USE OF PROPORTIONAL INTEGRAL DERIVATIVE (PID) ALGORITHM IN GRASS POISONING ROBOT

As'Ary Sahlul Irsyad[1*], Muhammad Ikhsan[1], Aidil Halim Lubis[1]

[1]Program Studi Ilmu Komputer, Universitas Islam Negeri Sumatera Utara

email: *ary.irsyad21@gmail.com

Abstract: Grass is one of the plants that live on God's earth, even grass is also written in Al-quran. Grass is currently also a pest for plants, so sometimes to minimize grass growth, many farmers or people eradicate grass by cutting it even by poisoning the grass. Each method used has its own risk of work accidents, such as using grass poison can experience insecticide poisoning. To anticipate this, a remotecontrol robot that sprays automatic grass poison using the PID method is designed. The test results found that the robot works with a voltage of 11.1 VDC with a 5-12VDC motor with a speed of 3000rpm and a gearbox motor is used so that it turns into a 5Kg load torque. Meanwhile, for control using the HC-05 interface which is connected to Android, the maximum distance transmission system is 0-10m. For watering grass, it has 2 scala heights, grass with a height of 10-15 uses PID 1, which is watered with a voltage of 11.1VDC delay (t) 1.5s. Grass with a height of 25-30 using PID 2, watered with a voltage of 14.8VDC delay (t) 3s. All watering the grass uses a 16VDC pump motor with 1500 rpm. After the robotic watering system is applied using the PID method, the P value = 14.56. The value of I = 22.08 and the value of D = 15.5.

Keywords : Control Remote; PID method; Poison sprinkler robot

Abstrak: Rumput merupakan salah satu tumbuhan yang hidup dimuka bumi allah, bahkan rumput juga tertulis didalam Al-quran. Rumput saat ini juga sebagai hama bagi tumbuhan, sehingga terkadang untuk meminimalisir pertumbuhan rumput, banyak petani atau orang yang membasmi rumput dengan cara dipotong bahkan sampai dengan cara meracun rumput tersebut. Setiap cara yang digunakan memiliki resiko kecelakaan kerja tersendiri, seperti menggunakan racun rumput bisa mengalami Keracunan insektisida. Untuk mengantisipasi hal tersebut, maka dirancang robot kendali distance jauh penyiram racun rumput otomatis menggunakan metode PID. Hasil pengujian mendapati robot bekerja dengan tegangan 11.1 VDC dengan motor penggerak 5-12VDC dengan kecepatan 3000rpm dan dipakaikan motor gearbox sehingga berubah kedalam bentuk torsi beban 5Kg. Sementara untuk kendali menggunakan interface HC-05 yang terhubung ke Android, sistem pengiriman distance maksimal 0-10m. Untuk penyiraman rumput, memiliki 2 scala tinggi, rumput dengan tinggi 10-15 menggunakan PID 1, yaitu disiram dengan tegangan 11.1VDC delay (t) 1.5s. Rumput dengan tinggi 20-30 menggunakan PID 2, disiram dengan tegangan 14.8VDC delay (t) 3s. Seluruh penyiraman rumputmenggunakan motor pompa 16VDC dengan rpm 1500. Setelah sistem penyiraman robot diterapkan dengan metode PID, maka nilai P = 14,56. Nilai I = 22,08 dan nilai D = 15.5.

Kata kunci: Kendali Jarak Jauh; Metode PID; Robot penyiram racun

INTRODUCTION

Grasses are monocot plants that have narrow, tapered leaves that grow from the base of the stem. To anticipate the development of the grass so that it does not increase, there are many ways that people do to eradicate the grass, such as cutting it with a hoe, cutting it with a lawn mower, and poisoning it with poison from the grass. On the other hand, grass poison or often called paraquat is also very dangerous if inhaled by humans, resulting in insecticide poisoning. Insecticide poisoning is a condition that occurs when large amounts of insect venom are ingested, inhaled, or absorbed into the skin. [1][2] .

To anticipate the spread of insecticides due to grass poison, there are several studies that discuss anticipating the spread of grass poisons through insecticides. Research conducted by Isrofi explains that the design of a robotic lawn mower is more effective than watering grass poison so that insecticide poisoning cannot occur [1][3]. Kafiar also conducts research that addresses the same subject, namely designing a liquid sprinkler system for plants, so that it can be applied to watering grass [4][5].

Meanwhile, the design of a watering robot using the microcontroller concept has been carried out a lot, such as by friends, designing a watering robot, where the error in reading the robot ranges from 5.27%, and the movement of the robot succeeds with 100% accuracy [6]. Agus and friends. The robot they designed found the test results, the sprinkler robot produces a current of 2 A and a voltage of 12 V with the heaviest load of water that can be carried is 1 liter with a control application from the mitt app inventor [7]. Firdaus and friends designed a robotic lawn mower with a fuzzy algorithm. The results that have been achieved from this research are car robots that can move automatically to explore a predetermined area for cutting grass with the Fuzzy logic method [8] [9].

Based on previous research, as well as conditions in the field, the tool design system in this study will design a robot to spray grass poison. The working system of the robot that will be designed by the user or the user does not need to be directly in contact with grass poison, so that the grass poison is not inhaled so it does not result in insecticide poisoning. As for the weaknesses in the design of this tool, the volume of poison carried is no more than 2.5 liters and the spray power is around 0.21 psi, where this result is the result of a calibration between 1000 kg water pressure, and a mass of gravity of 9.8, and a water level of around 0.15 liters, because the condition of the robot is in the form of a robot car, so there is still a lot of development, and the control system only reaches 10 meters, because it uses the HC-05 interface [10]. Solution To cover higher or longer distances, you can use a radiolink sender type for RC, but it has drawbacks in terms of cost which is quite expensive and radiolink networks that can be disrupted by other radiolinks.

METHOD

In the research conducted, the research method used is a qualitative research method which is descriptive in nature and tends to use analysis. The stages carried out in this research include:

Observation

The results of observations carried out in the field found that :

- Watering grass poison with spray can result in insecticide poisoning.
- Previous studies discussed the manufacture of robotic lawn mowers and sprinklers.
- Tool testing location in the coal housing area or in front of the yard with type 36.
- To design a robot, microcontroller technology and other electronic modules are needed.

Tool Design

To design a grass poison sprinkler robot using the PID algorithm, there are several modules or tools that must be designed one by one including:

- Controller with ultrasonic sensor
- Controllers with relay
- Controller with l298 driver ic
- Controllers with servos
- IC driver with dc motor
- Relay with pump motor on formula (1).

$$N = (f.120):P \qquad (1)$$

Trials

To test the design of the robot there are 5 stages that are passed, namely :

- Testing each circuit between controllers with inputs and outputs
- Test command between input and output with the controller
- Testing the voltage of each controller circuit or input and output
- The calculation of the PID algorithm (Proportional, Integral and Derivative) is shown in formulas 2, 3 and 4).

$$P - out = Kp.e\,(t) \qquad (2)$$

$$I_{out} = Ki \int_0^t e\,(t)dt \qquad (3)$$

$$D = Kd\,\frac{de\,(t)}{dt} \qquad (4)$$

Implementation and evaluation

Implementation in the design of a grass poison sprinkler robot with an android control system, found that the robot can be controlled from a distance of 0 to 10m, using an android and connected to a bluetooth frequency. Meanwhile, to drive the robot, it uses a DC 5V gearbox motor with a load of approximately 3 liters of grass poison liquid, and 1 kilo of robot weight and other components. In addition, the robot will sprinkle grass poison for grass heights ranging from 10 to 20, 21 to 30 cm.

RESULTS AND DISCUSSION

The results of testing the controller with IC Driver.

The driver IC used is an L298N type driver ic with a nano type board [3][4]. While the working voltage on the driver IC used uses a working voltage of 7.4VDC. The results of testing the IC driver with arduino nano shown in table 1.

Table 1. Controller Test Results, IC Drivers and DC Motor Loads

Voltage	Pin Motor	Status	Information
5 VDC	A1	HIGH	Move slow
	A2	HIGH	Move slow
	B1	HIGH	Move slow
	B2	HIGH	Move slow
7.4-11.1VDC (volt battery)	A1	HIGH	Move fast
	A2	HIGH	Move fast
	B1	HIGH	Move fast
	B2	HIGH	Move fast

on the table 1 above shows a dc motor with a working voltage of 5 to 11.1 VDC, and has a frequency of 50Hz. The datasheet on the two types of motors used in the robot design is shown in table 2.

Table 2. Motor Speed Specifications/Minute

No	Jenis motor	Vin	Arus	N = (F . 120) : P
1	Wheel driver motor	6-12VDC	70mA- 250mA	N = (50 . 120) : 2
				N=3000 Rpm
2	Motor Pomp	12 VDC	0,5-0,7mA	N = (50 . 120) : 4
				N =1500 Rpm

Water discharge is the volume of liquid flowing in a cross section or that can be accommodated per unit time. Mathematically, discharge is represented by the symbol Q. From its own understanding, it means that the discharge is affected by the volume of a liquid and the time it takes for the substance to flow. For the volume of water released by the pump motor, with a voltage of 12VDC it is capable of removing water of 700ml/30s. So that the water discharge in 1 minute is 1.4 liters/minute (LPM) or the equivalent of 0.023 l/s. This is supported by the equation below.

Meanwhile for the output nozzle with a thread size of 19 mm, and the length of the hose for draining grass poison is around 0.8 m. Obtaining a water volume value of around 15.2 ml/s according to the equation below.

After finding the volume of water in the hose, to find out the water discharge issued by the nozzle with a 19mm thread, and a water volume of 15.2 ml/s, the water discharge issued by the nozzle is around 289ml/s or the equivalent of 17.3 LPM . As shown in the equation below.

The results of testing the controller with ultrasonic sensors

The sensors used are ultrasonic sensors or distance sensors [4][6]. The function of the sensor in this study is to read the distance between the object and the sensor so that if the distance is less than the specified distance, the sensor will send data to the Arduino controller.

The working voltage used on the sensor uses a working voltage of 3.3VDC which is taken from the Arduino Nano supply controller. As for the results SFR05 or ultrasonic sensor testing is shown in the table 3.

Table 3. Test Result controller with SFR 05

No	Tegangan	*Distance*
1	5 VDC	16 cm
		20 cm
		25 cm
		30 cm

In the table 3 describes an ultrasonic sensor that works from a distance of 16 cm, so if you add a command if it is less than 16 cm, or more than 30 cm, the other output is active or not. The picture above shows the SFR-05 or ultrasonic sensor which is blocked by objects, thus displaying distance data according to table 3 or the serial monitor display.

The results of testing the controller with the HC-05 interface

The interface used is the HC-05 type, where the interface functions to connect Android devices to Arduino Nano devices, by utilizing the functions of the transmitter and receiver pins (data sending pins and data receiving pins) on each Arduino controller module [7][8][9]. The test results between the controller and the hc-05 bluetooth interface are shown in table 4.

Tabel 4. Result test arduino with interface hc05

No	Tegangan	*Controller*	*Interface*	adress	Data	distance
1	5VDC	RX	RX	*detected*	Not send	-
		TX	TX		terkirim	
2	5 VDC	RX	TX	*detected*	send	0 -10m
		TX	RX			

In table 4 explains that the Arduino receiver (rx) pin must be connected to the transmitter (tx) pin of the HC-05 interface and supplied with a 5VDC voltage, so that the data sent by Android can be read by the controller by intermediary from the interface or data sent and received. The picture above explains how to send data between the hc-05 interface and the Arduino Nano controller. Testing can be seen by comparing the data sent by the input (android) with the data received by arduino (Serial monitor).

PID Method Test Results (Proportional Integral and Derivative)

The use of ultrasonic sensors must be compared with readings from a ruler or ruler, so that the difference results are obtained which will later be converted into differences in distance comparisons or errors.

1. Difference distance ($S_{p|u}$) or error e(t) = ($S_{p|u}$) or e (t) = 247 – 231 = 16 cm
2. Different voltage pomp (∂) = 3.7 VDC
3. Gain Konstanta (K) = 16 / 3.7 = 4.32

System trials in the field

In the field conditions and the shape of the robot, the system or setpoint (SP) trials were tested at a distance of 15cm, 20cm, 25cm and 30cm according to the grass conditions and the size of the robot. For conditions, the sensor is installed above and facing down so that it reads the height of the grass. Meanwhile, for the place where the grass poison is placed, it is placed in a water tank which has a debit weighing 2.5 liters.

Tablel 5. Test Konstanta proportional (Kp) in field

No	Konstanta Proportional (Kp)	Error	Pout = Kp. e (t),
1	15	16	240%
2	20	16	320%
3	25	16	400%
4	30	16	480%

240%Δs = distance low1 + 2.4*Δ
       = 53.4 cm

320%Δs = distance low2+ 3.2*Δ
       = 71.2 cm

400%Δs = distance low3 + 4,0*Δ
       = 84 cm

480%Δs = distance low4 + 4,8*Δ
       = 96,8 cm

Delay time

Condition t, is a time condition where the start time is 5 seconds (delay in void setup), equal to 5000 delay or 5s, so if the distance is 15 cm (the lowest distance is 1), then the time is 20 s, and if the highest distance is 30 cm (The lowest distance is 4) , then the time is 35 s.

t80% = Time distance low 1 - Time Start
t80% = 20 - 5 = 15

t320% = Time distance low 4 - Time Start
t320% = 35 - 5 = 30

Konstanta time efektif (Ts)

$\qquad$ Ts = 1.5 * (t320%-t80%)

$\qquad$ Ts= 22.5

Deadtime (d)

$\qquad$ θ = t320% - T

$\qquad$ θ = 7,5

Transfer fungsi gain G (s)

G(s) = (GAIN K (θs)) / (τs + 1)

G (s) = 1,3

Menentukan KC, tI dan tD

Kc = (1/K)(τ/θ) ((16τ+3θ)/12τ)

Kc = (1/4.32) (22,5/7,5)

(16.22,5+3.7,5)/12.22,5)

Kc = 0,97 atau 1

τI = θ(32+(6θ/τ)) / (13+(8θ/τ))

τI = 7,5 (32+(60/22.5)) / (13+(80/22.5))

τI = 15,6

τD = 4θ / (11+(2τ/τ))

τD = 4 .7,5 / (11+(2.22,5/22,5))

τD = 2,3

Nilai Kp, Ki, dan Kd

Kp = Kc

Kp = 0, 97 atau 1

Ki = Kc/τI

Ki = 0,97/15,6

Ki = 0,06

Kd = Kc*τD

Kd = 0,97 * 2,3

Kd = 2,23

After obtaining the proportional gain (Kp), integral gain (Ki), and derivative gain (Kd), then to determine the proportional term (P), integral term (I) and derivative term (D), use the formula in Figure 1, and figur 2 .

P = Kp. e(t)

P = 0,91. 16

P = 14,56

$$I = Ki . \int_0^t e(t).dt$$

$$= 0,6\int_0^t 16. 2,3$$

$$= 0,6. 36,8$$

$$= 22,08$$

$$D = Kd \frac{de(t)}{dt}$$

$$= 2,23 \frac{16}{2,3}$$

$$= 15,5$$

Implementation PID witj pomp

$\qquad$ After knowing the proportion-al constant (Kp) at an accurate test distance, as well as the difference in Va and Vb voltage, and the average error of 1.6cm or a total of 16cm distance, and also obtained the pump inlet discharge at 12VDC voltage of 0.023 l/s or equivalent with 0.016 LPM. Meanwhile, for the water discharge that comes out of the nozzle with a size of 19 mm, with a 0.8m exit hose volume, the water volume is 15.2 ml/s.

$\qquad$ Implementation of the PID method The water pump consists of 2 activations, namely if a distance between 15 and 20 cm of grass is detected, the PID 1 method will be active, namely the pump will water the grass with a voltage scale of 11.1 Volts for 5 seconds. Conversely, if the height is 25 to 30 cm, watering with a second voltage or PID 2 will be active, that is, the pump will spray grass poison at a speed or with a voltage of 14.8 V or the water is heavier and more discharge when compared to the PID 1 method.

Tabel 6. Implementation with PID robot lawn poison sprinkler robot

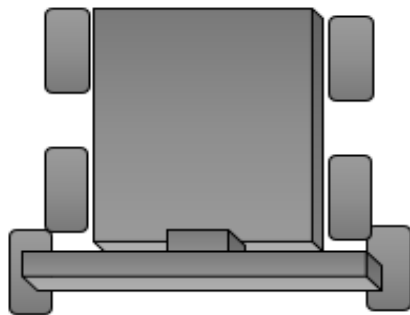| No	Konstanta Proportional (Kp)	Va	Vb	QVa dan QVb	Vnozel	Qnozel	Time delay
1	15	11,1	-	433.5 ml/s	15,2ml/s	289ml/s atau 17.3 LPM	15 or 1,5 S atau 1500 ms
2	20	11,1	-	433.5 ml/s			
3	25	-	14,8	867ml/s			30 or 3,0 S atau 3000 ms
4	30	-	14,8	867ml/s			

Image 1. Robot Design

Image 2. appreance Robot

CONCLUSION

To anticipate it happening insecticide grass poisoning by inhalation by users who want to water grass poison manually, a weed sprayer robot is designed by utilizing microcontroller technology. Robots can be controlled using remote commands from Android, namely using the control system from Android (Bluetooth) with a maximum distance of 10 meters. The use of the bluetooth network is because the bluetooth frequency system cannot be disturbed due to reading the address of the interface device. In addition, the grass poison watering robot will also water using the PID method with a PID1 distance of 15 to 20 cm, the pump will be active with a voltage of 11.1 vdc. Meanwhile, with a distance of PID 2, a distance of 25 to 30, the pump will be active with a voltage of 14.8vdc.

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