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Simple Control System Training for Students and Teachers of Vocational School in Purwakarta

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ABSTRACT

Everyday life depends on control systems. If a system has a good control system, it will give you the results we want. Through the control system, we can change things like temperature, speed, pressure, level, and other physical numbers to the way you want them to be. There are two kinds of control system: open loop control and closed loop control. The open loop control system is the easiest to use because the person controls the system without getting any feedback. While the closed loop control system will get feedback from the system output so that the system will automatically reach the desired state. Teachers and children at vocational school in Purwakarta get to try out open loop and closed loop control system applications during this community service project. This is important so that teachers and students can get the experience in control system application.

Keywords: *simple control system, vocational school, teacher, student*

1. INTRODUCTION

Control systems play a key role in modern society. Control systems have wide applications in several domains, encompassing the regulation of voltage in residential settings, the management of temperature via air conditioning systems, the operation of automated lighting, and the control of water tank levels, among other examples. The most basic control system is comprised of three main components: input, process, and output, as depicted in Figure 1.

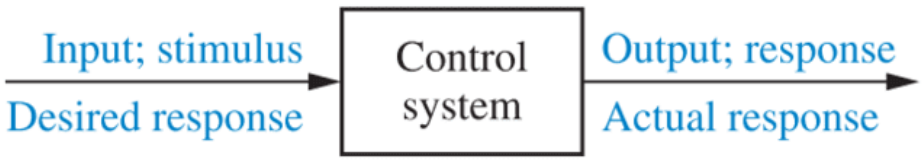

Figure 1. The simplest control system component (Nise, 2020).

Based on figure 1, we must provide the correct input to the system so that it can respond and process in order to produce the desired output/response. For example, we want the air

conditioner to maintain a temperature of 25 degrees Celsius in the room. Then, the air conditioner's control system will activate the cooling system to produce the intended room temperature.

The control system can be classified into two main types: open loop control system and closed loop control system **(Ogata, 2010)**. An open loop control system is characterized by its lack of feedback, meaning that the output of the system does not influence the control action **(Pramanda & Aswardi, 2020)**. As an illustration, when the accelerator pedal of an automobile is pressed, the vehicle will accelerate at a rate proportional to the amount of force applied to the pedal. A closed-loop control system refers to a control system in which the control action is influenced by the output or response of the system **(Natsir et al., 2019).** Closed loop control systems are commonly referred to as automatic control systems or feedback control systems in academic literature. In the context of air conditioning, an illustrative instance may be observed wherein the temperature sensor integrated within the air conditioning system is employed to monitor and assess the prevailing environmental conditions in real time, with the objective of achieving a desired temperature setting. Once the temperature exceeds the designated threshold, the air conditioner will be off. Once the temperature begins to increase, the air conditioner will resume functioning in order to achieve the desired temperature. Furthermore, and so forth. The closed-loop control system is a type of control system that operates in an on-off manner, wherein the control signal is adjusted by either raising or lowering it in response to the system output condition **(Burlian et al., 2021; Hidayat, 2018; Natsir et al., 2019; Yunas & Pulungan, 2020).**

Control system skills are important, especially for vocational students who are studying engineering clusters, because these skills can be used in many different areas of study. In mechanical education, students must learn how to control the speed of a motorcycle or car based on how much pressure is put on the pedal. Without a way to control it, speed can change in ways that don't follow a straight line. Electrical engineering vocational schools and similar fields can use water level control systems, pressure control systems, temperature control systems, and household voltage stability control systems, among other types of control systems.

Considering all of this, it's important for vocational school teachers and students to learn about simple control system uses through a community service project. Teachers and students can use this simple control method on other systems in the future. This training plan will be done offline. Here are some of the things that will be talked about:

- Introduction to basic control systems: open loop control systems and closed loop control systems
- Practical application of open loop and closed loop control systems with temperature control case study

2. METHODS

The methodology for implementing this community service activity is divided into 3 stages as in figure 2, namely the preparation stage, implementation stage, and evaluation stage **(Zakaria et al., 2022).**

Figure 2. Method of the community services.

The explanation of these stages is as follows:

Preparation stage
The preparation stage began with discussions related to designing the temperature control system trainer and the preparation of its module. The team test the trainer to make sure the system works properly. In addition, the team communicated with related parties to obtain training participants. After that, the team prepared technical matters related to the room, consumption and other things.

Implementation stage
The team conducted training activities on control systems for the participants, which included an introduction to fundamental open loop and closed loop control systems, as well as practical exercises including temperature control case studies. Additionally, participants will be provided with an activity evaluation questionnaire.

Evaluation stage
During the evaluation stage, the team will assess all conducted training activities and analyze the questionnaires completed by participants to gather insights for enhancing future training activities.

This training involved lecturers and students of the Mechatronics and Artificial Intelligence study programs, UPI Purwakarta Campus.

3. RESULTS AND DISCUSSION

Activity Description
This training activity was held on Saturday, September 16, 2023 starting at 08.00-12.00 at the Smart Classroom UPI Purwakarta. This activity was attended by 30 participants consisting of 7 teachers and 23 vocational students in Purwakarta. The activity was opened with remarks from the Vice Director for Resources, Finance, and General Affairs of UPI Purwakarta Campus, Dr. Suci Utami Putri, M.Pd. and the head of the Mechatronics and Artificial Intelligence study program, Dewi Indriati Hadi Putri, S.Pd., M.T. as shown in Figure 3.

Figure 3. Opening of training activities.

The next activity was a presentation on basic control systems given by Diky Zakaria, S.Pd., M.T., the chief executive officer of this training activity. The presented material discusses the fundamental concepts of control systems, open loop versus closed loop control with examples and an overview of the participants' workshop. Furthermore, participants joined a workshop on the implementation of a simple closed loop control system with the on/off method to a temperature control case study. Figure 4 depicts the workshop's documentation.

Figure 4. Presentation of basic concepts of control systems.

Simple Control System Application Workshop

After the speaker session, the activity continued with a simple control system application workshop. The case study carried out is temperature control with on off control. Actuators used to regulate temperature are water heating elements and lamps. The tools and materials needed in this workshop are arduino nano+ shield, 16x2 LCD, 4x4 keypad, solid state relay module, male to female jumper, female to female jumper, male to male jumper, a set of alligator clips, type b USB, temperature sensor (PTC), water heater and lamp. The circuit scheme of the control system can be seen in Figure 5.

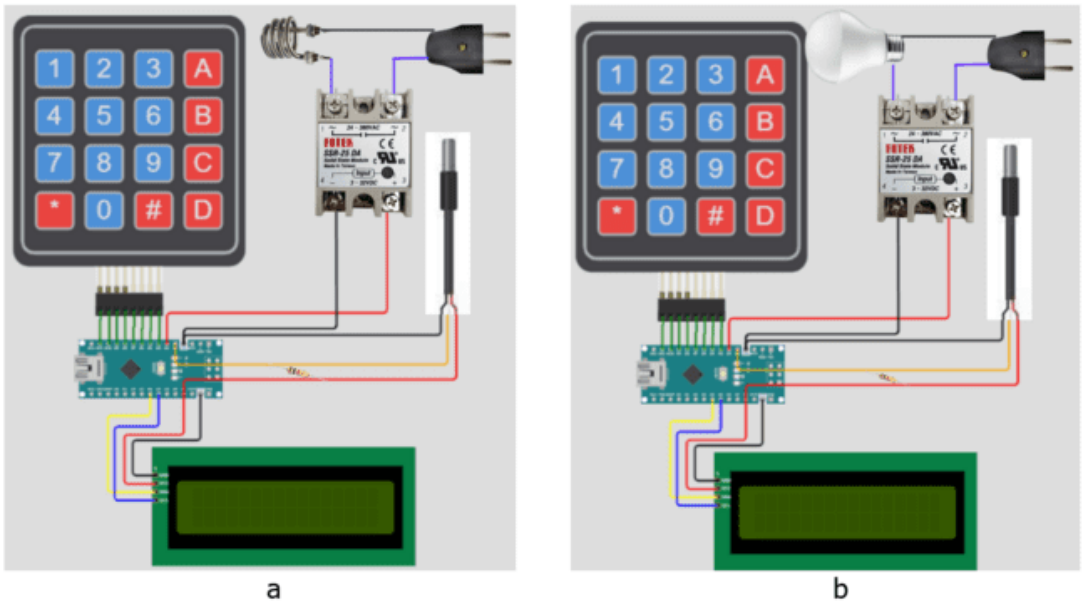

Figure 5. Schematic of the control system circuit to be created by the participants.

Based on Figure 5, Figure (a) is a circuit scheme with a heating element actuator and Figure (b) is a circuit scheme with an incandescent lamp actuator. In working principle, both circuit schemes have the same function, namely for heat control. The heating element will heat the water and the lamp will turn on. The temperature sensor will be placed in the water and near the lamp. When the temperature has reached the desired setpoint, the system will turn off the actuator. The coding algorithm for the control system follows Figure 6.

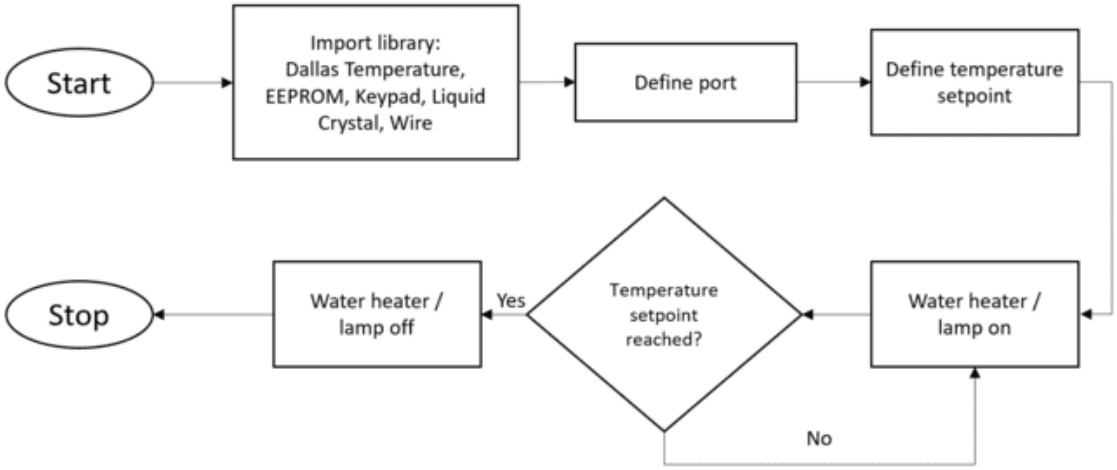

Figure 6. Coding algorithm for on off control system.

Based on Figure 6, during training, participants are required to have software and libraries that must be installed on their laptops, namely Arduino IDE, CH304 library, DallasTemperature, OneWire library and LCD library. Furthermore, participants were given coding files that had been prepared previously. The 30 participants were then divided into 8 groups accompanied by 6 mentors. Here is the documentation of the workshop activities (Figure 6).

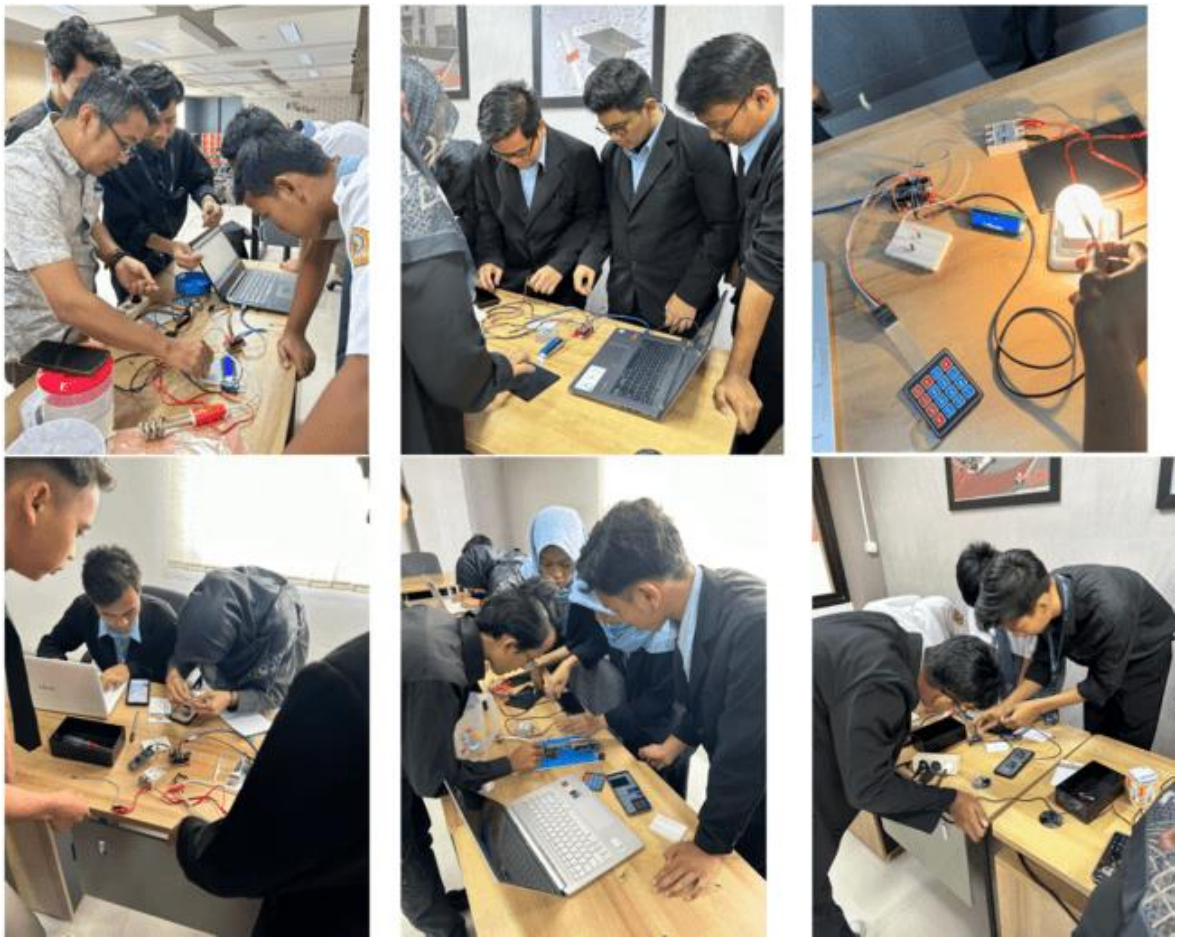

Figure 7. Documentation of workshop activities.

As shown in Figure 7, participants assembled each component according to the schematic in Figure 4 accompanied by the mentor. Mentors provide direction to participants so that the training process runs smoothly and the system can function properly as desired. As a result, all groups can apply the on off control system to the water heater and lights. The evaluation results of this activity were collected in a google form filled in by the participants. The assessment form follows a scale of 1-5 (bigger means better). 25 out of 30 participants filled out the questionnaire given. The evaluation results from the participants are depicted in table 1.

Table 1. Participant evaluation results of the training activity.

No	Questionnaires	Scores				
		1	2	3	4	5
1	Participants understand the purpose of the Simple Control System Application Training activity.	0%	4%	4%	32%	60%
2	The methods used in this training are suitable for you.	0%	0%	16%	32%	52%
3	Presenters and mentors provide material in an interesting and fun way.	0%	0%	0%	20%	80%
4	This training activity is useful for me.	4%	0%	0%	16%	80%
5	The supporting facilities for this activity are very good.	0%	0%	0%	16%	84%
6	Mentors are very helpful to participants who face difficulties.	0%	0%	8%	16%	76%
7	Participants are interested in learning more about simple control system applications.	0%	4%	8%	40%	48%
8	Overall quality of this activity.	0%	0%	4%	36%	60%

Based on the results in Table 1, the majority of participants were satisfied with the training provided. Scores below 4 will be an evaluation for the team to improve the next training. The next plan is to conduct a more advanced level of control system training, namely PID control. PID control is a control theory that is widely used in industry **(Akbar et al., 2021; Zakaria et al., 2021)** therefore, it is important for vocational teachers and students to know and master it.

4. CONCLUSIONS

Control systems are inseparable and have been integrated in everyday life. This community service activity aims to introduce the basic concepts of control systems to students and teachers of Vocational High Schools in Purwakarta. From the results of the training that has been carried out, it shows satisfactory results. All participants successfully applied the on off control system in the temperature control case study. From the results of the activity evaluation, the majority of participants were satisfied with the training activities carried out with the score 4 or 5. Things that are given low scores from the evaluation results will be improved in the next training. The next training will discuss the application of the PID control system which is the most commonly used control theory in the industrial world.

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