Control System based Photocell, Timer and Temperature Sensor

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Abstract. The development of automation has penetrated in various fields including electro. Photocell; Timers; and Temperature Sensors-based control systems (FTS) is systems with performance that can save work time and simplify work through the process of automation. This study aims was to make innovations in practical equipment that can facilitate the learning process of controlling techniques, namely designing FTS-based controller systems. The research method used developing method of the ADDIE model. The research was conducted at the Unima Electrical Engineering Education Laboratory of the Faculty Engineering. The results of the study show that the design of the FTS control system can be used and applied in daily life, such as the needs in the field of agriculture and fisheries, it can also be used as an integrated laboratory learning media in electrical engineering education. This FTS-based controller system design can also improve the understanding of electrical engineering students about controlling techniques.

1. Introduction

The development of automation has penetrated in various fields including electro. The progress of science and technology in automation can maximize a work with a low cost and a short time through a tool known as a controlling system. Control system is a collection of tools that form a configuration system that can control, govern and regulate the state of other equipment. The type of controlling system is differentiated based on 1) manually and automatically [1]; 2) closed networks and open networks [2]; 3) continuous and discontinuous [3]; 4) Servo and regulators [4]; 5) according to hard source: electric, pneumatic, hydraulic, and mechanical [3]. One example of a controlling system according to hard source is a photocell; timer; and temperature sensor-based controller system.

Many researchers have developed a controlling system based on the source of motion, including 1) Hariadi who utilized the advances in science and technology in the field of automation by regulating several variables in greenhouses to suit the needs of plant growth in the cultivation of plants [5]; 2) Riyadi and Purnama who designed an SMS-based home door security control system using a microcontroller [6]; 3) Basile, Chiacchio, and Gerbasio design industrial automation systems based on PLC [7]. The researchers pointed out that the development of a control system can be built from various tools with different objectives but with the same principle, namely automation to simplify a job.

In the learning process of the controller system in the field of electrical engineering education, practicum equipment is needed which is able to make students understand the work process of system automation [8] and based on its purpose to provide provisions for them in future work. Photocell; timers; and temperature sensors (FTS) -based controller systems are one simple control system that
can be used as a practical tool to understand settings with photocells that use sunlight as a driver, timer settings as a timer in systems and temperature sensors that utilize ambient temperature. This study aims to make innovations in practical equipment that can facilitate the learning process of controlling techniques, namely designing FTS-based controller systems.

2. Method
This study uses the ADDIE model development method, The reason is that the ADDIE Model can be a guideline in building effective, dynamic training devices and training programs or learning programs and supporting the performance of the training itself in several stages. which consists of five phases, namely analyze; design; develop; implement; and evaluate [9], [10]. Procedure This model is presented in Figure 1. The research was conducted at the Electrical Engineering Education Laboratory on the Faculty of Engineering Unima. The implementation phase was carried out for semester V electrical engineering students. the advantages of developing this model are one of the interactive learning processes with the basic stages of effective, dynamic and efficient learning.

Figure 1. Research Procedure

The Guideline procedure of research in figure 1 above are explained in table 1 below.

| ADDIE Phase | Sample Tasks | Sample Output |
|-------------|--------------|---------------|
| Analysis    | Needs Assessment | Needs, Problem Statement |
|             | Problem Identification | Tasks analysis |
| Design      | Develop Media | Prototype Panel |
|             | Identify Resources | Specification |
| Development | Development Learning Media | Control system Panel |
| Implementation | Student Training | Learning Outcomes |
|             | Try out | |
| Evaluation  | Expert Validity | Recommendations |
|             | Revise Learning Media | Revise Prototype |
|             | Survey Graduate | |
The evaluation phase is carried out together with the implementation phase. Prior to implementation, the evaluation was conducted in a one-to-one manner with experts aiming to test FTS-based control system panel media, and evaluation by means of a small group to test the use of control system panel media. The implementation phase is a field trial.

3. Results and Discussion

3.1 Analysis

Observation results for several electrical courses in the electrical engineering department, found that in courses containing practice, especially the Control Engineering courses, it is still a lack of application of scientific use in terms of assembly control system panels that explore the environment as in the field of animal husbandry, agriculture and agroindustry. The need for appropriate technology to be the basis for designing and developing a control system panel that can be used in agriculture and other fields. In addition, the development of this control system panel as a means to develop knowledge in the Department of Electrical Engineering Education. Development of a control system begins with determining the purpose of the system controller being developed. In this study the purpose of making a system control panel for use in agriculture, especially for controlling the watering process in nurseries in greenhouses automatically and regulating the temperature of the nursery area with the appropriate temperature for plants.

3.2. Design

The design process begins with planning as outlined in planning drawings using equipment that is suitable for the purpose of development. The design of the FTS-based controller system which consists of a control circuit as an example to run the pump and layout drawing of equipment placement in the panel box. In detail the design of the controller system can be seen below:

3.2.1. Control Circuit

The Control Series consists of: 1) Overcurrent security or 1 phase MCB with 4 Ampere specifications; 2) Fotocell; 3) Timer Relay (TDR); 4) Stop Digital Timer; 5) Temperature Sensor; 6) Contactor consisting of Main contact and Auxiliary Contact; 7) Pushbutton; 8) Control lights; 9) Terminal. The arrangement of equipment in the control circuit was designed as in figure 2 below:

![Figure 2. Control Circuit](image)

In Figure 2, the control circuit was designed in 3 conditions, namely condition 1 uses a timer, and condition 2 uses a temperature sensor and condition 3 using the push button/manual.

3.2.2. Layout panel
Placement of equipment such as photocells, timers and sensors in a panel size of 30 x 40 is adjusted to the size of the equipment and the position of the tools. Safety equipment such as the Mini Circuit Breaker is placed in the upper left and parallel to several contactors, and at the bottom other contactors are installed when the upper Omega rail is full. The timer is installed in the lower right area. Clearly the layout of the equipment is illustrated as in Figure 3 and 4 below.

![Figure 3. Panel Equipment Layout](image1)

![Figure 4. Panel Door](image2)

The panel layout is adjusted to the placement of panels in the outdoor area such as those in figures 3 and 4, so that the direction of the wiring groove is in the lower position with the intention of preventing leakage due to natural conditions such as rain or humidity caused by cold.

3.3. Develop

The development phase starts from designing a control circuit in accordance with the use of each equipment in the controlling system. The functions of each equipment in the system control are: 1) MCB as a safety short circuit current and over load which is greater than 4 Ampere which works when the controlling system circuit experiences interference; 2) the photocell functions as an electric circuit breaker to the contactor, which in the NC contact can function to connect the current to the TDR, where the source of the drive is sunlight which hits/illuminates directly on the photocell system so that it can disconnect the switches inside the photocell with a duration of 5 minutes to run loads/pumps; 3) A digital timer socket that serves to regulate the voltage on the socket to be able to drain an electric current to the load/pump according to the time setting, for example in the afternoon for 15 minutes; 4) temperature sensors that function to help consumers as equipment users when needed a manual system to turn on the pump as desired outside the time/situation that has been designed automatically; 5) Contactors that function as disconnect switches for the main circuit/Power on the motor, according to the planned regulatory system.

The control system developed in assembling the control panel has the following work methods: 1) Condition 1, Electric current from the voltage source through the MCB as a safety overload and short circuit current is flowed to the line in the photocell, then through the output to the timer coil, and the timing of the timer is adjusted to two conditions, namely in the morning and evening to turn on contactor 2 so that the water pumping machine that functions to water the plant seeds works for 10 minutes; 2) Condition 2, To activate the performance of the temperature sensor in the electric current control circuit of the MCB flowing into the temperature sensor input, then through the output on the temperature sensor flows to contactor 3 to turn on the water pump which functions as a condenser to maintain air temperature quality around the greenhouse set using the timer theb on the position for 5 minutes. H1 control lights can be on when contactor 1 works, and H2 control lights can be on
when contactor 3 works; 3) Condition 3, if we want to turn on the pump to water the plant seeds manually according to our own wishes, where the electric current flows from the MCB to the pushbutton on terminal 23 which functions as input. If we turn on the pushbutton the electric current from terminal 24 as the output will flow to contactor coil 1 and will turn on the water pump to water the plants.

3.4. Implement

Implementation in the development research was carried out after expert one-to-one evaluations and small group evaluations. The implementation phase is a field trial. Implementation of the results on this studies was the use of learning media system control panel in control engineering courses. The process of learning to use the media control system panel, to make students learn to understand and assemble panels that are designed for various purposes such as agriculture, fisheries and others. The use of learning system panel control media fosters student creativity in practical activities so that it has an increase in the achievement of learning outcomes.

3.5. Evaluate

The evaluation phase is carried out together with the implementation phase. Prior to implementation, the evaluation was conducted in a one-to-one manner with experts aiming to test FTS-based control system panel media, and evaluation by means of a small group to test the use of control system panel media. The implementation phase is a field trial.

The results of one-to-one by experts found obstacles in the operation of the control system that is setting the clock on a timer that is not in accordance with the field of testing and placement of photocell sensors directly facing the sun, so it is recommended to revise the clock settings according to the time; the position of the sun, and the position of the sensor is adjusted not facing directly into the sun.

The small group test results were carried out on 5 students majoring in electrical engineering, where in the learning process students were initially unable to understand well about the control process in the control system, and recommendations from the results of the small group test were the need for a practical guidebook for lecturers and students.

The results of the field test showed that there was an increase in the average student learning outcomes before and after learning using the control system panel media. the final test average is 3.49 and the preliminary test average is 2.01. The effectiveness test was carried out by paired t test obtained by t count = 23.444 > t table = 2.069 which means the average final test is greater than the average preliminary test.

3.6. Review on the development and Educational implication of the study

After evaluating one-to-one experts [11], several obstacles were found in the process of running the system, then improvements were made, for example for timer programs that were not in accordance with the conditions in the field, repairs or rearrangements. For the temperature sensor section, the problem is the placement of the position of the sensor facing the sun, because it is adjusted to the location of the greenhouse, then do the rearrangement to get the right position. After the equipment was adapted to these constraints, it was then tested again in a small group [11] and the results of the trial recommended making a guidebook to facilitate the learning process. Field trials which are the implementation of research results in this case the learning system panel control media, produce results that are in accordance with the purpose of designing and developing equipment.

In using the panel box as a medium for learning, students are good enough to operate the FTS-based control system, because repeated training is held. The results of the series testing on the FTS-based control system indicate that the system can run according to the purpose of developing tools / media, namely to be utilized in agricultural technology, especially for chili nurseries.

Learning in the classroom using the FTS-based controller system panel as learning media provides increased learning motivation because it is given a challenging task [12], so that through the learning
process and creativity of each student [13], they acquire complex knowledge and skills about the practice of making control systems, and ultimately improve learning outcomes.

4. Conclusion
The design of the FTS control system can be used and applied in daily life, such as the needs in the field of agriculture and fisheries, it can also be used as an integrated laboratory learning media in electrical engineering education. This FTS-based controller system design can also improve the understanding of electrical engineering students about controlling techniques.

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