Development of Environmental Testing Chamber Monitoring System Using Node Red

[1,2] Suhartinah
[1] Astra Manufacturing Polytechnic, Jakarta, Indonesia
[2] Master of Mechanical Engineering
Swiss German University
Tangerang City, Indonesia
zahrasaina@gmai.com

Hanny J. Berchmans
Master of Mechanical Engineering
Swiss German University
Tangerang City, Indonesia
hanny.berchmans@lecturer.sgu.ac.id

Henry Nasution
Master of Mechanical Engineering
Swiss German University
Tangerang City, Indonesia
henry.nasution@sgu.ac.id

Mada Jimmy FA
Astra Manufacturing Polytechnic, Jakarta, Indonesia
mada.jimmy@polman.astra.ac.id

[1,2] Elroy FKP Tarigan
[1] Astra Manufacturing Polytechnic, Jakarta, Indonesia
[2] Master of Mechanical Engineering
Swiss German University
Tangerang City, Indonesia
elroy.fransiskus@gmail.com

Eka Samsul M
Astra Manufacturing Polytechnic, Jakarta, Indonesia
eka.samsul@polman.astra.ac.id

Abstract*—The market potential for testing machines for environmental conditions is very large in Indonesia, such as in food industry, cosmetic industry, pharmaceutical industry, etc. These industries in their product development often experience problems in testing environmental condition test machines, because almost 100% of them are imported products and there are no locally made environmental conditions testing machines. The condition has led the author and the teams to take the initiative to try to develop a test machine control system for environmental conditions that monitors temperature, humidity, air pressure and CO gas in an environment as the main parameters in food testing. The test machine is designed using Raspberry pi zero wifi as a control device and Node Red as an application for display monitoring that can be accessed remotely. With the concept of IoT control and monitoring chamber, it can be done remotely using the Node Red Software.

Keywords—node red, monitoring, raspberry pi zero w, environmental test chamber.

I. INTRODUCTION

Food is anything derived from biological sources of agricultural, plantation, forestry, fishery, animal husbandry, water products, either processed or unprocessed which is designated as food or beverage for human consumption, including food additives, food raw materials, and other materials used in the process of preparing, processing and/or making food or beverages. Foodstuffs that arrive at consumers have different nutrition, quality and durability [1]. The government also plays a role in ensuring the quality of food consumed by the public. On the basis of Article 8 paragraph (2) of Government Regulation Number 28 of 2004 concerning Food Safety, Quality and Nutrition, the BPOM (Food and Drug Supervisory Agency) makes proper regulations to ensure that the food that reaches consumers is of good quality and feasibility. Thus, producers and distributors of food products must pay attention to the regulations that have been set by the BPOM Such as the resistance of the product at the storage room temperature and the length of time a good quality product consumed before the growth of bacteria, etc.

Food product manufacturers have their own challenges in maintaining the quality and confidence of their products in terms of taste, quality and durability. To answer these challenges, it is necessary to conduct in-depth research on the products to be launched, so that later solutions can be found such as manufacturing standards, storing standards, etc. One of the research methods that can be done is to make a container or room where the temperature can be adjusted, so that the environmental temperature test of the product to be tested can be carried out. In the process, the room temperature must be strictly maintained to obtain accurate data. Therefore, someone has to perform monitoring during the testing process. Monitoring is the work of observing an object with the aim of getting the desired data. This job requires at least 1 human force to observe 1 data variable [2].

Based on these problems, the authors developed a monitoring system from the Environmental Testing Chamber based on node red. Parameters such as temperature, humidity, CO gas and air pressure can be monitored directly by accessing the node red dashboard page that has been created on the webserver, anytime and anywhere [3-4]. So, it really helps reduce human duties in monitoring work.

II. SYSTEM ANALYSIS

Monitoring parameters in the Environmental Test Room (ETC) have four important parameters, namely temperature, humidity, CO and air pressure which is controlled using a Raspberry Pi Zero W based controller [5-6]. Existing hardware configurations and newly developed software are described in the following sections. Node red application based software makes the limitations in terms of monitoring can be overcome [7].

A. *Existing Systems*

The existing control system consists of an Environmental Test Chamber, Controller and relay. Fig. 1 shows a detailed architecture of the existing ETC system.

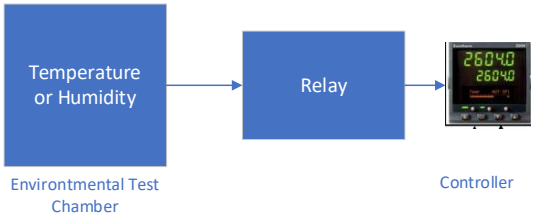

Fig. 1. Architecture of existing systems ETC

The existing environmental testing machines are still conventional namely monitoring the temperature and the other parameters are still done manually by writing it down. The machines do not have the option of storing data and viewing post-test values. This is because the control system used by environmental machines is only a thermo control system connected to a solid-state relay (SSR) with a thermocouple as a feedback. This condition led the authors to take the initiative to try to develop a test machine for environmental conditions, which is called the local-based Environmental testing chamber. An environmental test chamber will be developed with an update on the ability to record parameters during testing, where these parameters can be stored on a local server or web server and can be accessed using a gadget. The use of this application allows customers who have test specimens to be able to find out information when testing and viewing the test results online. The specimens that will be tested in this development are food products. Monitoring parameters on the machine include temperature, humidity, CO gas content and air pressure in the machine.

B. *Innovative Systems*

To overcome the limitations of the existing methods, hardware and software are selected and used to control and monitor as well as store the data remotely with a closed-loop control system.

The detailed architecture of the Innovative and new systems is shown in Fig. 2.

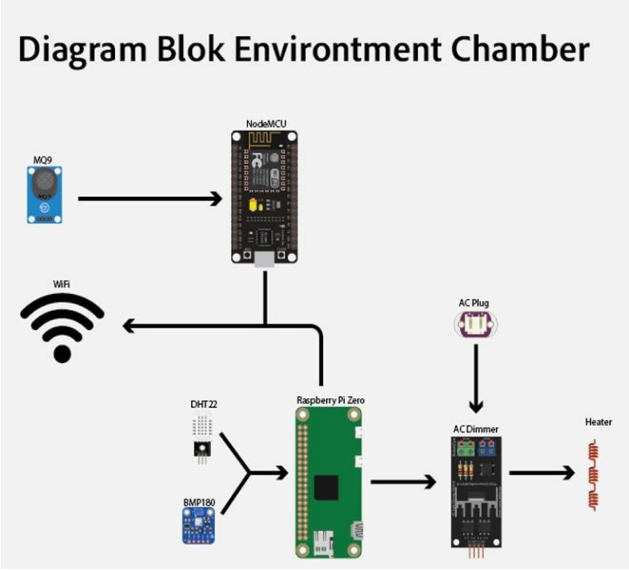

Fig. 2. Proposed system ETC

Based on the picture above, the proposed ETC control system consists of several parts: Raspberry Pi Zero, ESP8266, Light AC Dimmer, heater, sensor BMP180, DHT22, MQ9 connected to wifi and programmed using Node Red.

C. *Sofware Design*

Software to monitor and control the processes is developed using Node Red. This software was developed to control temperature, to store and display data on temperature sensors, air pressure sensors, and carbon monoxide sensors. The program flow diagram is shown in Fig. 3 and dashboard in Fig. 4. First, the program will read the values for temperature, air pressure and carbon monoxide in the chamber. The monitoring of the readings of these three sensors is displayed in gauge form on the monitoring page.

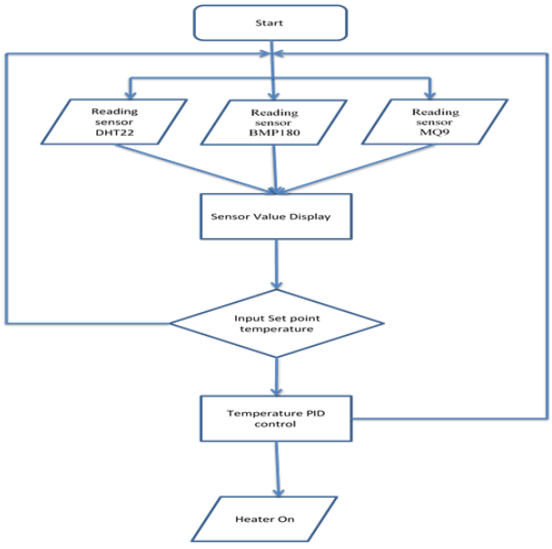

Fig. 3. Flow chart of ETC

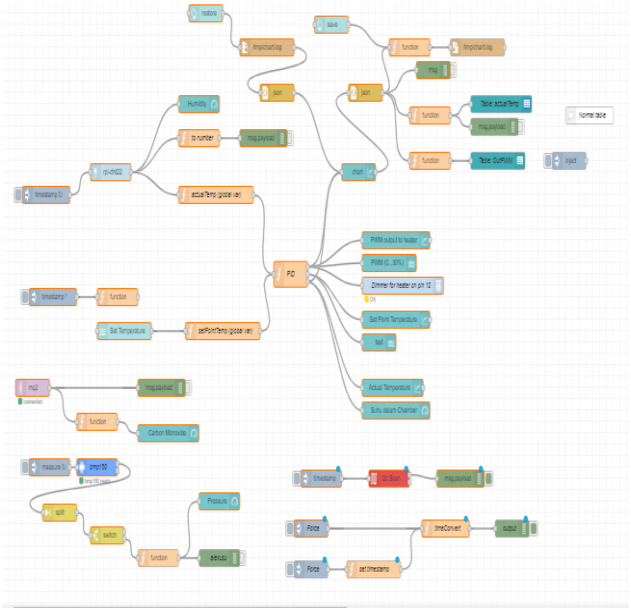

Fig. 4. Flow Program ETC in application Node red

Creating a monitoring dashboard must go through the creation of a flow program on Node Red. Because the dashboard is the result of the flow program of Node Red.

III. RESULT AND DISCUSSIONS

The development of a monitoring system in the environmental testing chamber is intended to make it easier for users to control temperature and monitor other parameters such as humidity, air pressure in the chamber and CO content when testing specimens. The display of temperature, humidity, air pressure and CO values can be seen anywhere and anytime using a smartphone or laptop/PC connected to the internet network. This is done so that users can do other work while testing the quality of the product/specimen in the environmental testing chamber.

In this study, a temperature sensor test was carried out to ensure that the sensor was in good condition and match the specifications standards on the data sheet. Temperature sensor testing is done by measuring the temperature in the chamber at various temperature conditions. Temperature sensor testing is done by placing the temperature sensor in the chamber filled with air. The heater in the chamber is heated, and then the temperature rises from the ambient temperature. The temperature inside the chamber will gradually increase from the ambient temperature to 50ºC. Then by using the help of a digital measuring instrument, namely a digital thermometer, air temperature measurements were taken from 27ºC to 50ºC. The following table is a test and comparison between the DHT22 and the Krisbow digital thermometer as shown in Fig. 5 and Fig. 6.

Fig. 5. The comparison of temperature measurement of DHT22 sensor and krisbow digital thermometer

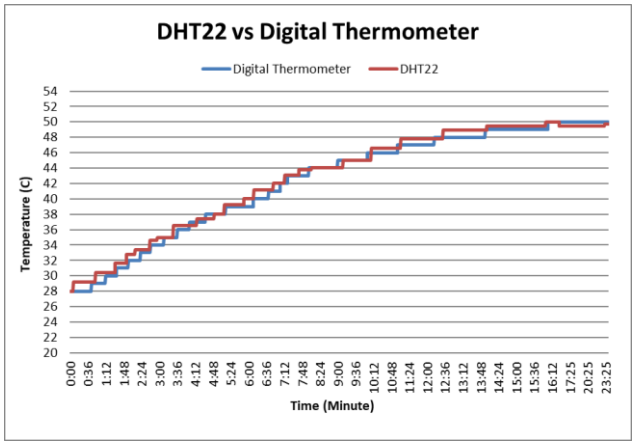

Fig. 6. The comparison of reading temperature result between DHT22 sensor and krisbow digital thermometer

Based on the graph obtained from the direct test results on the DHT22 temperature sensor and the comparison with the reading from the calibrated temperature sensor on the digital thermometer, the DHT22 sensor reading value is still within the allowable tolerance range of 1ºC. Thus, it can be ignored that the temperature sensor is still in standard conditions and suitable to be used in this study. The validation of the humidity values was carried out using a measuring instrument from the Krisbow, namely calibrated hygrometer. From the measurement results, the humidity value follows the temperature in the chamber. If the temperature increases, the humidity value will decrease and vice versa. The value obtained from the humidity measurement is in the range of 30% - 95%. While the air pressure value remains at 1 atm or 1000 KPa.

Fig. 7 is IoT dashboard of environmental testing chamber monitoring system in webserver.

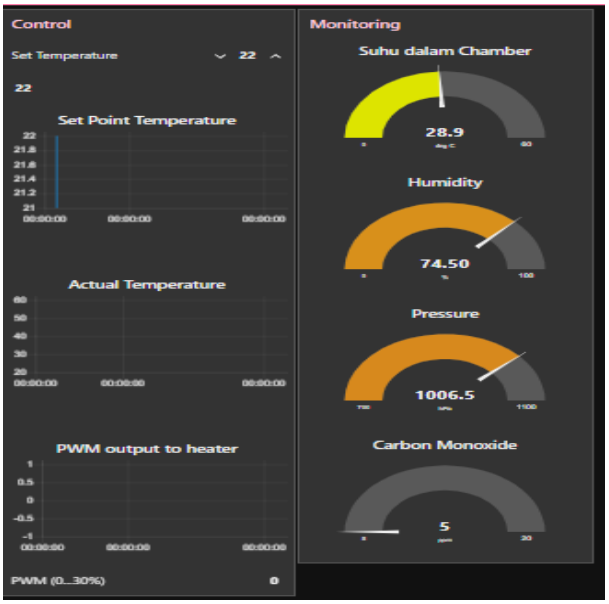

Fig. 7. Dashboard of ETC monitoring system in webserver

On the dashboard display, Node Red is divided into 2 parts, namely the control section and the monitoring section. The monitoring section is made in the form of a gauge to determine humidity, air pressure and CO gas content in the chamber. By using the node red application, the parameters monitoring on the environmental test chamber (ETC) machines make the users easy to check anytime and anywhere using the gadget on the monitoring dashboard page in the webserver.

IV. CONCLUSION

Based on data obtained from several experiments and tests, the conclusions of this study are :

Based on the results, the use of the Node-Red dashboard installed on the Raspberry is able to control the environmental system through wireless communication; this is because the raspberry pi zero already has a wifi chip that can be connected to an intranet or the internet. The Node Red dashboard display consist of two parts namely temperature control and temperature monitoring. The control part in graphical form for set point displays actual temperature and PWM (%) value, while the gauge in the monitoring part displays the actual temperature. The measurement on this system starts from 26ºC - 60ºC.

Based on the results, on the Node Red dashboard, there is a monitoring section for (carbon monoxide, pressure, and humidity) which is done online. Display in the monitoring section for humidity, carbon dioxide and air pressure are in the gauge form. The results obtained humidity values from a value of 0 - 100%. During the test the humidity values ranged from 30 - 95%. Air pressure displays a value of 1 atm or 1 kPa while the CO value sensor displays values of 5 - 8 ppm.

ACKNOWLEDGMENT

The author would like to thanks to Dr. Ir. Hanny J Berchmans, M.T., and Dr. Ir. Henry Nasution, M.T., and all the Lecturers in Polman and SGU for their collaboration on this research.

REFERENCES

[1] A. Arif, “Metode accelarated shelf life test (ASLT) dengan pendekatan arrhenius dalam pendugaan umur simpan sari buah nanas, pepaya dan cempedak,” *Informatika Pertanian*, 25 (2), pp. 189–198, 2016.

[2] M. D. Karankumar, B. M. Shreya, and S. R. Kapil, “Analysis of TOI (Things of Internet) industrial monitoring system on raspberry pi platform,” *Int. J. of Comp. Sci. and Mob. Apps.*, 2 (11) , pp. 33–40, 2014.

[3] S. Mulyono, M. Qomaruddin, and M. Syaiful Anwar, “Penggunaan node-red pada sistem monitoring dan kontrol green house berbasis protokol MQTT,” *J. Transistor Elektro dan Inform. (TRANSISTOR EI)*, 3 (1), pp. 31–44, 2018.

[4] G. E. Dominguez, L. M. Martinez, E. Cardiel and P. R. Hernandez, "Development of a system for measuring and controlling environmental parameters in an chamber for in vitro cell cultures experimentation," 2017 Global Medical Engineering Physics Exchanges/Pan American Health Care Exchanges (GMEPE/PAHCE), 2017, pp. 1-4, doi: 10.1109/GMEPE-PAHCE.2017.7972115.

[5] S. Vatsal and M. Bhavin, “Using raspberry pi to sense temperature and relative humidity,” *Int. Research J. of Eng. and Tech.*, 04 (02), pp. 380-385, 2017.

[6] A. Sunardi, D. Agus, H. Aditya, and W. Susila, “Online air velocity control, temperature and humidity monitoring system for clean room using Raspberry Pi,” IOP Conf. Ser. Mater. Sci. Eng., 550 (1), pp. 1-6, 2019. doi: 10.1088/1757-899X/550/1/012011.

[7] M. S. Murugan, L. Srikanth and V. P. S. Naidu, "Design and development of LabVIEW based environmental test chamber controller," 2017 International Conference on Electrical, Electronics, Communication, Computer, and Optimization Techniques (ICEECCOT), pp. 1-4, 2017, doi: 10.1109/ICEECCOT.2017.8284638.