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# Developing Internet of Things (IoT) Trainer as a Learning Media for Remote Control Subject

[1]Mahfud Jiono, [2]Fauzy Satrio Wibowo
[1,2]*College of Mechanical and Electrical Engineering, National Taipei University of Technology, Taiwan*
t110a89404@ntut.edu.tw, t109a89402@ntut.edu.tw

[3]Muladi Muladi, [4]Siti Sendari, [5]Heru Wahyu Herwanto, [6]Mokh. Sholihul Hadi
[3,,4,5,6]*Department of Electrical Engineering, Universitas Negeri Malang, Indonesia*
muladi@um.ac.id, siti.sendari.ft@um.ac.id, heru_wh@um.ac.id, mokh.sholihul.ft@um.ac.id

***Abstract***— This paper describes the proposed system, which could help the user to understand the basic knowledge of the Internet of Things (IoT) for education purposes. The proposed method has been developed using an all-in-one package trainer of IoT, consisting of several parts, i.e., node sensor, web-based application, node master, and output module. Therefore, three main functions could help the user understand the basic knowledge of IoT: monitoring, data logging, and control functions. Moreover, this proposed system has been developed using System Development Life Cycle (SDLC) method, and it has been validated by material experts and media experts of media kit development. The result shows that the proposed system got a validation score of as much as 95.83% & 97.12% by the experts. Furthermore, the feasibility score from the small group implementation is 91%, while the large group implementation is 93%. Based on the validation and implementation data, it can be concluded that the developed product is feasible to be applied.

***Keywords*— Digital Media, Education, Internet of Things (IoT), Trainer**

## I. INTRODUCTION

Nowadays, the internet facility is often used for daily life purposes, such as health, transportation, economic, education, etc. In 2010 - 2018, 7 billion users connected to the internet [1]. Hence, to maximize the enormous potential of internet network connectivity, IoT systems were designed and proposed to be applied in daily life [2] [3]. The massive IoT ecosystems were predicted to be connected with 50 million devices from all sectors of human life by 2020 [4]. Currently, there is two fundamental parts of IoT research, namely IoT protocol and IoT application. The IoT protocol research theme mainly discusses memory consumption, request message size, response message size, and response latency [5]. This theme of IoT research has more focused on the detail and advanced communication between sensor, device, and protocol. Thus, these parameters are essential to measuring the interoperability of the IoT system. Recently, several standard protocols have been used for IoT communication, such as OGC Puck over Bluetooth, TinySOS, SOS over CoAP, OGC SensorThings API, and others [5].

The IoT systems were often implemented in various human activities, including health, education, transportation, and safety [6] [7]. Those IoT applications need a web service platform to understand users' input tasks or devices into particular objects [8][9]. Yet, many people did not become fully aware and prepared about the availability and maximize the potential intelligent services that IoT could provide to daily human life [10].

This paper describes the developed system, which could help the user understand the basics of IoT applications, such as monitoring, data logging, controlling. The proposed approach was created using an all-in-one package trainer, and it has been implemented on a Remote Control Subject in the State University of Malang. A Remote Control System Subject (NTEL 679) is a compulsory subject for bachelor degree students of Electrical Engineering Program, State University of Malang [11]. Students have to study the implementation of the Internet of Things application in this subject.

According to the interview with Electronics Competency Group Leader of Control System and the Head of Electrical Engineering Laboratory, this department's learning media for this subject is yet to be developed. Based on the problem, another goal of this research is to prepare the learning module for Remote Control Subject (NTEL 679) as a trainer kit. The IoT trainer was designed using node communication, which is developed using node master, web-based application, node sensor, and output module.

## II. METHODS

The proposed system was developed using System Development Life Cycle (SDLC) method, which has several steps, such as planning, analyzing, designing, implementing, and maintaining processes [12].

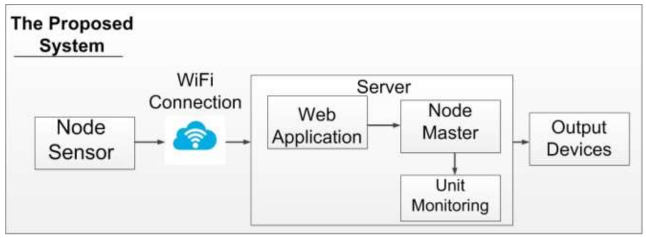


Fig. 1. The Proposed System

The proposed system has four main parts: node sensor, web-based application, node master, and output module, as described in Figure 1. Here, the node sensor has developed with two types of sensors, i.e., temperature-humidity and CO gas sensor. Meanwhile, the web-based application and the node master are categorized as a server in this proposed system. They process the input data from the node sensor as command control for the output module. Furthermore, the output module in this proposed system was developed using a fan sensor, a motor dc, and a LED. The block diagram of the proposed method is shown in Figure 2. Thus, this proposed system can help the user understand IoT basics, such as monitoring, data logging, and controlling. The complex proposed method is described as follows.

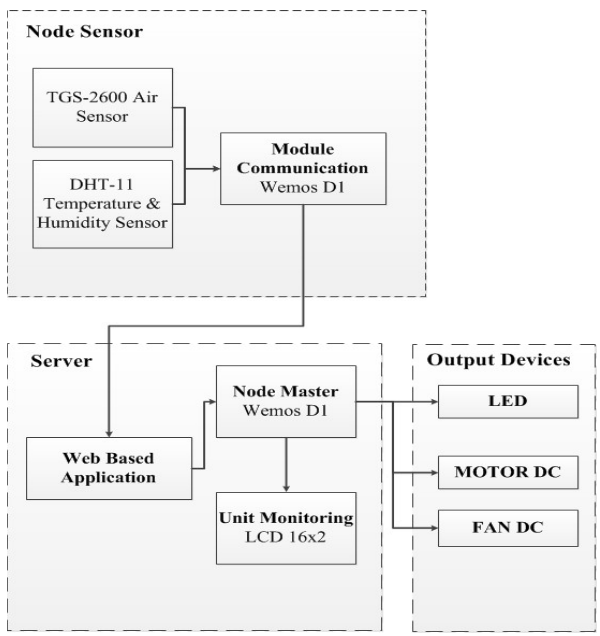


Fig. 2. Block Diagram of Proposed System

### *A. Node Sensor*

The node sensor is a device module used to send the data to the server. The node sensor has been developed using an integrated WiFi module to read the input sensors. The node sensor has developed using several parts, i.e., (1) Wemos D1 to deliver data sensor through the server; (2) a TGS2600 is used to detect CO value on the surrounding area; and (3) a DHT 11 is used to detect temperature and relative humidity on the surrounding area. The design of the node sensor is shown in Figure 3.

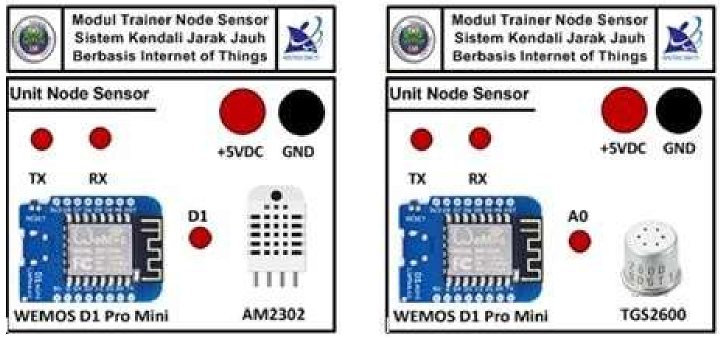


Fig. 3. Design of Node Sensor

*B. Web-based Application*

The web-based application is a server used to receive and process the data from the node sensor. It displays the data for monitoring and data logging purposes. Here, the flowchart of the web-based application is described in Figure 4.

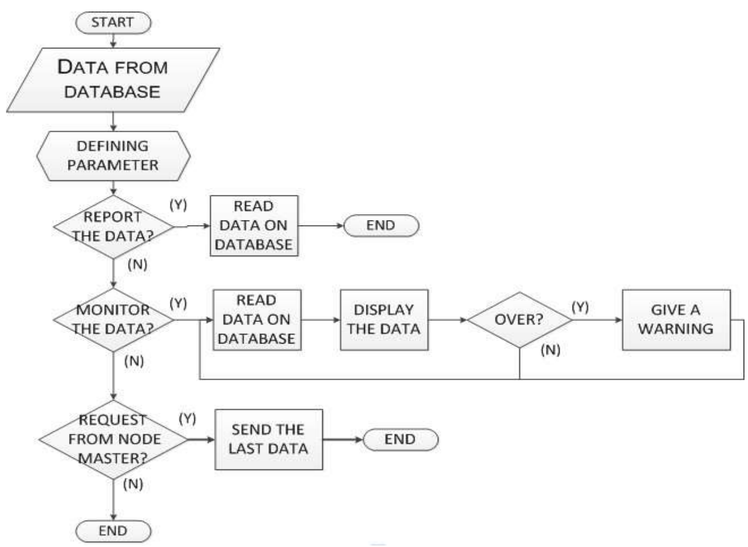


Fig. 4. Flowchart of Web Application

As mentioned in Figure 4, the data from the node sensor will be stored on a web-based application database. Therefore, the web-based application has three primary functions: reporting the data, monitoring the data, and sending the last data to node master. These functions help the user to understand the concept of data logging and monitoring application.

*C. Node Master and Output Module*

The node master is a device module used to process the node sensor and web application data. This process occurs to control the condition of the output module. Moreover, the node master can monitor the data using a hardware display. The node master has developed using an integrated WiFi module to process the input data. The node master has been designed using Wemos D1 and LCD 16x2 as a monitoring device. Meanwhile, the output module has integrated with node master in the same module to give the user knowledge of controlling the application. The design of the node master is shown in Figure 5.

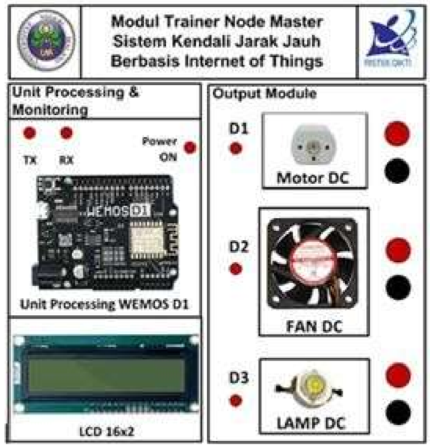


Fig. 5. Design of Node Master

*D. Monitoring and Data Logging Function*

As explained before, the proposed system has monitoring, data logging and controlling function to help the user understand the basic of IoT application. The monitoring and data logging function required node sensor and web application to complete the process. Here, the flowchart of process is described in Figure 6.

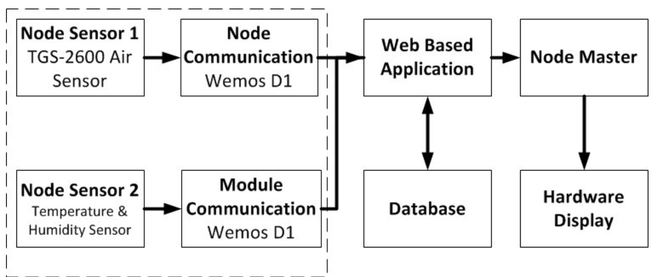


Fig. 6. Flowchart of Monitoring and Data Log Function

The monitoring function could be done either in the web-based application or hardware display; meanwhile, the data logging function was executed in the web-based application.

*E. Controlling Function*

The proposed system has a controlling function, which requires the whole system of the trainer (node sensor, web application, node master, and output module). Here, the type of control system is an open loop. The output of an open-loop system has either logic condition or PWM voltage. The node master determines these conditions to control the output module. Thus, the flowchart design of the controlling function is shown in Figure 7.

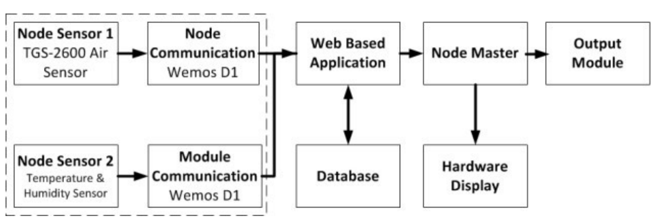


Fig. 7. Flowchart of Controlling Function

*F. Implementation Evaluation*

To validate each function of the development product, it must be measured by the expert. Material experts and media experts conducted the validation result of this research. Here, the validation measurement of this research used Sa'dun Akbar equation and classification [13], while for feasibility used Sanjaya classification [14].

$$V_x = \frac{T_{se}}{T_{sh}} * 100\ \%\ [13] \quad (1)$$

Where, Vx is the validation result (%), Tse is the empiric number, and Tsh is the maximum measurement score. Thus, the validation and feasibility grades are described in Tables 1 and 2. With this feasibility we can measure that our propose system perform.

TABLE I. VALIDATION GRADE

| No | Validity Grade | Status |
|---|---|---|
| 1 | 81.26% - 100.00 % | Very Valid |
| 2 | 62.51% - 81.25% | Valid (Minor revision required) |
| 3 | 43.76% - 62.50% | Not valid (Major revision required) |
| 4 | 25.00% - 43.75% | Not Applicable |

TABLE II. FEASIBILITY GRADE

| Percentage | Feasibility Grade |
|---|---|
| 82% - 100 | Very Feasible |
| 63% - 81% | Feasible |
| 44% - 62% | Less Feasible |
| 25% - 43% | Not Feasible |

## III. RESULTS AND DISCUSSION

This section describes the result performance for the development product. The development product is shown in Figure 10.

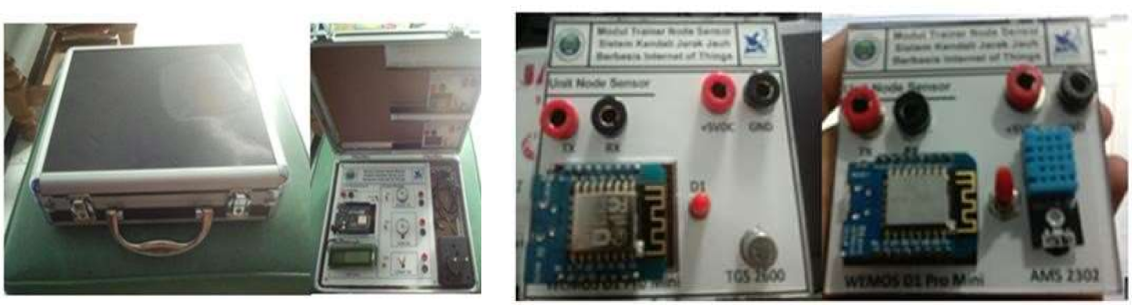


Fig. 10. Remote Control Trainer Based on IoT Kit and Node Sensor Modul Kit

The product has passed the validation test by the material and design expert. The product has obtained a 95.83% validation score from a material expert. Furthermore, the product has acquired a 97.12% validation score from a media expert. The detailed measurement of material and media experts is shown in Table 3 and Table 4. The measurement parameter from material experts were consists of several aspects, i.e., suitability of material, the language of material, and additional material of presentation. Meanwhile, the media expert's measurement parameter consisted of several aspects, i.e., suitability of media, completeness of media, and communicative and interactive.

Based on the validation grade from Table 1, the product was categorized as very valid, and the functions were operated normally. The next stage is to analyse the data from small and large group implementation. The trial has been conducted with 9 and 32 bachelor electrical engineering students in each corresponding performance. The data were acquired from questionnaire instruments regarding the suitability of media, completeness of media, language aspect, communicative & interactive aspect, and additional aspect of the presentation. The number of evaluated by media kit development material specialists with the score 95.83% and media experts was 97.12% respectively. The result of small group implementation could be seen in Table 5, while the result for large group implementation could be seen in Table 6.

TABLE III. DETAIL MEASUREMENT SCORE FROM A MATERIAL EXPERT

| No | Measurement Aspect | $T_{se}$ | $T_{sh}$ | V (%) |
|---|---|---|---|---|
| 1 | Suitability of Material | 34 | 36 | 94.44% |
| 2 | Language of Material | 23 | 24 | 95.83% |
| 3 | Additional Material of Presentation | 12 | 12 | 100% |
| | **Total** | **69** | **72** | |
| | Average | | | 95.83% |

TABLE IV. DETAIL MEASUREMENT SCORE FROM A DESIGN EXPERT

| No | Measurement Aspect | $T_{se}$ | $T_{sh}$ | V (%) |
|---|---|---|---|---|
| 1 | Suitability of Media | 41 | 44 | 93% |
| 2 | Completeness of Media | 40 | 40 | 100% |
| 3 | Communicative and Interactive | 20 | 20 | 100% |
| | **Total** | **101** | **104** | |
| | **Average** | | | **97.12%** |

TABLE V. DETAIL MEASUREMENT SCORE FROM SMALL-GROUP IMPLEMENTATION

| No | Measurement Aspect | $T_{se}$ | $T_{sh}$ | V (%) |
|---|---|---|---|---|
| 1 | Suitability of Media | 198 | 220 | 90% |
| 2 | Completeness of Media | 194 | 220 | 88% |
| 3 | Language | 49 | 60 | 82% |
| 4 | Communicative and Interactive | 73 | 80 | 91% |
| 5 | Additional Aspect of Presentation | 53 | 60 | 88% |
| | **Total** | **567** | **640** | |
| | **Average** | | | **89%** |

TABLE VI. DETAIL MEASUREMENT SCORE FROM LARGE-GROUP IMPLEMENTATION

| No | Measurement Aspect | $T_{se}$ | $T_{sh}$ | V (%) |
|---|---|---|---|---|
| 1 | Suitability of Media | 814 | 880 | 93% |
| 2 | Completeness of Media | 822 | 880 | 93% |
| 3 | Language | 219 | 240 | 91% |
| 4 | Communicative and Interactive | 305 | 320 | 95% |
| 5 | Additional Aspect of Presentation | 227 | 240 | 95% |
| | **Total** | **2387** | **2560** | |
| | **Average** | | | **93%** |

## IV. CONCLUSION

The proposed system was developed using the System Development Life Cycle (SDLC) method and evaluated by media kit development material specialists and media experts. The proposed system obtained validation scores tend to range from 95.83% to 97.12% from both material and media experts. Furthermore, the feasibility score for small group implementation is 91%, while the feasibility value for large group implementation is 93%.

Based on the findings of the validation and testing, we conclude that internet of things (IoT) trainer as a learning media can improve the student understanding the basics of IoT applications, such as monitoring, data logging, controlling specially in the Remote-Control subject. On the other hand, based on the result finding from small and large group implementation, we can make sure that our proposal is acceptable to use real-life classroom situation.

For the future work, one of the aspects that should be addressed and improved in the study and development of this instructional material was the supplied material or content. As technology evolves, the content must evolve to match these advancements. It is also expected to be able to include IoT trainer into other areas of instructional materials, such as adding more sensors, as suggested by media experts, and as produced in practice questions such as pre-test and post-test to evaluate student understanding.

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