Multi-Sensors Module Development Using Microcontroller

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Abstract. Sensors and transducers are one of the theoretical courses that must be followed by all students Electrical Engineering Department. Practicum implementation using team based project method is still not optimal yet. This is due to the lack of practical equipment in accordance with the learning outcomes of the subject. This research developed a multi-sensors practicum module. The results of this study include a study of theory and application of sensor components, transducer components, actuators, controllers and various series of control system applications in industry. Materials in this modul is a combination of the trainer component of the sensor transducer and the application of a series of industrial instrumentation systems. The multi-sensor practicum module has 16 experiments and it can still be developed. The test results show that this module is very eligible for theory and practicum in sensors and transducers course.

Keywords: Multi-Sensors, Module, Development, Microcntroller

1 Introduction

Students of the engineering study program must have practical skills through learning experiences during their education. Therefore, the development and use of learning media is very much needed[1]. One way that can be done is by utilizing technology in the learning process. Technology can be used to support the learning process with the help of hardware and software. The use of technology in the learning process has several advantages, including adding to the learning experience, supporting full-day learning, building skills and increasing student involvement and motivation in learning activities[2].

The development of technology is currently growing rapidly so that it has a great influence on the world of higher education. Technological progress must be accompanied by efforts to improve the quality of human resources and the quality of education. Especially the use of technology in the innovative learning process[3]. Innovation in the learning process can be integrated with technological developments to produce improvements in the learning process, effectiveness and efficiency of learning as well as improving student learning outcomes[4]. This is in line with the national education goals of the Republic of Indonesia which are stated in the curriculum of the Indonesian National Qualifications Framework (KKNI).

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Technological developments are also very influential in the industrial sector. Industry utilizes technology for process efficiency and product quality improvement. Utilization of technology in the fields of electricity, sensors, automation systems, control systems and computer applications has become a necessity for industry. To meet technological needs in the industrial sector globally, many companies are developing technology in the field of electronic-based sensing (sensors), controllers (controllers), and actuators[5].

Therefore, the knowledge and skills of human resources in utilizing technology in the industrial sector. Graduates must be able and skilled in using and utilizing these technologies. The improvement of human resource competence has been carried out by conducting training on the use of the technology. Technology training in the fields of sensors, controls, and drives can be carried out to achieve learning outcomes at several levels, including: understanding, application, analysis, or evaluation. However, there are still many graduates and job seekers who are not yet skilled in using and utilizing technology in the industrial sector[5].

Universitas Negeri Medan is one of the universities providing academic education that implements the IQF-based curriculum. Medan State University (UNIMED) has several engineering study programs, one of which is Pendidikan Teknologi Informasi dan Komputer (PTIK) study program. The aim of this study program is to produce graduates who are able to work professionally in the fields of computer programming, automation, computer networks, multimedia and entrepreneurship. One of the compulsory subjects in the curriculum structure in the Pendidikan Teknologi Informasi dan Komputer (PTIK) study program is Sensors and Transducers. Graduates are required to be skilled and master the theory and application of sensors in the industrial world.

Based on the observations we made, the lecture process for the Sensor and Transducer course at the PTIK Study Program has been going well, but when conducting experiments through a team based project it was still not optimal. This is due to the lack of experimental equipment (trainers) in accordance with the learning outcomes of the course. Currently, the trainers owned by the study program are old product trainers that are more than 10 years old. Most of these tools have been damaged and are difficult to repair. The limited number of trainers has caused many experimental activities to be constrained. Ideally, each student must actively experiment through assigned projects. The impact of this is the lack of technical skills possessed by graduates of the study program, even not mastering applicable practices in the field of Sensors and Transducers[1].

Sensors and Transducers is one of the theoretical courses that must be followed by all students of the PTIK study program. At the time of theoretical learning materials, some students were less active in group discussions or class discussions, the ability of students in compiling or conducting experiments was also not very creative[6]. Students also have not been able to apply the concept of sensors and transducers to industrial work equipment. Students' analytical skills on sensors and transducers are still not optimal[7]. This causes lecturers to have difficulty delivering learning materials, so that learning outcomes are still not appropriate due to the low ability of students to apply the theory learned to real conditions in the industry.

Researchers also found that there are still many students who play smartphones and are busy with their respective activities. They pay less attention to the lecturer when delivering theoretical material. Especially if the learning is carried out face-to-face. Furthermore, the researchers also observed that the learning process was dominated by lecturers with the help of power points and

teaching materials. While the objective of the material in the sensor and transducer course is that students have knowledge and skills for the concepts, characteristics, circuits and implementation of sensors in industry[8].

Another problem that occurs is the limited meeting time to deliver complex material. Students are also less active in asking questions or looking for other learning resources independently. For example, during a class that discussed the working principle, properties, and characteristics of sensors, most of the students were less interested and bored quickly because the material presented was done using a lecture model. As a result, students do not understand the working principle, nature, and characteristics of sensors. In the process of learning the material, students did not experiment because of the limited media (trainer) available.

Efforts that can be made to improve the effectiveness of the learning process are to use interesting teaching materials and also innovative modules. A good module must be packaged attractively according to the subject matter and equipped with pictures, illustrations, instructions, case examples or contextual cases and adequate experimental devices to support the learning outcomes of the course[9]. Therefore, it is necessary to develop learning media for sensors and transducers to improve students' theoretical and practical abilities[10].

The development of multi-sensors application modules based on Project Based Learning is an appropriate alternative in order to overcome the problems above. The development of a project-based multi-sensors application module is the alternative chosen to help lecturers carry out a project-based learning process. Besides that, the use of modules can also help develop students' ability to work through project activities. Students will also be able to find and connect one concept with another so as to create a meaningful learning[11]–[14].

2 Method

The research method used is the Research and Development (RnD) method. Research and development is a process or steps to develop a new product or improve an existing product and can be accounted for. The product can be hardware or software. Hardware such as books, modules, learning aids in the classroom or in the laboratory. The software includes data processing computer programs, classroom learning, libraries, laboratories, educational models, learning, training, guidance, evaluation, management, and others[15].

The model in this development research is a procedural model, which is a descriptive model and outlines the development steps. Based on Sugiyono's theory, the steps that must be followed to produce a product include the potential and problem stages, data collection, product design, design validation, product design revision, product trial, product revision, usage trial, product revision, and mass production[15]. The orientation of this research is to produce learning media products for students in the form of Multi-Sensors Application Module.

The design of this research is Research and Development (RnD) which is a study that produces or develops a product design then validated to experts and tested on students after the product is revised to get the product. There are several development procedures proposed by several experts. One of them is the development research procedure proposed by Sugiyono[15].

After the module has been developed, the next step is to conduct a closed-door trial of the module by involving several students and lecturers in the area of expertise. The trial was carried out to see how the performance of the module and the feasibility level of the trainer module as learning media for Sensors and Transducers was. The design of this research can be described in a process flow diagram. The flow chart of the implementation of all research activities is shown in Figure 1.

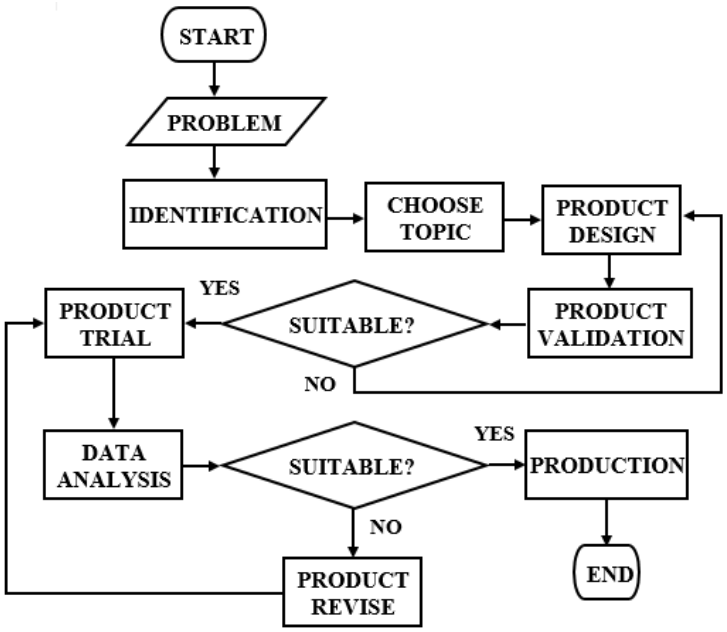

Fig 1. Research flowcharts

3 Results

This research produces a product in the form of a trainer as equipment for conducting experiments. The trainer consists of several sensors including Ultrasonic sensors, Passive Infra Red Sensors, Flame Sensors, Temperature and Humidity Sensors, LDR Sensors and Sound Sensors. All sensors are controlled by a single ATmega2560 type microcontroller module. The microcontroller can be programmed according to the sensor and actuator implementation instructions. The complete trainer sensor design can be seen in Figure 2.

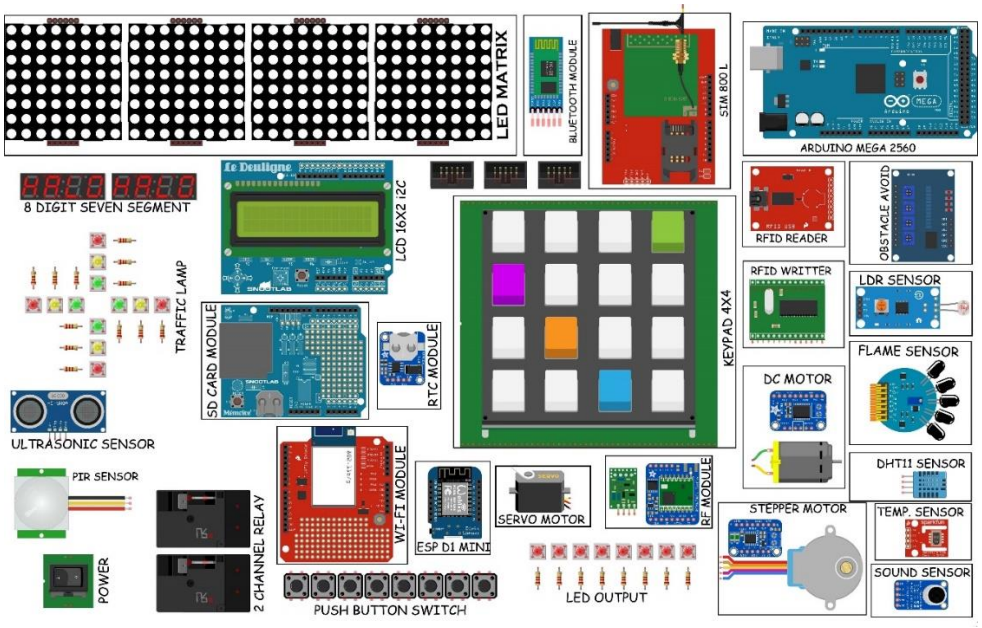

Fig 2. Design of sensors trainer

In addition, this research also produces a teaching module that has been developed. The teaching module contains theory and experimental instructions for implementing these sensors. This module explains the definition, working principle, characteristics, circuit and programming for each sensor. This module also provides the source code of the program as an experimental example of implementing sensors in a simple system.

Trainers and teaching modules must be validated by material experts and media experts to determine the feasibility of the module. Validation was carried out by 4 material experts and 4 media experts. Material validation instruments and media validation use instruments from the Indonesian National Education Standards Agency. Material validation includes 4 aspects including content feasibility, presentation feasibility, language feasibility and contextual assessment. Media validation includes 3 aspects, namely graphic feasibility, security feasibility and language feasibility. The results of the validation of material experts and media experts can be seen in table 1 and table 2.

Table 1. Material Expert Validation Results

No	Instrument	Material Experts				Average (%)	Category
		I	II	III	IV		
1	Content Eligibility	4	5	4	4	85%	Very Eligible
2	Serving Eligibility	5	5	4	5	95%	Very Eligible
3	Language Eligibility	5	4	5	4	90%	Very Eligible
4	Contextual Assessment	5	5	5	5	100%	Very Eligible

Tabel 2. Media Expert Validation Results

No	Instrument	Material Experts				Average (%)	Category
		I	II	III	IV		
1	Graphic Eligibility	4	5	4	5	90%	Very Eligible
2	Safety Eligibility	5	5	4	4	90%	Very Eligible
3	Language Eligibility	5	4	5	5	95%	Very Eligible

4 Discussion

The result of this study is a prototype Multi-Sensors module using the ATMega2560 microcontroller and other supporting modules. The resulting product is validated by 3 (three) media experts with a Very Eligible criterion value. Based on the results of this assessment, it can be said that the learning media is suitable for use in microprocessor practicum activities. Then the product is validated by 3 (people) material experts with a very good criterion value. Based on the results of the assessment, it can be concluded that the material contained in the practicum module developed is in accordance with graduate learning outcomes and course learning outcomes.

The results obtained from the validation of media experts with an average rating of 91.33% or in the Very Eligible category. With these results, it can be said that the research on the development of learning media has been completed and achieved maximum results. Based on the results of the assessment of media experts, it can be concluded that the learning media that have been developed are suitable for use in the teaching and learning process. Based on the data in table 3, the results of the validation assessment from material experts with an overall average value of 92,5% were obtained. With the average value obtained, it can be said that the material presented in interactive learning media is in the Very Eligible category. So it can be concluded that the material presented can be used in the teaching and learning process and in accordance with the competencies to be achieved.

Product trials were also carried out to students who took the Sensors and Transducers course. This is done to see the level of student success in using learning media, which is seen through student learning outcomes. The results of product trials are expected to improve student learning outcomes in following the Sensors and Transducers course. For its implementation, lecturers can be given reinforcement to be able to develop learning media in the teaching and learning process. It aims to make learning more interesting and students more active.

5 Conclusion

Based on the data in table 1, the results obtained from material expert validation with an average assessment of 92.50% or in the Very Eligible category. Based on the data in table 2, the results obtained from material expert validation with an average rating of 91.67% or in the Very Eligible category. With these results, it can be said that the multi-sensors teaching module and experimental trainer have achieved maximum results. Based on the results of the assessment from media experts, it can be concluded that the multi-sensors teaching module that has been developed is feasible to be used as one of the medians in learning activities for the Sensor and Transducer course.

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