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Development of Integrated IoT Trainer (LRioT) for Practical Work in Electrical Engineering Education Program Amid Pandemic

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***Abstract*—The COVID-19 pandemic there have been many changes in every segment of human life, including the education segment. The Indonesian state itself is taking action to close all educational institutions and shift learning to distance learning to limit the spread of the virus. However, distance learning cannot always be a learning solution, especially for practicum learning. Department of electrical engineering education, University of Pendidikan Indonesia, especially in the subject of practicum sensors and microprocessors, there is no learning media that can help students to do lab work remotely. On this basis, the researchers made an integrated IoT trainer design that can send and receive data to the IoT platform cloud service and can be developed into an IoT remote laboratory to meet the needs of remote practicum learning. The method used in this study is an experiment which includes design and testing. The design carried out is an integrated IoT trainer communication system, a gateway device, and an integrated IoT trainer. The trials were carried out by ensuring the data that was sended by the trainer was the same as the data accessed by the end-user on the IoT cloud platform. The trial results show that the end-user can access the same data as the existing data on the trainer. So it can be said that the trainer functions according to the plan. In the future development this trainer can be used as IoT remote laboratory that can support online practical work in amid pandemic.**

Keywords—Internet of Things, learning media, IoT platform

I. INTRODUCTION

The development of microprocessor (computer) or microcontroller technology was so fast in the era of the industrial revolution 4.0. The industrial revolution 4.0, one of which gave birth to a technology called the Internet of Things. Internet of Things (IoT) is an integrated technology for exchanging and controlling data between electronic devices via the internet [1]. IoT in its application can identify, find, track, monitor objects automatically and in real-time so that it has a significant impact on society in the fields of economic management, production operations, social management and even personal life [2].

The COVID-19 pandemic is a tragic disaster for all inhabitants of the earth. All segments of human life on earth are disturbed, without exception of education. Many countries have decided to close schools, colleges and universities to limit the spread of the virus, including Indonesia [3]. This is a challenge for all educational institutions in Indonesia to be able to provide facilities and infrastructure to fulfil distance learning activities [4]. Distance learning is not always a solution in every learning; learning that involves direct activities such as practicum cannot quickly be done using distance learning methods.

Today much research is being done to create IoT systems. Pandey et al. [5] explain or describe the improvement of the library management system, which was previously an intelligent automatic library system where all information about the condition of books can be known and recorded intelligently. Both systems that access books and read them on time via the Radio Frequency Identification network (RFID). Nath et al. [6] describe how to monitor a room intelligently to monitor the condition of the patient in the room from various variables such as lighting, humidity, temperature, television, air conditioning (AC), and other variables. This is an excellent solution to streamline the time and energy of the (nurse) guarding the room. Data will be transferred via IoT (Tx and Rx) either using a cellphone or modem facility on a computer. Then another study also made an IoT microcontroller trainer using ESP32 to monitor photovoltaic systems via the cloud [7]. Then the IoT system is also applied to agriculture to control water use and monitor soil fertility [8]. Therefore, the development of IoT research is currently being carried out by many people.

In the electrical engineering education department of the Universitas Pendidikan Indonesia, especially in the sensor and microprocessor practicum subjects, there are no learning media that can be used in remote practicum. That is very unfortunate because it can interfere with the learning process for students. On this basis, the researcher aims to conduct development research on integrated IoT microcontroller trainers that can send data to cloud services using various connectivity. The resulting output is the creation of an integrated IoT trainer that can be used in remote practicum learning activities.

II. Methods

The method used was the experiment with the design stage and then testing. At the design stage, researchers designed a communication topology system for IoT trainers using radio communication via LoRa or the internet network. Even though it uses radio communication, to get to other electronic devices such as computers and cellphones (end users), of course, the data sent must be stored in the cloud so that these devices can access it. So it is also necessary to design a gateway device to accommodate all data from the trainer via radio frequency connectivity and then send it to the cloud using internet connectivity. The Antares platform is used as a cloud on this system.

Furthermore, the integrated IoT trainer design stage is carried out. This trainer uses ESP32 as the main microcontroller. The pins on the microcontroller will be allocated so that they are completely connected to other components (input, output, and connectivity components). Input components used are fingerprint sensor, MLX90615 infrared temperature sensor, raindrop sensor, ultrasonic sensor, BME280 sensor, load cell sensor and joystick. Meanwhile, the output component uses a dual relay module, two servo motors, and a display screen (can be input as well). Then for the component sending data to the gateway using LoRa RFM95w with a frequency of 915 MHz. **Figure 1** is the integrated IoT trainer block diagram design.

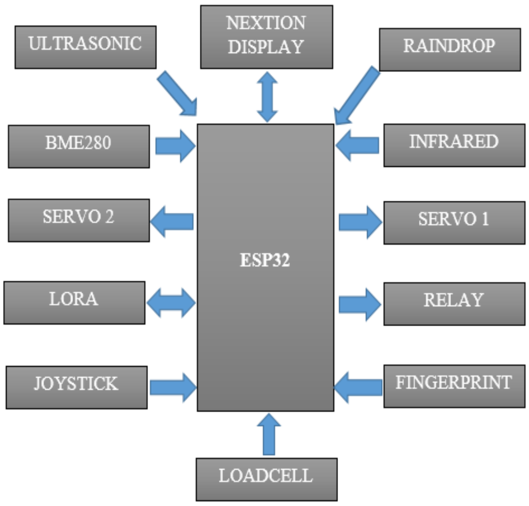

Fig. 1. Integrated IoT trainer block diagram.

After the hardware design process is carried out, a trainer trial is conducted. Trainer testing includes testing one of the projects that can be done on this trainer. The data to be seen are data on the display screen and data on the end-user, namely the computer through the Antares platform. So that if the data in the two places are the same, it can be an indicator of the success of developing IoT trainers.

III. Results and Discussion

A. Design Results

The design of a communication topology system for IoT trainers using radio communication via LoRa and the internet connection has the results shown in **Figure 2**.

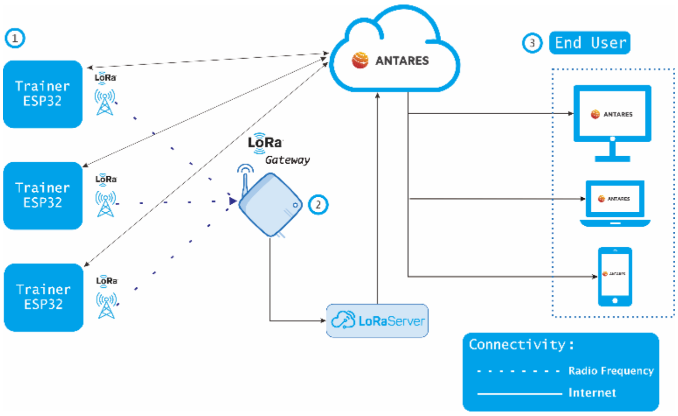

Fig. 2. The result of integrated IoT trainer communications design.

In this topology, sending data to this trainer can be done using two events, the first is using internet connectivity where data is sent directly from the end device to the cloud service using the internet. Then the second one uses LoRa radio connectivity, data from the IoT trainers will be sent to one gateway where the data will then be forwarded by the gateway to the Antares platform IoT cloud so that end-users can access the data. Therefore, the IoT trainer can be used in a different room with end-user devices. Then the gateway uses the LoRa gateway component RAK831 series which is integrated with a single-board computer Raspberry Pi 3B. The selection of these components is based on data sent from the IoT trainer via radio frequency so that the gateway device can receive it through the LoRa gateway RAK831. Which then the data will be temporarily stored on the Raspberry Pi and forwarded to the Antares platform IoT cloud via internet connectivity. The LoRa gateway RAK831 series was chosen because it is cheap and robust over a wide range of temperatures. Meanwhile, the Raspberry Pi 3B was chosen because it is cheap, and the specifications can accommodate extensive data considering the many IoT trainers and connectivity features via the internet. **Figure 3** is a form of the LoRa gateway used.

Fig. 3. LoRa gateway.

Then the block diagram that has been designed produces an Integrated IoT trainer as in **Figure 4**.

Fig. 4. Integrated IoT trainer.

B. *Trials*

In this trial, researchers conducted a trainer trial using the Weather Station Project to see the display of data from sensors on the trainer screen and end-users who access data from the Antares platform. This project uses two sensors, namely raindrop, to detect rainfall and BME280 to determine temperature, humidity and barometric pressure. The output component uses the Nextion Display so that data regarding rainfall, temperature, humidity, and barometric pressure can be displayed on the screen and an image displays whether the weather is rainy or sunny. The first trial was carried out to determine the first weather conditions, as shown in **Figure 5.**

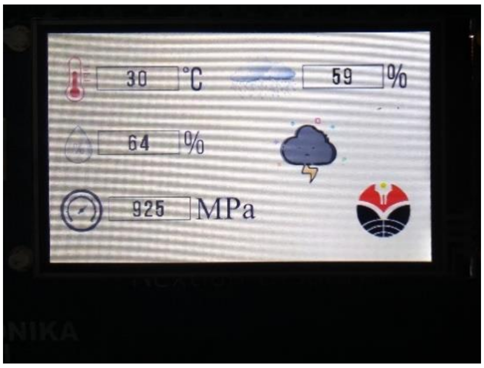

Fig. 5. HMI nextion display.

In this condition, the data from the BME280 sensor detects the temperature, humidity, and barometric pressure of the environment. At the same time, the raindrop sensor detects the intensity of water attached to the sensor. The data from the two sensors is processed by the ESP32 and displayed on the nextion display. Figure 5 shows the nextion display showing a rainy weather display using a dark cloud image. The program compares the data from the BME280 sensor with data from the raindrop sensor and shows that the temperature data from the BME280 is smaller than the water intensity data on the raindrop sensor. The data in the display can also be accessed via the Antares platform by end-users in other rooms, as shown in **Figure 6** (a), (b), and (c).


{
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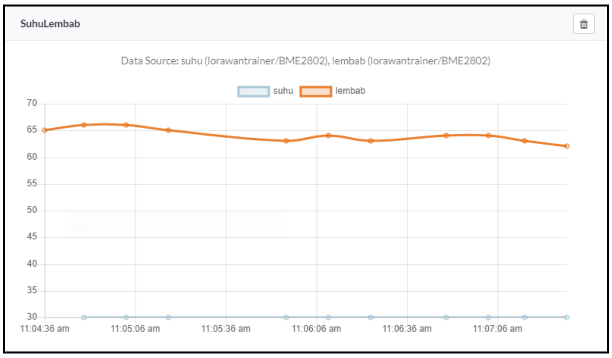
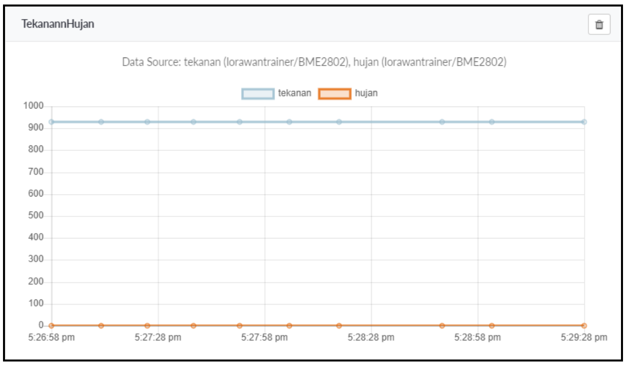
}

(a)



(b)



(c)

Fig. 6. (a) Data view on cloud IoT platform, (b) Temperature and humidity data chart, (c) Air pressure and precipitation data chart.

All data displayed from the Antares IoT platform is real-time data so that the data on the Nextion display and the Antares IoT platform display will have the same. This shows that data can be accessed from various places because the data sent by the trainer and forwarded by the gateway is the same data as the data accessed by end-users from the cloud IoT platform.

IV. Conclusion

Based on the results and discussion, it can be concluded that the integrated IoT trainer design was successfully made according to the plan. All components can work correctly, and Integrated IoT trainer can send data to the Antares.id IoT platform through LoRa and internet connectivity. The subsequent development of this trainer will be developed into an IoT remote laboratory so that it can be used as a learning media for remote practicum in this amid pandemic.

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