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IoT Garden Irrigation System

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ABSTRACT—

Rapid technical advancements have been used in a variety of spheres of life, including agriculture. By implementing technology in the agricultural industry, it is possible to save energy and time that would otherwise be lost while using conventional methods. The Internet of Things (IoT) is one of the technological breakthroughs that is currently in vogue. The Internet of Things (IoT) is a technology that enables real-time connections between physical items and the internet. By remotely managing the water pump and keeping track of the soil moisture in the garden, this study integrates the Internet of Things into the irrigation system for gardens. The Internet of Things application allows gardeners to monitor and measure soil moisture in their crops. Consequently, effectively managing usage

I. INTRODUCTION

In this period, agricultural cultivation management has to be improved. Along with the numerous instances of crop loss brought on by insufficient field conditions management. The inability of apple garden owners to control irrigation in their far-flung gardens served as the inspiration for this study. The garden owner drives from home to garden frequently merely to physically check the irrigation channel.

Nearly all facets of life, including job (work affairs), home, social interactions, health, religion, entertainment, and formal and informal education, can benefit from the IoT idea. Numerous other industries, including homes, politics, the social environment, health, transportation, and the government bureaucracy, can also use the IoT system [3] [7] [8]. You can see from this that the Internet of Things (IoT) application may be utilised in many areas to enhance technology and make life easier for people. For best growth, plants require fertile soil. The balance of oxygen, water, and nutrients must be maintained as a fundamental component in managing soil fertility. Depending on the soil wetness, each plant manages its water differently. Water may be drained or added by watering.are urgently needed at this time. Applying technology in the plantation sector can reduce energy and time wasted by using effective irrigation methods.

This research want to solve problems of lower efficiency of conventional farming method. At the dry soil stage and requires a water supply, the water pump must be active to drain the water to supply the needs of the apple plant. The strength of this research is that controlling the irrigation system can be done anywhere and anytime when we are connected to an internet network that controls using an Android application.

This research aims to create an irrigation system based on Internet of Things [4]. In this system the owner of the garden can monitor the condition of soil moisture and control the flow of water that will be watered on plants. Thus increasing crop yields and optimizing water usage. This system uses a soil moisture sensor that will be processed by NodeMCU ESP8266 that is connected to the internet so that it can send data obtained from the sensor to Firebase..

II. RELATED RESEARCH

Many studies use Internet of Things technology to be developed in automatic irrigation systems. Research from

[4] applies the Internet of Things using Banana Pi as the sender of sensor values to the database. Research [5] applies the Internet of Things using ESP 8266 to send sensor data to the server and use Arduino Uno as the main controller. Research [6] applies the Internet of Things to hydroponic plants using Arduino and the Blynk Android Application as interfaces. The automatic irrigation reference used in this study was inspired by the inventions of the three studies, including work principles, communication media, and technological features.

This tool uses a soil moisture sensor FC-28 and sending sensor data to the database using the WiFi module ESP8266 which is also used as a humidity sensor microcontroller. The user interface for control and monitoring can use Firebase to determine soil moisture, activate the water pump and adjust the speed of the water pump. In addition the process of control and monitoring can also be done through a smartphone application that is connected to the internet.

The working principle of the proposed automatic irrigation system is to measure soil moisture by inserting a sensor in the soil. Then the WiFi Module ESP 8266 will send sensor values to firebase as a database. To set the set point for soil moisture can be done in firebase so that the pump can be active when the soil moisture value has reached the set point. Pump speed settings and how long for active pumps can also be done at firebase. In this research, setting a set point apart from firebase can also be done through a smartphone application that has been connected to the internet.

In this paper, the proposed system is to use the Wifi ESP 8266 Module which is directly connected to the Internet Router, to facilitate sending data to Firebase. In research [6] testing connectivity using the firebase server and Ethernet Shield by pinging the firebase server. This connectivity requires a long delay to connect to the database. The difference in time is long from the time of sending data to the time when the data reaches the database. The advantage of this study is that it only requires an average of 0.6 seconds based on test data from 20 attempts of sending data to the database and the value of soil moisture can be monitored anywhere as long as the smartphone has an internet connection. The number of sensor nodes can also be added if needed, as long as the area is covered by a WiFi network.

TABLE I. COMPARISON OF RELATED RESEARCH

Reference	**Processor**	**Connection Type**	**Monitoring Method**
[4]	Banana Pi	WiFi	Android app
[5]	WiFi ESP8266	WiFi	Website
[6]	*Ethernet Shield*	WiFi	Android app
This research	ESP 8266	WiFi	Android app

III. METHOD

The system block diagram is described in Fig 1. Which consists of the Esp8266 microcontroller which is also used as a WiFi Module, FC-28 soil moisture sensor, L298n Motor Driver and DC Water Pump as an actuator. This data will be sent through the internet network and monitored on the smartphone application.

A. Hardware Design

Hardware design and development consists of NodeMCU ESP 8266 microcontrollers, dc water pump, l298n motor driver, and FC-28 soil moisture sensor [15]. The N82MCU Esp8266 microcontroller functions as the main processing unit that handles most of the processes from tools such as controlling dc water pump, processing sensor data and sending sensor data to the database.

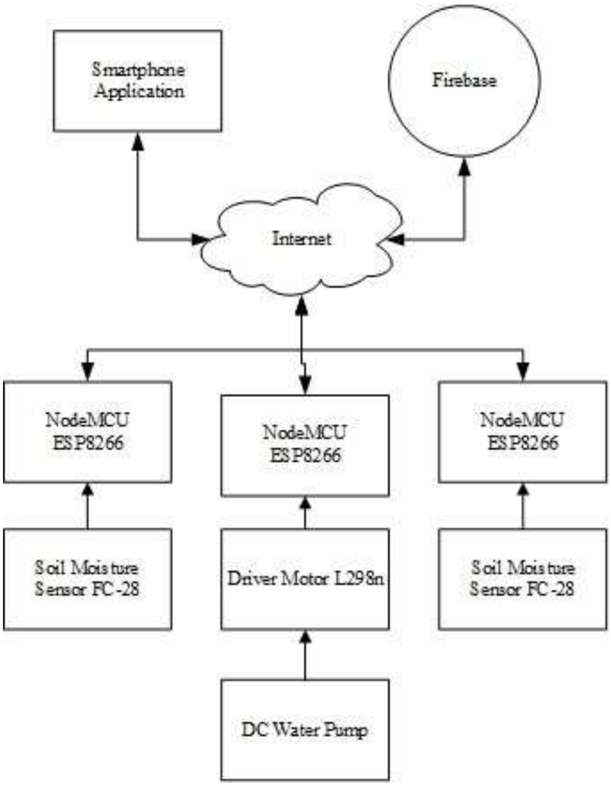


Fig 1. System diagram block

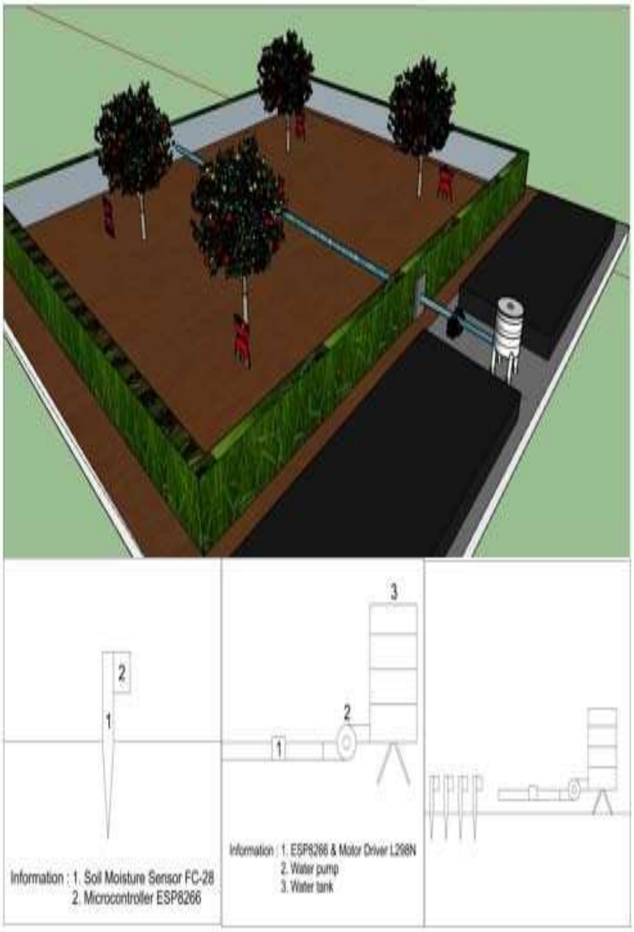


Fig 2. Layout of the supporting device of the system in the field

Figure 1 and Figure 2 show the diagram bloc and layout of the supporting device of the system. Soil moisture sensor data received by NodeMCU ESP8266 is then sent to Firebase via the internet network which is then displayed on the smartphone application. Similarly, taking data variables from a smartphone application is sent to Firebase first and then it can be read by NodeMCU ESP8266 on the device. An illustration of the process is described in Figure 3.

Fig 3. Illustration of Data Transfer Process

B. Software Design

Software design includes data processing on the NodeMCU ESP8266 microcontroller for the FC-28 soil moisture sensor data retrieval process and cloud database software design. The proposed system is using Firebase because it has compatibility on various platforms and has several features such as authentication, real-time database, storage, hosting and others. If data transmission fails, the device stores data in internal memory to be sent again in the next cycle.

The next software design is the design of smartphone applications. Smartphone applications have 2 main functions, namely controlling and monitoring tools. Data will be displayed in the application so that it can be monitoring wherever and whenever as long as you have an internet connection. Control in the application is the control of the water pump that can be turned on and off via a smartphone remotely while connected to the internet.

IV. RESULT AND ANALYSIS

Experiment was carried out to test the performance of the system. Testing includes sensors, actuators and data transfer behavior.

A. FC-28 soil moisture sensor Calibration

In this study, FC-28 soil moisture sensor was used to determine the condition of soil moisture in the garden. The FC-28 sensor will be calibrated by taking the ADC value from the sensor and comparing it with a standard soil moisture meter. The data displayed is the ADC value data. Then comparing the sensor readings with the moisture meter reading. The test is carried out continuously 10 times, with total 100 sensor data is taken for every single test. The 10 calibration results can be seen in Table 2.

Based on the test results, it was found that the difference in ADC values was quite high in between the 2 and 3 moisture meter values. Details of each data, please refer to Figure 4.

From the average results on the sensor data, a reference is made which shows that when the FC-28 ADC sensor value is around 312, the soil moisture is at a value of 10 moisture meters. Likewise, with other moisture meter values, where the value of 10 is when the soil is in wet humidity and the value of 1 is in dry humidity. From the graph in Figure 4, it is found that the difference in ADC values is quite high in soil moisture 2 and 3 so that the FC- 28 sensor does not give a linear value.

TABLE II. CALIBRATION RESULTS OF THE FC-28 SENSOR WITH A MOISTURE METER

No	*Moisture Meter value*	FC-28 **moisture sensor value**
1	1	891
2	2	858
3	3	599
4	4	546
5	5	487
6	6	457
7	7	441
8	8	414
9	9	354
10	10	312

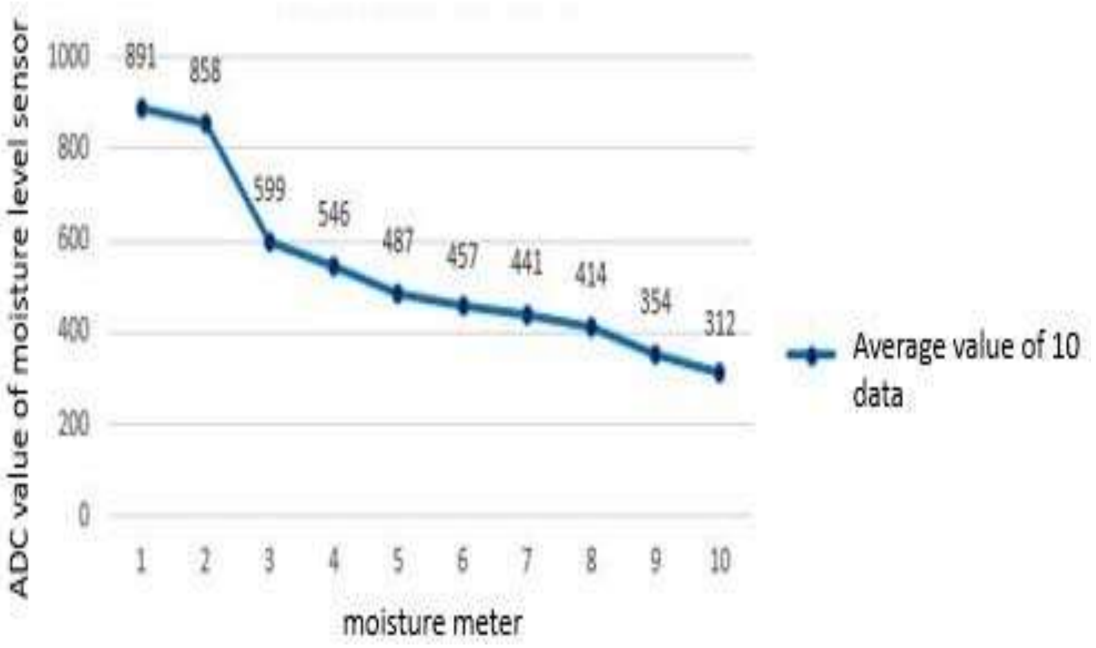
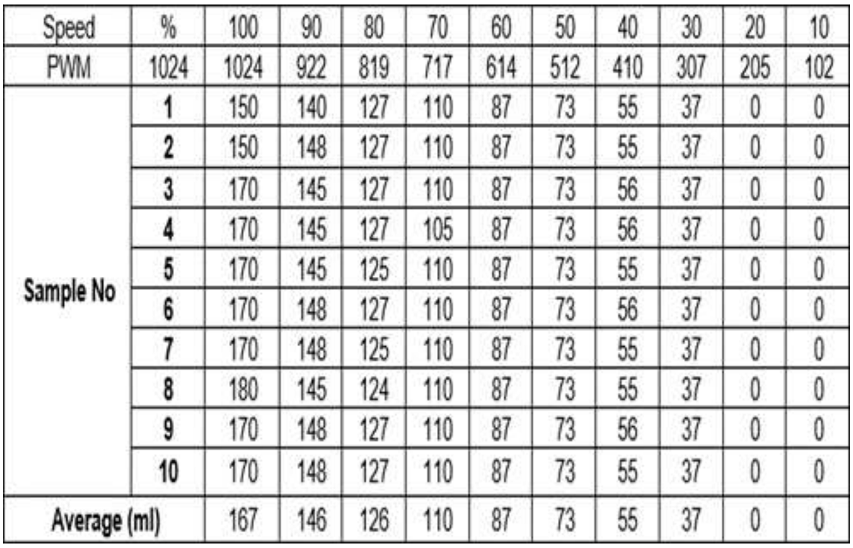


Fig. 4. FC-28 Soil moisture sensor experimental data

TABLE III. DC WATER PUMP DISCHARGE TEST



Speed	%	100	90	80	70	60	50	40	30	20	10
PWM	1024	1024	922	819	717	614	512	410	307	205	102
Sample No	**1**	150	140	127	110	87	73	55	37	0	0
	2	150	148	127	110	87	73	55	37	0	0
	3	170	145	127	110	87	73	56	37	0	0
	4	170	145	127	105	87	73	56	37	0	0
	5	170	145	125	110	87	73	55	37	0	0
	6	170	148	127	110	87	73	56	37	0	0
	7	170	148	125	110	87	73	55	37	0	0
	8	180	145	124	110	87	73	55	37	0	0
	9	170	148	127	110	87	73	56	37	0	0
	10	170	148	127	110	87	73	55	37	0	0
Average (ml)		167	146	126	110	87	73	55	37	0	0

B. DC Water Pump Discharge Test

This test is carried out to determine the water discharge flowed by the DC Water Pump in several time settings. From several time settings, the results of the water flow that can be pumped by the DC Water Pump will be measured using a measuring cup. Then it can be calibrated as desired.

Testing is done by looking at the water flow that is flowed in 3 seconds. The test is carried out continuously 10 times then the average value is taken. The test results can be seen in Table 5.

The average value of the water discharge flowed by the DC water Pump was collected. From the average results on these data, it is known that with a speed of 100% flowing 167ml of water for 3 seconds. Based on this data, it can be concluded that for 1 minute the Water Pump can drain up to 3340ml of water.

C. Data Transfer status from Sensor to Google firebase Data Transfer status from NodeMCU ESP8266 to

Google Firebase can be determined by looking at the time difference between data arriving at firebase and the time data is sent from ESP8266. This process can be observed on the Arduino IDE serial monitor application by activating the timecode so that response time can be seen with up to millisecond accuracy. The test is carried out continuously 10 times then the average value is taken. The results of testing the data transmission can be seen in Table 4.

TABLE IV. DATA TRANSFER STATUS OF THE SYSTEM

Samples sequent	**Data sent (HH:MM:SS.mS)**	**Data Received (HH:MM:SS.mS)**	**status**	**Response time (S)**
1	20:49:31.450	20:49:32.850	Success	1
2	20:49:32.850	20:49:34.930	Success	2
3	20:49:34.930	20:49:36.010	Success	2
4	20:49:36.010	20:49:38.050	Success	2
5	20:49:38.050	20:49:41.170	Success	3
6	20:49:41.170	20:49:41.970	Success	0,8
7	20:49:41.970	20:49:43.546	Success	2
8	20:49:43.546	20:49:45.906	Success	2
9	20:49:45.906	20:49:49.146	Success	4
10	20:49:49.186	20:49:53.266	Success	4

The results of the average response with 10 data samples is 2.28 seconds.

D. Data Transfer speed Using Three different Internet providers in Indonesia

The speed of data transfer to Firebase with 3 different internet service providers was measured. About 20 times data sample were. The results of testing the speed of data transmission can be seen in Table 5.

TABLE 5. COMPARISON OF DATA TRANSFER SPEED USING THREE DIFFERENT INTERNET PROVIDERS IN INDONESIA

Sample sequent	**First Media (sec)**	**MyRepublic (sec)**	**IM3 (sec)**
1	1	0,4	1
2	2	0,4	2
3	2	1	1
4	2	0,4	2
5	3	0,4	1
6	0,8	1	2
7	2	0,4	2
8	2	1	1
9	4	0,4	2
10	4	0,4	2
11	6	1	1
12	4	0,4	2
13	5	0,4	1
14	5	1	2
15	5	0,4	2
16	7	0,4	1
17	3	1	2
18	6	0,4	2
19	1	1	1
20	3	0,4	2
	Averages	**Averages**	**Averages**
	3,4	0,6	1,6

Based on the test data in table 3, “First Media” Provider takes an average of 3.4 seconds, MyRepublic Provider 0.6 seconds, and IM3 Data Package 1.6 seconds for sending data to Firebase. Based on these data, each internet provider has a different connection in the speed of sending data. Based on this, it can be analyzed that the speed of sending ESP 8266 data to Firebase does not require a long time and no more than 4 seconds for data to arrive at Google Firebase. Data transfer speed is strongly dependent on the internet provider used.

E. Data View in Google firebase and Mobile App

Raw data from 4 soil moisture sensor was sent to the cloud via internet connection. Figure 4 and Figure 5 show data view in Mobile App and Google Firebase respectively. Data from 4 sensor probe displayed in real time without problem.

21:00

Device Status

moisture 469 Node1 18:17:57

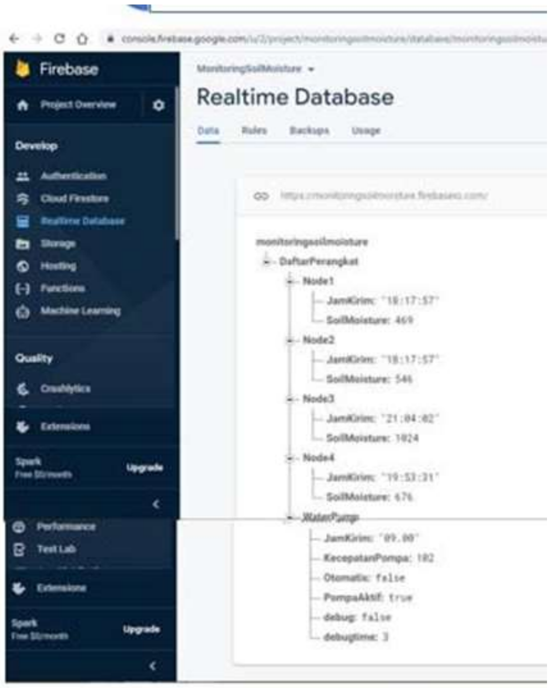
moisture 676 9:53:31

moisture 546 Node2 18:17:57

moisture 1024 Node3 21:04:02

RPM 102 Automatic no

Fig 5. Display of mobile app



```
monitoringsoilmoisture
  - DaftarPerangkat
    - Node1
        JamKirim: "18:17:57"
        SoilMoisture: 469
    - Node2
        JamKirim: "18:17:57"
        SoilMoisture: 546
    - Node3
        JamKirim: "21:04:02"
        SoilMoisture: 1024
    - Node4
        JamKirim: "19:53:31"
        SoilMoisture: 676
    - WaterPump
        JamKirim: "09.00"
        KecepatanPompa: 182
        Otomatis: false
        PompaAktif: true
        debug: false
        debugtime: 3
```

Fig 6. Display of real-time data in a Firebase database

IV. CONCLUSION

Based on experimental data, it can be concluded that data transfer to the database did not experience problems. But there is an average delay of 2.28 seconds. Based on testing of 3 internet providers, the results of the speed of sending data to the firebase averaged no more than 4 seconds. The process of sending data is dependent on the speed of internet provider.

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