Evaluation of an Affordable Wireless Node Sensor (Mote69) Designed for Internet of Thing (IoT) Device

Z F Ruhiyat, Y Somantri, D Wahyudin*, and D L Hakim

Electrical Engineering Education, Universitas Pendidikan Indonesia, Bandung, Indonesia

*deewahyu@upi.edu

Abstract. This research aims to determine the student's response to the implementation of Internet of Things (IoT) device based on RFM69, called Mote69, for practical work of Aircraft Electronic Circuits and Controllers. Participants in this study were students of a vocational high school of Aircraft Electronics which consisted of three groups. The first group is the students who have grades above the average class. The second group is the students who have grade the average class. The third group is the students who have grades below the average class. The research phase consisted of (1). Observation and Assessment of Empirical Issues; (2). Testing of Media Feasibility and Research Instruments; (3). Accumulate and Processing of Field Data; and (4). Results and Data Conclusions. The result of media feasibility showed that Mote69 is appropriate to be used in practical work of Aircraft Electronic Circuits and Controllers subject.

1. Introduction

Media for learning is one of the essential elements of the vocational high school to support the education process. Application of media in learning can raise interest, motivation, and stimulation of learning activities [1]. The results of some research also proved that media for learning could increase the student's interest and progress in learning [2]. Based on the experience in School Experience Program especially in the subject of Aircraft Electronic Circuits and Controllers, the researcher found problems in the learning process. In the practical work, teachers only used conventional learning methods and they did not use any media to learning. Hence, the students unmotivated to study hard. On the other hand, lab equipment's are costly. It impacted to the school committee that could not be able to fund lab equipment. Hence, it is necessary to develop a training kit that is user-friendly, low cost, industry-oriented requirements, and portable [3]. In recent years, Arduino microcontroller is an appropriate device for education. It has increased the learner's interest efficiently and progresses in learning [4]. Also, the results of research in also showed that the development of technologies such as the Internet of Things (IoT) should be utilized in the field of education. It provides an intelligent and innovative learning media that can be used by many learners [5].

This paper explains the evaluation of an affordable wireless sensor node, named Mote69, designed for IoT device. We used Arduino Pro Mini microcontroller, a wireless module of RFM69, and various sensors as an IoT trainer to be used in the subject of Aircraft Electronic Circuits and Controllers. It has low cost, Arduino Pro Mini also has many advantages, i.e., has a lot I/O pins. Hence learners could use various sensors in the IoT projects. The printed circuit board (PCB) in this trainer had been designed to
compatible with Arduino Mega. So, the device would have more space that could be more flexible to add some module or shield.

2. Mote69 Design
IoT device based on RFM69 is an IoT trainer that can be used to support students in the practical work of microcontroller programming course. This section describes the design and materials of Mote69 with Arduino Mega PCB layout as shown in Figure 1. However, the block diagram of the system is shown in Figure 2.

![Figure 1. PCB layout of Mote69](image)

![Figure 2. Diagram block of Mote69](image)

Based on the block diagram in Figure 2 several components used in this trainer such as a microcontroller, sensors, and a transceiver module. The following are the explanation of each part.

2.1. Microcontroller Unit (MCU)
The microcontroller is the brain of the trainer kit system. This component serves to process data obtained from inputs such as sensors and then process it before transmitting by the RFM69 module. Most of the microcontrollers can work in real-time. It worked by inserting the program into the microcontroller [6]. We used Arduino Pro Mini version 3.3 V based on ATmega328 microcontroller. The Arduino has 14
digital input/output pins that are six pins as PWM output, six analog inputs, an on-board resonator, reset button, and holes for pin header installation. Six pins can be connected to the FTDI series. Arduino Pro Mini is selected as a microcontroller that used in this trainer because this microcontroller is more efficient than the other type. This microcontroller has all the pins that required for the Trainer kit, such as the SPI pins (MISO, MOSI, and SCK) that the controller needs to communicate with the RFM69, the PWM pin and the ADC pin that required for sensors and actuators. Also, Arduino Pro Mini also has the lowest price compared to other types of Arduino. It has a small size so that this Trainer becomes more portable or easy to carry anywhere.

2.2. Sensors
The sensor is the front end of the IoT systems. These are so-called “sense” of the system. The primary purpose is to gather data from its surrounding (sensors) or provide data to its surrounding (actuators). Sensors may be analog, or digital sensors, for example, Temperature, Humidity, Pressure, Gas, GPS, IR, and LDR [7]. In this IoT device, the various sensor was utilized so that the learners can practice many experiments.

2.3. Wireless Module
Mote69 used RFM69 as the transceiver module that similar to Wireless Sensor Network (WSN) devices. RFM69 is capable of operating over a full frequency in the range 315, 433, 868 and 915 MHz. However, due to reason that Mote69 could be used in the indoor area, hence it uses RFM69 with the frequency of 433 MHz. RFM69 can be optimized that able to use a low power consumption but with high RF output power. Besides that, in Indonesia, the regulation on the use of radio frequency is regulated in the Minister of Communication and Informatics Regulation. Radio frequency band 433-435 MHz is used for the operation of tools and communication devices at close range (Short Range Device). The research about WSN as one of the applications of IoT technology has been done, such as research on data security on WSN [8]. In Mote69 design, wireless module is used to send and receive data between two or more Mote69 as a mesh network.

3. Method
The method used in this study using qualitative methods that intends to understand the phenomenon of subjects experienced such as perception, motivation, and action. Moreover, presented by the description in a natural context and by utilizing various natural methods [9].

There are five approaches to qualitative research: biography, phenomenology, grounded theory research, ethnography, and case studies [10]. The researcher chose case study as an approach to the implementation of this research. The case study implies the researcher do intensive analysis on one unit of analysis examined (case). A case can be one individual, one organization, one event, one decision, one period, or a system that can be studied thoroughly and holistically [11]. This study focused on the analysis of student's perceptions of Mote69 implementation.

The experiment was conducted at the department aircraft electronics in an aircraft vocational high school in Bandung, the capital of Java province, Indonesia. The research activity was focused on the feasibility of Mote69 as a trainer, and examined the student's response to the implementation of this trainer on the subjects of Aircraft Electronic Circuits and Controllers.

3.1. Usability Study of Mote69
The Feasibility of Mote69 is obtained based on an expert judgment by an expert of media and learning, and the usability testing involved some students.

3.2. Students Response to the Implementation of Mote69
Participants in this study were students of grade 12th of Aircraft Electronics study which consisted of three group of students. The first group is the students who have grades above the average class. The second group is the students who have grade the average class. The third class is the students who have
grades below the average class. The participants were asked to do practical work with the scenario as shown in Figure 3. Their practical work activity then monitored and observed by the researcher. They also asked to give opinion about Mote69 usability.

![Figure 3. Practical work design using two Mote69 devices](image)

### 4. Results and Discussion

#### 4.1. Usability Study of Mote69
The result of media feasibility showed that Mote69 is proper to be used in practical work of Aircraft Electronic Circuits and Controllers course. It is capable be used in classrooms with the aim of developing educational programs related to microcontroller programming.

#### 4.2. Students Response to the Implementation of Mote69
The results of evaluation of Mote69 implementation showed the positive response from all participants. This IoT device could promote innovation and motivation for students during the learning process especially on the subject of Aircraft Electronic Circuits and Controllers. The implementation of this mote also helps the teacher to arouse the curiosity of students through experiments that enhance the students’ affective and skills.

### 5. Conclusion
This paper is concerned with two primary objectives: the first one is to approve the feasibility of Mote69 as a trainer used in practical work on the subject of Aircraft Electronic Circuits and Controllers. The evaluation evidence also shows the student's response. It is proven that Mote69 could be used in classrooms with the aim of developing educational programs related to the microcontroller. It promotes innovation and motivation for students during the learning process.

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