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Implementation of Omnidirectional Movement on Rugby Robot

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ABSTRACT

Robots in the KRAI competition (Indonesian ABU Robot Contest) is required to be able to maneuver and move well, efficiently and quickly in order to be able to carry out the task of picking up and kicking rugby balls. For the robot to move quickly and precisely, a wheel that can move dynamically is needed. The wheel used is the Omni wheel. This wheel has a small wheel located on the outer side of the main wheel, so that the movement of the rugby robot can run smoother when changing positions. With dynamic and efficient maneuvers and displacement of the rugby robot, the robot can move more agile and can stop in the desired position. Rugby robot using the mapping method. determine the initial position of the robot in the star zone position towards the kick zone using the rotary encoder sensor and compass sensor

Keywords: *omni wheel, rpm, maneuver, rugby*

I. INTRODUCTION

Every year the Directorate General of Learning and Student Affairs, Ministry of Research, Technology and Higher Education (DIKTI) always holds the Indonesian Robot Contest (KRI). In the robot contest there is a division called the Indonesian Abu Robot Contest (KRAI). For the KRAI division, Sanata Dharma University was represented by the DOMESTOS NOMOS Team.

This year the DOMESTOS NOMOS team from Sanata Dharma University has 2 rugby robots, consisting of a rugby ball picker, kicker, passer and rugby ball receiving robot. In the development of the rugby robot, there are still many challenges that must be faced, one of which is how to move the rugby robot dynamically, efficiently and quickly.

Therefore, the focus of this research is to discuss how the movement of the rugby robot will be used in the contest. This research refers to the 2016-2020 Sanata Dharma University Research Master Plan which is found on page 55 about the rapid development of information and communication technology that focuses on the development of the Internet of Things (IoT) era which changes the scale, speed, ease and efficiency of the acquisition process, transfer and processing of data as well as system control related to the retrieved title. The research topic: Implementation of omnidirectional movement in rugby robots will be developed on Innovation and the application of Optimum control in engineering fields and other production processes. Application of Stochastic Control (Stochastic Control) and Stochastic Filtering (Stochastic Filtering) in Various Fields including Engineering. Modeling the implementation of omnidirectional movement on rugby robots can also involve real problems in various fields (physics, engineering, etc.) with stochastic processes

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and analysis using the latest stochastic theories.
The wheel that the author uses in this Indonesian robot contest is 3 omni wheel with a triangular configuration. this configuration allows the robot to move in all directions without additional motion and less friction [1]. This less friction will increase the efficiency of the robot's movement. And the dynamic movement of the wheels makes it easier for the robot to maneuver when the robot is running [6].

II. METHOD

Domestos Nomos team Sanata Dharma University decided to use a three-wheel drive because of the rich maneuverability and due to the simple control. This type of wheels has small rollers to allow the wheels to move freely on any direction [7]. They move along the primary diameter, just as any other wheel. Though, the smaller rollers along the outside of this diameter allow free rotation along an orthogonal direction to the powered rotation. The basic mechanics even must adjust the position of the kicker of the rugby ball so that in this case the three-wheel mechanic doesn't interfere with the kicker of the rugby ball. The use of a pg45 dc motor and an omni wheel with a diameter of 100 mm can withstand a load of no more than 25 kg. The mechanical construction is shown in Figure 1.

Figure 1. Three-Wheel Drive Mechanical Construction Design

Three PG45 DC motors coupled to Omni wheels mounted at an angle of 120 degrees between other motors, aligned as shown in equilateral triangle so that the axes intersect in the robot middle. This PG45 dc motor has a rotary encoder that is already attached to the axle of the motor and can be used to find out how many revolutions there are.

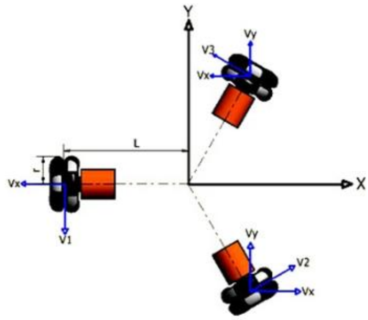

Figure 2. Kinematic Representation of an Omni Directional Triple Drive System

The inverse kinematics model is considered that the representative coordinates of the robot were in its center [8]. Each wheel is placed in such orientation that its axis of rotation points towards the center of the robot and there is an angle of 120° between the wheels [4].

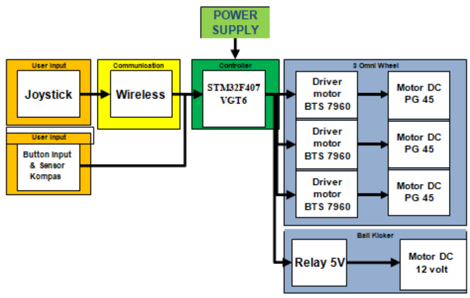

Figure 3. Block System

This rugby robot consists of input, process, and output, for the input itself is divided by input from the joystick, compass sensor, rotary encoder and buttons. For processing the program using STM32F407VGT6 has a data speed bus width of 32 bits. For the output of this system in the form of a PG45 motor that uses a BTS 7960 driver capable of passing 43 amperes of

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current. For the kick ball itself, it uses a 12-volt gearbox wiper motor on the car.

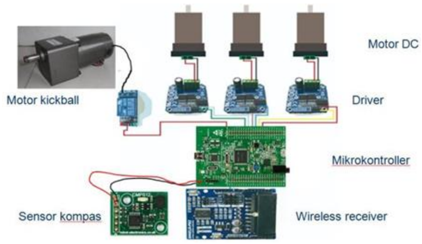

Figure 4. Electric Circuit Rugby Robot

Magnetic Compas CMPS03

Magnetic Compass is a compass sensor that can find out the angular position. This sensor is specially designed for the rugby robot with the aim of being a navigator used for the movement of the rugby robot. In this study the magnetic compass used is CMPS03.

Rotary Encoder

Rotary Encoder is an electro-mechanical component that has a function to monitor the angular position on a rotating shaft. From the rotation of the object, the monitored data is converted by the rotary encoder into digital data in the form of pulse width and then sent to the controller (Arduino Microcontroller). Based on the data obtained in the form of an angular position (angle) then it can be processed by the controller so that it gets data in the form of speed, direction, and position of the rotation of the axis.

PID controllers are widely used in industry and have a great contribution to the dc motor control industry in this rugby robot using PID because: simplicity and efficiency [2]. This study will also test the feasibility of the algorithm in simulation and real applications. The PID controller is the center of the system and plays an important role in ensuring optimal output for the system on this rugby robot. PID controller, it set the value on each part which consists of proportional factors (KP), integral factors (KI) and derived factors (KD). All three This will then determine the stability, steady-state error, overshoot, settling time and rise time of the dc motor motor [3][5].

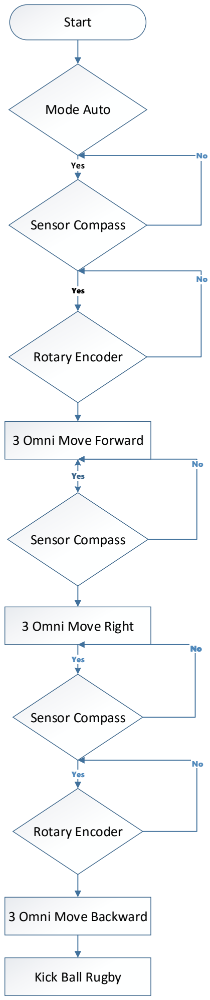

Figure 5. Flowchart Rugby Robot

When the first rugby robot is run it will read the input from the PS2 joystick, the robot will follow the direction buttons on the Joystick. pressed forward then the rugby robot goes forward, pressed backward then the rugby robot goes backwards, when pressing the right button the robot will move to the right, and when the button is pressed to the left the robot moves to the left. For the auto button, the rugby robot will move from the start zone to the kick zone (KZ3) position independently. The movement from the star zone to the kick zone (KZ3) is in accordance with the parameters of the rotary encoder sensor and compass sensor that have been installed in the robot's body.

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III. RESULTS AND DISCUSSION

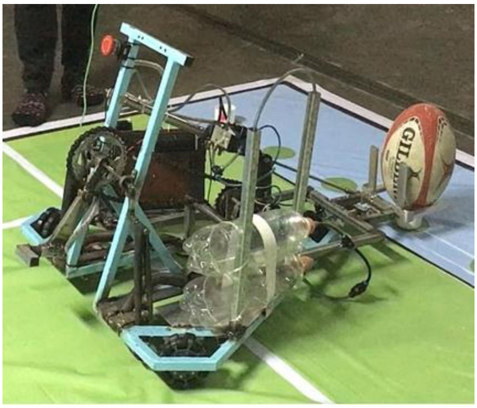

Figure 6. Result Rugby robot

Parameter estimation the robot mass was measured, and it was 4.5 kg for the three wheeled robot. Omni wheel Robot Movement Testing, the purpose of testing the system is to know how the rugby robot moves and communicates in accordance with the control performed by the user. Testing is done by trying the existing buttons on the control in button joystick PS2. Each test is done step by step forward, backward, right, left, and stop.

Table. 1 Experiment using PS2 button

No	Button PS 2	Omni Wheel 1	Omni Wheel 2	Omni Wheel 3	Rugby Robot Movement
1	Up button	OFF	CW	CCW	Moving Forward
2	Down button	CCW	OFF	CW	Moving Forward
3	Right button	CW	CCW	OFF	Turning Right
4	Left button	CWW	OFF	CW	Turning Left

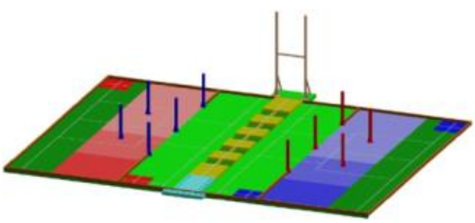

Figure 7. Game field Rugby robot 3D view

Figure 8. Game field Rugby robot

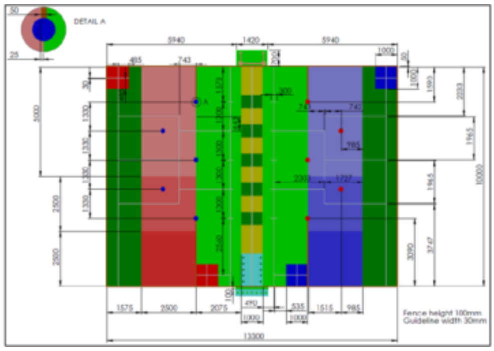

Figure 9. Rugby Field Game Size

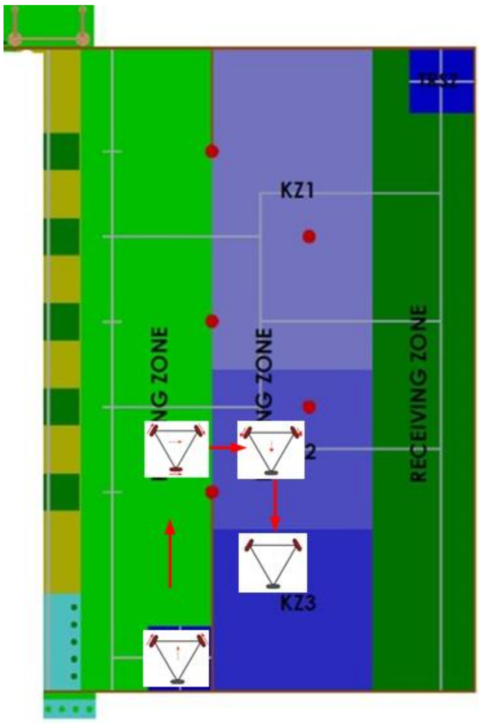

Figure 10. Rugby robot track

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Travel Time Test

In the test, calculated distance time travel robots. Starting from the starting position, enter to the Start Zone room to the kick zone position (KZ23). take robot travel time carried out in 5 trials.

Table. 2 Traveling time

No	Experiment	Time (second)
1	1	13,5
2	2	13
3	3	12,6
4	4	11
5	5	11

The time difference that occurs in the experiment above is due to several factors, namely, the placement position in the start zone and the kick zone position on Kz3 with respect to the kick is not quite right, as well as the difference maneuver the robot when walking towards room.

Robot Movement Deviation Analysis

In this test, measurements were made to the magnitude of the deviation that occurs with compare start position and end position robot. The mileage used is 7.5 m long.

Table. 3 Rugby robot movement deviation

No	Experiment	Starting Angle	Deviation
1	1	0	15 cm
2	2	0	9 cm
3	3	0	17 cm
4	4	0	11 cm
5	5	0	15 cm

Based on the table of 5 experiments, it is known that when the rugby robot is running, the robot's position cannot be straight to a predetermined degree. Thing This can be caused by several factors, namely the influence of the robot component such as, installation of wheels that are not tight, CMPS03 compass sensor, DC motor, different maneuvers for each walking robot and other.

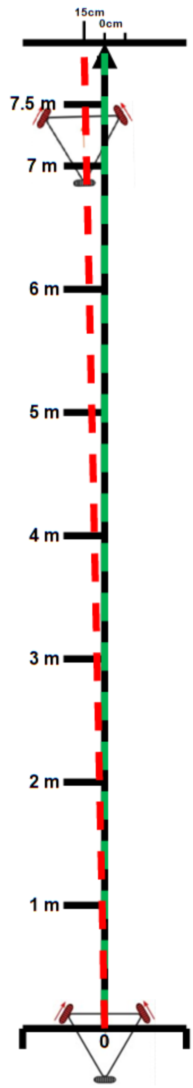

Figure 11. Deviation In Movement Rugby Robots

IV. CONCLUSION

In ABU Robocon robot contest, the time a robot takes to reach the kick zone (KZ3) is of extreme importance. The faster it gets the ball the more chances it has to score a goal. The faster you reach the kick zone 3 position, the more chances to kick and score goals. with the 3-wheel drive configuration described in

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this paper a robot can move in a straight line all the time. The control software is very simple and efficient as described. According to the direction angle only three values are calculated by using a cosine value and a multiplication.

If the kicker is not in the robot moving direction an angular speed needs to be used together with the linear speed while the robot moves towards the ball, to point the kicker to the right direction.

V. Acknowledgements

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