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Design and Build a Saghai Ball Thrower at the 2019 Indonesian Abu Robot Contest

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ABSTRACT

Abu Robocon 2019 will be held in the country of Mongolia with the competition theme "The Great URTUU Spreads Knowledge". The 2019 Indonesian ash robot contest made 2 robots, namely MR 1 (Manual Robot) which is run automatically and MR2 (Automatic Manual). In one of the race sessions there was a section of throwing saghai balls. The parameter that must be achieved is the optimization of the embattlement mechanic by landing a throw on target and getting maximum points. The KRAI 2019 robot thrower uses pneumatics. The wind pressure determines the throwing force of the saghai ball. Angle testing to find out the right angle in order to achieve a good and precise on-target throw. Based on the test results of the pitcher's angle of 500, the ball was thrown 20 times resulting in the robot being able to throw well and the average speed was 4.82 m/s. It can be concluded that the angle of 500 is the right angle to produce a lot of 50 points. Testing with a throwing angle of 600, the ball was thrown 20 times resulting in the robot being able to throw, as well as the average speed produced which was 5.20 m/s. The third test with an angle of 700, the ball was thrown 20 times resulting in the robot being able to throw, as well as the average speed produced which was 6.17 m/s. Testing the angle of 500 is the right angle because it can produce a good throw and produce 50 points.

1. Introduction

The 2019 Abu Indonesia robot contest was organized by the Ministry of Research, Technology and Higher Education, the 2019 KRAI robot competition with the theme "Sang URTUU Spreading Knowledge" [1]. The KRAI 2019 robot is required to make 2 robots consisting of MR1 (Manual Robot) and MR2 (Automatic Robot) robots are expected to carry out missions according to Abu Robocon regulations. An industrial robot is a device designed to manipulate and transform a device to traverse a pre-programmed trajectory or mission [2]. The mission of the KRAI 2019 robot is to deliver garage to the ukhai zone which refers to the Abu Robocon rules. The KRAI robot consists of 2 robots, namely manual and automatic. After delivering the garage on the automatic robot. The Saghai ball used in the race is determined by Abu Robocon, the saghai ball used in the race is 3. For the assessment of the result of the throw is determined based on the position of the saghai ball when it falls, when the yellow color is above then the resulting points are 50, if the black color is above then it gets 40 points, and if the blue color is above then it gets 20 points. The KRAI 2019 Manual Robot is made with drive in the form of omni wheels that have the advantage of moving in all directions, without turning first [3]. The KRAI robot uses an omni wheel using 4 wheels [4]. Designing a thrower using pneumatics, the design of the ABU robot utilizes wind pressure to throw saghai balls [5]. The most appropriate replacement for DC motors is pneumatic. Pneumatic is a drive that uses air [6]. The robot's movements are controlled according to the operator's wishes using the play station 2 [7] controller.

2. Research Method

2.1. Control System Block Diagram Algorithm

The saghai ball that had been picked up and carried by the robot manual came to the throwing zone. STM 32F310C8 as a robotic microcontroller is used to stabilize the robot's motion. STM 32F310C8 requires a 3.3 Volt power supply to provide microcontroller voltage. The relay serves as a switch used to deliver voltage to the robot's solenoid. The solenoid on the robot functions to regulate the wind pressure that is channeled to the pneumatics to move the thrower. Pitchers are made with different angles of inclination to produce the right throw. The thrower's motion is controlled by the play station 2 stick. Play station 2 stick to move the thrower if pressed the box button then the robot will throw the saghai ball and if pressed the x button then the thrower will return to the starting position and can be seen in Fig. 1.

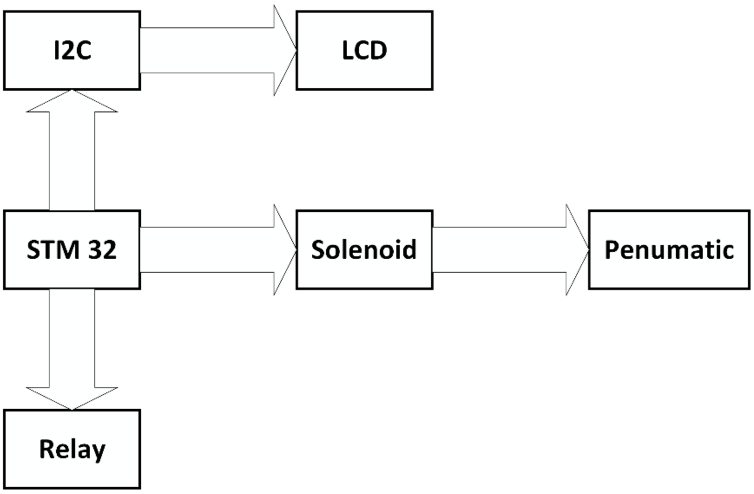

Fig. 1. Robot performance system diagram

The thrower on the KRAI 2019 robot uses pneumatics. The pneumatic working system is that the wind is stored in 4 big bottles that have been modified the lid to be strong. Bottles are used to store wind pressure up to 6 bar/kPa. The wind indicator is used to find out the wind pressure value contained in the bottle. Wind faucets are used to fill and emit wind. A solenoid is a valve driven by electrical energy through a solenoid, a solenoid has a coil as a drive used to drive a piston driven by DC current. Pneumatic solenoid valve or solenoid valve has an output hole, input hole and exhaust hole. In this manual robot uses 1 thrower, then the solenoid used 1. The solenoid functions to control the open wind valve and the wind cap valve on the thrower. Pneumatics has a hole called an actuator ball valve which consists of 2 vents. Each hose has a function, namely to open the ball valve and close the ball valve. Pneumatics works with the wind pressure contained in the air storage tube. The pneumatic used is a type of pneumatic double acting, this type of pneumatic can work by opening and closing the ball valve from wind pressure [8]. The pneumatic system on the throwing robot is as shown in Fig. 4 pneumatic piping.

2.2. Method Name

The Abu Indonesia robot contest in 2019 consists of 2 robots, namely manual and automatic. The manual robot will be designed saghai ball throwing robot using pneumatic as a throwing system. The microcontroller used in the robot, namely STM 32F310C8, functions to control the relay that will drive the DC voltage to the solenoid.

2.3. Parabolic Motion

Abu Robocon 2019 with the theme "The URTUU Spreads Knowledge", Based on research on the trajectory traversed by the saghai ball when thrown in the form of parabolic motion. Parabolic motion is a combination of Regular Straight Motion (GLB) and Regular Changing Straight Motion

[9]. The parabolic motion of the trajectory is in the form of a parabola. The motion of the parabola can be seen in Fig. 2.

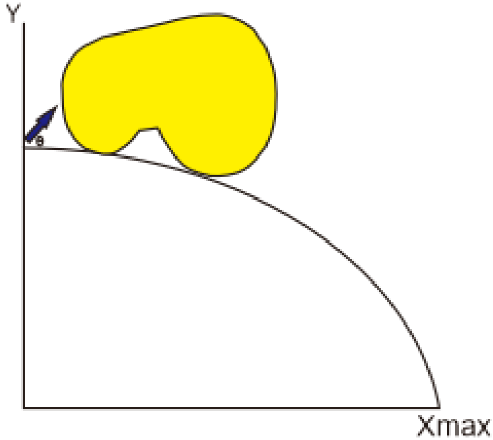

Fig. 2. Parabolic motion

In parabolic motion, there are 2 directions, namely vertical and horizontal. In the vertical direction or y-axis is a straight motion changing irregularly. Horizontal or x-axis is a regular straight motion. At the furthest point of Xmax:

At the farthest position of Xmax used the equation (1)

$$Xmax \frac{vo^2 \sin 2\theta}{g} \tag{1}$$

In the equation it is necessary to find sin 2θ, to find the used equation (2)

$$\sin 2\theta = 2 \sin\theta \cdot \cos\theta \tag{2}$$

With remembering X-max = R in equation (3) end equation (4)

$$R = \frac{vo^2 \sin 2\theta}{g} \tag{3}$$

$$Rg = vo^2 \sin 2\theta$$

$$vo^2 = \frac{R}{\sin 2\theta}$$

$$vo = \frac{\sqrt{R.g}}{\sqrt{\sin 2\theta}} \tag{4}$$

Information:

v = Speed (m/s)

g = Earth gravity 10/9.8 (m/s2)

R = Distance (m)

t = Time(s)

Xmax = Longest distance (m)

3. Method

3.1. System Design

The design of the throwing robot frame uses 1 pneumatic piece with a maximum robot weight of 25 kg. The wind pressure used did not exceed 6 bar/600 kPa. As well as the robot's voltage power supply allowed to exceed 24 V. On the terms of the manual robot match (MR 1) is required to be able to throw the ball at the throwing session. In the manual robot, the throwing system uses pneumatics to throw saghai balls. The robot uses a wind-storing tube that is used to drive pneumatics can be seen in Fig. 3.

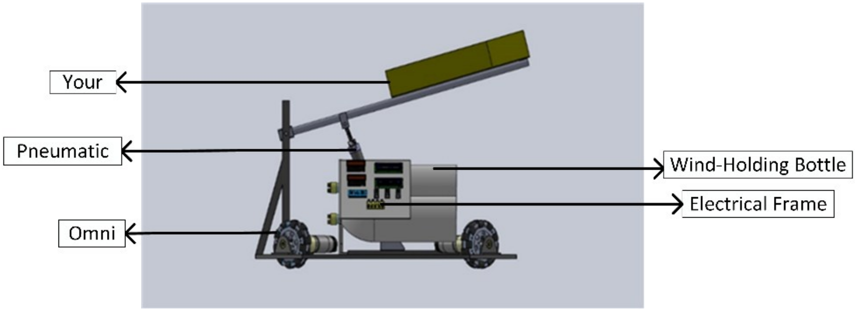

Fig. 3. System design

Robot design is in accordance with Abu Robocon 2019 regulations, robot design includes robot design that is adjusted to Abu Robocon 2019 regulations. In mechanical design, the robot is made using aluminum for the bottom frame, aluminum has the advantages of strength and lightness. The throwing mechanic uses 1 throwing lever. The electrical robot uses STM 32F310C8 as a controller. I2C LCDs are used to display visual data of robotic commands or conditions. The relay works when the iron core is electrified, when it is electrified the magnetic field will work [10]. The application of pneumatic cylinders is position control, where the piston of the pneumatic cylinder can only stop at the ends of the cylinder.

The KRAI 2019 robot is designed using the Solidwork application to create 3-dimensional designs. The 3-dimensional design makes it easy to make the mechanics. The robot uses 1 pitcher lever with a specification of 1 angle thrower 50°, 2 pitcher angle 60°, 3 pitcher angle 70°.

3.2. Wiring Diagram

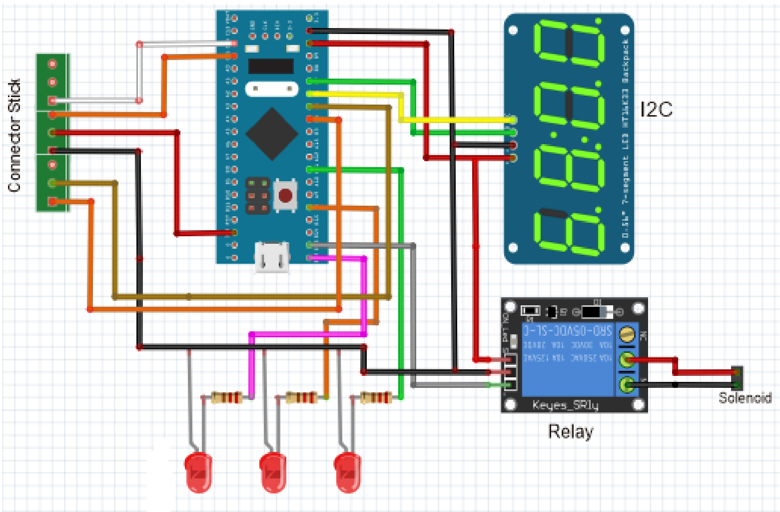

Fig. 4. Wiring circuit

This throwing system works when receiving a given pitch through a joystick. The wind pressure storage bottle is filled first so that the pneumatics can run, after that then turn on the mini system. The mini system has an indicator if it works according to the commands given via the led and I2C which provides a code if the program runs according to the command. When the mini system has no problem then performs a display test, this system works according to the commands given, if pressed the box then the system will work to throw the ball saghai and if pressed X it will be in a stand by position or ready to throw.

Based on Fig. 4 the following ports are used:

PB13: Control Input Relay

PB 6: SDA (Serial Data) I2C

PB 7: SCL (Serial Clock Line) I2C

PB 4: Data connector joystick

PB 5: Command connector joystick

PC14: Attention connector joystick

PC15: Clock connector joystick

3.3. Algorithm

Flowchart on the KRAI 2019 thrower for microcontrollers using STM 32F310C8. The play station is used to control the pitcher, when the jockey will throw the ball saghai. The robot will throw a saghai ball with a relay and a solenoid switch used to open and close the pneumatic. Designing theflowchart see Fig. 5.

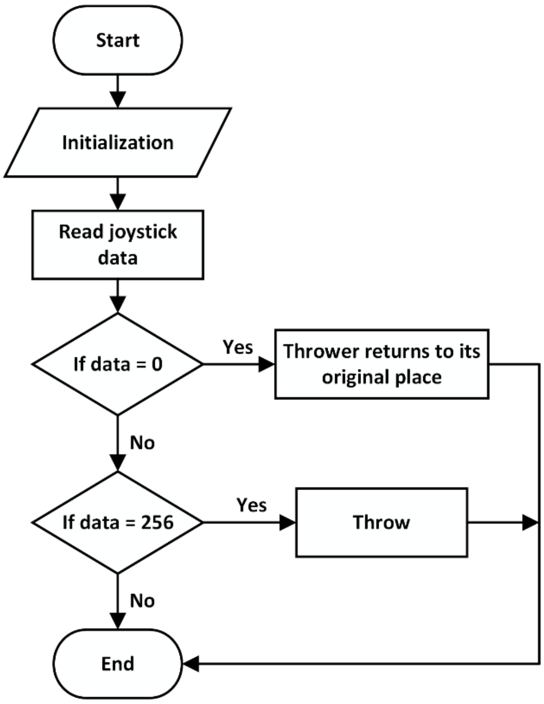

Fig. 5. Flowchart

3.4. Program design

The throwing robot is programmed when the ball is in the container and the robot is in the throwing zone then the jockey will control it through the play station. The robot will throw if pressed the box button on the play station. To restore the position of the thrower lever to its original position, press the X button on the play station, the thrower's position will return to the position ready to throw. To find out whether the program is executed according to the command can be seen through the indicator lights in the form of LEDs and I2C LCDs on the PCB board. The script code can be seen in Fig. 6.

```
void loop()
{
 data = Psx.read();
  lcd.setCursor(3,0);
  lcd.print("BISMILLAH");
  digitalWrite(led2, HIGH);
 if (data == 256)
 {
  lcd.clear();
  digitalWrite(relay, HIGH);
  digitalWrite(led1, HIGH);
  digitalWrite(led3, LOW);
  digitalWrite(led2, LOW);
  lcd.setCursor(3,0);
  lcd.print("BISMILLAH");
  lcd.setCursor(5,1);
  lcd.print("KOTAK");
```

Fig. 6. Script code

If press the box (data 256) then the relay value will be connected and there will be an indicator LED 1 lit, LED2 and LED3 off. On the LCD it says BOX. If data X (data 512) the relay will give a value of LOW or (NO) and there will be an LED3 indicator on and LED1 and LED2 off.

4. Results and Discussion

Pitcher testing is done to find out the results of the pitcher, the test is carried out with different angles namely, angle 50, angle 60, angle 70. From the third test, the angle is seen the distance from the result of the throw. The pressure used was 5.9 bar and carried out as many as 20 experiments.

4.1. Pitcher Testing

In this saghai ball throwing test in the variation of the pressure value and angle of the thrower can be seen at Fig. 7.

Fig. 7. Degrees of circles

Fig. 7 is a degree image of a circle used to vary the angle value of a saghai ball thrower. The position of the degree of the circle is vertical against the thrower's lever. There are three angles formed in the saghai ball thrower, namely 50, 60, 70, At each throw – each angle is also in the variation of the maximum pressure value of the pressure value which is 6 bar. This 6 bar pressure corresponds to the robocon ash rule. To find out what pressure value is stored in the wind storage bottle, a wind pressure indicator can be used which can be seen in Fig. 8.

Fig. 8. Wind Indicators

4.2. 50 Degree Angle Testing

The 50° angle test is carried out after the pitcher lever angle is set at an angle of 50°. The angle of the lever thrower affects the result of the throw. Testing on 50° angle was carried out 20 times. The wind pressure used starts from 5.9 bar. This test can be seen in Fig. 9, Fig. 10, Fig. 11, Fig. 12 and Fig. 13.

Fig. 9. Testing 1

Fig. 10. Testing 1

Fig. 11. Testing 1

Fig. 12. Testing 1

Fig. 13. Testing 1

The results of the Fig. 9, Fig. 10, Fig. 11, Fig. 12 and Fig. 13 are images taken during the saghai ball throwing test 20 times. Fig. 9, Fig. 10, Fig. 11, Fig. 12 and Fig. 13is a sample of 20 experiments. After testing, data is obtained as in Table 1.

Table 1. 50° angle testing

No.	Pressure (Bar)	Succeeded or Didn't Throw	Points	Distance (m)	Initial Speed (m/s)
1	5.9	✓	50	2.3	4.83
2	5.9	✓	40	2.29	4.82
3	5.9	✓	50	2.3	4.83
4	5.9	✓	50	2.28	4.81
5	5.9	✓	40	2.29	4.82
6	5.9	✓	40	2.3	4.83
7	5.9	✓	50	2.3	4.83
8	5.9	✓	40	2.29	4.82
9	5.9	✓	50	2.3	4.83
10	5.9	✓	20	2.29	4.82
11	5.9	✓	50	2.3	4.83
12	5.9	✓	50	2.3	4.83
13	5.9	✓	50	2.28	4.81
14	5.9	✓	50	2.29	4.82
15	5.9	✓	20	2.29	4.82
16	5.9	✓	50	2.28	4.81
17	5.9	✓	40	2.3	4.83
18	5.9	✓	20	2.3	4.83
19	5.9	✓	20	2.29	4.82
20	5.9	✓	50	2.3	4.83

From Table 1, the average speed resulting from throwing is 4.82 m/s and the average distance is 4.82 m. Fig. 14 is the result of a video of data retrieval at an angle of 50 which is processed using python software. Fig. 12 is a picture of the trajectory through which the saghai ball passes when it is thrown. The highest point in Fig. 14 is 109 cm and the lowest point when the ball falls is 61 cm.

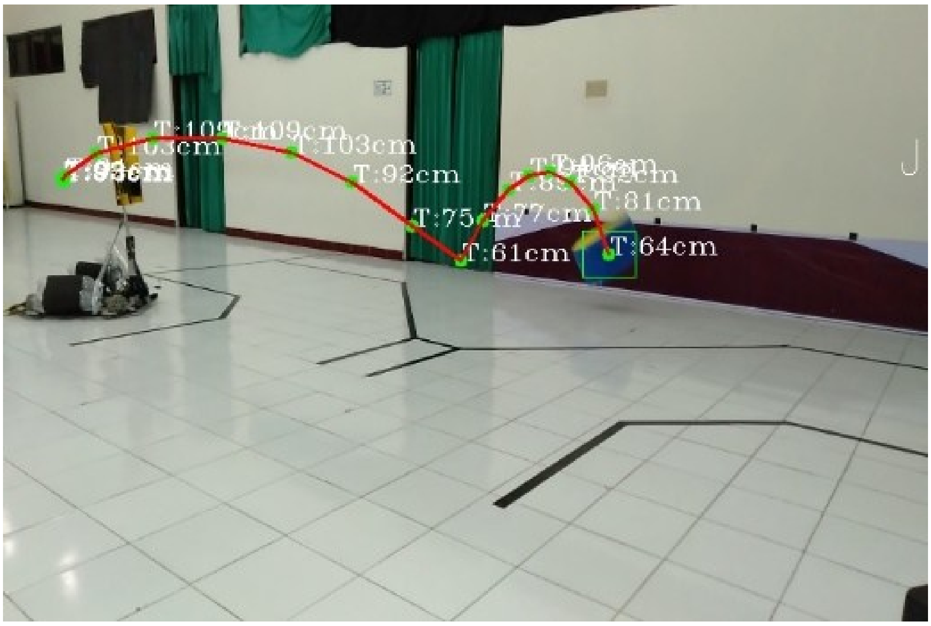

Fig. 14. Processing using python programs

Based on Fig. 15 it can be concluded that the relationship of pressure and speed is that the greater the wind pressure used, the faster the throwing of the ball saghai

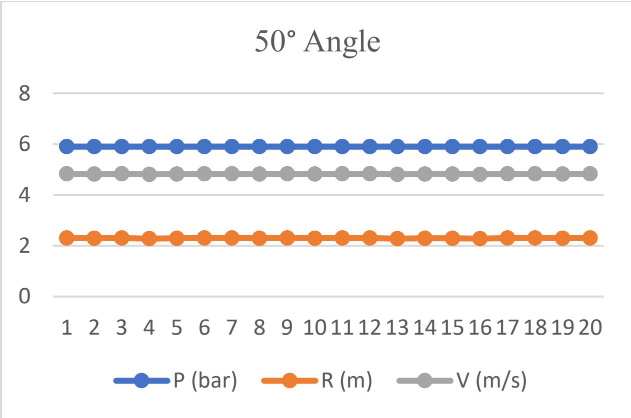

Fig. 15. Graph of the relationship of pressure and distance

4.3. 60 Degree Angle Testing

The 60° angle test is carried out after the pitcher lever angle is set at an angle of 60°. The angle of the lever thrower affects the result of the throw. Testing at an angle of 60° was carried out 20 times. The wind pressure used starts from 5.9 bar. This test can be seen in Fig. 16, Fig. 17, Fig. 18, Fig. 19 and Fig. 20.

Fig. 16. Testing 2

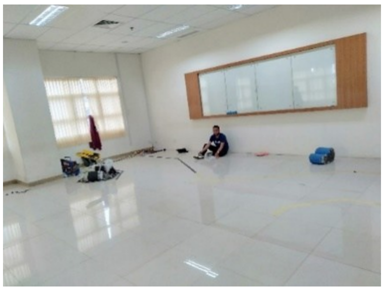

Fig. 17. Testing 2

Fig. 18. Testing 2

Fig. 19. Testing 2

Fig. 20. Testing 2

Fig. 16, Fig. 17, Fig. 18, Fig. 19 and Fig. 20 are images taken during saghai ball throwing testing 10 times. Fig. 16, Fig. 17, Fig. 18, Fig. 19 and Fig. 20 is a sample of 20 experiments. After testing, data is obtained as in Table 2.

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Table 2. 60° angle testing

No.	Pressure (Bar)	Succeeded or Didn't Throw	Points	Distance (m)	Speed (m/s)
1	5.9	✓	40	2.35	5.21
2	5.9	✓	20	2.33	5.19
3	5.9	✓	50	2.34	5.20
4	5.9	✓	40	2.35	5.21
5	5.9	✓	20	2.33	5.19
6	5.9	✓	20	2.35	5.21
7	5.9	✓	40	2.24	5.20
8	5.9	✓	50	2.35	5.21
9	5.9	✓	20	2.34	5.20
10	5.9	✓	20	2.33	5.19
11	5.9	✓	40	2.34	5.20
12	5.9	✓	50	2.35	5.21
13	5.9	✓	40	2.34	5.20
14	5.9	✓	40	2.33	5.19
15	5.9	✓	50	2.34	5.20
16	5.9	✓	40	2.35	5.21
17	5.9	✓	50	2.35	5.21
18	5.9	✓	40	2.35	5.19
19	5.9	✓	40	2.35	5.21
20	5.9	✓	50	2.35	5.19

From Table 2, the average speed resulting from throwing is 5.20 m/s and the average distance produced is 2.34 m. Fig. 21 is the result of a video of data retrieval at angle 60 which is processed using python software. Fig. 19 is a picture of the trajectory that the saghai ball passes when it is thrown. The highest point in Fig. 19 is 107 cm and the lowest point when the ball falls is 58 cm.

Fig. 21. Processing using python programs

Based on Fig. 22, it can be concluded that the relationship between pressure and speed is that the greater the wind pressure used, the faster the saghai ball throws.

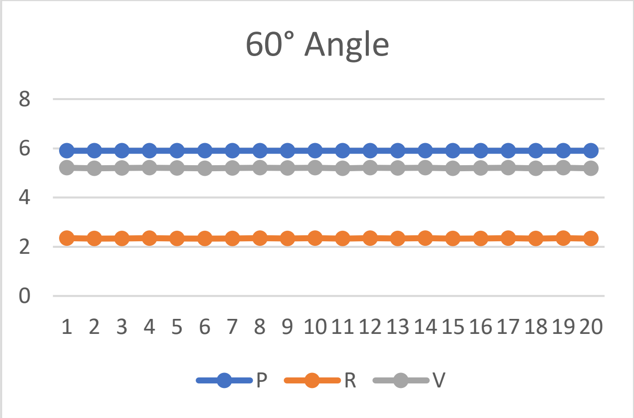

Fig. 22. Graph of the relationship of pressure and distance

4.4. 70 Degree Angle Testing

The 70° angle test is carried out after the pitcher lever angle is set at an angle of 70°. The angle of the lever thrower affects the result of the throw. Testing at an angle of 70° was carried out 20 times. The wind pressure used starts from 5.9 bar. This test can be seen in Fig. 23, Fig. 24, Fig. 25, Fig. 26 and Fig. 27.

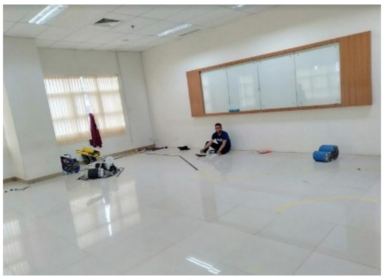

Fig. 23. Testing 3

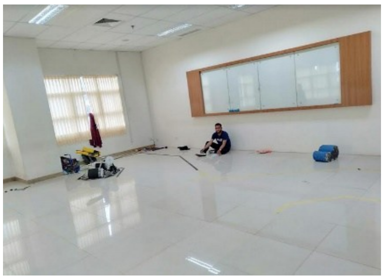

Fig. 24. Testing 3

Fig. 25. Testing 3

Fig. 26. Testing 3

Fig. 27. Testing 3

Fig. 23, Fig. 24, Fig. 25, Fig. 26 and Fig. 27 are images taken during saghai ball throwing testing 20 times. Fig. 23, Fig. 24, Fig. 25, Fig. 26 and Fig. 27 is a sample of 20 experiments. After testing, data is obtained as in Table 3.

Table 3. 70° angle testing

No.	Pressure (Bar)	Succeeded or Didn't Throw	Points	Distance (m)	Speed (m/s)
1	5.9	✓	20	2.46	6.19
2	5.9	✓	50	2.46	6.19
3	5.9	✓	20	2.45	6.17
4	5.9	✓	40	2.44	6.16
5	5.9	✓	40	2.45	6.17
6	5.9	✓	20	2.44	6.16
7	5.9	✓	50	2.46	6.19
8	5.9	✓	40	2.45	6.17
9	5.9	✓	20	2.46	6.19
10	5.9	✓	40	2.44	6.16
11	5.9	✓	50	2.46	6.19
12	5.9	✓	50	2.44	6.16
13	5.9	✓	20	2.45	6.17
14	5.9	✓	40	2.46	6.19
15	5.9	✓	20	2.45	6.17
16	5.9	✓	50	2.45	6.17
17	5.9	✓	20	2.46	6.19
18	5.9	✓	20	2.45	6.17
19	5.9	✓	40	2.44	6.16
20	5.9	✓	20	2.46	6.19

From Table 3, the average speed resulting from throwing is 6.17 m/s and the average distance is 2.45 m. Fig. 28 is the result of a video of data retrieval at angle 60 which is processed using python software. Fig. 28 is a picture of the trajectory that the saghai ball passes when it is thrown. The highest point in Fig. 28 is 123 cm and the lowest point when the ball falls is 55 cm.

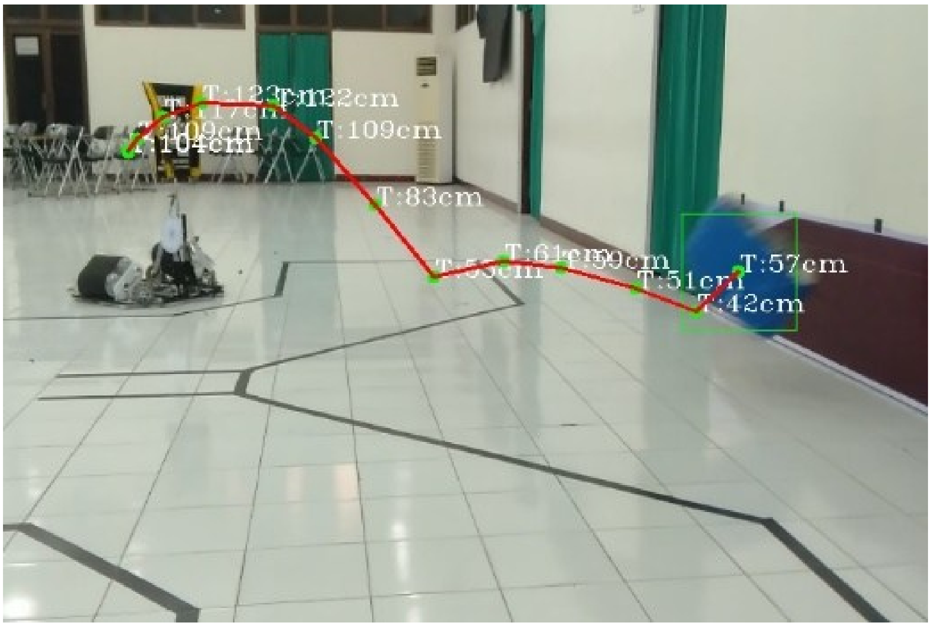

Fig. 28. Processing using python programs

Based on Fig. 29, it can be concluded that the relationship between pressure and speed is that the greater the wind pressure used, the faster the saghai ball throws.

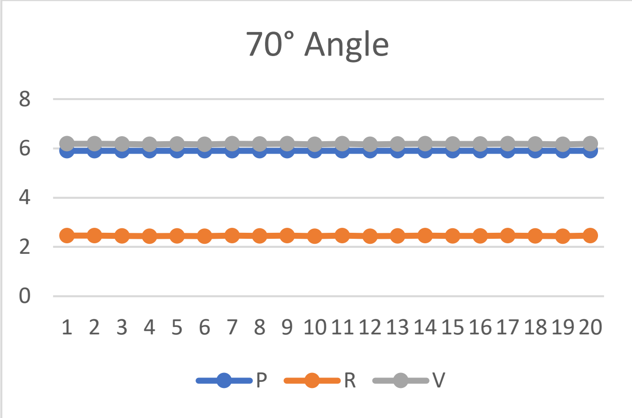

Fig. 29. The relationship of pressure and distance

5. Conclusion

The purpose of the study entitled "Design and Build a Saghai Ball Thrower in the 2019 Indonesian Abu Robot Contest" is to maximize the pitcher on the KRAI robot. The mechanical design of the thrower uses pneumatic and throwing levers. The first test with a throwing angle of 500, the ball was thrown 10 times resulting in the robot being able to throw well and its average speed was 4.42 m/s. It can be concluded that the angle of 500 is the right angle to produce a lot of 50 points. The second test with a throwing angle of 600, the ball was thrown 10 times resulting in the robot being able to throw, as well as the resulting average speed of 5.12 m/s. The third test with an angle of 700, the ball was thrown 10 times resulting in the robot being able to throw, as well as the average speed produced which was 7.12 m/s. Throwers on robots can try other alternatives such as using DC motors or Power Window motors.

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