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Trainer Kit Module for DC Motor Speed Control Using Voice Commands Based on Arduino

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Abstract— Based on the results of observations made by researchers through direct observation of lecturers in the field of electricity, Electrical Engineering Education Study Program, it was found that there is a need for additional trainers as learning media in the electrical machine control course. This study aims to find out how to design a trainer kit design module for DC motor speed control using voice commands by utilizing the Arduino microcontroller. We also learned the results of testing the design of a trainer kit design module for DC motor speed control using voice commands by utilizing the Arduino microcontroller. The research method researchers use is the Research and Development (R&D) method, which aims to develop new products or innovations that benefit. Based on the results of expert validation, it can be concluded that the Arduino Microcontroller-Based Trainer Kit Practical Module obtained a high percentage of media experts at 96%, material experts at 95.5%, and language experts at 80%. These results indicate that this module gets the "Very Eligible" category to be applied to the Electrical Machine Control course.

Keywords: Trainer kit module, dc motor speed control, voice commands, Arduino, microcontroller

I. INTRODUCTION

Teaching materials in printed media, almost the same as books, are often called modules; modules contain theories and all stages of work in detail on practicums carried out in the laboratory (Hamdani & Yohandri, 2020; Kustandi & Darmawan, 2020; Nugroho et al., 2022; Pamenang et al., 2020). In the teaching and learning process, the modules that are used as guides are usually not only lecturers who can provide guidance, but students who have undergone and understand practicums usually become educators who guide students so that the practicums carried out in the laboratory run well and correctly and convey the objectives of the practicum.

Electrical machine control is a system designed to regulate the operation of an electric machine or motor so that it functions according to the desired needs. The primary purpose of electrical machine control is to control specific parameters, such as speed, direction of rotation, and torque of the motor, to achieve optimal performance (De Doncker et al., 2020; Hughes & Drury, 2019; Rakha Firdaus et al., 2023; Yudha, 2020; Yusdartono et al., 2023).

A trainer kit is a device or piece of equipment designed to provide practical learning or training in a particular field. Its primary purpose is to help users understand theoretical concepts through hands-on implementation and experimentation (Anugrah et al., 2022; Beard & Wilson, 2018; Dewi et al., 2020; Said & Asnawi, 2018; Schallock et al., 2018).

Usually, students doing practicums only understand the various teaching tools available in the laboratory, even though, along with the development of sophisticated technology, these tools are already available in the form of trainers (Koloway & Kattie, 2023). However, only some of the Electrical Engineering Education Laboratory trainers are complete. In the electric motor control course, an additional trainer, namely a trainer kit, is considered necessary because it is a unique tool or equipment designed to provide lessons or training to students.

Based on the results of observations made by researchers through direct observation of lecturers in the field of electricity, Electrical Engineering Education Study Program, it was found that there is a need for additional trainers as learning media in the electrical machine control course. This study aims to find out how to design a trainer kit design module for DC motor speed control using voice commands by utilizing an Arduino microcontroller. Moreover, to find out the results of testing the design of a trainer kit design module for DC motor speed control using voice commands by utilizing an Arduino microcontroller.

II. METHOD

This research uses quantitative research methods. Quantitative research is carried out with various accurate stages supported by evidence, calculations, or basic theoretical formulas, which can support the results of the research (Anjarwati et al., 2024; Fischer et al., 2023).

Researchers use the research and development (R&D) method, which aims to develop new products or innovations that benefit (Oei et al., 2024). To design an inverter practical module in the power electronics course, researchers must go through several stages to become teaching materials that can be used.

The primary purpose of research and development (R&D) is not only limited to the development of effective products that can be optimized in educational environments, especially in schools, not only depends on the understanding of educational theories but also on the creation of effective products that can be used optimally in educational environments, especially in schools (Adriani et al., 2020; Sarpong et al., 2023). Therefore, R&D has a vital role in education development by helping to create innovative and beneficial products for the world of education. Thus, it can be concluded that R&D is a study carried out systematically to develop valid and effective educational products to be used optimally in educational institutions. The research and development flow can be seen in Figure 1.

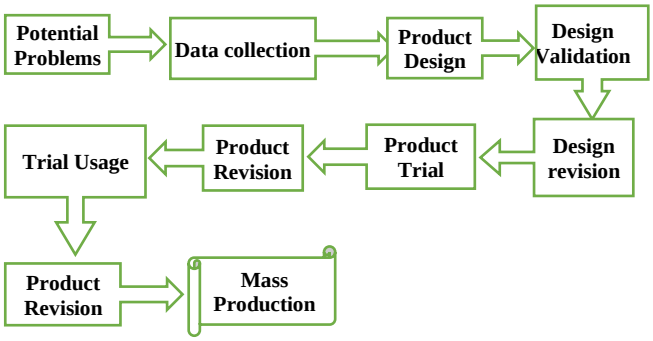

Figure 1. Research & Development (R&D) Flowchart

In this study, researchers simplified the product development steps into several more straightforward stages. The instrument used in this study was a validation sheet that included assessments from media, material, and language experts. This validation sheet assessed the validity and feasibility of the media, material, and language aspects used in the study. Using this instrument, researchers can measure how much these three aspects meet the standards and criteria set to achieve the research objectives used in this study.

The data successfully collected through the media expert validation sheet will be processed to describe and solve the underlying problems. In this study, the data analysis technique combines quantitative analysis. In this study, the data analysis method used is quantitative analysis. The quantitative analysis process begins by using data obtained from interviews, observations, and expert input in words, responses, suggestions, and criticisms. The next step involves processing the data by applying relevant formulas. The analysis results are used as a guideline for improving and developing the product, aiming to improve its quality based on feedback provided by respondents or experts involved.

III. RESULTS AND DISCUSSIONS

A. Research Results

This cover page shows the title and symbol of the DC motor and the name of the module compiler (see Figure 2).

Figure 2. Practical Module Cover Design

Figure 3. Practical Work Regulations Sheet

These practical rules page explains several practical rules that students must obey when doing practical work. Students who do not obey the rules are prohibited from participating in practical work. The purpose of the practical rules is to ensure that all students who participate in practical work can maintain security and smoothness during the practical work (see Figure 3).

Figure 4. Table of Contents Sheet

The table of contents page shows the points listed in the practical module to make it easier for students to find material or other points listed in the practical module (see Figure 4).

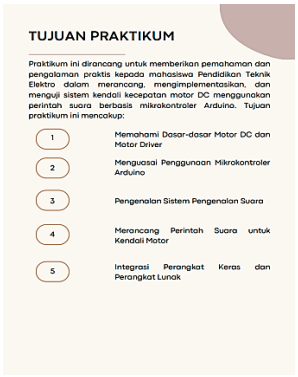

Figure 5. Practical Objective Sheet

1. Contains Formulated Objectives

On the practical objectives page, explain to students the understanding and experience needed to design, implement, and test a DC motor speed control system using voice commands based on an Arduino microcontroller. The objective is for students to understand the basics of DC motors and motor drivers, master the use of Arduino, understand voice recognition systems, and integrate hardware and software (see Figure 5).

Figure 6. Student Ability Sheet

This sheet shows the expected abilities of students when taking the practicum. The expected abilities are a basic understanding of electronics, basic knowledge of microcontrollers, basic programming skills, the ability to read and understand datasheets, systematic thinking skills, and the ability to use electronic measuring instruments (see Figure 6).

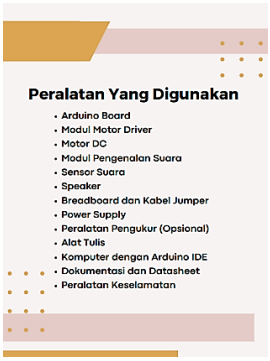

Figure 7. Sheet of Equipment Used

This page shows some tools used during the DC motor speed control practicum using Arduino microcontroller-based voice commands in the electrical machine control course (see Figure 7).

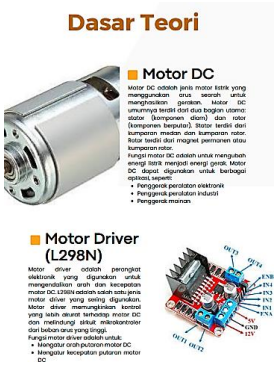

Figure 8. Basic Theory Sheet

2. Contains Learning Materials Packaged Into Small/Specific Units So That It Facilitates Comprehensive Learning

This page explains the theoretical basis listed in the practicum module so that students know the basic theories that explain the tools and materials used in the practicum (see Figure 8).

Figure 9. Work Steps Sheet

3. Providing Examples and Illustrations That Support the Clarity of Learning Material Explanation

This sheet explains the practicum steps for controlling a DC motor's speed using voice commands based on an Arduino microcontroller. These steps make it easier for students to carry out the practicum in the course on controlling electrical machines (see Figure 9).

Figure 10. Implementation Sheet

This implementation sheet explains how to implement components that have been assembled or installed. This program aims to implement a program on an Arduino Uno so that it can receive voice commands from the user and control the output according to the voice commands (see Figure 10).

Figure 11. Test Sheet

In this test sheet, students can test the performance of the DC motor speed control trainer kit using Arduino microcontroller-based voice commands by saying various voice commands. The test can be done at different distances to find out if the trainer can receive the voice commands correctly (see Figure 11).

Figure 12. Reference Sheet

This sheet lists the reference sources used in designing the DC motor speed control trainer kit module, which uses voice commands and is based on the Arduino microcontroller (see Figure 12).

Figure 13. Quiz Sheet

4. Displaying Practice Questions, Assignments, and the Like That Allows Users to Give Responses and Measure Their Level of Mastery

This quiz sheet displays several questions that students must work on after completing the practicum. The goal is to increase students' insight into knowledge about DC motors (see Figure 13).

Figure 14. Author and Supervisor Profile Sheet

This profile sheet displays the profile of the author who has completed the writing of the Arduino microcontroller-based trainer kit practical module and the supervisors who have been willing to guide the author until the completion of this module. This chapter will discuss the results of designing a DC motor speed control trainer kit module using Arduino microcontroller-based voice commands, as well as the results of expert validation testing and material validation to determine the feasibility of the practical module designed by the researcher (see Figure 14).

B. Validation Results

In this study, the feasibility of the Arduino microcontroller-based trainer kit practical module in the electrical machine control course was evaluated through a validation questionnaire sheet filled out by three experts. The three experts selected to validate and test the feasibility of this practical module, which discusses DC motor speed control using Arduino microcontroller-based voice commands in the electrical machine control course, are lecturers with relevant knowledge and experience in their fields.

In this validation process, experts were asked to provide assessments of several specific aspects of the Arduino microcontroller-based trainer kit practical module in the electrical machine control course. These aspects involve completeness of features, clarity of display, and ease of use of the module. After the validation questionnaire sheet was filled out and collected, the data was analyzed to determine the feasibility of the Arduino microcontroller-based trainer kit practical module in the electrical machine control course.

1. Media Validation Results

Validation of the Arduino microcontroller-based trainer kit practicum module in the electrical machine control course was carried out by Mrs. Raihan Islamadina, M.T. This validation aimed to obtain input, criticism, and suggestions from the validators regarding the feasibility of the Arduino microcontroller-based trainer kit practicum module in the electrical machine control course, especially regarding media. This was done with the aim that the practicum module could meet the feasibility test from the media aspect and be developed into a quality demonstration tool product in media. Validation was carried out by providing an assessment questionnaire to the validators to evaluate the feasibility of the media in the practicum module.

This questionnaire consists of 3 questions that assess aspects of media feasibility, such as module size accuracy, cover design, and module content design. Media validation is carried out to ensure that the Arduino microcontroller-based trainer kit practical module in the electrical machine control course has good media quality and can be developed into a quality teaching aid product in terms of media.

Table 1 shows the results of the media feasibility validation. Based on the validation results by the media expert validator, the Arduino microcontroller-based trainer kit practical module obtained an average percentage of 96%, indicating a very feasible criterion. Thus, it can be concluded that the Arduino microcontroller-based trainer kit practical module is very feasible to use as a learning medium.

Table 1. Media expert validation instrument grid

No	Aspect	Question Criteria	Value Criteria
1	Module Size	Module size conformity according to ISO A4 standard (210mm X 297mm)	5
		It shows a good center-point	5
		Layout element colors are harmonious and clarify the function	4
2	Cover Design	The letters used are attractive and easy to read	5
		Do not use too many font styles	5
		Describe the contents of the material	5
		Shape, color, size, proportionality of objects according to reality	4
		Display a good center-point	5
3	Module Content Design	The letters used are attractive and easy to read	5
		Do not use too many font styles	5
		Describe the contents of the material, shape, color, and proportional objects according to reality	5
Total			53
Percentage			96%

2. Material Validation

Mr. Baihaqi, M.T., validated the material in the Arduino microcontroller-based trainer kit practical module in the electrical machine control course to ensure its material feasibility.

This validation aims to obtain input, criticism, and suggestions from the validators regarding the feasibility of the material in the Arduino microcontroller-based trainer kit practical module in the electrical machine control course. This validation aims to ensure that the material presented in the practical module is of good quality and can positively contribute to students' understanding of the course.

This validation was carried out on the Arduino microcontroller-based trainer kit practical module by material experts with knowledge and experience. The researcher got an average percentage value after checking the material with the validator, as seen in Table 2.

Table 2. Grid of Material Expert Validation Instrument

No	Aspect	Question Criteria	Value Criteria
1	Learning objectives	Students can practice the trainer kit practical module in the electrical machine control course	5
		The practical module of the trainer kit helps students implement it in the electrical machine control course	5
		The trainer kit module can increase students' knowledge about controlling the speed of electric motors	5
		The trainer kit planning module can create abstractions about controlling the speed of electric motors	4
2	Material	The trainer kit module can present material according to the concept of electrical machine control	5
		Showing a good center point	5
3	Time	The trainer kit module can help speed up the explanation of the material on controlling electric motor speed	5
4	Benefit	The trainer kit module can facilitate material delivery on electric motor speed control	5
		The trainer kit module can be a learning medium for controlling electrical machines	4
Total			43
Percentage			95,5%

3. Language Validation

Language validation was carried out together with Mrs. Silvia Sandi Wisuda Lubis, M.Pd, to ensure the language eligibility of the practical module of the DC motor speed control trainer kit using voice commands based on the Arduino microcontroller in the electrical machine control course.

This validation aims to obtain criticism and suggestions related to the language aspect of the Arduino microcontroller-based trainer kit practical module in the electrical machine control course. The goal is to ensure that the language used in the module is straightforward, easy to understand, and follows applicable language standards. Criticism and suggestions from the validator will help improve and perfect the module to become an effective and comprehensive learning medium. Validation is carried out in the language of the Arduino microcontroller-based trainer kit practical module in the electrical machine control course by material experts with knowledge and experience.

The results of validating the language feasibility of the Arduino microcontroller-based trainer kit practical module in the electrical machine control course can be seen in Table 3. It is known that the Arduino microcontroller-based trainer kit practical module obtained an average percentage of 80%, which indicates a category that is suitable for use as a learning medium.

Table 3. Grid of Language Expert Validation Instruments

No	Questions	Value Criteria
1	Applying the principles of proper and correct language	4
2	Using terminology that follows the concepts discussed	4
3	Using language that is clear and easy for students to understand	4
4	The language used is communicative	4
5	Choosing the right words to explain the material	4
6	Sentences are used to reflect the content, message, or information to be conveyed	4
7	Using simple and straight-to-the-point sentences	4
8	Accuracy in spelling	4
9	Consistency in the use of terms	4
10	Consistency in the use of symbols or icons	4
Total		40
Percentage		80%

C. Discussions

1. Expert Validation Results

This research was conducted to design a practical module trainer kit based on an Arduino microcontroller in the electrical machine control course as a learning tool using the Research and Development (R&D) research model.

The main objective of this study is to create a valid and practical learning tool that can be applied effectively in the learning process of electrical machine control subjects. Thus, this study focuses on the design, development, and evaluation of the learning tool to ensure that it meets the validity standards and can be effectively used in the context of learning the course. This Arduino microcontroller-based trainer kit practical module has undergone a media, material, and language validation process. In the media trial, media experts gave a score of 96%, and material experts gave a score of 95.5%. At the same time, language experts scored 80%.

Therefore, the Arduino Microcontroller-Based Trainer Kit Practical Module is "very feasible" overall. Media, material, and language experts conducted validation on the Arduino Microcontroller-Based Trainer Kit Practical Module to ensure that it can be applied well to the electrical machine control course in terms of media, material, and language. Positive validation results from media, material, and language experts provide confidence that this module can deliver appropriate material, is easily understood, and is supported by appropriate media and language.

Thus, the Arduino Microcontroller-Based Trainer Kit Practical Module can be considered an excellent choice to help students more optimally understand the concept of DC motor speed control through voice commands. The graph in Figure 15 displays validation data collected by the researcher from media, material, and language experts. The graph reflects the evaluation conducted by the experts on the media, materials, and language used in the module.

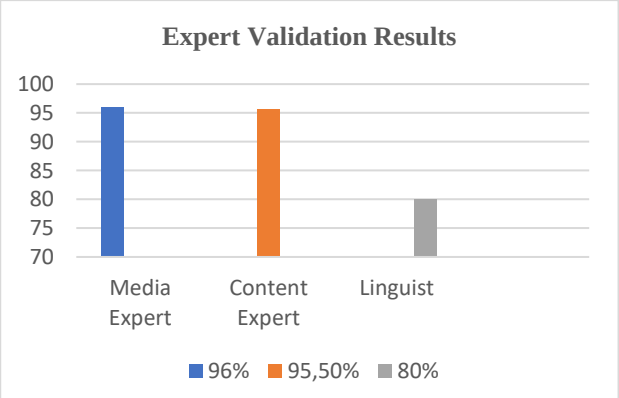

Figure 15. Media, Material, and Language Validation Results Graph

Based on Figure 15, the results of the validation test of the Arduino Microcontroller-Based Trainer Kit Practical Module have been assessed as feasible for use as a learning medium in the electrical machine control course. The validation results show that in terms of media, the Arduino microcontroller-based trainer kit practical module follows the theoretical basis of learning media. Regarding material, the Arduino microcontroller-based trainer kit practical module also follows the existing theoretical basis. Regarding language, the Arduino microcontroller-based trainer kit practical module also follows the language used.

Expert validation confirms that using the Arduino Microcontroller-Based Trainer Kit Practical Module to learn to control electrical machines in the course will provide significant benefits for students. With the support of appropriate media, materials, and language, students are expected to more easily understand the basic concepts of controlling electrical machines and improve their skill development.

2. Course Learning Outcomes (abbreviated as CPMK in Indonesian)

The Arduino microcontroller-based trainer kit practical module has undergone a validation process, which states that it is very suitable for use in courses on controlling electrical machines, which cover the material on the working principles of electric motors and electric generators. Electric motors operate based on the principle of electromagnetics, where electric current flowing through a coil of wire in a magnetic field produces a force that causes mechanical movement (Ceraolo & Poli, 2014; Tong, 2022). There are two common types of electric motors: DC (direct current) motors and AC (alternating current) motors (Kim, 2017).

a) DC Motor

DC motors work on the principle of Faraday's law of electromagnetics, where current flowing through a coil of wire in a magnetic field produces a force that causes the rotor to rotate (Cuevas et al., 2025). The rotor in a DC motor usually consists of a coil of wire (coil) located in a stationary magnetic field. Using a commutator (a system of rings and brushes) in a DC motor helps change the direction of current flow through the rotor windings, ensuring continued rotation (Cuevas et al., 2025).

b) AC Motor

AC motors work on the principle of electromagnetic induction, where alternating current produces a magnetic field that makes the rotor rotate.

The rotor in an AC motor is usually a coil made of conductive material, which produces eddy currents when exposed to a magnetic field. A rotating field in an AC motor is caused by the phase difference between the stationary magnetic field (stator) and the current flowing to the rotor (Nam, 2018).

The working principle of an electric motor is based on the interaction between a magnetic field and an electric current, which produces mechanical movement in the rotor. The speed or direction of rotation can be controlled by adjusting the amount of current or using devices such as commutators (in DC motors) or electronic control systems (in AC motors) (Nam, 2018).

The Arduino microcontroller-based trainer kit practicum module has gone through a validation process so that it is very suitable for use in electrical machine control courses, especially in the practicum of the material on the working principles of electric motors and electric generators, so that it helps students understand the working principles of electric motors. Thus, the Arduino microcontroller-based trainer kit module can be used in the student practicum process on the material on the working principles of electric motors and electric generators so that it helps students understand the concept of electric motors.

IV. CONCLUSION

Based on the results of expert validation, it can be concluded that the Arduino Microcontroller-Based Trainer Kit Practical Module obtained a high percentage of media experts at 96%, material experts at 95.5%, and language experts at 80%. These results indicate that this module gets the "Very Eligible" category to be applied to the Electrical Machine Control course. With a high percentage of validation from all aspects, including media, material, and language, this module follows quality standards. It can be relied on as a good learning tool in the context of the course in question. The module's suitability with the criteria set by media, material, and language experts proves that the Arduino microcontroller-based trainer kit practical module is feasible for use in the Electrical Machine Control learning process. The preparation of the Arduino microcontroller-based trainer kit practical module was designed using Sugiono's Research and Development (R&D) method, which had several stages to suit the researcher's needs.

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