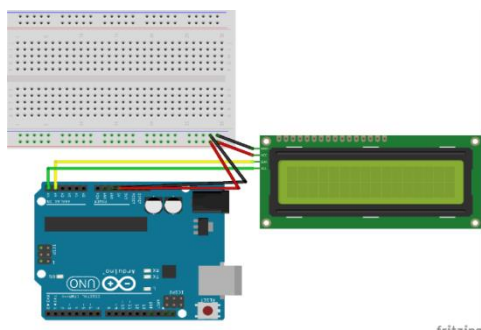


Figure 7. LCD connection to Arduino UNO

Then for assembling the next section, attach the jumper cable to the Hygrometer Module on pin A0 and for the GND and VCC sections attach it to the (-) section of the Breadboard. Next, attach a jumper cable for the Soil Moisture Sensor section from the VCC pin for the (+) pin and the SIG pin for the (-) pin on the Hydrometer Module. The result can be seen in Figure 8.

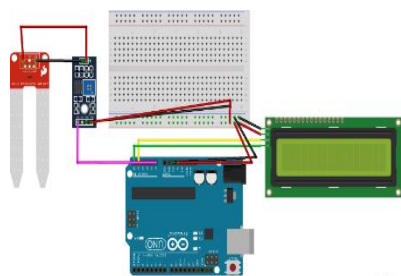


Figure 8. Soil moisture module connection to Arduino UNO

The final hardware assembly process is assembling for the installation of relays as conductors of electric current for the batteries which will later power the water pumps so they can circulate water. The assembly begins with a jumper cable from the Arduino UNO at pin 8 and for the middle and sides are the GND and VCC sections which will be attached to the jumper cables on the (-) section of the Breadboard. Then for the three pin section C on the relay, a jumper cable is attached to the positive part of the battery and for the NO pin on the relay, a jumper cable is attached to the water pump connection cable, as well as the minus part of the battery, the cable is connected to the water pump connection cable, then the assembly results can be seen like picture 9.

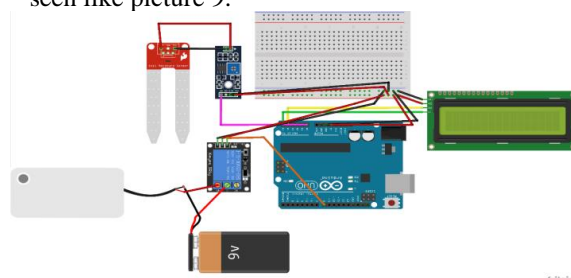


Figure 9. Relay connection, water pump and battery to Arduino UNO

4.4 System Programming

Programming on the Arduino UNO is done in the Arduino IDE, the initial steps and preparation before programming in the Arduino IDE is to open the Arduino IDE then connect the Arduino Uno board, wait for Windows to do the driver installation, open the Windows control panel, then open the device manager, look for Ports (COM & LPT), right-click and select "Update Driver Software". Then select "Browse my computer for Driver software" option, look for the driver file with the name "arduino.inf", in the "Drivers" folder. The folder can be found where the Arduino IDE software is installed. Figure 10 below shows the results of the Arduino UNO installation

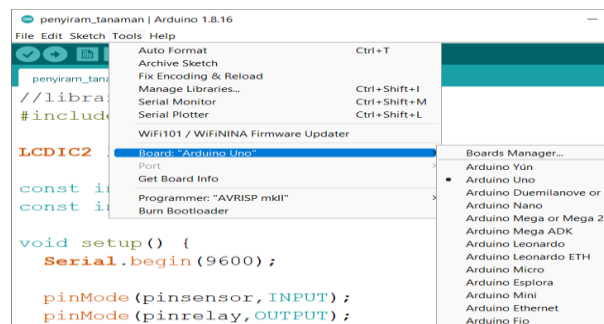


Figure 10. Arduino UNO installation on arduino IDE

After installing Arduino UNO on the Arduino IDE, the next step is to install the library needed for this project, the LCDI2C.h library. The I2C LCD module is an LCD module whose way of working is

based on serial control and synchronized with the I2C/IIC (Inter Integrated Circuit) or TWI (Two Wire Interface) protocol. Normally, the LCD module is controlled in parallel for both the data and control lines. However, parallel lines will eat up a lot of pins on the controller side (eg Arduino, Android, computer, etc.). At least it will need 6 or 7 pins to control an LCD module. The way to install the library is by opening the Arduino IDE then opening Tools -> Manage Libraries as shown in Figure 11.

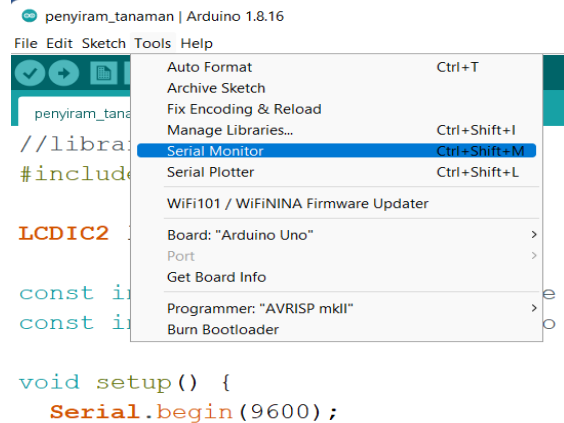


Figure 11. Installing the library on the Arduino IDE

In manage libraries when typing IC2 a library with the name LCDIC2 will only appear, and click the install button, after waiting for a few seconds the LCDIC2 library will be installed. The results of the Arduino UNO library installation are shown in Figure 12 below

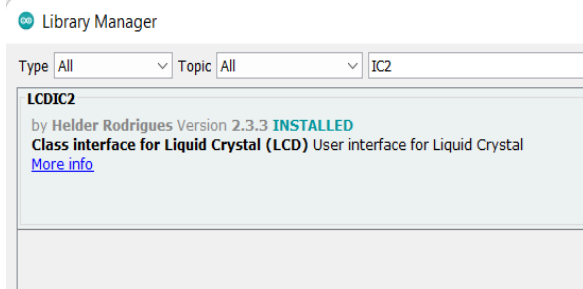


Figure 12. Installing the library on the Arduino IDE

After the IDE is installed and also the required libraries, it's time for the programming stage, along with the code contained in the system.

```

//library lcd
#include "LCDIC2.h"
LCDIC2 lcd(0x27, 16, 2);
const int pinsensor="a0";
const int pinrelay=8;
void setup() {
  Serial.begin(9600);
  pinMode(pinsensor, INPUT);
  pinMode(pinrelay, OUTPUT);
  lcd.begin();
}

void loop() {

```

```

int sensor=analogRead(pinsensor);

if (sensor<=300)
{lcd.print("Wet");
digitalWrite(8,HIGH);}
else if(sensor>=300)
{lcd.print("Dry");
digitalWrite(8,LOW);}
Serial.print(sensor);
Serial.println(" ");
delay(2000);
//digitalWrite(8,HIGH);
lcd.clear();
}

```

After the coding process is complete, the next step is to connect the USB cable on the Arduino UNO to the computer. After all the cables are connected, the upload process can be done. The result is as shown in Figure 13.

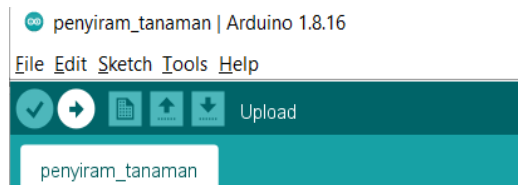


Figure 13. Upload process button.

4.5 Final Result of Assembly

After the process of assembling and testing the existing tools and systems, the final results of all components can be seen in Figure 14.

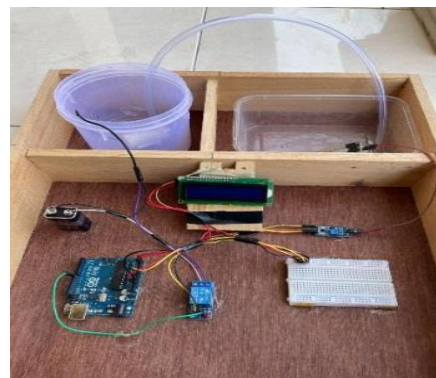


Figure 14. Final Result of Assembly

4.6 Soil Moisture Sensor Test Result

Soil Moisture Sensor is a module for detecting soil moisture, which can be accessed using a microcontroller such as Arduino. This soil moisture sensor can be used in agricultural, plantation, or hydroponic systems using hydrotons. After the pin of the Soil Moisture Sensor is connected to the Arduino component pin, the sensor can be used for testing. If the soil moisture value detected on the

Serial Monitor on Arduino shows the number ≥ 300 RH then the soil will be detected with the status "DRY" which will appear on the LCD monitor, but if the soil moisture value detected on the Serial Monitor shows the number ≤ 300 RH then the soil will be detected with the status "WET" which will appear on the LCD monitor, so the test of the Soil Moisture Sensor has been successful and can run according to its function.

4.7 Relay Testing Analysis

Relays use electromagnetic principles to move the switch contacts so that with a small electric current (low power) they can conduct electricity with a higher voltage. In this study, the relay has a role as a conductor of electricity for a battery with a capacity of 9V and a mini water pump. The relay can run if the Soil Moisture Sensor has obtained a predetermined soil moisture value, that is, if the soil moisture value is ≥ 300 RH, the relay will activate and conduct electricity to the battery and will be followed by an active water pump which will circulate water to the soil. When the soil is wet and the soil moisture value has reached ≤ 300 RH, the relay will emit an electric current and the water pump will automatically stop.

4.8 Overall Tool Test Results

Based on the process of assembling hardware components and coding, it was found that all components were connected properly. And the control device can work well to do automatic watering on plants with a moisture content ≥ 300 RH, a temperature of 22 degrees Celsius and a soil moisture of 75%

5. Conclusions and Suggestions

Based on the results of the research that has been made, tentatively an Automatic Plant Waterer with a Soil Moisture Sensor Based on the Internet of Things, the following conclusions can be drawn that the system can detect soil moisture values accurately according to the specified limits, namely ≤ 300 RH and ≥ 300 RH, then the system utilizes the Arduino IDE software to function properly. Initially, the dry soil moisture value has a limit of ≥ 1000 and the system requires a device such as a laptop or PC to be able to install the software needed and the installation requirements needed for the system to run.

As for suggestions that can be given for the development and improvement of this system both in the scope of software and hardware, suggestions for further research can be described as it is better to add a feature to detect all plants other than chilies so that it can be used for all plants and the size of the sensor that needs to be developed so that it can be

applied to large volumes of land such as paddy fields.

References :

- Abdullah, et al, (2021), *Utilization of IoT (Internet of Things) in Monitoring Smoke Concentration Levels and Camera Tracking Control*. CIRCUIT: Scientific Journal of Electrical Engineering Education, Vol.5, No.1, pp. 86-92.
- Ali, M. & Suryani, M.A, (2014), *Methodology and application of educational research*, Jakarta: Bumi Aksara.
- Ashton, K, (2017), *Making sense of IoT How the Internet of Things became humanity's nervous system*. Hewlett Packard.
- Behmann, F. & Wu, K., (2015), *Collaborative Internet of Things (C-IoT): for Future Smart Connected Life and Business*. Wiley
- Darlis, D, (2012), *Design of a Microcontroller-Based Automatic Water Sprinkler System*, Final Project, Telecommunications Engineering, Telkom University.
- Hardyanto, R.H, (2017), *Internet Of Things Concept In Web-Based Learning*, Journal of Informatics Dynamics, Vol. 6, No. 1, pp. 87-97.
- Indriyono, B.V, et al, (2022), *Automatic Lock Control System on Automatic Motors Using an Android-Based Microcontroller*. National Seminar on Innovation and Development of Applied Technology. Cilacap. 2022.
- Isnawaty, et al, *Design of Soil Moisture Monitoring System Prototype Through Sms Based on Plant Watering Results Case Study of Chili and Tomato Plants*, semanTIK, Vol.2, No.1, pp. 97-110.
- Kinzel, H. (2016). Industry 4.0 - Where Does This Leave The Human Factor? [Online] Available: https://www.researchgate.net/publication/308614137_Industry_40__Where_does_this_leave_the_human_factor., Accessed 20-03-2018.
- Megawati, S & Lawi, A, (2021, *Development of an Internet of Things Technology System that Indonesia Needs to Develop*, JIEET:(Journal Information Engineering and Educational Technology), Vol 05, No 01, pp. 19-26.
- Nuraharjo, E & Fahrurrozi, M, (2020), *Automonitoring Moisture Growing Media*, Informatics Dynamics, Vol.12, No.2, pp. 60-67
- Prasetyo, E.E, (2017), *Internet Of Things (Iot) Application For Monitoring And Controlling Electrical Loads In The Room*, Technical Journal, Vol. 4 No. 2, pp. 28-39.
- Rusli, S.J, (2021), *Smart Concept Implementation Iot Based Farming And The Benefits*, Journal of Engineering and Computer Science, Vol. 5, No. 1, pp. 233-237

- Safaat, N, (2015), *Android-Based Smartphone and Tablet PC Application Programming*. Bandung : PT Elex Media Komputindo.
- Sasmoko, D & Wicaksono, Y.A, (2017), *Implementation of the Application of the Internet of Things (Iot) in Infusion Monitoring Using Esp 8266 and the Web to share data*, Informatics Scientific Journal, Vol 2 No. 1. pp. 90-98.
- Schwab, K, (2017), *The Fourth Industrial Revolution*. World Economic Forum: Germany
- Sugiono, (2016), *Quantitative, Qualitative and R&D research methods*. Bandung : Alfabeta, 2016.
- Susanto, F., et al, (2022), *Internet Of Things Implementation In Everyday Life*. Imagine Journal,. Vol. 2 No 1, pp. 35-40.
- Triyono, MB., (2017): *Challenges of the 4th Industrial Revolution (I4.0) for Vocational Education*, Denpasar - Bali, Vocational and Technology National Seminar (SEMNASVOKTEK), pp. 1-5.