DESIGN OF IOT-BASED OPEN PAN EVAPORIMETER MONITORING SYSTEM AT CLASS II CLIMATOLOGICAL STATION JEMBRANA

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Abstract: *Technological developments from time to time develop rapidly, not because of ease of use but accuracy in the world of work. One of them is in the world of agency work at the Jembrana Class II Climatology Station. Regarding the tools at the Jembrana Class II Climatology Station, it is still classified as a manual, one of the tools in question is the Open Pan Evaporimeter. The application for this tool is strived to make it easier for observations to take place, therefore an IoT-based monitoring system tool is made to read the occurrence of evaporation on the device. The VL53L0X sensor is used to measure the water level and the DS18B20 sensor is used to measure the water surface temperature. The creation and display of data is used by the Thingspeak web server, this makes it easier to read measurement data. Evaporation data was taken for two months from May to June, in one day three observations were made. The first observation was carried out at 07.30 WITA - 07.51 WITA, the second observation was carried out at 13.30 WITA - 13.51 WITA, and the last observation was carried out at 17.30 WITA - 17.51 WITA. Comparative data in May for monitoring system tools obtained a comparative value of 94.0 mm for manual tools, 75.2 mm for automatic tools and comparison data in June for monitoring system tools, obtained a comparative value of 127.0 mm for manual tools 108.0 mm for automatic tools.*

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Introduction

Technological developments that occur until now continue to change according to human needs. Technology has several fields in which there are still shortcomings in its application. These shortcomings encourage the creation of innovations that will facilitate a job so that the deficiencies that occur can be overcome. The application of innovation by creating new technology has been carried out in various agencies, one of which is the Meteorology, Climatology, and Geophysics Agency (BMKG), especially at the Jembrana Class II Climatology Station. This shows that there are still tools with systems that are still done manually, one of which is the Open Pan Evaporimeter (Putera & Toruan, 2016). Open Pan Evaporimeter is an evaporation device that can only be read at certain times. Evaporation occurs by the process of changing a substance that was previously a liquid into a gas and is accompanied by the release of heat. In evaporation, when water evaporates and rises into the air, some of the radiant energy from the sun can be converted into heat energy (Rustika et al., 2018). This tool is equipped with a Hook Gauge as a measure of the water level which will later be used to see how much evaporation occurs and a floating thermometer as a measure of the surface temperature of the water. Thus, when the observation takes place, the observation needs to be spacious or where the tool is located to get the data, this is very less effective when viewed from the data collection takes place. Therefore, a monitoring system based on IoT (Internet of Things) is needed (Sorongan et al., 2018). This monitoring system, of course, uses several necessary components, including the NodeMCU ESP8266 microcontroller and several sensors with the addition of a program from the Arduino IDE (Pangestu et al., 2019). To display the data results using the Thinkspeak Web whose output is in the form of a graph or numbers, thus observation activities are no longer carried out in the field or where the tool is located, of course, it can be carried out in a room (Gani et al., 2019).

According to research by Nasrulloh and Baswara (in August 2021) for the use of sensors using the HC-SR04 sensors for measuring water levels while the DS18B20 sensor for measuring water temperature, in obtaining water level and water temperature data in this evaporation pan, the data display uses a graph (Wahyu S J Saputra et al., 2021). The data will be taken in the form of errors obtained between the data manually and the data automatically (Nasruloh & Baswara, 2021). Meanwhile, Azola Zubizarreta's research (in June 2020) for the Open Pan Evaporimeter tool uses Arduino-based Lora wirelessly, using design, implementation, testing, and analysis methods. In the ongoing test, the percentage error was 1.5% for the DB18S20 sensor, 22.2% for the MPU6050 sensor, and 36.3% for the LM393 en-coder sensor. In previous applied research regarding IoT-based open pan evaporimeters, there are several differences. The difference is seen in the use of several components including the microcontroller used. The data collection that takes place in research, produces different data, in this case, it certainly makes a picture for further research (Hafdiarsya Saiyar, 2019).

Based on the explanation above, the author plans to examine the effect of an IoT-based open pan evaporimeter monitoring system at the Jembrana Class II Climatology Station. The results of this study will later see the effect obtained between evaporation data and an IoT-based monitoring system with evaporation data manually, then it can be seen on thingspeak which has an important role for water level data during evaporation and water surface temperature with a graphical display in real-time and can download data files during the observation (Ratna, 2020). Based on the explanation above, the author wishes to review the effect of an IoT-based open pan evaporator monitoring system. The difference itself in this study is using the VL53l0X sensor as a water level gauge, for measuring water surface temperature using the DS18B20 sensor (Saputro & Prasetyo, 2022). In addition, this tool is needed because the data manually on the water surface temperature from the data collection is still empty because the manual temperature measurement tool is damaged. So we need this tool as an IoT-based monitoring system to make it easier to use at the time of observation.

Method

In designing the IoT-based Open Pan Evaporimeter monitoring system, which has a systematic system design stage, it can be done with the following steps.

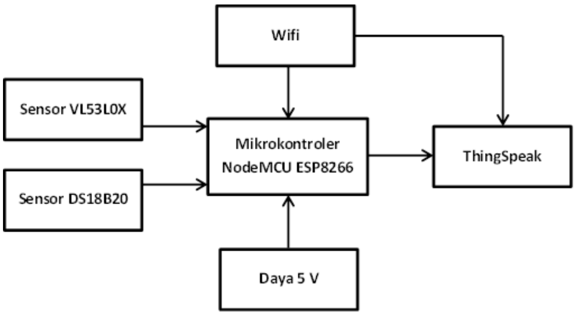

Figure 1. Monitoring System Hardware Block Diagram

Above the use of the open pan evaporimeter monitoring system will use the NodeMCU ESP8266 microcontroller. For this microcontroller, a 5V voltage source is needed, due to the ESP8266, it is necessary to have a wifi connection system for the monitoring process. This ESP8266 NodeMCU has the task of retrieving, processing, and displaying data on the Thingspeak web. The DS18B20 sensor is used for data collection in the form of temperature on the water surface and the VL53L0X sensor is used for measuring the water level in the evaporation tank. In this case, the sensor inputs data and will be sent to a microcontroller and displayed on the web, the data will appear in the form of graphs and in real-time with data updates for 15 seconds.

IDE, an abbreviation of Integrated Development Environment, is a program system used in the development of the NodeMCU ESP8266 program. The sketch is a program created in the Arduino IDE software, the file to be saved has the existence of .ino. The Arduino IDE software is also equipped with a kind of massage box that functions as an error message status, compiles, and uploads programs

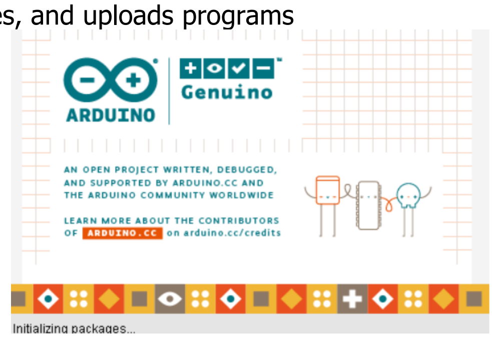

Figure 2 Arduino IDE

Thingspeak is a website platform that is of course used for a project with an IoT system. Thingspeak can be used open source to run applications and APIs. Incoming data on Thingspeak can also be stored and retrieved by various devices using HTTP via an internet connection or LAN (Local Area Network). Thingspeak as a cloud platform allows us to perform system monitoring and control on IoT systems. Thingspeak can receive data and can display data to be sent to other devices or interfaces.

Figure 3. Thingspeak

Below is an illustration of the wiring diagram that will be made on an IoT-based open pan evaporation monitoring system.

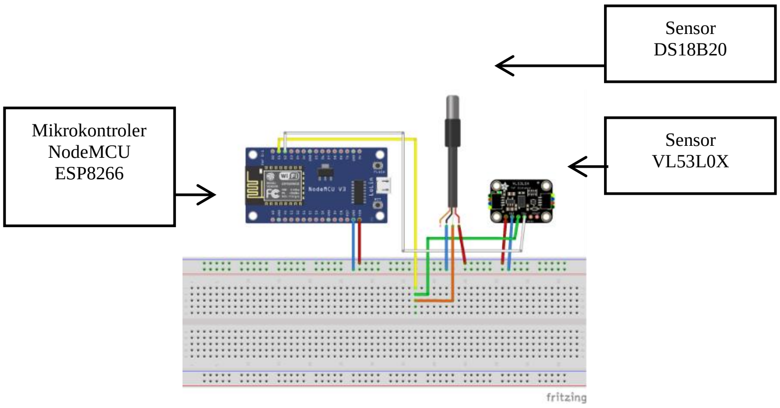

Figure 4. Thingspeak Wiring Diagram with Fritzing

Implementation of this system is made to realize a design that will be made. In this case, several components are needed, including:

Table 1. IoT Components

No.	Component Name	Number of Units
1	NodeMCU ESP8266	1 Pcs
2	Sensor VL53L0X	1 Pcs
3	Sensor DS18B20	1 Pcs
4	Breadboard	1 Pcs
5	Jumper Cable	Enough

Making the tool in this IoT-based open pan evaporimeter monitoring system with the initial step of making it done by making a placement in the form of a panel box which will later be used for components such as microcontrollers and sensors. In this case, of course, the placement is more waterproof for the sake of protection of the components in it. The material used for the panel box is stainless steel which of course can resist rust. The panel box is placed in the evaporation pan, then the panel box is locked to make it stronger. The VL53L0X sensor as a water level measurement should not change because it will make observations not match the expected data. Another thing in determining the components that must be used and their specifications must be taken into account, considering this is a monitoring system that will be implemented in the long term. The components that have been determined are then designed according to the wiring diagram and previously of course the necessary steps when the program is running in the form of a flowchart. This flowchart certainly makes it easier when the work system process in monitoring activities takes place. The following flowchart display can be seen in the image below as follows.

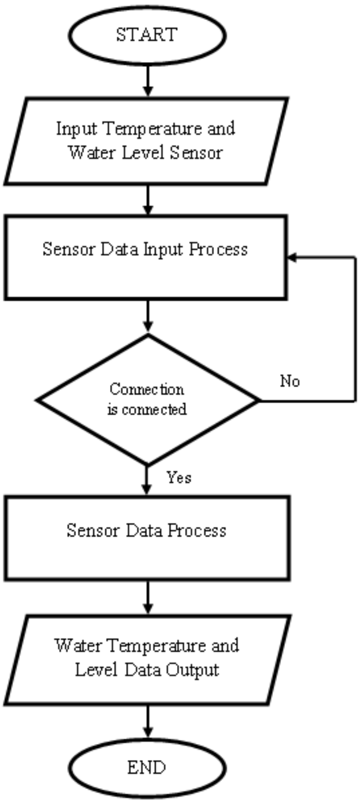

Figure 5. Flowchart

In data processing and analysis, it will be displayed in the form of a graph, this makes it easier for data analysis. Without the need for observations to enter data manually and of course, it is more efficient when the observation takes place. The results of the data that have been obtained in the form of this graph will have two data, namely water level data in units (mm) and water surface temperature data in oC units. Then the data is analyzed in the form of evaporation data, where the evaporation data itself is carried out three times a day. Morning observations get data results and compare them with afternoon observations, and after afternoon observations, afternoon observations are continued. This is obtained by data from the process of evaporation.

Previously, to get data and analysis, of course, there was a calculation in data analysis. The calculation of evaporation (E0) based on the water level, namely the initial measurement height P0 and the final measurement height P1 is divided into 4 ways, namely

a. If it doesn't rain, then
   E0 = (P0 – P1) mm
b. When it rains X mm, and P0 > P1, then
   E0 = (P0 – P1) + X mm
c. When it rains y mm, and P0 = P1, then
   E0 = Y mm
d. When it rains Z mm, and P0 < P1, then
   E0 = Z – (P0 – P1) mm

Result and Discussion

In the discussion of the results of observations and discussions of the IoT-based open pan evaporator-ter monitoring system. The results and discussions are made in the form of evaporation data on an open pan evaporimeter or evaporation tank, namely data on water level and water surface temperature. The tool used is a box panel made of stainless steel. The use of these materials is because the tool is outside the room and does not corrode. This certainly reduces tool repair activities from a component placement in the form of a box panel. The box panel is equipped with a foot containing a lock in the form of a rodent, this is used to be attached to the evaporation tank so that it does not change its place when carrying out observation activities and changing the position of the VL53L0X sensor. Under the box panel, there is a hole to place the VL53L0X sensor and the DS18B20 sensor. For the evaporation tank, it is reduced to make it easier to explain when the test takes place, the data reading is taken when the water level in the evaporation tank is generally 1 liter, which is calculated as 1 mm, while the one made for this test is 1 liter which is calculated as 1 cm. Below is a picture of the open pan evaporimeter monitoring system tool.

Figure 6. Overall View of the Open Pan evaporimeter Monitoring System Alat

In the implementation of data storage, it is expected to display evaporation data in real-time, this makes the function of the monitoring system tool work well. Therefore, on a web server made with thingspeak, data can be obtained by downloading data that has been obtained from previous observations. Below is a display of evaporation data between water surface temperature data and water level data. This data continues to enter in real-time with a time period or delay of 15 seconds.

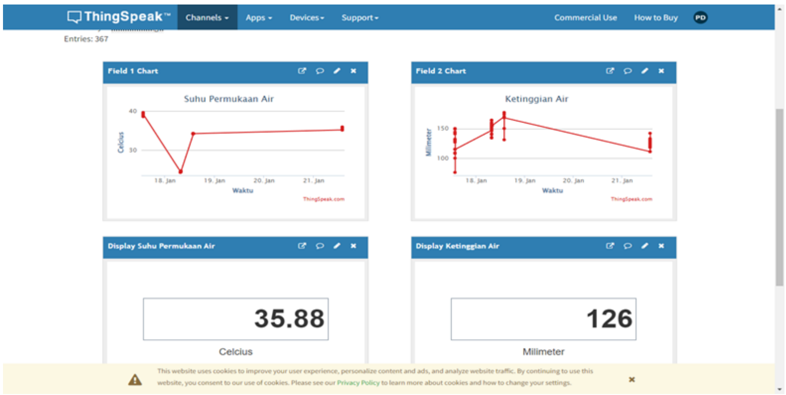

Figure 7 Data Display On Thingspeak

From the results of testing the open pan evaporimeter monitoring system, data was obtained for 2 months from May to June. This study looks for data on the surface temperature of the water with the water level in the evaporation tank and the results are in the form of evaporation data. With the results of this data, it aims to compare the automatic IoT-based open pan evaporimeter monitoring system with the manual open pan evaporimeter monitoring system. Previously, testing was carried out to check the tool and ensure the performance of the tool was functioning properly. For research data that has been obtained, it will be compared with manual data tools. This manual data was taken when the observation took place manually by taking data on the water level in the evaporation tank while the data for water temperature was not obtained because the floating thermometer was damaged. Meanwhile, the results of the data obtained from observations automatically are data on measuring water levels and water surface temperatures and obtaining evaporation data from previous observations.

Observation data in May was obtained from a manual tool, in the morning observation the evaporation amount was 24.0 mm, in the afternoon observation the evaporation amount was 27.7 mm, and in the afternoon observation, the evaporation amount was 42.3 mm. So the total number of observations manually is 94.0 mm. While the observation data obtained from the tool automatically in the morning observations get the amount of evaporation of 20.0 mm, in the afternoon observations get the amount of evaporation of 21.1 mm, and in the afternoon observations get the amount of evaporation of 34.1 mm. So the total number of observations automatically is 75.2 mm. So the comparison of data in May is 94.0 mm: 75.2 mm. The following is a comparison table of observations in May obtained from evaporation in the morning, afternoon, and evening as follows.

Table 2. May IoT Data Evaporation Component

Month	Weekly	Morning		Afternoon		Afternoon	
		Manual Evaportion Data (mm)	Auto Evaoration Data (mm)	Manual Evaportion Data (mm)	Auto Evaoration Data (mm)	Manual Evaportion Data (mm)	Auto Evaoration Data (mm)
V	19	4.1	3.0	9.2	8.1	9.4	8.0
	20	5.8	5.0	7.0	4.0	12.6	12.0
	21	6.0	5.0	6.9	5.0	8.6	7.0
	22	8.1	7.0	4.6	4.0	11.7	7.1
Amount		24.0	20.0	27.7	21.1	42.3	34.1
Average		6.0	5.0	6.9	5.3	10.6	8.5

Furthermore, the observation data in June was obtained from the tool manually, in the morning observation the evaporation amount was 38.3 mm, in the afternoon observation the evaporation amount was 37.0 mm, and in the afternoon observation the evaporation amount was 51.7 mm. So the total number of observations manually is 127.0 mm. While the observation data obtained from the tool automatically in the morning observations get the amount of evaporation of 37.0 mm, in the afternoon observations get the amount of evaporation of 23.0 mm, and in the afternoon observations get the amount of evaporation of 48.0 mm. So the total number of observations automatically is 108.0 mm. So the comparison of data in June is 127.0 mm: 108.0 mm. The following table and graph comparison of observations in June obtained from evaporation in the morning, afternoon, and evening is as follows.

Table 3. June IoT Data Evaporation Component

Month	Weekly	Morning		Afternoon		Afternoon	
		Manual Evaportion Data (mm)	Auto Evaoration Data (mm)	Manual Evaportion Data (mm)	Data Pen-guapan Otomatis (mm)	Data Pen-guapan Manual (mm)	Manual Evaportion Data (mm)
VI	23	9.5	10.0	7.2	6.0	8.4	8.0
	24	9.9	9.0	6.2	7.0	20.4	20.0
	25	9.7	10.0	9.2	8.0	10.9	10.0
	26	9.2	8.0	7.9	2.0	12.0	10.0
Amount		38.3	37.0	30.5	23.0	51.7	48.0
Average		9.6	9.3	7.6	5.8	12.9	12.0

Conclusion

Based on the results of observations that have been made, the comparison of data in May is 94.0 mm: 75.2 mm. the comparison of data in June is 127.0 mm: 108.0 mm. The effect obtained is very large when viewed from the evaporation ratio.

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