Research Article

Telegram-Based Design of Automatic Plant Watering System

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Abstract: Regular watering is a very important activity in plant maintenance because plants need water to carry out photosynthesis and obtain the nutrients necessary to grow and develop properly. An automatic watering tool has been designed that can perform watering commands remotely. This automatic watering instrument is achieved by using a soil moisture sensor to measure the water content or soil moisture and a DHT22 sensor that can detect air temperature and humidity. Soil moisture information is sent via Telegram, using the Telegram bot feature on this automatic plant watering tool, so that the tool can be controlled remotely. This plant monitoring can save time and energy and maintain plant quality more effectively. Plant conditions can also be checked periodically to ensure that the plant's water needs are being properly met. This automatic plant watering solution therefore has the potential to increase productivity and efficiency in case of irregular watering of the plants.

Keywords: Capacitive Soil Moisture Sensor; DHT22 Sensor; Telegram; Watering Plant System, Automatic System.

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1. Introduction

Plants are living things that need nutrition to grow and develop properly. Water is one of the nutritional components that plants need to grow and is one of the components to fertilize the soil (Kafiar et al., 2018). Watering plants, or what you can also call plant watering, encounter difficulties because it still has to be done manually and people do not know how much water the plants need (Kafiar et al., 2018). In addition to water, you should also pay attention to soil moisture so that the soil does not dry out or lack water, which often occurs in the dry season (Prayama et al., 2018).

Automation technology is developing more and more and offers convenience when carrying out routine tasks. For example, the use of microcontrollers in various tools can help people perform tasks that were previously done manually(Widiyanto et al., 2022). One of the chores that is done regularly is watering the plants, which is done every day. Watering plants is one of the activities performed in plant maintenance because plants need water to carry out photosynthesis and obtain the nutrients necessary to grow properly (Kadi, 2021).

Research has been done on watering plants using different methods such as Erricson Zet Kafiar who designed a tool for automatic plant watering using YL-39 and YL 69 humidity sensors where this design is based on Arduino Uno The implemented design is connected to a smartphone with an Android operating system, where the connection used is Bluetooth. The function of a smartphone is only a tool to provide information about soil moisture via sensors (Kafiar et al., 2018). Another research by Yessi Mardiana and Riska was to design an automatic watering device with a rain sensor and Arduino Uno. This design only provides information that the plants have been watered or not. This information is taken from the rain sensor and then sent to the smartphone to notify whether or not the plants have been watered, and to switch the pump on or off (Mardiana & Riska, 2020).

Another research conducted by Deddy Prayama, Amelia Yolanda, and Andi Wellyno Pratama was to design a tool to automatically control plant watering using soil moisture sensors in agricultural land areas. The designed system uses soil moisture sensors that are also supported by web-based monitoring methods. Arduino automatically turns on the pump when the soil to be measured has a moisture level below a predetermined limit, and turns off the pump when the desired moisture level is met. In this study, the soil moisture limit used was between 200 and 700 (Prayama et al., 2018).

This research aims to design a system that can water plants based on soil moisture using a capacitive soil moisture v2.0 sensor and a temperature sensor supported by a monitoring and control system using an application, namely the Telegram application. The operation is carried out using the Telegram application and ensures that the pump is controlled in such a way that it can water the plants. This application can provide information about soil moisture. Previous researchers such as in references [7-17] specifically and in detail, the use of the theory and practice of Telegram applications in various applications such as the development of the Internet of Things, with detailed methods.

2. Literature Review

2.1 The ESP8266 Microcontroller

The ESP8266 is generally also known as ESP8266EX. The use of the ESP8266 in this study is because the ESP8266 is a microcontroller integrated with WiFi as a Single on Chip (SoC). The WiFi connection on the ESP8266 uses IEEE 802.11 b/g/n standards with WPA/WPA2 certification. In addition to using integrated WiFi, the ESP8266 can also be used to control and process input data from sensors (Kocer et al., 2021).

2.2 The Capacitive soil moisture sensor

The Capacitive soil moisture sensor is a moisture sensor that measures soil moisture with capacitive measurements and is made of materials that are resistant to corrosion. This Capacitive soil moisture sensor is a module that is equipped with a voltage regulator so that it can work with a voltage range between 3.3 and 5.5 V (DFRobot, 2018). Using this capacitive sensor has several advantages, such as being able to read various materials such as plastic, iron, water, and skin. In addition, measurements from this capacitive sensor can be used without having to be connected and the advantage of reading this sensor is that it can read over large distances. In addition to the various advantages mentioned, there is another advantage, namely that the power consumption of this sensor is quite small (Capacitive Sensors - Definition, Explanation, Uses, FAQs, n.d.).

2.3 The DHT22 sensor

The DHT22 sensor is a temperature and humidity sensor, also called the AM2302 sensor. This sensor provides data in the form of digital signals converted using calculations performed by the MCU-8bit. This sensor is precisely calibrated with temperature compensation in the adjustment room where the compensation value is stored in the integrated OTP memory. This sensor has a wider range of temperature and humidity measurement results and is capable of transmitting measurement result signals over cables up to 20 meters (Kurnia Utama, 2016). As done by Feriawan Saputra, Devie Ryana Suchendra, and Muhammad Ikhsan Sani researched the DHT22 sensor to stabilize the temperature and humidity in the room, where the results of the research conducted showed a difference of about 0.30 o C in comparison with a room thermometer (Saputra et al., 2020). Meanwhile, research conducted by Fitri Puspasari, Trias Prima Satya, Unan Yusmaniar Oktiawati, Imam Fahrurrozi, and Hristina Prisyanti conducted research by comparing the DHT22 with a Thermohygrometer. In their research, it was stated that the accuracy of the DHT22 sensor in reading temperature and humidity was said to be good and acceptable as this was appropriate. With the data sheet of the sensor itself, the measurement difference is approximately 2-5% for humidity and ±5 C for temperature (Puspasari et al., 2020).

2.4 Telegram

Telegram is a messaging application that works via an internet connection, just like the WhatsApp or Facebook Messenger applications. This application can receive and send messages via a WiFi connection or mobile data connection (Hema & Yadav, 2020). Telegram can also be said to be a cloud-based application with an encrypted system that offers end-to-end encryption, message self-destruction, and multi-data center infrastructure. The convenience offered by this Telegram application not only allows it to run on all platforms but also makes it easy for administrators to build a notification system by utilizing the open API (Application Programming Interface) facility (Fahana et al., 2017).

3. Method

3.1 Hardware Design

In this section, we discuss the system designed in this study. This system design focuses on how the design of this system is achieved. This system is designed and developed using Unified Modeling Language (UML). The system diagram in this design uses a Wifi module namely NodeMCU ESP8266, DHT22 sensor, capacitive soil moisture sensor, relay, and pump. Modules are needed to design the architecture of the system that will be built to understand the principles of how the tool works. The designed system architecture is shown in Figure 1, the design of the microcontroller section, while Figure 1 and Figure 2 are design images of the moisture floor module and NodeMCU ESP8266.

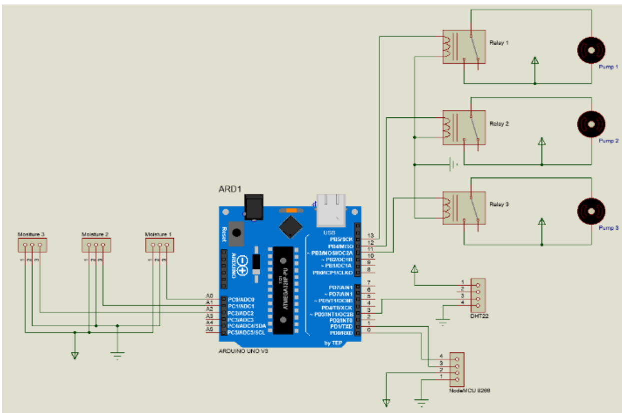

Figure 1. Schematic System

Moreover, Figure 1 is a design drawing of the Arduino module connected to all modules using connectors. Figure 1 also shows the connection between the motor, in this case, it is assumed to be a pump motor connected to a relay, the function of this relay being used as a switch to activate and deactivate the pump motor. And Figure 2 is an image of capacitive soil moisture. This research uses 3 soil moisture sensors, which are later placed in three pots of different sizes. Meanwhile, Figure 3 is an image of the ESP8266 used to connect Arduino to the Internet via WiFi.

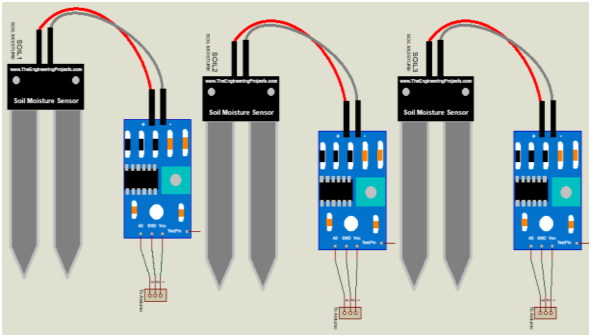

Figure 2. Schematic diagram of capacitive soil moisture sensor

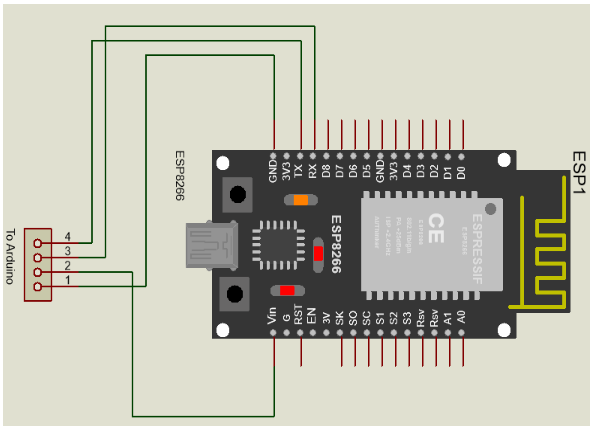

Figure 3. Schematic ESP8266

3.2 UML Design

Furthermore, Figure 4 is a deployment diagram of the system being designed. Fig 4. shows the hardware and software configuration used in this system. Based on the deployment shown, there are 6 hardware devices, namely a capacitive soil moisture sensor, DHT22 sensor, Arduino NodeESP 8266, relay, pump, and PC/smartphone. Users can access or control the system via a PC/smartphone with the Telegram Messenger application installed. The function of the relay is to activate and deactivate the pump controlled by the Arduino Uno. Meanwhile, the PC/smartphone connection via WiFi is provided by NodeESP 8266.

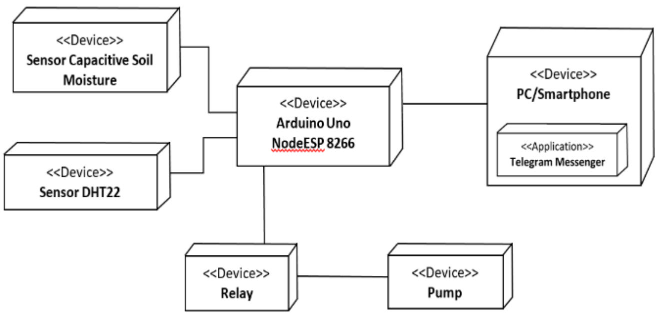

Figure 4. Deployment of Diagram System

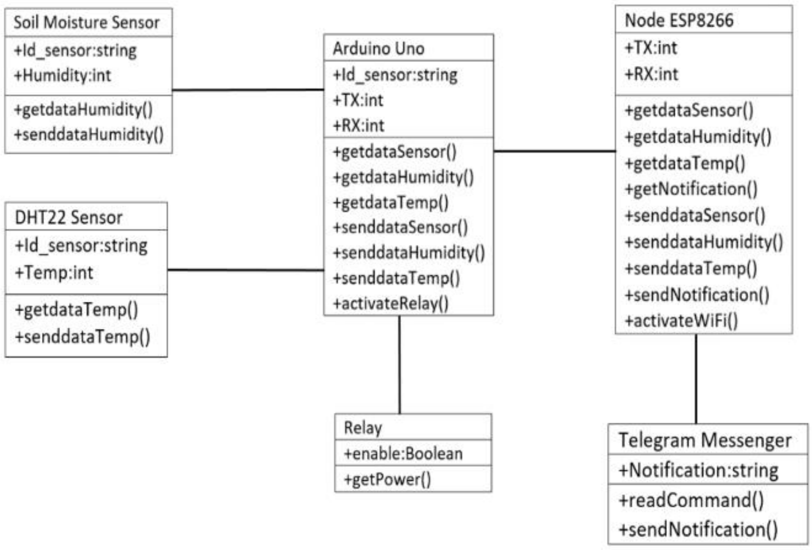

Figure 5. Design a Class Diagram System

Moreover, Figure 5 is a class diagram of the system being designed. The designed system has 6 classes, namely: soil moisture sensor class, DHT22 temperature sensor class, Arduino class, ESP8266 Node class, relay class, and telegram messenger class.

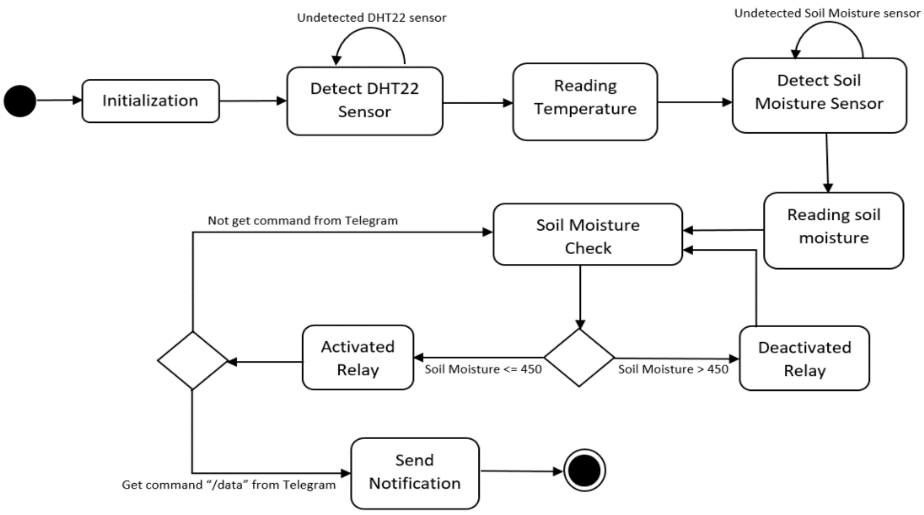

Figure 6. Design a State of Diagram System

Furthermore, Figure 6 is a state diagram of the entire system. The DHT22 sensor status detection and soil moisture sensor status detection will continue to run in this state if both sensors are not detected. The relay activation condition works when the value read by the soil moisture sensor is <= 450, which indicates that the pump will work to provide moisture to the soil by adding water and the pump will turn off when the soil moisture becomes > 450. Conditions for the measurements performed by the soil moisture sensor are sent to Telegram when the system receives the command "/data" from the user.

4. Result and Analysis

4.1 Performance of Arduino and Telegram Application

In this section, we discuss the tests performed, namely testing the connection between Telegram and Arduino and testing the entire system. Figure 7 is the result of tests performed on the Telegram application with Arduino.

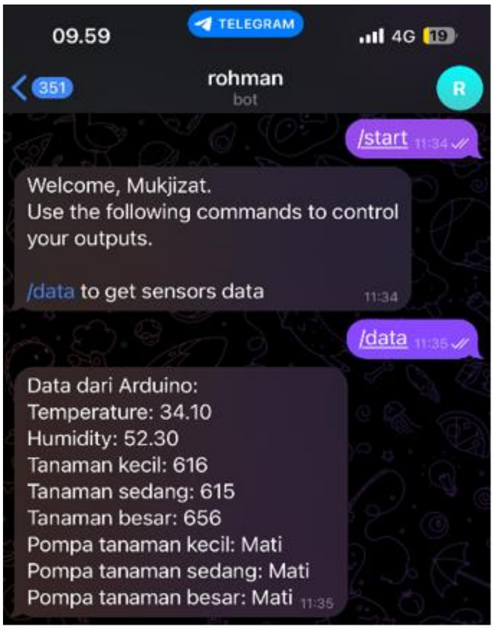

Figure 7. Testing the connection between Arduino and the Telegram application

This test starts by sending the command "/start" to start the Telegram bot. When the Telegram bot responds, the words "Welcome, Wonders" will appear. Use the following commands to control your outputs" and "/data to get sensor data". Then continue with the command "/data" to have the data read out by the DHT22 sensor and soil moisture sensor, as well as the status of the pump. The next test after the connection test is performed is a test of the entire system. System testing was conducted in the West Cigadung Raya area, Bandung City. The entire system has been tested with 3 plant pots with different pot sizes, namely a small pot with a diameter of 10 cm, a medium pot with a diameter of 12 cm, and a big pot with a diameter of 15 cm. This test was carried out over 7 days, with the measuring time divided into 2 times, namely during the day with the measuring time between 9:50 AM and 2:40 PM., and at night with the measuring time between 9:00 PM. and before 11:10 PM. The results of tests performed during the day are shown in Table 1, while the results of tests performed at night are shown in Table 2.

Table 1. System Testing Result During the Day

Day	Time	Temp (°C)	Pot	Humidity (RH)	Pump Status	Pump Status Expected results
1	09:54	32	Small Pot	616	Off	Off
			Medium Pot	615	Off	Off
			Big Pot	656	Off	Off
2	13:55	28	Small Pot	536	Off	Off
			Medium Pot	539	Off	Off
			Big Pot	582	Off	Off
3	13:32	32	Small Pot	461	Off	Off
			Medium Pot	480	Off	Off
			Big Pot	520	Off	Off
4	14:34	31	Small Pot	408	On	On
			Medium Pot	411	On	On
			Big Pot	453	Off	Off
5	12:45	33	Small Pot	584	Off	Off
			Medium Pot	577	Off	Off
			Big Pot	620	On	Off
6	10:56	30	Small Pot	510	Off	Off
			Medium Pot	503	Off	Off
			Big Pot	552	Off	Off
7	11:45	29	Small Pot	453	Off	Off
			Medium Pot	449	Off	On
			Big Pot	492	Off	Off

Table 1 with the results of the system tests shows that several system errors have occurred, such as the test on day 5, when the moisture value measured by the soil moisture sensor exceeded the specified upper limit, leaving the soil in the pot still moist, so there was no additional addition required watering or activating the pump, but when tested the system activates the pump to wet the soil so that it is moist. As well as testing on day 7, when the humidity value is below the indicated lower limit, which means that the soil in the pot is not moist enough and therefore water must be added to moisten the soil in the pot, but when the test is carried out, the system does not activate the pump.

Table 2. System Testing Result During the Night

Day	Time	Temp (°C)	Pot	Humidity (RH)	Pump Status	Pump Status Expected results
1	21:14	28	Small Pot	572	Off	Off
			Medium Pot	578	Off	Off
			Big Pot	619	Off	Off
2	23:03	29	Small Pot	494	Off	Off
			Medium Pot	512	Off	Off
			Big Pot	548	Off	Off
3	22:34	28	Small Pot	437	Off	Off
			MediumPot	446	Off	On
			Big Pot	488	Off	Off

Day	Time	Temp (°C)	Pot	Humidity (RH)	Pump Status	Pump Status Expected results
4	22:54	29	Small Pot	617	Off	Off
			Medium Pot	635	Off	Off
			Big Pot	422	On	On
5	22:01	27	Small Pot	539	Off	Off
			MediumPot	536	Off	Off
			Big Pot	583	On	Off
6	21:56	28	Small Pot	481	Off	Off
			MediumPot	484	Off	Off
			Big Pot	528	Off	Off
7	23:04	27	Small Pot	421	On	On
			Medium Pot	418	On	On
			Big Pot	473	Off	Off

Table 2 shows the results of system tests performed overnight. The test results show that the soil in the pot is less moist at night. On the third day of testing, a test error occurred that occurred on a medium pot where the pump should have been on, but when the pump was tested it was off, as well as when testing on day 5 when the pump was tested on it should have been. This may arise because the results of the measurements taken are displayed and the time at which the data is sent to Telegram does not occur at the same time, causing a time difference.

5. Conclusions and Suggestions

Based on the test results, the overall system works well and Telegram, which is typically used as a messenger, can be used to control the microcontroller via an Internet connection. The results of tests performed on pots of different sizes have different moisture levels. It can therefore be concluded that the size of the pot influences the soil moisture content, with a small pot becoming less moist more quickly than a medium and large pot. The results of the tests carried out show that the pump is working properly and that the control carried out can be properly read using commands in the form of messages via telegram. The weakness of this study is that there is no real-time readout, so the sampling time still requires manual readout.

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Author contributions: All authors are responsible for building Conceptualization, Methodology, analysis, investigation, data curation, writing—original draft preparation, writing—review and editing, visualization, supervision of project administration, funding acquisition, and have read and agreed to the published version of the manuscript.

Conflicts of Interest: The authors declare no conflict of interest.

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