Temperature Monitoring System Based on Protocol Message Queue Telemetry Transport (MQTT)

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***Abstract*— The Internet of Things based monitoring system will display temperature and humidity in the room using the *Message Queue Telemetry Transport* (MQTT) protocol. The mqtt protocol is one of the internet-based communication protocols, in this discussion trying to implement the mqtt protocol by transferring data consisting of temperature and humidity to be carried out in an experiment with room conditions made in such a way. Some experiments with cold, normal and hot conditions to determine whether the sensor can run well or whether the mqtt protocol can be applied. Temperature and humidity sensors DHT 11 will produce data in the form of temperature and humidity that will be connected to node MCU as a microcontroller that has access to connect data to the internet using a Wi-Fi network. The broker used is broker.mqqttdashboard.com. The clients that can monitor temperature are a laptop and android, on a laptop using MQTT Box while on Android using the MQTT dashboard application. The data obtained will display 3 conditions of temperature and humidity, when cold conditions, the average value of temperature and humidity are 15.04^{0}C and 69.39%. Normal conditions of average values of temperature and humidity are 31.31^{0}c and 87.95%. Hot conditions average values of temperature and humidity are 40.65^{0}C and 95%.**

Keywords—Sistem Monitoring, Internet of things, MQTTT Protocol

I. INTRODUCTION

One of the developments in internet technology is the development of the Internet of Things (IoT). The Internet of Things is a global infrastructure for information society, enables sophisticated services, by connecting objects (things) both physically and virtually based on current information exchange technology and its development and communication technology [1].

In research [2] that uses the IoT concept, data collection takes the form of monitoring water quality by applying the XMPP protocol and proceeding with classification of water quality data using the Naive Bayes method.

Research that addresses temperature monitoring is very useful if done in large areas, hazardous areas or for data retrieval speeds because only sensor equipment and transmission systems are on site. Remote access can be via cable, wireless or optical fiber both point to point and network.

Research [3] uses the IoT concept to measure the temperature of a remote lab space using Arduino. Research related to monitoring or measuring long-range temperatures already exists with various methods both the way of remote transmission and the protocol used. In the article [4] sending temperature data is carried out point to point wirelessly using the *Universal Asynchronous communication protocol Synchronous Receiver Transmitter* (UASRT), which is a standard protocol for serial data transmission on the microcontroller. In the article [5] temperature data delivery uses cellular communication channels with the Short Message Service (SMS) protocol. This system is able to reach long distances but is still point to point.

Measurement of temperature changes can use several data communication methods such as *Message Queuing Telemetry Transport* (MQTT), *Constrained Application Protocol* (CoAP), *Hypertext Transfer Protocol* (HTTP) and so on. This study refers to the publication [6] which discusses data communication using MQTT. MQTT minimizes network bandwidth and device resource requirements when trying to guarantee reliability and delivery. This approach makes the MQTT protocol very suitable for connecting machines to machines (M2M), an important aspect of the concept of Internet of Things [6].

In this discussion, we are trying to implement the MQTT protocol by sending data in the form of temperature and humidity that will be conducted experiments with room conditions that are made in such a way. Some experiments with cold, normal and hot conditions to determine whether the sensor can run well and whether the mqtt protocol can be applied.

II. LITERATURE SURVEY

A. System Monitoring

Monitoring system is a system that performs continuous processes [7]. Monitoring of the system required in the monitoring process must be carried out.

B. DHT11 Temperature and Humidity Sensor

In this sensor there is a thermistor type NTC (Negative Temperature Coefficient) for measuring temperature, a resistivity type humidity sensor and an 8-bit microcontroller that processes both sensors and sends the results to the output pin in bi-directional single-wire format

(single cable two-way) [8].

C. MQTT Protocol

1) Definition of MQTT

MQTT (*Message Queue Telemetry Transport*) is MQTT (Message Queue Telemetry Transport) is a publish-subscribe lightweight protocol used over the TCP / IP protocol. MQTT is open, simple and designed to be easily implemented. These characteristics make it ideal for use in many situations, including limited environments such as Machine to Machine communication (M2M) and the context of the Internet of Things (IoT) where small footprint codes and / or limited networks are needed. The pattern of publish-subscribe messages requires a message broker. Brokers are responsible for distributing messages to interested clients based on the topic of the message.

A Publish - subscribe protocol allows messages to be published once and several consumers (applications / devices) to provide decoupling between producers and consumers to receive messages. One producer sends a message to the topic (subject). A consumer subsidizes a message on a topic (subject). A message server / broker according to publication to subscribe (subscribe). If there is no match the message will be discarded. If one or more messages match, the message is sent to each subscribed customer. The monitoring system is based on IoT technology and consists of three important parts: MQTT Client Publisher, Server or Broker and MQTT Client Subscriber.

2) MQTT Publisher

In the Publisher block, there is a sensor, for example there is sensor A. Each sensor will be connected to a gateway such as Ethernet shield, ESP8266, SIM800L or similar devices that can connect us to the MQTT Broker. Between the gateway and the sensor there must be a controller, you can use a controller like Arduino, Raspberry Pi or another. Now, the task of the Publisher Block is quite simple: sending data taken from sensor A to an MQTT Broker with the example of Topic data1.

3) MQTT Subscriber

The Subscriber block is responsible for subscribing data to topic data1. After getting the data in the form of sensor A value from the publisher, we can process these data to be entered into the database, analyzed or can we process it into a monitoring system that is structured and has selling points.

4) MQTT Broker

MQTT Brokers have an address that can be accessed by Publisher and Subscriber. The task of this MQTT Broker is as a data transaction link between the publisher and the subscriber. MQTT Brokers also recognize data through a grouping or commonly called topic. When the Publisher sends sensor A data to topic data1, and someday there is a Subscriber that subscribes to the same topic data1, it is certain that the Subscriber will receive sensor A data from Publisher.

III. METHODOLOGY

The design of an IoT-based monitoring system with the MQTT protocol is carried out in several stages. Stages carried out follow the research framework that has been designed beforehand so that the work is structured and follows the path.

Stages carried out include topology design, hardware and software, data retrieval and testing, application of the MQTT protocol, monitored temperature and data validation and analysis. The flow of the framework created can be seen in Figure 1.

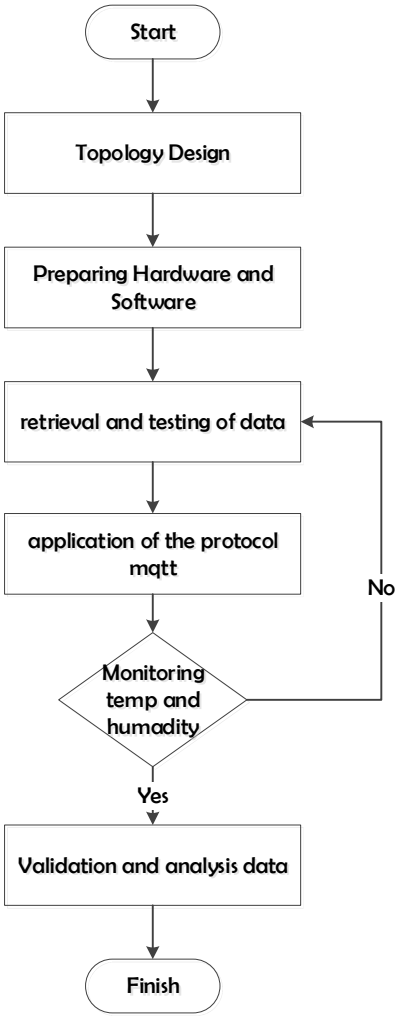

Fig. 1. Flowchart

The design of a hardware temperature monitoring system on this network consists of DHT11. That is Integrated with the same internet connection in one network.

The topology used is star topology because monitoring is centered on one broker each device sends a request to the broker then the information obtained is sent to the broker. The topology used is like Figure 2.

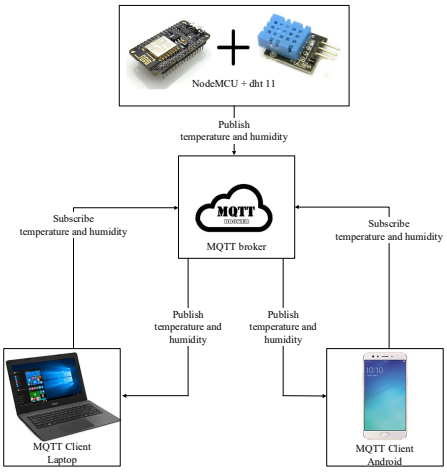

Fig. 2. Topology IoT

IV. RESULT AND DISCUSSION

A. *Testing on the sensor*

Testing of the DHT 11 sensor that is connected to the Wi-Fi network via NodeMcu uses the Arduino program. In Arduino first do some configuration such as preparing libraries from dht 11, esp8266 and mqtt. The following are the results of the serial print on Arduino like Figure 3

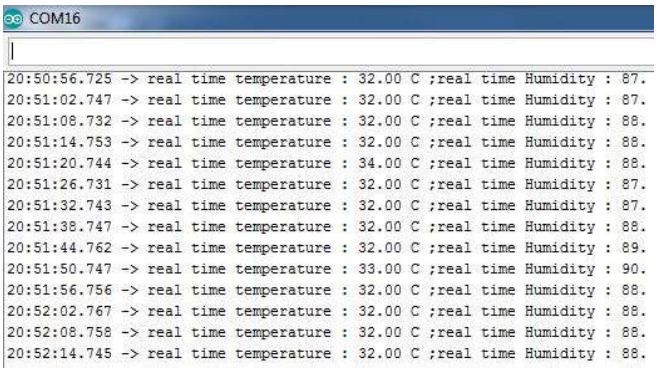

Fig. 3. Display temperature and humidity on the monitor serial

B. *Testing on client laptop*

On a client laptop device, MQTTBox is needed to monitor temperature and humidity, MQTTBox is used because MQTTBox can be connected with a specified broker. The display of temperature and humidity in the MQTTBox is seen in Figure 4 below.

Fig. 4. Display temperature and humidity on the MQTTbox

C. *Testing on client smartphhone Android*

On the android client to be able to monitor the temperature and humidity sent from the sensor dht 11 used mqttdashboard. On the Android client, just like the laptop client, you need the same broker server and client ID configuration. The display of temperature and humidity on the MQTT Dashboard is seen in Figure 5 below.

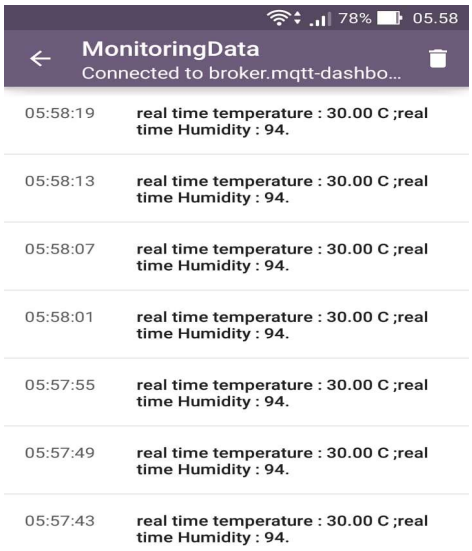

Fig. 5. Display temperature and humidity on the MQTT Dashboard

D. *Testing with cold, normal and hot conditions*

After doing the testing, get the graph results that show temperature and humidity. Testing is done by determining the conditions when the temperature and humidity are cold, normal and hot. Testing is done by determining this condition because it is to find out whether the sensor can work well and whether it can be monitored using the mqtt protocol. Cold, normal and hot experiments are carried out for 10 minutes each. The temperature and humidity charts of all conditions are shown in figure 6 below

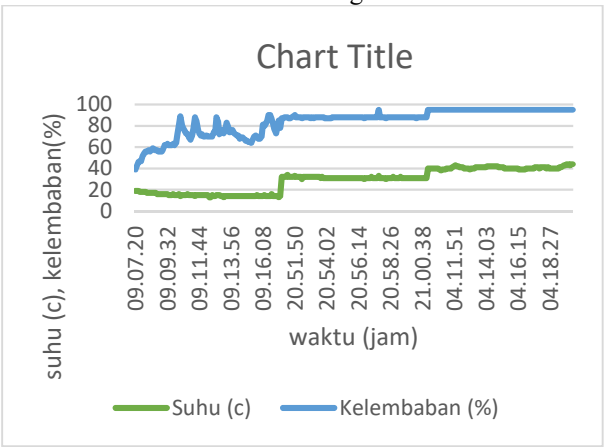

Fig. 6. Temperature and humidity charts of all conditions

Information:

- = Temperature (c)
- = Humidity (%)

Can be seen from the graph, temperature and humidity display graphics that different according to conditions. When conducting experiments with cold conditions carried out when at 9:07:20 WIT until 9:17:20 WIT. When conducting experiments with normal conditions, it is carried out at 20:50:56 WIT until 21:00:56 WIT. When conducting experiments with heat conditions carried out when at 4:10:03 WIB until 4:20:03 WIT.

- Cold conditions chart in Figure 7

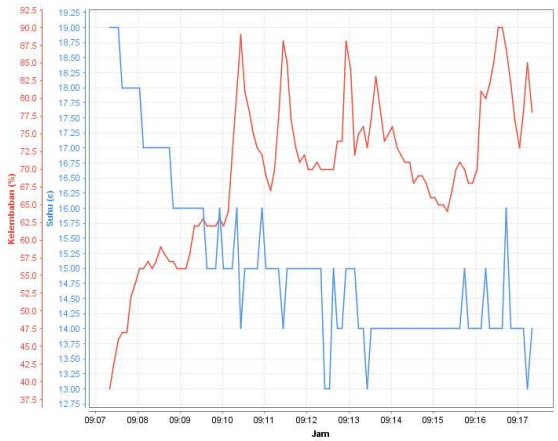

Fig. 7. Temperature and humidity chart of cold conditions

Chart of temperature and humidity when cold conditions are carried out for 10 minutes starting at 09.07 until 09.17 WIT. The red chart shows the humidity (%) that has fluctuations between 39% and 90%, while the blue chart shows the temperature value (^{0}c) between 13^{0}c to 19^{0}c.

- Normal condition chart in Figure 8

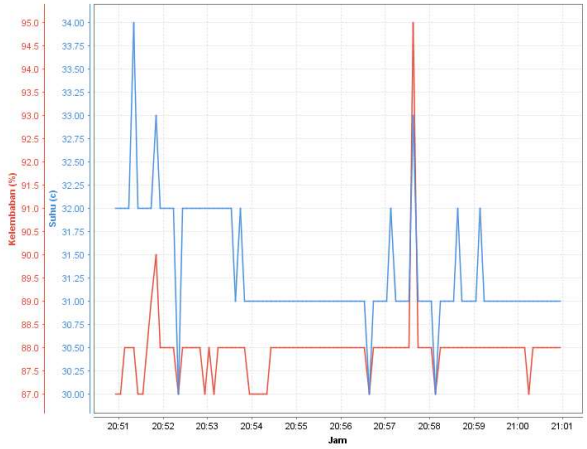

Fig. 8. Temperature and humidity chart of normal conditions

Chart of temperature and humidity when normal conditions are carried out for 10 minutes starting at 20.51 until 21.01 WIT. The red chart shows humidity (%) which has fluctuations between 87% and 95%, while the blue graph shows the temperature value (^{0}c) between 30^{0}c to 34^{0}c.

- Hot condition chart in Figure 9

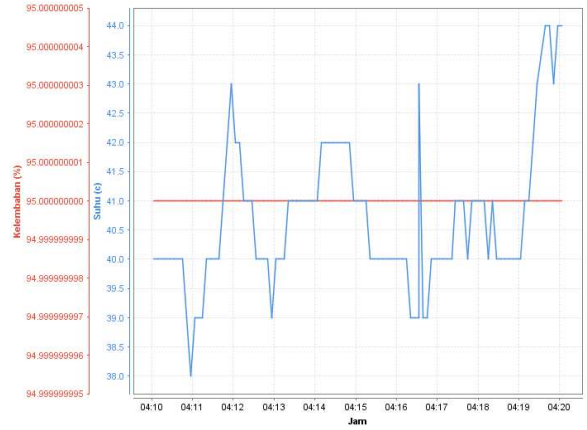

Fig. 9. Temperature and humidity chart of hot conditions

Chart of temperature and humidity when hot conditions are carried out for 10 minutes starting at 04.10 until 04.20 WIT. The red color chart shows the humidity (%) during the test is 95% while the blue chart shows the temperature value (^{0}c) between 38^{0}c and 44^{0}c.

From the results obtained each consists of 3 different temperature conditions, namely when cold, normal and hot conditions. The following is the average temperature and humidity with 3 conditions:

Table 1. The results of the average temperature and humidity in each cold, normal and hot condition.

Condition					
Cold		Normal		Hot	
Temperature	Humadity	Temperature	Humadity	Temperature	Humadity
15,04 ^{0}C	69,39%	31,31 ^{0}C	87,95%	40,65 ^{0}C	95%

The results obtained by determining the conditions themselves so that the temperature and humidity sensors can run well. The red graph in Figures 7, 8 and 9 shows data on humidity and blue indicating temperature. To get cold conditions, do it by preparing a box filled with ice cubes to produce temperatures with cold conditions. The sensor is placed on the ice cubes without touching the ice cubes. At the beginning of the test, the temperature graph shows the number 19^{0}c and then fluctuations between 13-19^{0}c.

To get the normal condition of the sensor put in the room as usual then the sensor successfully reads the temperature value between 30-34^{0}c. While when hot conditions are tested by providing a glass filled with hot water then the sensor is placed on top of the glass. For heat conditions the sensor is able to read the temperature value between 38-44^{0}c.

V. Conclusion

From the results of the discussion, The MQTT protocol can be implemented in monitoring temperature and humidity. Based on the testing that has been done the broker that is used is a broker MQTT-dashboard that is able to become a liaison between clients. Client sensors in the form of NodeMCU and DHT 11 are able to send temperature and humidity data to android clients and laptops through brokers on agreed topics. During cold conditions the average value of temperature and humidity is 15.04^{0}C and 69.39%. During normal conditions the average value of temperature and humidity is 31.31^{0}c and 87.95%. During hot conditions the average value of temperature and humidity is 40.65^{0}C and 95%.

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