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Design of PLC and VSD Trainers for Starting Electric Motors in Electrical Machine Control Courses

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Abstract

Starting an electric motor using a PLC and VSD is one of the materials in the Electrical Machine Control course which requires a medium to facilitate students during practicum. This practical trainer was developed as an aid to assist lecturers in elucidating the material on starting electric motors using PLC and VSD. The types of PLC and VSD trainers in this research used Zelio PLC type SR2 B201FU and VSD Altivar 312. This research used research & development methods in designing the PLC and VSD trainers. The instrument of this research was a media expert and material expert validation sheet to examine the feasibility of the trainer to be applied in the Electrical Machine Control Course. The results of media experts' and material experts' validation prove that Using PLC and VSD trainers for starting electric motors in the Electrical Machine Control Course is very feasible in terms of media and material. Where the percentage of scores obtained from media expert 1 was 96%, media expert 2 was 92%, material expert 1 was 80%, and material expert 2 was 94%. So, the feasibility of this trainer is included in the very feasible category to be applied in the Electrical Machine Control Course.

***Keywords**: Planning, Starting Electric Motor, Trainer, PLC, VSD*

Abstrak

Starting motor listrik menggunakan PLC dan VSD merupakan salah satu materi yang ada dalam mata kuliah Pengendalian Mesin Listrik yang membutuhkan suatu media untuk memudahkan mahasiswa/i saat praktikum. Trainer praktikum ini dikembangkan sebagai alat bantu dosen dalam menjelaskan materi starting motor listrik menggunakan PLC dan VSD. Jenis dari trainer PLC dan VSD pada penelitian ini menggunakan PLC Zelio tipe SR2 B201FU dan VSD Altivar 312. Penelitian ini menggunakan metode research & development dalam perancangan trainer PLC dan VSD. Instrumen dalam penelitian ini menggunakan lembar validasi ahli media dan ahli materi untuk menguji kelayakan trainer untuk diterapkan dalam Mata Kuliah Pengendalian Mesin Listrik. Hasil validasi ahli media dan ahli materi membuktikan bahwa trainer PLC dan VSD untuk starting motor listrik dalam Mata Kuliah Pengendalian Mesin Listrik sangat layak dari segi media dan materi. Berdasarkan persentase nilai yang diperoleh dari ahli media 1 memperoleh nilai 96%, ahli media 2 memperoleh 92%, ahli materi 1 memperoleh nilai 80%, dan ahli materi 2 memperoleh nilai 94% sehingga kelayakan trainer ini termasuk dalam kategori sangat layak untuk diterapkan dalam mata kuliah Pengendalian Mesin Listrik.

***Kata kunci**: Perancangan, Starting Motor Listrik, Trainer, PLC, VSD.*

Introduction

The impact of technological developments on human existence is very significant, one of which is the development of learning media which is facilitated by various technologies. The use of learning media in educational environments offers a fresher approach to increasing the effectiveness of the learning process. The use of learning media in the teaching and learning process is one of the advances that can be seen in the world of education. With nowadays developments, various new technologies have emerged, including in the field of 1-phase and 3-phase electric motor control. Currently, processes in control systems are no longer limited to manual sequences. Many industries have switched to using PLC and VSD systems for starting electric motors. The application of this control system has even become part of the Electrical Machine Control course

Electrical machine control courses are mandatory subjects in the Electrical Engineering Education Study Program, which discusses the systems of controls in electrical machines including electric motor control systems, VSD (Variable Speed Drive) control, electric machine control using PLC, etc. Based on observations in electrical machine control courses, many students do not understand how to control electric machines using PLCs and VSDs due to the lack of learning materials and PLCs and VSDs trainers. The purpose of this research is to design and assess the feasibility of a PLC and VSD trainer capable of controlling the starting motor for use as a trainer kit in the laboratory activities of the electric machine control course. The result of this research was expected to make it easier for students to carry out practicum by implementing the Trainer kit system from PLC and VSD as a useful teaching aid to assist an effective learning process.

Method

In this study, the researcher designed a teaching aid product that was intended as a learning aid in the practical course of controlling electrical machines, therefore the research design used was research development (Research & Development). Research and Development is research used to develop and validate products. In this research, the R&D stage used was only up to the trainer validation stage, because the researcher only wanted to test the feasibility in terms of trainer materials and media.

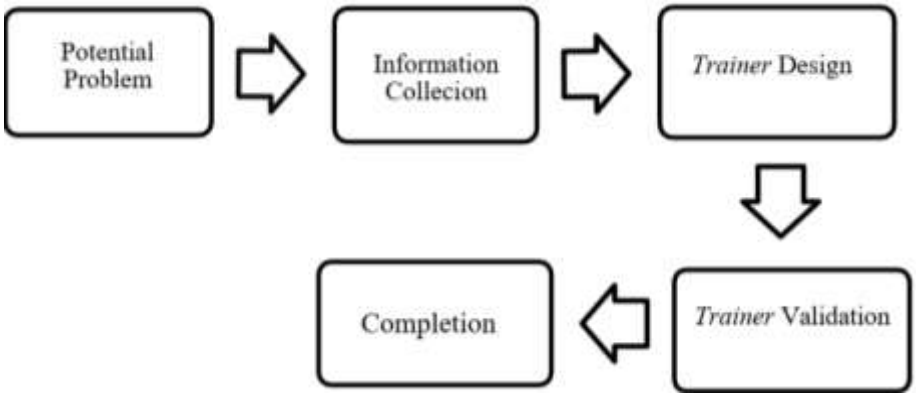


Figure 1. R&D Research Stages

a. Trainer Design

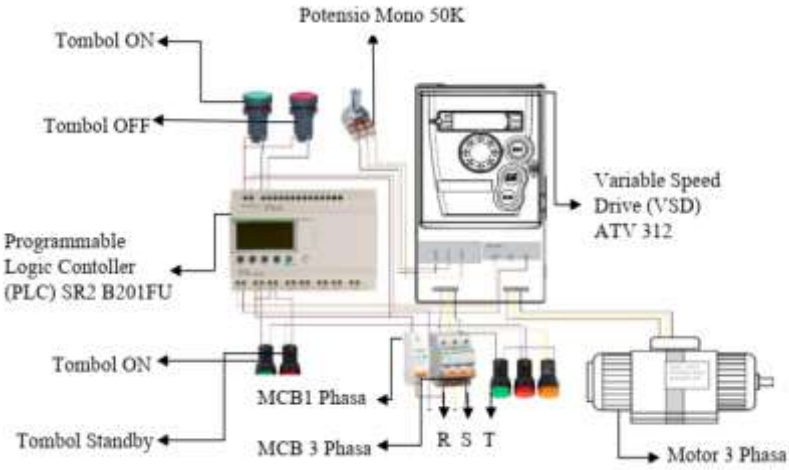


Figure 2. PLC and VSD Trainer Circuit for Starting Motor Electricity Design

b. Data Analysis Technique

The data analysis used in this research is descriptive analysis with a quantitative approach. with the formula:

$$\text{Feasibility Percentage} = \frac{total\ score\ of\ overall\ answers}{total\ score\ of\ maimum\ possivle\ answers} x100 \quad (1)$$

The categories of expert validation results are based on the percentage level of answers in table 1.

Table 1. Feasibility Percentage Category

Categorization	Percentage Rate (%)
Very Feasible	81 – 100
Feasible	61 – 80
Neutral	41 – 60
Not feasible	21 – 40
Totally Not feasible	0 – 20

Result

a. Design Results of PLC and VSD Trainer

Figure 3. Display of the Assembled Component Series

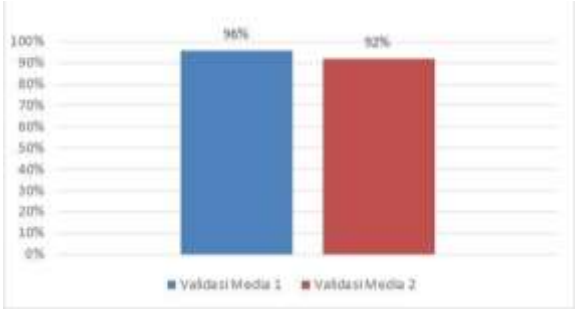
Figure 4. Phase Electric Motor.

Designing PLC and VSD trainers which connected to 3-phase electric motor is a step in developing an electric machine control system. The PLC trainer functions as the brain that controls the operation of the electric motor by regulating various inputs and outputs which allows students to understand the concept of automatic control and program the PLC to optimize the performance of the electric motor. Meanwhile, VSD provides the ability to precisely regulate the rotation speed of electric motors, enabling efficient adaptation to changing loads and operational requirements. The integration between PLC and VSD trainers allows the development of students' practical skills in designing, configuring and optimizing complex control systems for 3-phase electric motors.

b. Media Validation Test Result

This media validation was carried out to test the feasibility of this media trainer in terms of its appearance as a learning media that will be used in electrical machine control courses. The results of the media validation test by validator 1 and validator 2 can be seen in graph 1.

Graph 1. Media Validation Test Result

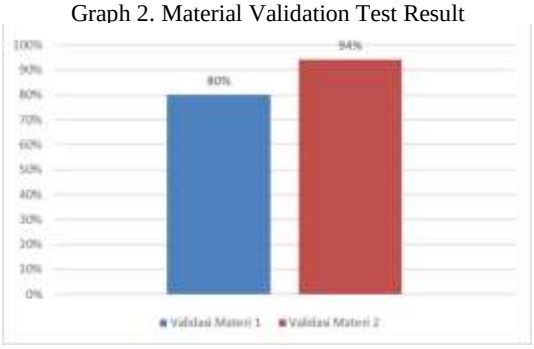


Graph 1 shows the results of two media expert validation, with each obtaining a percentage value of 96% from validator 1 and 92% from validator 2, and the average of the two percentage results from both media expert validation is 94%. So, the feasibility of this PLC and VSD trainer is classified in the "Very Feasible" category to be applied to the Electrical Machine Control Course.

c. Material Validation Test Result

This material validation was carried out to determine the feasibility of the trainer in terms of the material that will be used in the electrical machine control course. The results of the material validation test by validator 1 and validator 2 can be seen in graph 2.

Graph 2. Material Validation Test Result



Graph 2 shows the results of two material expert validation, with each obtaining a percentage value of 80% from validator 1 and 94% from validator 2, and the average of the two percentage results from both media expert validation is 87%. So, the feasibility of this PLC and VSD trainer is classified in the "Very Feasible" category to be applied to the Electrical Machine Control Course.

Discussion

Validation of media and material experts in designing PLC and VSD trainers for starting electric motors in the Electrical Machine Control Course has a complementary role. The collaboration between media and material experts helps build a balanced instructional design, combining the advantages of an attractive visual presentation with the technical accuracy necessary for students to thoroughly master the concepts of controlling electrical machines. From the results of media and material experts validation for the feasibility of PLC and VSD trainers, it is clear that in terms of media, the trainer is following the theoretical basis of learning props, especially the characteristics of teaching aids, and in terms of material the PLC and VSD trainers are following the learning material of starting an electric motor using a PLC and

VSD. So, based on the validation results from media and material experts, this trainer is "Very Feasible" to be applied to the Electrical Machine Control Course.

Conclusion

This research was conducted to design PLC and VSD trainers for starting electric motors which will be used in electrical machine control courses. From the validation test results, both media and material experts stated this PLC and VSD trainers is very feasible for application in Electrical Machine Control courses. With this PLC and VSD trainers, students can provide a more in-depth and practical understanding of how to control electric machines using PLC and VSD and lecturers can provide more effective and interactive demonstrations in practicums.

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