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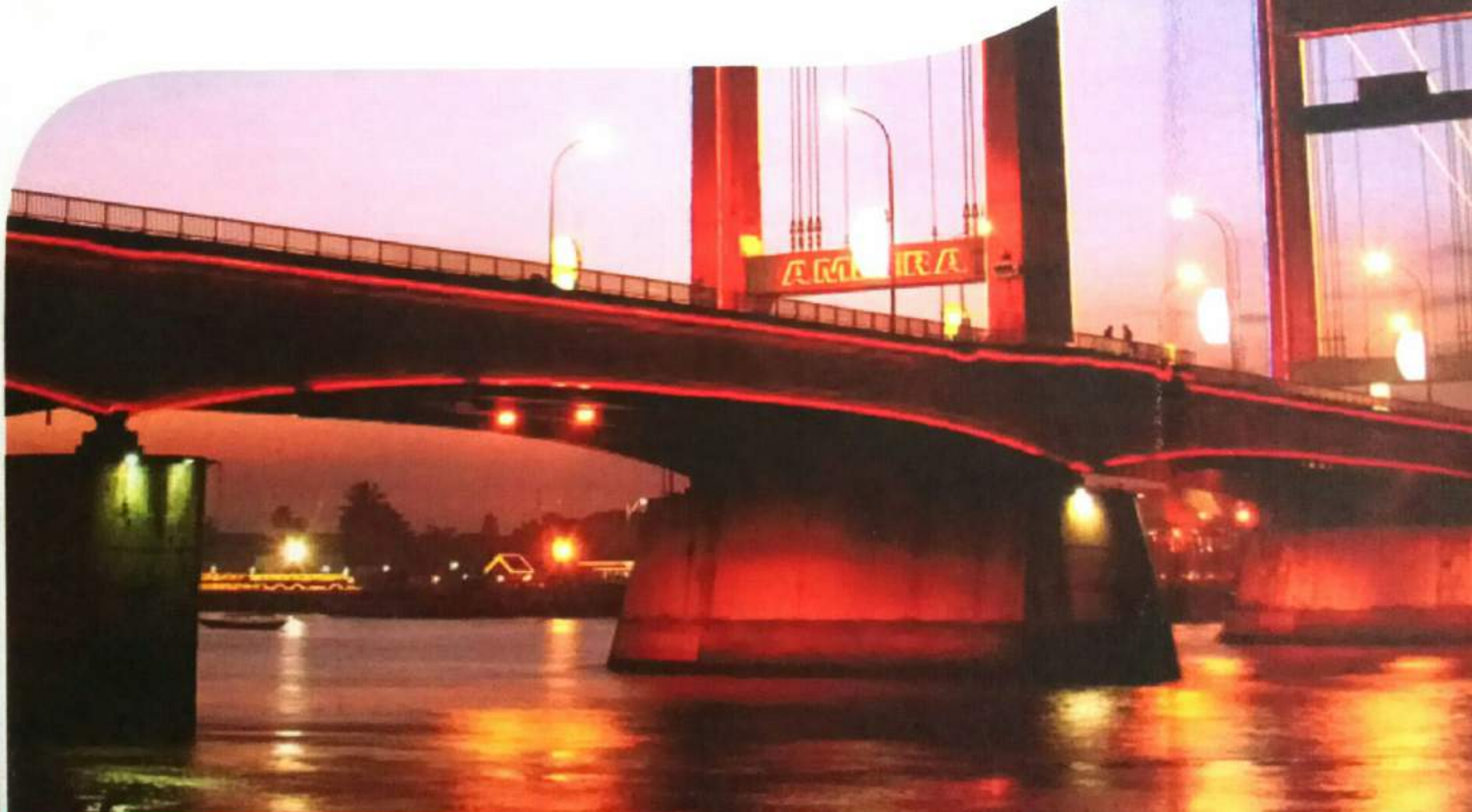

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DR. Deris Stiawan
Pacu Putra, B.CS., M.Comp. Sc.
Munawar A.Riyadi, Ph.D
Imam Much. Ibnu Subroto, Ph.D

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Obstacle Avoidance Functions on Robot Mirosot in The Departement of Informatics of UPN "Veteran" Yogyakarta

Wilis Kaswidjanti
wilis.kas@gmail.com

Hidayatulah Himawan
if.iwan@gmail.com

Awang Hendrianto Pratomo
awang.upn@gmail.com

Hafidz Fajar Abdur Rahman
hafidzfadjara@gmail.com

***Abstract*- The robot is a machine that can perform physical activity repeatedly, either with human control or works automatically with the use of artificial intelligence. In the process, the robot can perform various kinds of sports, one of which is a branch of football. Robot football match organized by the Federation of International Robot-Soccer Association (FIRA) consists of several categories, one of which Micro Robot Soccer Tournament (MiroSot). MiroSot is five to five games consisting of a robot measuring 7.5 cm x 7.5 cm x 7.5 cm were able to move and adapt to the environment without human intervention. Currently Informatics UPN "Veteran" Yogyakarta began to develop MiroSot but there are still some problems found that the movement of the robot is irregular, so that frequent collisions of the robot opponent. So it takes a function to avoid obstacles on the robot MiroSot. Capitalize knowledge of Obstacle Avoidance of the book "Soccer Robotics" [1], the function of avoiding obstacles using the potential field based navigation univector algorithm to determine the future path of the robot and dodge the functionality tailored to the characteristics of the robot MiroSot Information Engineering UPN "Veteran" Yogyakarta. The program is created using programming language C ++ with Visual Studio 2008 IDE and sent to the robot from the main computer via radio frequency, the robot can move properly using speed camera support above 50 frames per second as robot vision. Function to avoid obstacles on the robot defender position MiroSot in the Departement Informatics of UPN "Veteran" Yogyakarta made this using the function position to move towards the goal and using mathematical calculations to determine the movement path avoiding obstacles based on potential field. In the development of this function can avoid obstacles in the form of a robot team, not only the robot opponent avoided. When the moving speed of the robot was given control of the speed depends on the distance of the destination position or positions are also obstacles. The use of sensors gyroscrope expected to provide an effective movement while avoiding obstacles. The success rate using a gyroscope sensor to avoid obstacles on the position of defender of 96% and the average time needed to reach the goal position at 5:33 seconds so much faster.**

I. Introduction

Robot soccer is a game of football robot using robots are small, equipped with artificial intelligence and have their respective roles to achieve the same goal. Existing technology in robotic soccer is image processing, control theory, artificial intelligence, multi-agent systems and motion planning [2]. So in this field can learn, create and train so that a robot can play football [3]. Basically, the robot can play football has its own motion mechanism and can cooperate with other robots that required a strategy game so that the robot can move to the right in certain situations [4]. Robot soccer game is set in a body that is the Federation of International Robotsoccer Association (FIRA), that there are several categories of robot soccer, one of which is the Micro-Robot Soccer Tournament (MiroSot) [5].

MiroSot is a category of robot soccer be appropriate testbed for multi-agent systems research in several robots and robot intelligence systems [6]. MiroSot a robot soccer game 5 5 opponents with the size dimensions of 7.5 cm x 7.5 cm x 7.5 cm in every length, width and height, the robot soccer is played on the field measuring 220 cm x 180 cm, while the balls are used in robot soccer game is an orange golf ball [5]. MiroSot system consists of several devices that are needed are MiroSot robots, vision systems, communication systems with radio frequency (RF) and computer. In general, a camera vision system mounted 2.8 m above the ground to catch the objects that are in the field through a patch that is attached on top of the robot is used to determine the identity of the team colors and robots [7]. Then the data is sent to a computer system (host computer) to calculate the movement of the robot and transmitted via radio frequency (RF) to the robot for execution [8].

At the time of the robot game MiroSot 5 vs. 5 held in Malaysia on 24-29 August 2013, a team of robots of Informatics Departement of UPN "Veteran" Yogyakarta seen that the movement of the robot are still many shortcomings and is not in accordance with the orders made in the strategy. This condition makes the robot in determining the direction of motion towards the destination point and put yourself in the position is still not accurate and precise. This happens because the robot soccer is still not able to control their movements well especially frequent collisions on the opponent robots because there is no function to avoid obstacles.

Obstacle avoidance function is one part of the strategy in robot soccer game. When the robot moves toward the target and there are obstacles in front of him then this function helps the robot to avoid obstacles, by using a mathematical approach to the movement of the robot toward the target can be more precise and accurate capitalize on the knowledge base on Obstacle

Avoidance of the book "Soccer Robotic "[1]. The movement of the robot who is still chaotic and irregular that is applied to the robot MiroSot Informatics Departement of UPN "Veteran" Yogyakarta, even frequent collisions on friend and foe alike robot can be resolved with this obstacle avoidance function. In the obstacle avoidance function applied research on the defensive, based on the movement of individual robots to avoid an obstacle nearby. When on the defensive is not the function of the robot avoid obstacles will often foul during the match, the robot will hit another robot in front of him when the robot moves toward the direction of the ball to perform his duties as a robot to survive.

II. IMPLEMENTATION

Implementation in the manufacturing function to avoid obstacles, especially on the position of the robot defender MiroSot Information Engineering UPN "Veteran" Yogyakarta. Capitalize on the knowledge of the function Obstacle Avoidance on the book "Soccer Robotics" which was developed by Kim et al., 2004. The function will be implemented in the robot MiroSot Informatics UPN "Veteran" Yogyakarta to determine the success of the robot avoid obstacles and can determine the time taken by the robot until towards the targets. So that the data obtained from these functions can be avoided when the robot movement in the form of graphs. Thus Obstacle Avoidance function implementation is becoming a benchmark to build a function to avoid obstacles on the robot defender position MiroSot and coupled with the use of sensors in order to move the robot gyroscrope more effectively and quickly. This function will also be implemented in order to obtain some of the data including the data of success to avoid obstacles, the time data to determine how fast the robot can move up to the position of the destination and graph data while avoiding movement. In the position of defender also implemented on the function to block the ball so as not to be able to get into the goal. This function is also implemented to obtain data on the percentage of success in blocking the ball robot.

A. *Obstacle Avoidance Function*

Obstacle avoidance function is a function of the robot avoid obstacles in football, especially in the category MiroSot developed by Prof. Kim et al., 2004. The robot will avoid obstacles with yellow color detection is the identity of the opposing team. So the robot will avoid obstacles while moving towards the target by using the function to detect obstacles that are closest to him. Robot to perform this function takes a supporting function is a function of position the robot to move at a speed of 70 m / s. The speed is the average speed that is sent to the robot but the actual speed of more than that. The robot is currently performing this function uses two faces so that when applied in a position to be more effective defender to block the ball movement. In the Obstacle Avoidance function is a combination of several functions, namely functions PositionAvoidObstacle (determines the speed and using two face when moving towards the target), the function N_Obstacle (specify angle to avoid obstacles by potential field), and the function OpponentRobot * GetNearOpponent (specify the nearest obstacle in the robot). Function to avoid obstacles on the defensive is when the robot was ordered to go to the target, the first step is known coordinates of the robot. In addition to detection of the robot coordinates, coordinates detection of obstacles and targets must be known in order to know the angle to avoid obstacles, as well as the potential field is used to determine which direction the robot movement based univector navigation in the field. The robot will move towards the target (Gx, Gy) to avoid robot friend, when the coordinates (y) the robot is greater than the coordinate (y) obstacles the robot will move to right (clockwise) to get to the target, while the coordinates (y) robot less than the coordinate (y) obstacles the robot will move left (clockwise) to get to the target. This obstacle avoidance functions using function position where if the robot was headed on a previous targets will stop doing turning parallel to the y-axis. Flowchart function to avoid obstacles on the defensive can be seen in Figure 1.

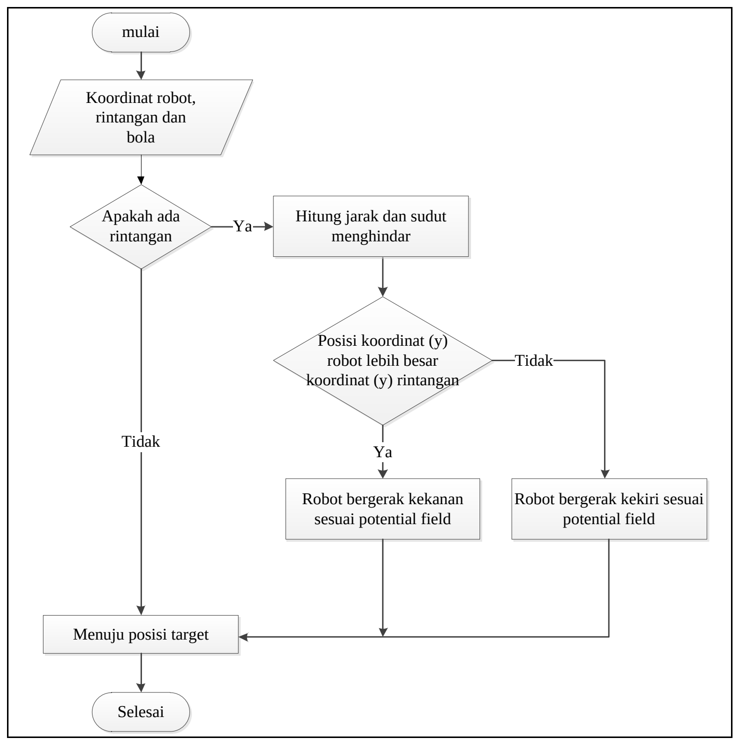

Fig 1. Obstacle Avoidance Function.

B. *Testing*

In this testing phase using robots MiroSot for Obstacle Avoidance test function to determine the movement of the robot base while avoiding. After the function is implemented on the robot MiroSot Informatics UPN "Veteran" Yogyakarta and performed testing on the function obtained results in the form of how quickly time (seconds) the travel is used to dodge and move toward the specific position at a constant speed of 70 m / s with distance (cm) of the obstacle and the goal position and angle (degrees) different. Percentage of success in avoiding the number of different obstacles make function developed by Prof. Kim et al., 2004 can be used as a basis to develop a function to avoid obstacles in the defender position.

Function to avoid obstacles on the position of defender was examined by avoiding obstacles in the form of robot friends with patches of blue color, whereas in Obstacle Avoidance function can only avoid obstacles in the form of an opponent robot with yellow patches. In the movement of these functions use the same two faces, namely the front and rear can be used to move so that the defender position is very effective in blocking the movement to block the ball or an opponent.

Testing the function of avoiding obstacles on the robot position using MiroSot defender with a gyroscope sensor, the test results in the form of a data speed (seconds) at any angle (degrees) and distance (cm) different. Tests performed 10x for each condition, the average value taken the time required and the average success in avoiding obstacles. Tests to avoid obstacles on the defensive can be seen as figure 2.

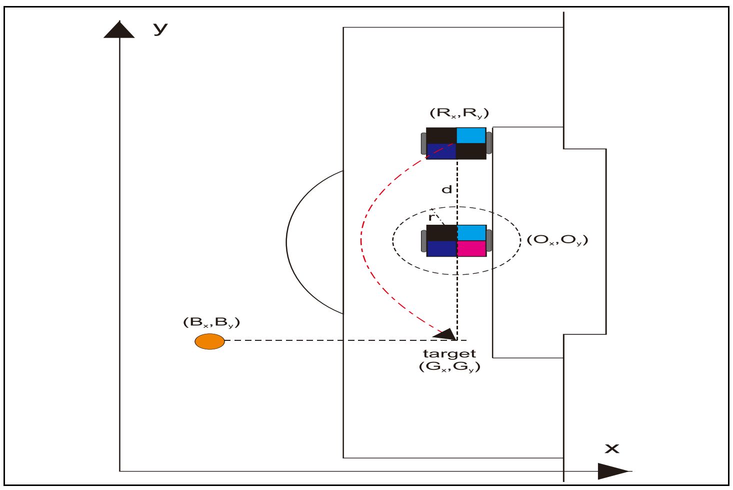

Fig 2. Obstacle Avoidance Function Testing.

The results of the testing that has been done will be recorded in Table 1 and then searched the average time (sec) and the success of the robot can be avoided with a certain distance and angle. So it will be graphed on obstacle avoidance function and can be viewed visualization of the robot while avoiding.

TABLE 1
DATA SPEED (SECOND) OF TESTING THE OBSTACLE AVOIDANCE FUNCTION DEVELOPED BY KIM ET AL., 2004 WITH TOTAL BARRIERS 1

The number of obstacles	The distance to the target (cm)	The distance to the nearest obstacle (cm)	The angle between the target and obstacles (degrees)	Time (sec)	Description (successful/ no)
1	100	30	0	5.31	Successful
			30	3.38	Successful
			60	3.48	Successful
			-30	4.09	Successful
			-60	4.94	Successful
		50	0	5.57	Successful
			30	4.81	Successful
			60	3.54	Successful
			-30	4.66	Successful
			-60	5.25	Successful
		70	0	3.83	Successful
			30	5.47	Successful
			60	5.84	Successful
			-30	4.69	Successful
			-60	5.25	Successful

Further testing Obstacle Avoidance function using two obstacles to find the average speed data and percentage of success resulting from testing this function, the level of success in avoiding two obstacles still many are successful about 60%. Test results can be seen in Table 2.

TABLE 2
DATA SPEED (SECOND) OF TESTING THE OBSTACLE AVOIDANCE FUNCTION DEVELOPED BY KIM ET AL., 2004 WITH TOTAL BARRIERS 2

The number of obstacles	The distance to the target (cm)	The distance to the nearest obstacle (cm)	The angle between the target and obstacles (degrees)	Time (sec)	Description (successful/ no)
2	100	30& 50	0	5.11	No
			30	5.35	Successful
			60	4.65	Successful
			-30	6.03	Successful
			-60	6.42	Successful
		30 & 70	0	5.52	No
			30	4.46	Successful
			60	4.86	Successful
			-30	3.47	No
			-60	3.62	Successful
		50 &70	0	4.62	No
			30	4.59	Successful
			60	4.15	Successful
			-30	5.45	No
			-60	6.89	No

Obstacle Avoidance function testing using 3 different obstacles by laying in each test. With a predetermined angle will be obtained results during the time it takes the robot to avoid obstacles towards the particular position and the percentage of success in the robot avoid obstacles predetermined, the percentage of success obtained in the movement of the robot avoid obstacles around 53%. The results of the testing function Obstacle Avoidance can be seen in Table 3 to avoid 3 obstacles.

TABLE 3
DATA SPEED (SECOND) OF TESTING THE OBSTACLE AVOIDANCE FUNCTION DEVELOPED BY KIM ET AL., 2004 WITH TOTAL BARRIERS 3

The number of obstacles	The distance to the target (cm)	The distance to the nearest obstacle (cm)	The angle between the target and obstacles (degrees)	Time (sec)	Description (successful/ no)
3	100	30 & 50, (±25) & 70	0	4.11	Successful
			30	6.42	No
			60	6.20	No
			-30	4.14	Successful
			-60	5.56	No
		30 & 50, (20) & 70, (-20)	0	4.79	No
			30	5.18	Successful
			60	3.86	Successful
			-30	5.53	No
			-60	5.14	Successful
		30 & 50, (-20) & 70, (20)	0	3.92	No
			30	4.15	Successful
			60	4.36	Successful
			-30	4.59	No
			-60	4.08	Successful

Testing the function of avoiding obstacles by using a gyroscope sensor is done by determining the distance between the robot and the position of the destination point, the position of the robot with obstacle position, the initial angle of the robot, the number of obstacles and the level of success in avoiding obstacles. Robot avoid obstacles is the same friend or patch used on the robot. In the test the robot is able to avoid obstacles average time data used in the course to avoid obstacles and the percentage of success obtained from testing to avoid one obstacle can be seen in Table 4.

TABLE 4
DATA SPEED (SECOND) OF TESTING THE OBSTACLE AVOIDANCE FUNCTION WITH USING SENSOR GYROSCOPE TOTAL BARRIERS 1

The number of obstacles	The distanc e to the target (cm)	The distance to the nearest obstacle (cm)	The angle between the target and obstacles (degrees)	Time (sec)	Description (successful/ no)
1	100	30	0	4,43	Successful
			30	3,32	Successful
			60	3,06	Successful
			-30	4,08	Successful
			-60	4,15	Successful
		50	0	4,54	Successful
			30	4,04	Successful
			60	4,55	Successful
			-30	3,53	Successful
			-60	3,42	Successful
		70	0	3,27	Successful
			30	3,19	Successful
			60	4,24	Successful
			-30	3,7	Successful
			-60	4,1	Successful

Further testing of the function of avoiding obstacles by using a gyroscope sensor using two obstacles to find the average speed data and percentage of success resulting from testing this function, the level of success in avoiding two obstacles still many are successful about 67%. Test results can be seen in Table 5.

TABLE 5
DATA SPEED (SECOND) OF TESTING THE OBSTACLE AVOIDANCE FUNCTION WITH USING SENSOR GYROSCOPE TOTAL BARRIERS 2

The number of obstacles	The distance to the target (cm)	The distance to the nearest obstacle (cm)	The angle between the target and obstacles (degrees)	Time (sec)	Description (successful/ no)
2	100	30 & 50	0	4.68	No
			30	4.52	Successful
			60	4.44	Successful
			-30	4.65	No
			-60	4.99	Successful
		30 & 70	0	5.62	No
			30	4.52	Successful
			60	4	Successful
			-30	4.32	Successful
			-60	3.82	Successful
		50 & 70	0	3.76	Successful
			30	4.68	Successful
			60	4.14	Successful
			-30	5.61	No
			-60	5.31	No

Testing functions avoid obstacles by using the gyroscope sensor using 3 different obstacles by laying in each test. With a predetermined angle will be obtained results during the time it takes the robot to avoid obstacles towards the particular position and the percentage of success in the robot avoid obstacles predetermined, the percentage of success obtained in the movement of the robot avoid obstacles around 93%. The distance to the obstacle is a hurdle that must be avoided coordinates. The results of the testing function to avoid obstacles by using sensors gyroscopedapat seen in Table 6 to avoid 3 obstacles.

TABLE 6
DATA SPEED (SECOND) OF TESTING THE OBSTACLE AVOIDANCE FUNCTION WITH USING SENSOR GYROSCOPE TOTAL BARRIERS 3

The number of obstacles	The distanc e to the target (cm)	The distance to the nearest obstacle (cm)	The angle between the target and obstacles (degrees)	Time (sec)	Description (successful/ no)
3	100	30 & 50, (±25) & 70	0	4.9	Successful
			30	5.13	Successful
			60	5.41	Successful
			-30	4.37	Successful
			-60	4.3	Successful
		30 & 50, (20) & 70, (-20)	0	5.17	No
			30	4.21	Successful
			60	4.46	Successful
			-30	4.91	Successful

			-60	4.77	Successful
		30 & 50, (-20) & 70, (20)	0	5.51	Successful
			30	4.01	Successful
			60	3.87	Successful
			-30	3.9	Successful
			-60	4.96	Successful

The results obtained from tests performed on the obstacle 1, everything can be managed through the obstacles with a percentage of 100%, both of the trials of obstacle avoidance function and avoid obstacles with gyroscope, but from the graph it can be seen that the function of avoiding obstacles with gyroscope faster up of the use of obstacle avoidance function.

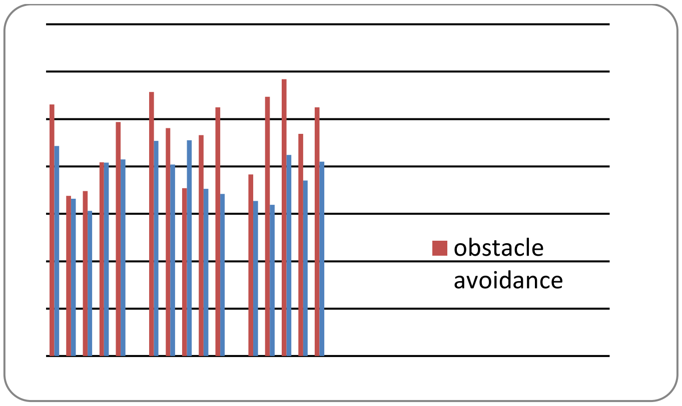

Fig 3. Grafik perbandingan waktu tempuh menggunakan 1 rintangan.

In the second obstacle to this can be obtained by percentage of 60% on the function of obstacle avoidance and obstacle avoidance using the gyroscope function by 67%.

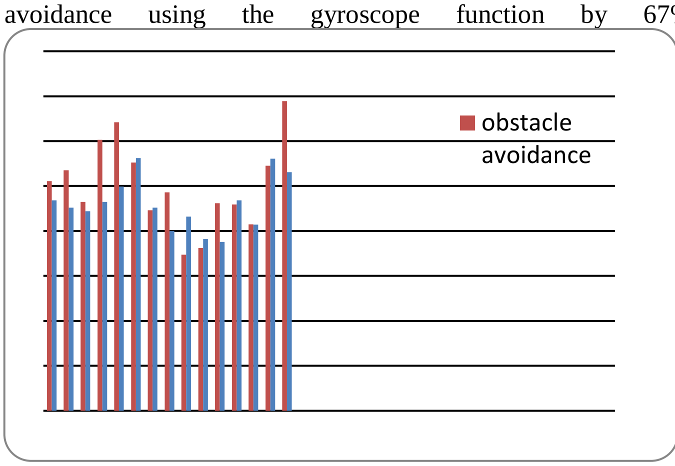

Fig 4. Grafik perbandingan waktu tempuh menggunakan 2 rintangan.

III. CONCLUSION

Based on the research that has been done, it can be concluded some of the following:

1. Have generated a function to avoid obstacles, especially in the position of the robot defender MiroSot in the Departement Informatics of UPN "Veteran" Yogyakarta.
2. Based on the existing potential in the field of navigation algorithms can be determined univector mathematical approach to avoid obstacles so that the resulting curve is the way to the target. Received more and more obstacles in the robot to the target, the greater the error position.
3. The function of avoiding obstacles on the defender position stems from the development of the function Obstacle Avoidance by Kim et al., 2004 and implemented on the robot Mirosot with a success rate of 59% and with an average wakti by 5.3 seconds at more than two obstacles.
4. The function of avoiding obstacles on the defender by using a gyroscope sensor has a 96% success with an average travel time of 4:33 seconds. So at imlementasinya use the gyroscope sensor, the robot move more effectively to avoid obstacles and faster to the target.

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