AUTOMATION OF TRASH CAN COLLECTION USING LINE FOLLOWER BASED ON WIRELESS CONTROL

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Abstract: Every school must have a cleaning staff whose job is to care for and maintain the cleanliness of the school building. At SMKN 2 Bawang, the building is spacious and separated between buildings, so collecting waste requires a lot of time and effort. An ineffective process occurs when the cleaning staff collects waste in a circular path. Automating garbage collection using a line follower robot with PID control and the blynk application to start and stop as well as a predetermined path at a particular gathering point, can save energy and time for cleaning staff. The tuning value for each PID Control constant P=0.2, I=0.3, and D=0.06 can smooth the robot's movement with the L298N motor driver. It is decided by the Arduino UNO microcontroller and wireless connection using NodeMCU (ESP8266) for direction taking. The reading sent by the infrared sensor with analogRead mode when dimmed is in the range of 175~270, and the maximum reading value of the sensor is 940~950. The decision to turn follows a predetermined line when the sensor is below 175, according to which the sensor hits the line. The robot will stop running when the ultrasonic sensor finds an object or obstacle less than 15 cm in front of it.

Keywords: automation, PID control, wireless control, arduino, esp8266.

1. INTRODUCTION

There must be a trash can in all building environments, and the number is not small. It can number from tens to hundreds of trash cans. Usually, there are two types of trash bins, organic and inorganic). With a large number of trash cans, several problems arise, such as the lack of staff taking the trash cans, relatively long collection times, and ineffective waste collection methods. As the author analyzed from the SMKN 2 Bawang Banjarnegara building, the structure of the building has a separate multi-story building, which will increase the effort to collect waste from its place. There are 45 classrooms and 25 Student Practice Rooms (RPS). One set of trash bins (organic and inorganic) is provided for two rooms, meaning that there are 70 trash cans scattered around. With this number, the cleaning staff manually collects garbage from each trash can to be disposed of in a giant landfill.

The human desire to do something effectively will stimulate the emergence of breakthroughs, especially in the technology field. Based on these conditions, line follower technology may help streamline the cleaning staff's work in cases of waste collection. In the industrial revolution 4.0, or the Cyber-Physical System, there was a collaboration between cyber technology and automation technology. Automation technology so that it can be operated requires an efficient control or control system. Automation is done because it wants better results in quantity and effectiveness than using human power. In the era of the industrial revolution 4.0, wireless control is often used because it transfers information or commands without a physical connection. Sensors are components

that detect changes in physical quantities such as pressure, force, electrical quantities of light, motion, humidity, temperature, and speed. In the robotic environment system, sensors provide functions like the five human senses, such as eyes, hearing, nose, and tongue, which a microcontroller like a brain will then process. Electronic control and measurement technology sensors convert physical quantities (eg, temperature, force, rotational speed) into proportional electrical quantities (Priansyah, 2020).

PID controller (from English abbreviation Proportional Integral Derivative Controller) is a control system that is used to determine the precision control of an instrumentation system with the characteristics of the feedback on the system (Pujiati, 2021). A PID controller continuously calculates the error value as the difference between the desired set point and the measured process variable. The controller tries to minimize the error value by setting the control variable. Kp is a proportional control that can improve the transient response, especially the rise and set times. Ki is an integral control that is slower than proportional control. Kd is a derivative control that will only change when an error changes, so the derivative control must be used with other controls. The following is a block diagram of the PID controller:
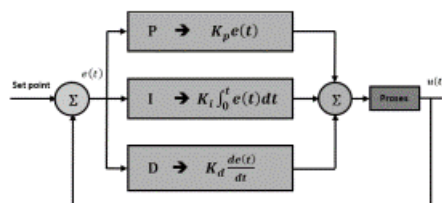

Fig. 1 Block Diagram of PID Controller

Arduino is an electronic kit or open-source electronic circuit board whose main component is a microcontroller chip with the AVR type. The microcontroller is a chip that has the role of the brain in a robotic device that can be given a command line using the Arduino IDE. The purpose of embedding the program on the microcontroller is so that the electronic circuit can read the input, process, and output of an electronic circuit (Ishak, 2018). A DC motor is a virtual electromechanical device that converts electrical power into mechanical energy. DC motor is a type of motor that uses DC voltage as its power source. The motor will rotate in one direction by providing a voltage difference between the two terminals. If the voltage polarity is reversed, the motor rotation direction will also be reversed. The polarity of the voltage applied to the two terminals determines the direction of the motor and its magnitude. The voltage difference between the two terminals determines the motor speed (Muhardian, 2020). Blynk is an iOS or ANDROID platform that controls Arduino Raspberry Pi, Wemos, and similar modules over the internet. This application is straightforward to use for people who are still a layman. This application has many features that make it easy for users to use. Blynk is not associated with any particular module or board. This application allows us to control anything remotely wherever we are with a record connected to the internet. This is one example of Wireless Control or Wireless Control (Berlianti, 2020).

2. MATERIALS AND METHODS

Research Flow can see in fig 2. In the process of collecting data and information, the author uses the method of literature study, observation, and interviews.

Research Data and Tools divide three part :

a. Research Data
    1) Material about robotics, especially Line Follower.
    2) Data and information on the waste collection process.
    3) Test and development data.
b. Hardware (Hardware)
    1) Arduino UNO
    2) NodeMCU ESP 8266
    3) Infrared Sensor
    4) Ultrasonic Sensor
    5) Wheel DC Motor Gearbox Set
    6) PCB Dot Matrix Hole
    7) Dual Channel Stepper Driver

8) Step Up / Step Down Power Supply Module
9) Micro Limit Switch
10) Lithium Battery
11) Trash Can
12) Black duct tape/tape
c. Software (Software)
    1) Arduino IDE App
    2) Online Visual Paradigm
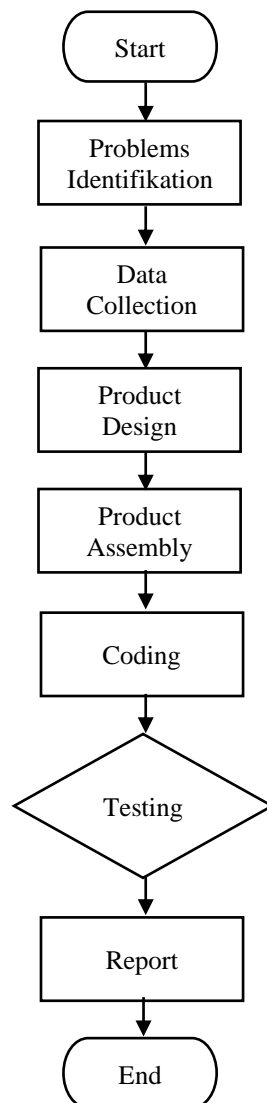   3) Blynk App

Fig. 2 Research Flow

The product design results are the final description of the device design for the product to be made.
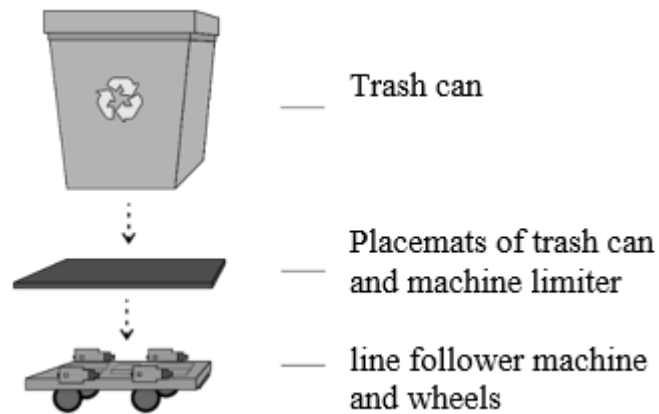
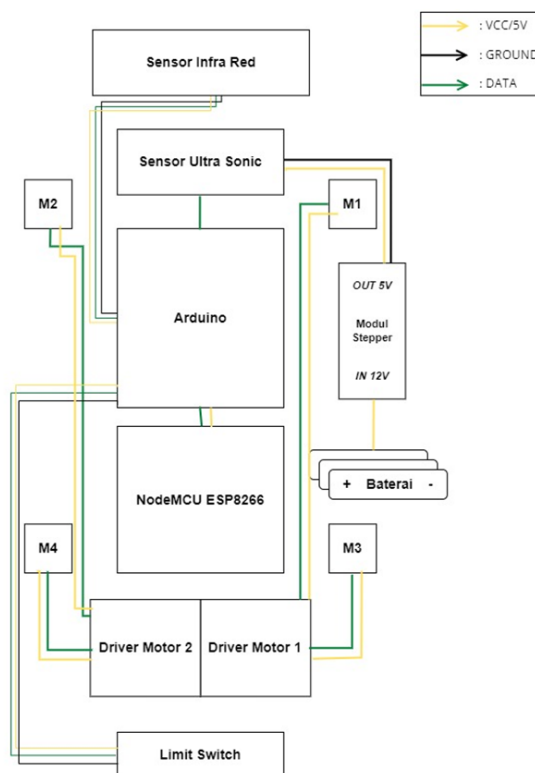Fig 3. Product Design

Hardware Design

Fig. 4 Hardware Design

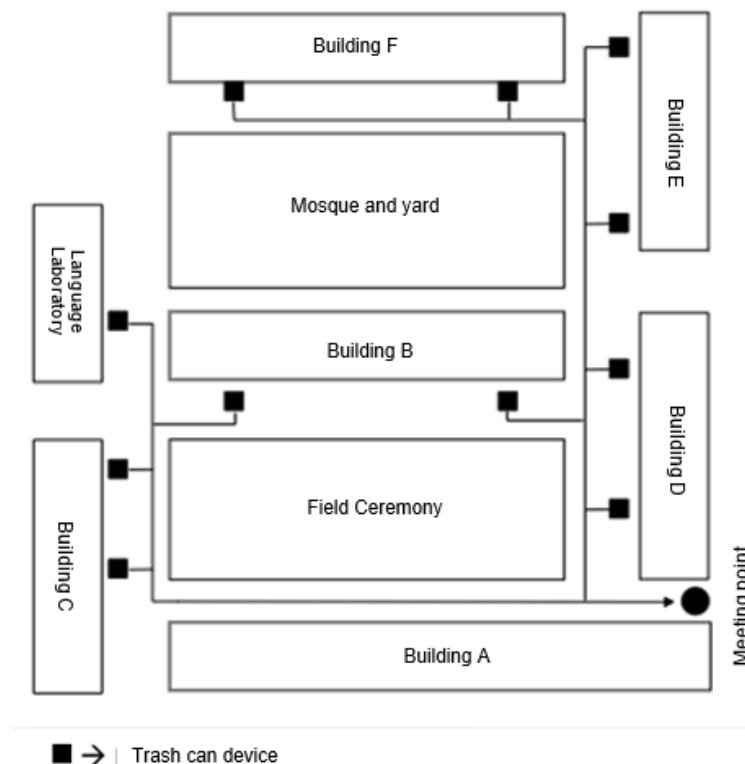Design of Garbage Collection Automation Path

Fig. 5 Automation Paths for Garbage Collection

PID (Proportional Integral Derivative) control is a controller to determine the accuracy of the instrumentation system by returning feedback to the system. The PID Control System consists of three parameters, namely P (Proportional), D (Derivative), and I (Integral) controls, each of which has advantages and disadvantages. When implemented, each method can work independently or can be combined. The following is a block diagram of the PID control system:
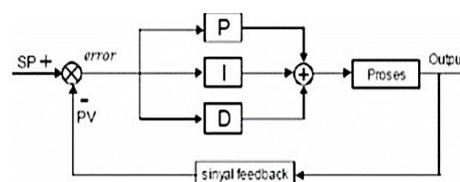

Fig. 6 Block Diagram of PID Control System

When designing a PID control system, what must be done is to adjust the P, I, or D parameters with the response of the system output signal with a specific input to get the desired value. PID parameter setting can be done by the Trial and Error method. By giving a specific value and then analyzing the feedback received. References that can be used to find the appropriate PID parameters can be seen in the following table:

Table 1 Changes in PID Parameter Parameters

Respon Closed Loop	Rise Time	Overshoot	Settling Time	Error Steady State
Proporsional	Decrease	Increase	Minor Changes	Decrease / Reduce
Integral	Decrease	Increase	Increase	Remove
Derivatif	Minor Changes	Decrease	Reduce	Minor Changes

Network topology is a method to connect computer devices using cable (UTP, Optical Fiber) or wireless (wireless) as a transmission medium. The topology affects the way devices are connected, which results in a compelling connection between network devices, and the following is the topology used in this study:
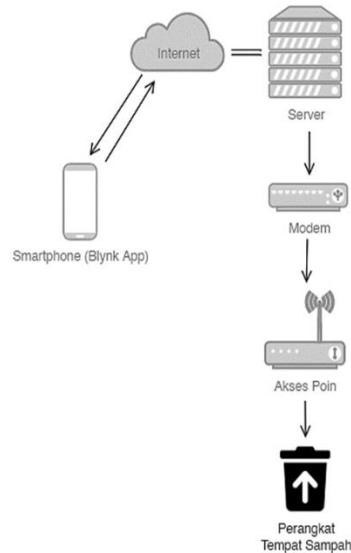

Fig. 7 Network Topology

3. RESULT AND DISCUSSIONS

PID Encoding
Calculates the PID value used to increase or decrease the motor speed.

```
void hitung_pid( )
{
 P = error;
 I = I + previous_I;
 D = error - previous_error;
 PID_value = (Kp * P) + (Ki * I) + (Kd * D);
 previous_I = I;
 previous_error = error;
}
```

Proximity Sensor Tuning Program
Calculation and adjustment (tuning) of the value emitted and captured by the ultrasonic sensor so that the output is in centimeters.

```
long duration, distance ;
digitalWrite(trigPin, LOW);
delay(2);
digitalWrite(trigPin, HIGH);
delay(10);
digitalWrite(trigPin, LOW);
duration = pulseIn(echoPin, HIGH);
```

distance = (duration / 2) / 58.2;

Directional Control Logic Program

```
if((distance > 10) && (hp == 1)){
   if(r1>175 && r2<175 && r3>175){
   //  MAJU
   goAhead();
else if(r1<175 && r2<175 && r3>175){
   //  BELOK KIRI TAJAM
   goSharpLeft();
   error = 101;
   Serial.println("Belok Kiri");
   }    else if(){
   //  BELOK KIRI
   goSharpLeft();
   error = 103;
   Serial.println("Belok Kiri Tajam");
   }
   else if(r1>175 && r2<175 && r3<175){
   //  BELOK KANAN TAJAM
   goSharpRight();
   error = 102;
   Serial.println("Belok Kanan");
   }    else if(r1>175 && r2>175 && r3<175){
   //  BELOK KANAN
   goSharpRight();
   error = 104;
   Serial.println("Belok Kanan Tajam");
   }
```

Road Branch Program

```
if (r1 < 175 && r2 < 175 && r3 < 175 && flag == 0 || flag == 0 && tmp_1 < 175 && tmp_2 <
175 && tmp_3 < 175) {
   //hitam semua
   flag = 1;
   }
   else if (flag == 1 && r1 < 175 && r2 < 175 && r3 < 175 || flag == 1 && tmp_1 < 175 &&
tmp_2 < 175 && tmp_3 < 175) {
   goSharpRight(); //belok kanan
   delay(500);
   flag = 2;
   }
   else if (flag == 2 && r1 < 175 && r2 < 175 && r3 < 175 || flag == 2 && tmp_1 < 175 &&
tmp_2 < 175 && tmp_3 < 175) {
   goSharpRight(); //belok kanan
   delay(750);
   flag = 3;
   }
   else if (flag == 3 && r1 < 175 && r2 < 175 && r3 < 175 || flag == 3 && tmp_1 < 175 &&
tmp_2 < 175 && tmp_3 < 175) {
   stopRobot();
   delay(5000);
```

```
    uTurnL();
    delay(1000);
    flag = 4;
  }
  else if (flag == 4 && r1 < 175 && r2 < 175 && r3 < 175 || flag == 4 && tmp_1 < 175 &&
tmp_2 < 175 && tmp_3 < 175) {
    goSharpLeft();
    delay(750);
    flag = 5;
  }
  else if (flag == 5 && r1 < 175 && r2 < 175 && r3 < 175 || flag == 5 && tmp_1 < 175 &&
tmp_2 < 175 && tmp_3 < 175) {
    goSharpLeft();
    delay(750);
    flag = 6;
  }
  else if (flag == 6 && r1 < 175 && r2 < 175 && r3 < 175 || flag == 6 && tmp_1 < 175 &&
tmp_2 < 175 && tmp_3 < 175) {
    uTurnR();
    delay(1000);
    flag = 7;
  }
  else if (flag == 7 && r1 > 175 && r2 < 175 && r3 > 175 || flag == 7 && tmp_1 > 175 &&
tmp_2 < 175 && tmp_3 > 175) {
    goBack();
    delay(1000);
    stopRobot();
  }
```

Wireless Control Via Blynk App

Analyse used the NodeMCU/ESP8266 device to the access point device and the Arduino Board to the Blynk Server and vice versa.
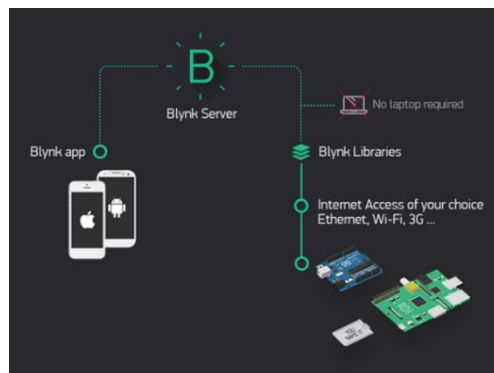

Fig. 8 Topology of Blynk

Connecting ESP8266 and Blynk

The first step to programming the ESP8266 to connect to the Blynk Cloud is to specify the Blynk Template ID, Blynk Device Name and Blynk Auth Token.

```
// Template ID, Device Name and Auth Token are provided by the Blynk.Cloud
// See the Device Info tab, or Template settings
#define BLYNK_TEMPLATE_ID        "TMPLypmqvVOZ"
#define BLYNK_DEVICE_NAME        "Tugas Akhir"
#define BLYNK_AUTH_TOKEN         "0JsziBdQ2TMAQfewsQ2PJcawg9P2tYGQ"
```

Fig. 9 ESP8266 to Blynk Cloud

Next, determine the WiFi credentials that the ESP8266 Board uses to get an internet connection.

```
// Your WiFi credentials.
// Set password to "" for open networks.
char ssid[] = "RUANG ALAT Ltd.";
char pass[] = "sambunginaja";
```

Fig. 10 Wifi Credentials

Capturing Data from Blynk Cloud to ESP8266

It is necessary to capture data from Blynk Cloud's Virtual Pin to ESP8266 which will be forwarded to Arduino UNO as a reference for device control values.

```
//READ VPIN BLYNK CLOUD
int v_hp;
BLYNK_WRITE(V0){
  v_hp = param.asInt();
  if(v_hp == HIGH){
    digitalWrite(16, 1);
  }
  else{
    digitalWrite(16, 0);
  }
}
```

Fig. 11 Capturing Data from Blynk Cloud

Table 2 Sensor Reading Table

No.	Sensor	Condition	Ideal Results	Test Results	Information
1.	Ultrasonic Sensor	Some objects are> 15 cm	Running	Running	appropriate
		Some objects are less than 15cm.	Stop	Stop	appropriate
		There is something stuck in the mouth of the Ultrasonic sensor.	Stop	Nilai lebih dari 700	Not appropriate
2.	Infrared Sensor	The left sensor reads the path	Turn left	Turn left	appropriate
		The middle sensor reads the path	walking straight	walking straight	appropriate
		Right sensor read path	Turn right	Turn right	appropriate
		Left and center sensors read path	Turn left left wheel stop	Turn left sharp	appropriate
		Right and center sensors read path	Turn right right wheel stop	Sharp right turn	appropriate

4. CONCLUSION

Based on the results of research, design, and implementation of an Automated Garbage Collection System Using a Line Follower Based on PID Control Algorithm and Wireless Control, it can be concluded that: 1)Based on the garbage collection process observation data, the automated method is more effective in terms of the collection duration than the manual method, as shown in Table 4.2. Results of the Observation of the Garbage Collection Process, 2)The load of the trash can that can be carried by the device (12v DC motor) is 2 kg maximum.

It is necessary to adjust the motor speed output if it is more than that, 3)Wireless Control can be used to control the On/Off status of the device via the Blynk App, 4)Infrared and Ultrasonic Sensors are path readers and object detectors, respectively, 5)PID control can be used as the device's DC motor wheel speed controller, 6)Inefficiency arises when robots are made for each of the existing trash cans, which is too expensive.

The following suggestions that the author wants to convey are based on the results of research that has been carried out, 1)The product concept can be added with a forklift so that it can collect garbage without carrying its place, 2)Products can be developed into a more compact and attractive design or form, 3)In its implementation, the track uses black vinyl tape. The path required for the size of a school building or the like can be tens to hundreds of meters. Because of this, the path becomes ineffective and inefficient in terms of price and durability. Further research is expected to be able to find a solution to this ineffective and efficient path problem, such as using paint that does not reflect light or the like, 4)Because there are several paid features, the Blynk Wireless Control application can be replaced with homemade ones to make it easier to develop as desired, 5)By Suggestion Number 3, the ESP8266 Web Server can be a device controller via HTTP Requests.

5. REFERENCES

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