Signal and Image Processing Letters
Vol. 3., No. 1, 2021, pp. 27-35
ISSN 2714-6677
https://simple.ascee.org/

Design and build a rugby ball thrower in the Kontes Robot ABU Indonesia 2020 using pneumatic

Ali Imran[1], Wahyu Sapto Aji[2,*]

Department of Electrical Engineering, Universitas Ahmad Dahlan
Jalan Ring Road Selatan, Tamanan, Banguntapan, Bantul, Yogyakarta 55166, Indonesia
[1] aliimran280698@gmail.com; [2] wahyusa@ee.uad.ac.id
* Corresponding author

ARTICLE INFO

Keywords
Pneumatic
Throwing Angle
Air Pressure

ABSTRACT

The Kontes Robot ABU Indonesia (KRAI) is a robot contest held by the Directorate General of Higher Education (DIRJEN DIKTI). The winner of the national robot contest then represented Indonesia at the ABU (Asia–Pacific Broadcasting Union) Robocon which in 2020 was held in Fiji. Robot competition consists of two kinds, namely manual robots and automatic robots. In the competition there is one session or section, namely throwing the rugby ball. In the rugby ball throwing session, it is expected that the ball can be thrown and right into the goal so that it gets a maximum point of 5 points. This study tested the throw using pneumatics with the aim of getting the throw to get 5 points. The parameter that must be achieved is mechanical optimization with the throw landing on target and into the goal so as to get maximum points. The KRAI 2020 robot thrower uses pneumatics. Wind pressure determines the strength of a rugby ball toss. In calculating the distance, the parabolic formula is used and the method used to retrieve data through trial and error is to experiment from two angles, namely 40, and 50 then take good data.

1. Introduction

The Kontest Robot Indonesia (KRI) is a competition held by Kemenristekdikti as a student level robot competition. The 2020 Kontest Robot Indonesia (KRI 2020) will be held in stages starting with the Regional Contest which will be held directly nationally according to a predetermined schedule and place [1]. The place for the implementation of the KRI is carried out at each tertiary institution due to the fact that the Covid-19 virus outbreak has not subsided [2]. resulting in the 2020 Kontest Robot Indonesia consisting of 6 divisions, one of which is KRAI (Kontes Robot ABU Indonesia) which will be held online. In 2020 the ABU Robocon 2020 international ash robot contest will be held in Suva, Fiji [3].

The theme of the Kontes Robot ABU Indonesia (KRAI) refers to the rules or culture of the host country [4]. The theme for the Kontes Robot ABU Indonesia (KRAI) in 2020 is "Robo Rugby 7s" [5]. In response to this event, the KRAI (Kontes Robot ABU Indonesia) team from Universitas Ahmad Dahlan came up with a robot design [6]. The design was carried out like a mechanical or electrical design. The design aims so that the operator can run the robot properly [7]. Participants determine themselves as the Red or Blue Team, and carry out the contest on the field that has been prepared at each tertiary institution. The contest lasts a maximum of three (3) minutes. Each team builds two (2) robots known as Pass Robot (PR) and Try Robot (TR) [8]. The two robots can be manual or automatic [9][10]. PR starts from PR Start Zone. PR takes one Try Ball from the Ball Rack and passes the Try Ball [11]. The TR starts from the TR Start Zone and moves to the Receiving Zone to receive a Try Ball from the PR [12]. TR then dodged the barricades to score a Try in one of the 5 Try Spots [13]. After a successful Try by TR, a kick step can be taken from the Kicking Zone to make a Goal [14].

The game continues until all five Kick Balls are used or the 3 minutes time is up [15]. The four-wheeled robot can pick up and throw rugby balls. To perform a thrower design consisting of levers, pneumatics, air pressure indicators and other electronic components [16]. Pneumatic is one of the most appropriate substitutes for DC motors because pneumatic uses air as its propulsion [17]. The pneumatic system is a system that uses energy stored in the form of compressed air and is used to get work.

2. Method

Research on robots resembles industrial robots. The mission of the robot is to throw a rugby ball which has been adapted to the ABU Robocon 2020 regulations. The design of building a rugby ball throwing robot requires the concept and design of a robot. Robot design using Solidwork software. Designing this robot is in accordance with the concept form that has been thought of before making it, namely from optimizing the mechanical drive so that it can adjust the center of gravity of the robot and the strength in throwing a rugby ball. The problem faced by the robot in terms of throwing a rugby ball is determining the wind pressure and the throwing distance that is achieved when throwing the rugby ball until the ball enters the goal.

2.1. Use of Throwing Angles

The use of angles when throwing a rugby ball is very influential on the results of throwing the ball, because the angle taken also depends on the distance the ball is thrown, with this angle method it makes a fairly efficient method taken in a test of a rugby ball throwing tool, because the distance we want will be obtained with the angle that we make as a test assisted by the wind pressure in the bottle.

2.2. Air Pressure

The robot will move according to the joystick command based on input from the user. This robot can also throw the rugby ball 5 times with a maximum throwing distance of 3.5 meters, with the remaining wind of 3.4 bars, from the initial wind of 6 bars.

2.3. Hardware Design

Hardware design begins with making a wiring diagram of the components used and then hardware assembly. Assembly is the process of connecting the cables of all devices. The whole system wiring diagram can be seen in Fig. 1

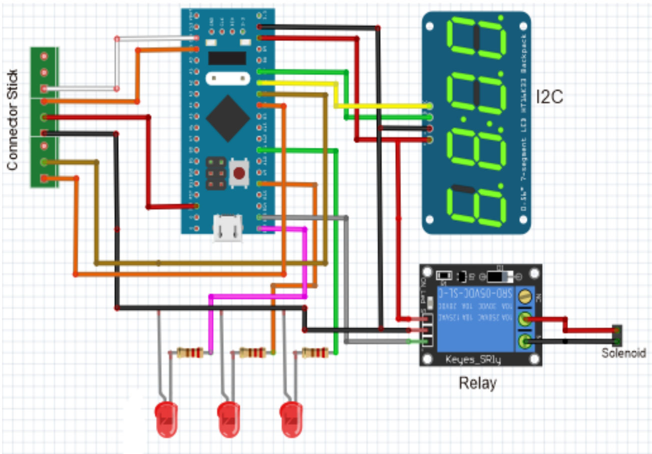

Fig. 1. Wiring diagram

Fig. 1 is a series of wiring for this system. This throwing system works when it receives commands given via a joystick. The air pressure reservoir bottle is filled with air so that the pneumatic can run, after that the mini system is turned on. The mini system has an indicator if it functions according to the command given via the LED and I2C which gives a code if the program runs according to the command. When the mini system doesn't have a problem then it does the throwing test, this system works according to the command given, if you press box then the system will work to throw a rugby ball and if you press X it will be in a stand by position or ready to throw position. The pins used in the wiring diagram can be seen in Table 1.

Table 1. Input and output pin

No	Pin STM 32	Information
PB 13	26 (SCK 2)	Control Input Relay
PB 6	42 (SCL 1)	SDA (Serial Data) I2C
PB 7	43 (SDA 1)	SCL (Serial Clock Line) I2C
PB 4	40 (JTRST)	Data Connector Joystick
PB 5	41 (SMBA 1)	Commend Conector Data Joystick
PC 14	3 (OSC32 in)	Attention Connector Joystick
PC 15	4 (OSC32 out)	Clock Connector Joystick

2.4. Rugby Ball Throwing System Design

The design of a rugby ball throwing system uses levers, pneumatics, solenoids, relays, joysticks. The way the robot works when carrying out the mission of throwing the rugby ball is that the robot will take the rugby ball then the rugby ball will be brought up to the throwing zone, when it reaches the throwing zone the robot prepares to throw while waiting for the goal robot to approach the predetermined position to receive the rugby ball throw. The manual robot will throw the rugby ball into the goal robot. This robot will throw when it gets a command from the joystick it controls. The joystick will give commands to the relay then the solenoid will open the wind valve. The solenoid will channel air to the pneumatic, then the pneumatic will move the throw lever. The system design is in the form of a block diagram shown in Fig. 2.

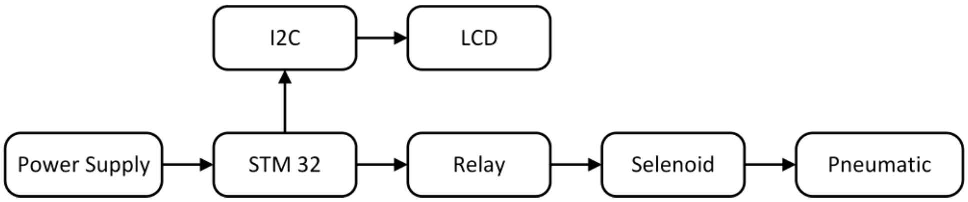

Fig. 2. Pneumatic system block diagram

The power supply is used as a source of electricity [1], I2C functions as a display of data, character letters, or graphics [2]. STM 32F103C8 is used as a program store [3]. Relay is used as a switch [4]. Solenoid is used to pull and push levers in pneumatic [5]. Pneumatics were used to move the throw lever. The power supply is turned on using the battery, after it is turned on it will give a signal in the form of a blue led. After the circuit functions according to its use, then check I2C by looking at the writing or characters that appear according to the program when the circuit is turned on. The relay functions as a switch, the function of the relay can be tested by using the joystick button when pressed, the relay will sound. The relay is connected to a solenoid so that it can move the pneumatic using air pressure.

2.5. Control System Design

The design of a rugby ball thrower robot frame using 1 pneumatic. The wind pressure is equal to 6 bar/600 kPa. As well as the robot's voltage power supply that is used is only 24 V. In terms of this rugby ball throwing robot, namely, throwing a rugby ball from a predetermined distance to the goal robot. Pneumatics for throwing rugby balls. The robot uses a wind storage tube to store wind which is used to drive pneumatics. The 3D design of the overall system can be seen in Fig. 3.

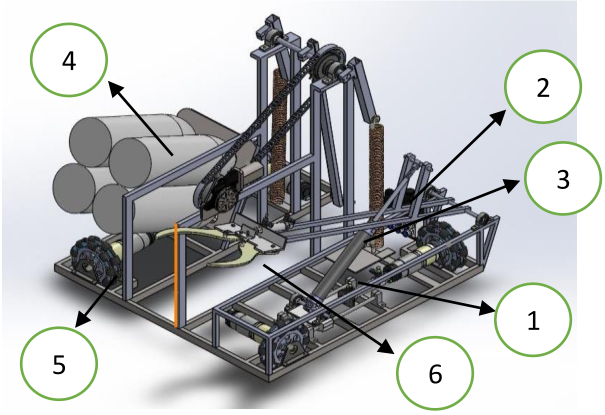

Fig. 3. Design of 3D throwing mechanical system

Fig. 3 is a mechanical 3D design of a rugby ball thrower which is designed simply so that the rugby ball can be thrown into the goal and produce maximum points. A more detailed explanation can be seen in Table 2.

Table 2. Explanation of the control box design

No	Component	Information
1	Pneumatic	As the main object of a rugby ball thrower
2	Solenoid	As a Pneumatic Drive
3	Thrower's Lever	Sebagai mechanic who throws rugby ball assisted by pneumatic
4	Air Bottle	As a place to store wind or air to move pneumatic
5	Omni Wheel	As a wheel that binds the robot and moves the robot to the left and the right
6	Gripper	As a rugby ball tackle mechanic so that the ball can be thrown properly and regularly

2.6. Electrical System Design

Fig. 4 is a picture of the mechanical electrical system of throwing a rugby ball so that the rugby ball can be thrown into the goal and produce maximum points. A more detailed explanation can be seen in Table 3.

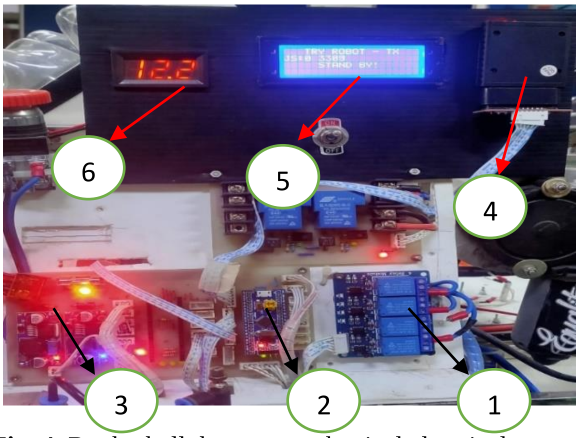

Fig. 4. Rugby ball thrower mechanical electrical system

Table 3. Explanation of the rugby ball thrower mechanical electrical system

No	Component	Information
1	Relay	As a switch operated by using electricity to activate the solenoid
2	STM 32	As a microcontroller or main controller of the robotic electrical system
3	Stepdown	Sebagai lowers the power voltage from the battery to be released to STM 32
4	Receiver	As a data sheet that receives signals from the joystick and can move the robot
5	I2C & LCD	As a display object a name,caracter,number to see if the ECU is active or not
6	Volt Meter	As an object of measuring the electrical voltage in a robot circuit

2.7. Software Design

The software design, namely the program for the STM 32 controller, is made through the Arduino IDE application and downloaded via a USB cable to the node board. The algorithm of the compiled program is represented by the flowchart shown in Fig. 5.

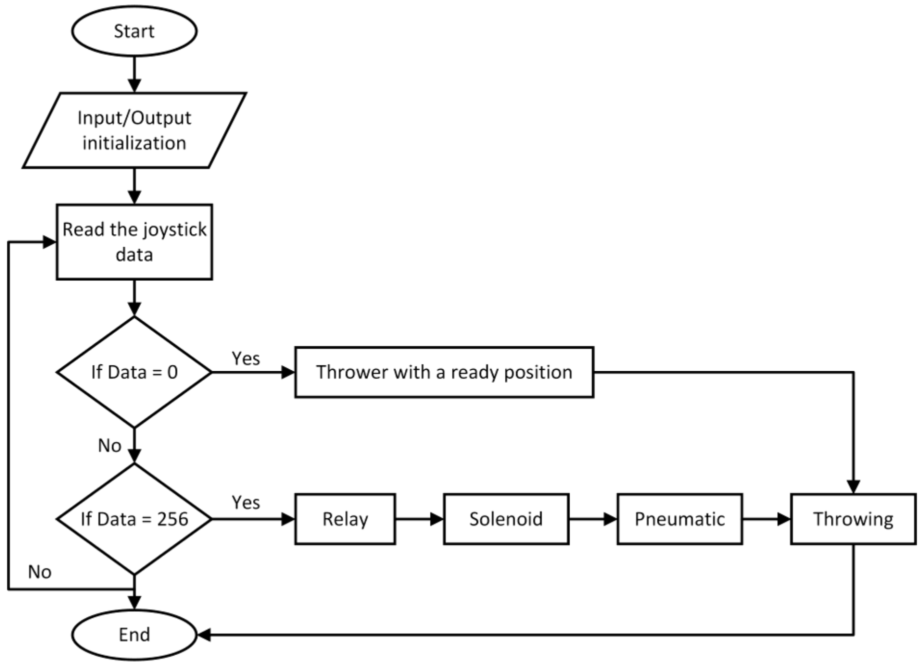

Fig. 5. System flowchart

In Fig. 5 it can be understood that the Robot system is turned on after connecting to the power supply, then the robot performs initialization or checks the mini system by marking the LED on the mini system. Check the connection between the joystick and the receiver by looking at the light on the joystick, if it is green then it is connected to the receiver. The throw lever will return to its original place if the data is 0 and will throw if the data is 256.

3. Results and Discussion

3.1. System Testing Steps

In this system test step, several system test stages are carried out. The system test is carried out after the robot design has been completed. The aim of the robot design to be completed first is to make it easier to arrange or arrange the placement of other components.

3.2. Electrical Circuit Testing

Electrical testing was carried out after the circuit was made the circuit was made using eagle software. The purpose of electrical testing is to find or check whether the circuit is functioning or not. Checking consists of seeing the path that has been printed on the PCB whether there is a connected path or not. Because if there is a connecting line there will be a short or short circuit. Short circuit will result in damaged components. The next check is measuring the current or voltage after all the components are soldered on the PCB board. Measurement of current or voltage aims to find out how much current or voltage comes out when the circuit is connected to the power supply.

3.3. Pneumatic Piping Testing

The pneumatic piping test aims to determine whether the pneumatic circuit is appropriate and to test whether the pneumatic can function as desired. This test also functions to look for leaky connections on nipples or faucets. After all is done, then do the testing of the rugby ball thrower using pneumatics.

3.4. Rugby Ball Throwing Test

This rugby ball throwing test was carried out to determine whether the ball was thrown successfully or not until it reached the goal robot. In throwing the ball, the wind pressure used varies.

This study aims to find out how the mechanics of throwing a rugby ball in the 2020 Indonesian ash robot contest use pneumatics by using STM 32F103C8 and using a throwing mechanic that has been designed in such a way. This throwing test consists of two angles, namely the 40° angle and the 50° angle. This test is carried out to get the right throw and earn points. Testing is also to determine the distance achieved by using different pressures.

3.5. Rugby Ball Throwing Test at 40° Angle

In testing the rugby ball thrower uses a 40° angle, that is, adjusts the position of the thrower lever at an angle of 40° to the degree of the circle placed at point 0 on the thrower, while the position of the degree of the circle is horizontal to the thrower's lever. the thrower's position is at an angle of 40°, after setting the thrower's angle then testing the throw. The throwing test was carried out 32 times using a wind pressure of 6 bar.

Table 4. Data collection at an angle of 40°

No.	Air Pressure (Bar)	Success/No Throw	Points	Distance (m)	Initial Speed (m/s)
1	6.0	✓	1	3.6	6.06
2	6.0	✓	1	3.5	5.98
3	5.9	✓	1	3.6	6.06
4	5.9	✓	1	3.5	5.98
5	5.8	✓	1	3.4	5.90
6	5.8	✓	1	3.5	5.98
7	5.7	✓	1	3.3	5.81
8	5.7	✓	1	3.4	5.90
9	5.6	✓	1	3.4	5.90
10	5.6	✓	1	3.5	5.98
11	5.5	✓	1	3.4	5.90
12	5.5	✓	1	3.2	5.72
13	5.4	✓	1	3.4	5.90
14	5.4	✓	1	3.1	5.63
15	5.3	✓	1	3.3	5.81
16	5.3	✓	1	3.4	5.90
17	5.2	✓	1	3.2	5.72
18	5.2	✓	1	3.1	5.63
19	5.1	✓	1	3.3	5.81
20	5.1	✓	1	3.2	5.72
21	5.0	✓	1	3.2	5.72
22	5.0	✓	1	3.1	5.63
23	4.9	✓	1	3.1	5.63
24	4.9	✓	1	3.0	5.54
25	4.8	✓	1	3.1	5.63
26	4.8	✓	1	3.0	5.54
27	4.7	x	1	2.8	5.36
28	4.7	x	0	2.7	5.26
29	4.6	x	0	2.9	5.42
30	4.6	x	0	2.8	5.36
31	4.5	x	0	2.7	5.26
32	4.5	x	0	2.8	5.36

So after 32 experiments it was concluded that the 40° angle test resulted in an average speed of 5.72 m/s. After 32 experiments, it was concluded that the 40° angle test resulted in an average distance of 3.31 m. Then from the test plotting graphs were carried out to determine the relationship between the parameters tested. For the graph itself is shown in Fig. 6.

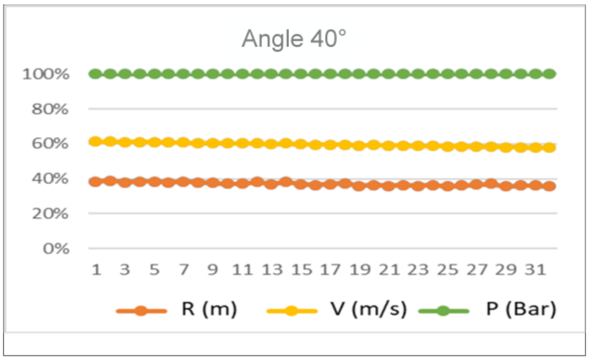

Fig. 6. Graph of pressure and velocity relationship at an angle of 40°

Based on Fig. 6, it can be concluded that the relationship between pressure and speed is that the greater the wind pressure used, the faster the rugby ball is thrown.

3.6. Data collection at an angle of 50°

In the test of throwing a rugby ball at an angle of 50°, position the lever at an angle of 50° to the degree of the circle placed at point 0 of the thrower. The position of the circle degrees to the throwing lever is horizontal. position the throwing lever at an angle of 50°, after adjusting the lever position then do a throwing test. The throwing test was carried out 32 times with a maximum wind pressure of 6 bar.

Table 4. Data collection at an angle of 50°

No.	Air Pressure (Bar)	Success/No Throw	Points	Distance (m)	Initial Speed (m/s)
1	6.0	✓	1	3.8	6.24
2	6.0	✓	1	3.7	6.16
3	5.9	✓	1	3.8	6.24
4	5.9	✓	1	3.7	6.16
5	5.8	✓	1	3.6	6.06
6	5.8	✓	1	3.6	6.06
7	5.7	✓	1	3.5	5.98
8	5.7	✓	1	3.4	5.90
9	5.6	✓	1	3.5	5.98
10	5.6	✓	1	3.4	5.90
11	5.5	✓	1	3.3	5.81
12	5.5	✓	1	3.5	5.98
13	5.4	✓	1	3.4	5.90
14	5.4	✓	1	3.4	5.90
15	5.3	✓	1	3.3	5.81
16	5.3	✓	1	3.2	5.72
17	5.2	✓	1	3.4	5.90
18	5.2	✓	1	3.3	5.81
19	5.1	✓	1	3.4	5.90
20	5.1	✓	1	3.3	5.81
21	5.0	✓	1	3.3	5.81
22	5.0	✓	1	3.2	5.72
23	4.9	✓	1	3.2	5.72
24	4.9	✓	1	3.1	5.63
25	4.8	✓	1	3.0	5.53
26	4.8	✓	1	3.1	5.63
27	4.7	✓	1	3.0	5.53
28	4.7	✓	1	3.1	5.63
29	4.6	✓	1	3.0	5.53
30	4.6	✓	1	3.0	5.53
31	4.5	x	0	2.9	5.45
32	4.5	x	0	2.8	5.36

So after 32 experiments it was concluded that the 50° angle test resulted in an average speed of 5.83 m/s. After 32 experiments, it was concluded that the 50° angle test resulted in an average distance of 3.32 m. Then from the test plotting graphs were carried out to determine the relationship between the parameters tested. For the graph itself is shown in Fig. 7.

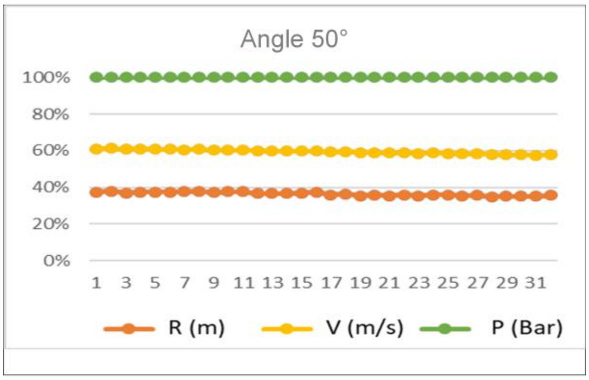

Fig. 7. Graph of pressure and velocity relationship at an angle of 50°

Based on Fig. 7, it can be concluded that the relationship between pressure and speed is that the greater the wind pressure used, the faster the rugby ball is thrown.

4. Conclusion

The aim of the research entitled "Design and Build a Rugby Ball Thrower in the Kontes Robot ABU Indonesia 2020 Using Pneumatic" is to test the manual KRAI robot can throw successfully or not and land on the goal robot. Based on the results of the test analysis, it can be concluded that the mechanical design of the thrower uses pneumatics and the thrower lever. The first test with a throwing angle of 40°, the ball was thrown 32 times resulted that the robot can throw well and its average speed is 5.72 m/s. It can be concluded that the 40° angle is the right angle to produce lots of 5 points. The second test is with a throwing angle of 50°, the ball is thrown 32 times resulting that the robot can throw, and the resulting average speed is 5.83 m/s. The 40 angle test is the right angle because it can produce good throws and earn points 5.

Based on the conclusions above, an outline can be drawn in the research "Design and Build a Rugby Ball Thrower in the Kontes Robot ABU Indonesia 2020 Using Pneumatic" that the design of throwing Rugby balls using pneumatics and an angle of 40 is the most appropriate angle because it can produce a lot of 5 points while an angle of 50 can throwing but the resulting points are less than the maximum.

References

[1] M. Khairudin, R. Asnawi, and S. Hadi, "Desain Robot Lengan Raket Dengan Kombinasi Aktuator Motor Dan Pneumatik Untuk Mendapatkan," *Proceedings Seminar Nasional Pendidikan Teknik Elektro 2015*, pp. 74-79, 2010.

[2] A. Agustiawan, "Algoritma Robot Otomatis Pelempar Shuttlecock," *Jurnal INOVTEK Polbeng - Seri Informatika*, vol. 3, no. 1, pp. 60-67, 2018, https://doi.org/10.35314/isi.v3i1.338.

[3] A. Ashari, F. R. Faruuq, M. Nur and F. Fauziah, "Rancang Bangun Pass Robot Kontes Robot ABU Indonesia (KRAI) 2020," *Mechatronics Journal in Professional and Entrepreneur (MAPLE)*, vol,. 1, no. 2, pp. 55-61, 2019.

[4] M. R. Naufal *et al.*, "Rancang Bangun Mekanik Ekspansi Robot Goalkeeper Sepak Bola Beroda Menggunakan Pneumatik," In *The 6th Indonesian Symposium on Robotic Systems and Control (ISRSC)*, pp. 99-103, 2018.

[5] F. S. Rozak and R. Riandini, "Rancang Bangun Lengan Robot Pelontar Bola dengan Sistem Pneumatik," *ELECTRICES*, vol. 1, no. 1, pp. 37-42, 2019.

[6] E. Eliyani, R. Azka, B. Bakhtiar, and A. Akhyar, "Rancang Bangun Robot Semi Auto Beroda Pengambil dan Pelempar Bola Rugby 7S (Pass Robot) Berbasis Mikrokontroller ATMEGA2560," *Jurnal Litek: Jurnal Listrik Telekomunikasi Elektronika*, vol. 17, no. 2, pp. 57-60, 2020.

[7] H. Amni, Y. Ruhayati, and K. Sultoni, “Pengembangan teknologi pelontar bola tenis lapangan berbasis microcontroller,” *Jurnal Terapan Ilmu Keolahragaan*, vol. 2, no. 1, pp. 18-24, 2017.

[8] D. Novriansyah, S. Soim, and A. S. Handayani, “Akurasisi Pelontaran Cakram Pada Robot Pelontar Berbasis Webcam Sebagai Pendeteksi Objek,” *Prosiding SNATIF ke-4*, pp. 91–96, 2017.

[9] D. Firdha, T. Winarno, and A. Komarudin, “Kontrol Kecepatan Motor Pelempar pada Robot Abu Robocon 2018 dengan Metode PID,” *Jurnal Elkolind: Jurnal Elektronika dan Otomasi Industri*, vol. 6, no. 2, pp. 17-26, 2021.

[10] H. Guntoro and Y. Somantri, “Rancang bangun magnetic door lock menggunakan keypad dan solenoid berbasis mikrokontroler arduino uno,” *Electrans*, vol. 12, no. 1, pp. 39-48, 2013.

[11] RISTEKDIKTI, 2020, “Kontes Robot ABU Indonesia 2020 KRAI-2020”.

[12] M. Saleh and M. Haryanti, “Rancang bangun sistem keamanan rumah menggunakan relay,” *Jurnal Teknologi Elektro*, vol. 8, no. 2, pp. 87-94, 2017.

[13] R. Rodika, J. Jamalludin, H. Handriko, A. Priyambudi, and A. Pranata, “Rancang Bangun Robot Pelontar Shuttlecock,” *Manutech: Jurnal Teknologi Manufaktur*, vol. 9, no. 1, pp. 67-71, 2017.

[14] A. Saefullah, D. Immaniar, and R. Juliansah, “Sistem Kontrol Robot Pemindah Barang Menggunakan Aplikasi Android Berbasis Arduino Uno,” *CCIT (Creative Communication and Innovative Technology) Journal*, vol. 8, no. 2, pp. 45-56, 2015.

[15] W. Suwito, M. Rif’an, and P. Siwindarto, “Pengaturan Posisi Piston Silinder Pneumatic Pada Lengan Robot KRAI,” *J. Mhs. Tek. Elektro Univ. Brawijaya*, vol. 2, no. 1, p. 117268, 2014.

[16] M. Subhan and A. Satmoko, “Penentuan Dimensi Dan Spesifikasi Silinder Pneumatik Untuk Pergerakan Tote Iradiator Gamma Multiguna Batan,” *Jurnal Perangkat Nuklir*, vol. 10, no. 2, 2017.

[17] M. S. Sungkar and Q. Qirom, “SOP Pengoperasian Score Board Led Matrix P10 Berbasis Arduino STM32 Kendali Android di Sport Center Politeknik Harapan Bersama Tegal,” *Power Elektronik: Jurnal Orang Elektro*, vol. 7, no. 2, 2018.

[18] I. Saptiadi, D. Minggu, and Y. Darmawan, “Rancang Bangun Sistem Kendali pada Robot Tempur Menggunakan Joystick Berbasis Arduino,” *TELKA-Jurnal Telekomunikasi, Elektronika, Komputasi dan Kontrol*, vol. 6, no. 1, pp. 49-55, 2020.

[19] A. P. Y. Waroh, “Analisa dan simulasi sistem pengendalian motor DC,” *Jurnal Ilmiah Sains*, vol. 14, no. 2, pp. 80-86, 2014.

[20] M. T. Afif and I. A. P. Pratiwi, “Analisa Perbandingan Bateai Lithium - Ion, Lithium-Polymer Lead Acid Dan Nickle -Metal Hydride Pada Penggunaan Mobil Listrik,” *Jurnal Rekayasa Mesin*, vol. 6, no. 2, pp. 95-99, 2015.

[21] M. R. Naufal *et al*., “Rancang Bangun Mekanik Ekspansi Robot Goalkeeper Sepak Bola Beroda Menggunakan Pneumatik,” In *The 6th Indonesian Symposium on Robotic Systems and Control (ISRSC)*, pp. 99-103, 2018.