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Developing Learning Tool of Control System Engineering Using Matrix Laboratory Software Oriented on Industrial Needs

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Abstract: The purpose of this research is to develop learning media of control technique using Matrix Laboratory software with industry requirement approach. Learning media serves as a tool for creating a better and effective teaching and learning situation because it can accelerate the learning process in order to enhance the quality of learning. Control Techniques using Matrix Laboratory software can enlarge the interest and attention of students, with real experience and can grow independent attitude. This research design refers to the use of research and development (R & D) methods that have been modified by multi-disciplinary team-based researchers. This research used Computer based learning method consisting of computer and Matrix Laboratory software which was integrated with props. Matrix Laboratory has the ability to visualize the theory and analysis of the Control System which is an integration of computing, visualization and programming which is easy to use. The result of this instructional media development is to use mathematical equations using Matrix Laboratory software on control system application with DC motor plant and PID (Proportional-Integral-Derivative). Considering that manufacturing in the field of Distributed Control systems (DCSs), Programmable Controllers (PLCs), and Microcontrollers (MCUs) use PID systems in production processes are widely used in industry.

1. Introduction

The development of science and technology is very fast. The competition between industries in the world will certainly cause the need for workers' ability to run the industrial process well. Thus, training or educational institution tries to improve the competence of graduate candidates demanded by the working world.

The comfort and speed system are highly demanded in the modern world where the system that works automatically will be more and more developed. The industrial automation field is a discipline that studies the device or system automation [18]. Learning automation theoretically is not enough because learning automation technology requires training probs (trainer) to support the theory obtained by students. Practically, vocational education is different from general education because it requires "up to date" equipment to train students to have a good life skill and be the competent graduates. The limitations of trainer learning media become a serious matter to be observed in vocational education. Using learning media, students can easily understand content of the lesson. As stated by Briggs [1] that learning media is the means to deliver learning content or materials, such as books, modules,

films, videos, trainers and so on. Then, the communication is printing and hearing-sight form, including hardware technology.

Planning an automation system in both large and small industrial scale will not be separated from an assumption how this system will run well viewed from the review behavior or system characteristics. The main characteristics that must be known is the electrical characteristics of the system such as start current surge, transient voltage profile to transient analysis when having system interruption. The ability to know the actual system condition will provide good and optimal planning results. The interpreting process or interpreting the system behavior is not an easy task because of dealing with the static and dynamic behavior system. Modeling and simulation should be performed in an interactive and real time. Using Matrix Laboratory software will also determine the accuracy of the model taken.

Regulatory system is the process of setting or controlling one or several quantities (variables, parameters) to obtain a price or within a certain range. The regulatory system is also a system in which the components are connected that forms system configuration. The control system regulates its own system or other systems to obtain response of the required system. According to [1], the student learning test shows the achievement of complete learning of all students was100%, after following the lectures using the engineering module on fundamentals of controlling system. Referring to the successful previous research, the writer developed learning media application of wider regulatory techniques. The regulatory techniques using Matrix Laboratory Software with Inquiry Based Learning device for Industrial Needs by giving examples of mathematical equations in controlling system applications using PID (Proportional-Integral-Derivative). Considering that manufacturing in the field of Distributed Control System (DCSs), Programmable Controllers (PLCs), and Microcontrollers (MCUs) use PID systems in production processes widely used in industry.

2. Research Method

The design of this study was experimental research using research and development (R & D) methods modified in the form of engineering methods of setting technique. The design of Regulatory Techniques Using Software Matrix Laboratory for industrial needs requires experts in education, engineering, and language. Thus, it takes a multi-disciplinary team-based approach, which the industry's manufacturing used PID systems in the production process. Figure 1 shown stage for using trainer in operating and setting the system using PID.

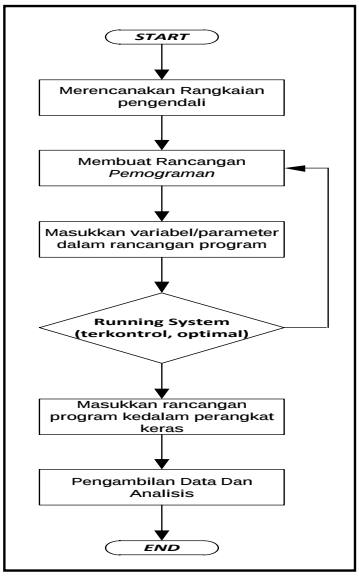

Figure 1. Flowchart of control system engineering design

PID control is famous for its structure simplicity, as well as the ease of tuning the control parameters, reliability, easy to fix, and more importantly PID control provides excellent control compared to other techniques that usually requires more effort and higher fund. Implementing logical theory is capable of creating a revolution in technology. The basic configuration of the PID control system can be seen in Figure 2.

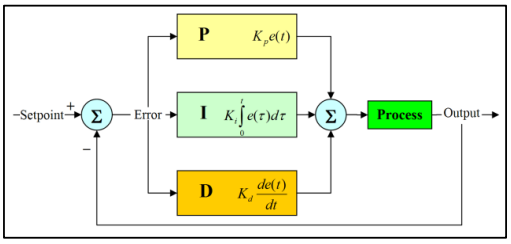

Figure 2. Configuration of PID Controller

This research was arranged in the form of learning device on trainer's regulatory technique with DC motor plant and PID Controller using Matrix Laboratory software with Arduino Uno Microcontroller.

3. Results and Discussion

This research has succeeded in producing learning device of PID-based system automation Trainer using Arduino equipped with ultrasound sensor. This trainer is a system to control DC motor speed. The speed of DC motor can be used to support the competence of regulatory techniques so that students can simulate the measurement and trial in an effective and efficient way.

This trainer consists of several components placed on the PCB board as a component of placement medium. Figure 3 shows the component specification design of the trainer setting system:

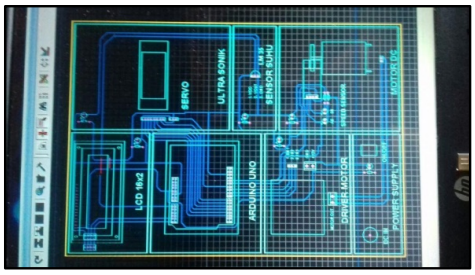

Figure 3. Design of Control System Engineering Trainer Board

The Trainer engineering method refers to industrial competence standards and is aimed to understand, operate, use and apply basic principles of basic regulatory techniques in electronic equipment including Arduino programming, LCD character programming, ultrasonic sensors using Arduino UNO microprocessors and Matrix Laboratory assisted design program on PID experimental circuit that controls DC motor.

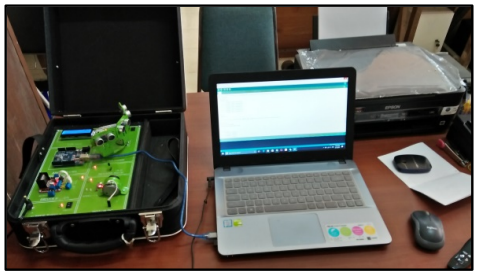

Figure 4. Trainer of Control System Engineering

To ease the learning process, students must understand the making process of series and programming with Arduino. The design simulation is done by making programming design on PC / Laptop. Simulation is done to minimize the circuit error application into automatic control using *Arduino Uno*. Then, the results of simulation and programming design are transferred to Arduino Uno hardware. Some competences gained in the learning process using these regulatory technique trainer is the first lesson of programming to display Ultrasonic Sensor Data:

```
int trig= 13;
int echo= 12;
long durasi, jarak;
void setup() {
pinMode(trig, OUTPUT);
pinMode(echo, INPUT);
Serial.begin(9600);       }
void loop()
{digitalWrite(trig, LOW);
delayMicroseconds(8);
digitalWrite(trig, HIGH);
delayMicroseconds(8);
digitalWrite(trig, LOW);
delayMicroseconds(8);
durasi= pulseIn(echo, HIGH);
jarak= (durasi/2) / 29.1;  Serial.println(jarak :); }
```

The second program learning to show temperature data and PWM of motor:

```
void lm35(){
 suhu=analogRead(A0);
 suhu_celcius=(suhu*500)/1023; }
void setup() {
pinMode(trigPin1, OUTPUT);
pinMode(echoPin1, INPUT);
pinMode(trigPin2, OUTPUT);
pinMode(echoPin2, INPUT);
pinMode(trigPin3, OUTPUT);
pinMode(echoPin3, INPUT);
pinMode(in1, INPUT);
pinMode(in2, INPUT);
pinMode(en1, OUTPUT);
Serial.begin(9600);
lcd.begin(16,2);}
void PWM_out() {
 if(speed_motor>0)
 {
   PWM=(unsigned char)speed_motor;
   digitalWrite(in1,HIGH);  digitalWrite(in2,LOW);  analogWrite(en1,PWM);
//maju
 }
 Else  {
   speed_motor=(unsigned char)255+speed_motor;
   PWM=speed_motor;
   digitalWrite(in1,LOW);  digitalWrite(in2,HIGH);  analogWrite(en1,PWM);
//mundur
 }   }
```

```
void setup()
{
pinMode(trigPin1, OUTPUT);
pinMode(echoPin1, INPUT);
pinMode(trigPin2, OUTPUT);
pinMode(echoPin2, INPUT);
pinMode(trigPin3, OUTPUT);
pinMode(echoPin3, INPUT);
pinMode(in1, INPUT);
pinMode(in2, INPUT);
pinMode(en1, OUTPUT);
Serial.begin(9600);
lcd.begin(16,2);
}
void loop()
{
digitalWrite(11,LOW);
lcd.clear();
  lm35();
  us_pid();
   lcd.setCursor (0,0); lcd.print ("P:");
  lcd.setCursor (2,0); lcd.print (kp);
  lcd.setCursor (4,0); lcd.print ("I:");
  lcd.setCursor (6,0); lcd.print (ki);
  lcd.setCursor (8,0); lcd.print ("D:");
  lcd.setCursor (10,0); lcd.print (kd);
  lcd.setCursor (13,0); lcd.print (us3);
  lcd.setCursor (14,0); lcd.print (us2);
  lcd.setCursor (15,0); lcd.print (us1);
  lcd.setCursor (0,1); lcd.print ("E: ");
  lcd.setCursor (2,1); lcd.print (error);
  lcd.setCursor (5,1); lcd.print ("PWM: ");
  lcd.setCursor (9,1); lcd.print (PWM);
  lcd.setCursor(13,1);
  lcd.print(suhu_celcius);
  lcd.setCursor(15,1);
  lcd.write(0xdf);
  delay(200);
}
```

And the third program of PID program to ultrasonic sensor to control motor:

The programming learning is then compiled into the system, the result of the compilation can be displayed on the LCD screen as shown in Figure 5.

Figure 5. the view of LCD to display ultrasonic data and motor speed

Article I. The results of data analysis and equipment testing in Student Competency Competition (LKS) 2012-2016 showed that the developed module has reached the fourth stage of research development method that is dissemination method *(disseminate)*. The developed teaching materials should not be the latest technology or the appropriate technology but include the development of learning device, so that this trainer is well used to improve students' competence in automation system design to support the regulatory technique course.

4. Conclusion

Based on the results of data analysis and discussion, the researchers can take the following conclusions:

This developed medium is research result and monitoring research conduced by team for 4 years which continuously has tried to develop the applied product research entitled regulatory techniques using matrix laboratory software with inquiry based learning device for industrial needs that is expected to produce the compatible regulatory technique learning device for industrial needs.

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