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Improving the Modelling of Robot Bunker With Camera

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Improving the Modelling of Robot Bunker With Camera

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Abstract. This study proposed an improvement on the model of robot bunker with camera. This is designed in order that robot is difficult to steal. The previous model is equipped with a security system. However, the system is not equipped with a camera so that when theft occurs, the action cannot be recorded. This study used 16 rules, because of the addition of variable pixels produced by the camera. The simulation is carried out as many as 30 (thirty) possible conditions of actions taken by the people on the robot with Matlab Fuzzy Toolbox. In the result of the simulations, the test results can change from safe conditions to alert or dangerous conditions. This is caused by changes in the number of pixels. The pixel value increases when someone tries to take a robot from the robot bunker. Thus the proposed model is more sensitive in detecting changes that occur around the robot bunker. Therefore this model can be applied in securing / protecting robot from theft.

1. Introduction

At present theft of public facilities often occurs in Indonesia. This caused the government to lose a lot of money [1], [2], [3], [4]. Though public facilities are very supportive so that the city looks clean and comfortable. In big cities in developed countries, robots are also used as supporting facilities in an effort to make the city look clean and comfortable, such as garbage cleaning robots, security robots for certain areas [5], [6], [7]. But the price of the robot is relatively expensive and this causes the government to think twice about buying the robot [8], because it is vulnerable to theft. In the previous study a robot bunker model was proposed. This robot bunker functions as a robot hiding place when it has finished its task. This robot is equipped with various sensors, namely ultrasonic sensors [9], LDR sensors [10] and PIR sensors [11]. The sensors are used as variables in fuzzy logic with the Sugeno method [12]. But this previous robot bunker model still has weaknesses, because there are no cameras in the proposed system. This causes the robot bunker not able to record events when the detection process by the sensor occurs. Whereas in some studies, the camera can be used to detect human movements [13], [14], [15], [16], [17] [18]. That is why the improving model of the robot bunker is proposed so that the robot bunker model can be more reliable to use.

2. Improving The Modelling of Robot Bunker

In previous studies the robot model was equipped with sensor-based security system for its detection process[19]. But this detection process still has weaknesses, because it cannot record events when theft activity was carried out. For this reason, in the next study the system is equipped with a camera as shown in Figure 1.

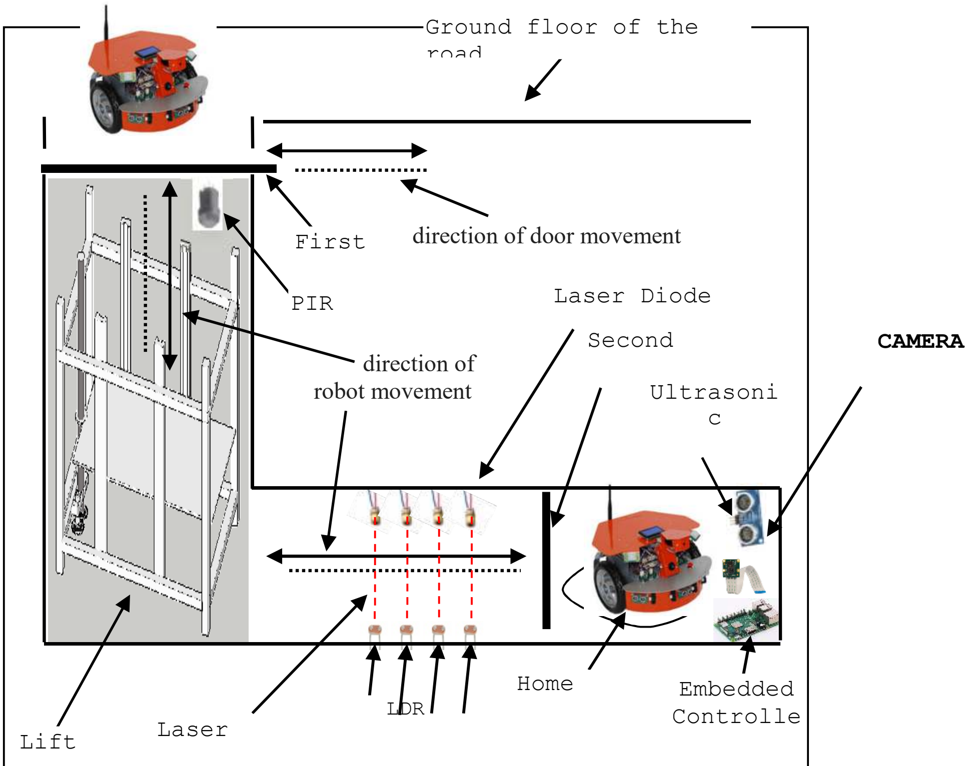

Figure 1. Improving The Model of Robot Bunker

3. Result of Simulation and Discussion

In the previous research and the proposed method was verified through simulation using MATLAB. In previous research the rules used are 8 rules. The simulation is carried out by using 10 (ten) possible conditions that occur against the robot. Figure 2 is one of the simulation results. In this test the values for fuzzy input variables are as follows; the distance is 55 cm, the light obstruction is 1, and the movement is 7. In the simulation results, the output Crisp value is 1.5.

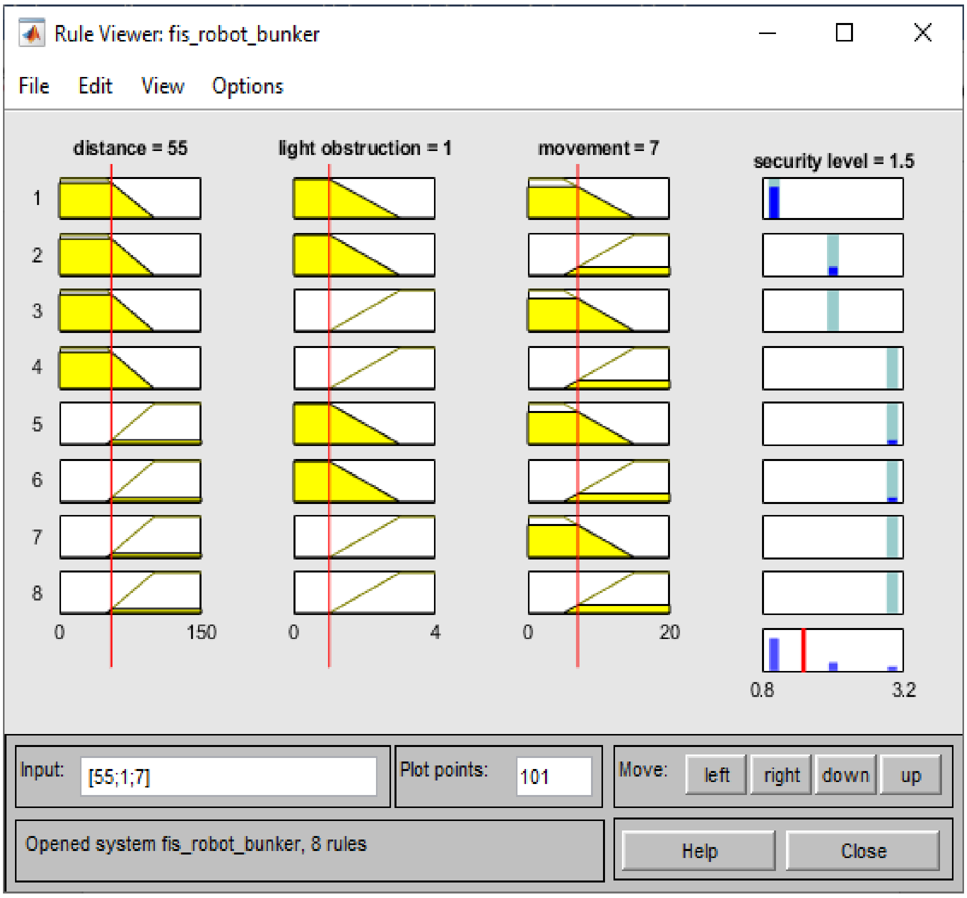

Figure 2. Test of Simulation with MATLAB

In figure 2 it can be seen that the input value of the fuzzy variable is; Distance = 55, Light Obstruction = 1, Movement = 7. Based on this value, the rules used are rule 1, rule 2, rule 5 and rule 6.

After the inference rule is completed, a defuzification process is performed to find the z valueas follows. The value of z is searched by the following equation :

$$z = \frac{apred1 * z1 + apred2 * z2 + apred5 * z5 + apred6 * z6}{apred1 + apred2 + apred5 + apred6}$$

$$z = \frac{0.8 * 1 + 0.2 * 2 + 0.1 * 3 + 0.1 * 3}{0.8 + 0.2 + 0.1 + 0.1} = 1.5$$

The defuzzification results obtained an crisp output value of 1.5 This value is used as a security level presentation. All simulations results can be seen in table 1.

Table 1. Fuzzy Logic Test Results

Number of test	Fuzzy Variables			Defuzzification (crisp Output)
	Distance	Light Obstruction	Movement	
1	40	0	1	1

2	51	1	2	1.04
3	55	1	7	1.5
4	57	2	8	2.17
5	60	2	12	2.42
6	70	3	6	2.5
7	85	4	13	2.86
8	98	3	14	2.96
9	110	4	7	3
10	128	2	10	3

In the proposed method, the modelling robot bunker was improved by adding camera, namely pixel variable. This simulation is carried out as many as 30 (thirty) possible conditions of action taken by people on the robot. In figure 3, 4 and 5 the value of input variable fuzzy such as ; distance, light obstruction and movement variable are made exactly the same as the value of the variable in figure 2. The difference is in the addition of pixel variables. Here, the values of different pixels are inputted: 500, 1500 and 2000 pixels.

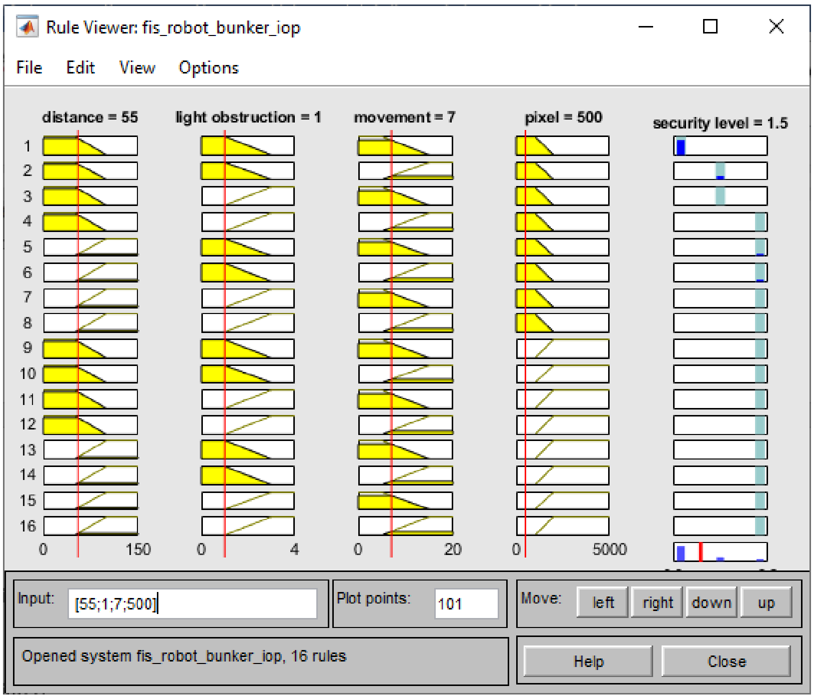

Figure 3. The 7th test of Simulation with MATLAB *using* Sugeno Method

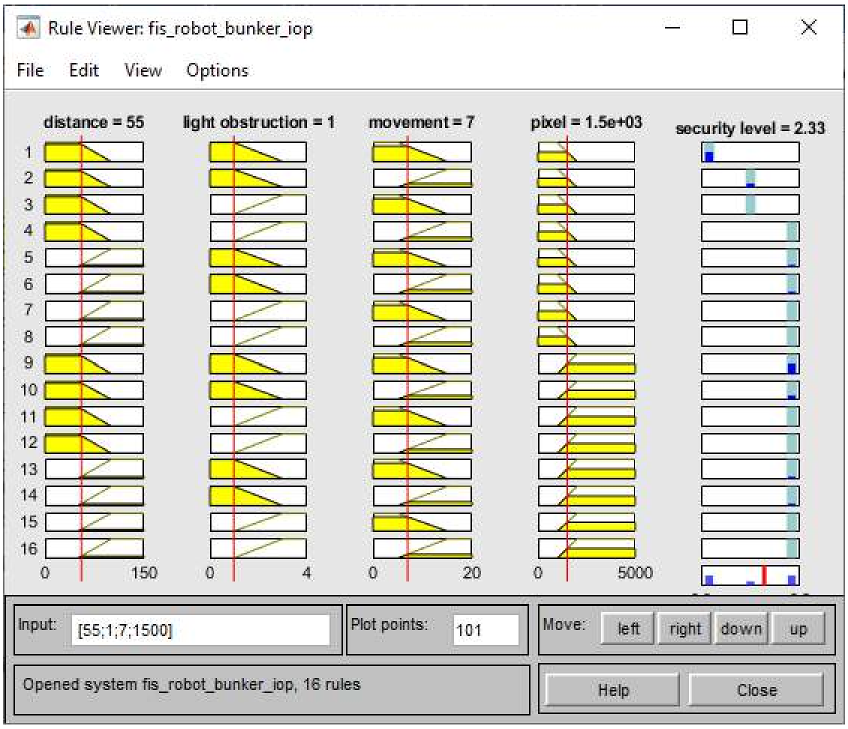

Figure 4. The 8th test of Simulation

Figure 5. The 9th test of Simulation

From the test results it can be seen that when the pixel value = 500, the crisp output values of tables 1 and 2 are exactly the same. But when the pixel count increases to 1500 or 2000 pixels, the output can change to 2 (alert condition) or 3 (danger condition). This means that if the camera detects a person trying to steal a robot, then the number of pixels that increases and the conditions that were previously safe can turn into alert or danger. All of the result of tests can be seen in table 2.

Table 2. Fuzzy Logic Test Results with Pixel Variable

Number of test	Fuzzy Variables				Defuzzification (crisp Output)
	Distance	Light Obstruction	Movement	Pixel	
1	40	0	1	500	1
2	40	0	1	1000	2
3	40	0	1	1500	3
4	51	1	2	500	1.04
5	51	1	2	1000	2.04
6	51	1	2	1500	3
7	55	1	7	500	1.5
8	55	1	7	1000	2.33
9	55	1	7	1500	3
10	57	2	8	500	2.17
11	57	2	8	1000	2.58
12	57	2	8	1500	3
13	60	2	12	500	2.42
14	60	2	12	1000	2.71
15	60	2	12	1500	3
16	70	3	6	500	2.5
17	70	3	6	1000	2.77
18	70	3	6	1500	3
19	85	4	13	500	2.86
20	85	4	13	1000	2.92
21	85	4	13	1500	3
22	98	3	14	500	2.96
23	98	3	14	1000	2.97
24	98	3	14	1500	3
25	110	4	7	500	3
26	110	4	7	1000	3
27	110	4	7	1500	3
28	128	2	10	500	3
29	128	2	10	1000	3
30	128	2	10	1500	3

4. Conclusions

The aim of this paper was to explain enhancement modelling of robot bunker with camera. The previous model is equipped with a security system (prevention, detection and reaction). However, the system is not equipped with a camera so that when theft occurs, the action cannot be recorded. In the table 2 the test results of the simulation can change from safe conditions to alert or dangerous conditions. This is caused by changes in the number of pixels. The pixel value increases when someone tries to insert a bunker robot to do theft activities. Thus the proposed model is more sensitive in detecting changes that occur around the bunker robot. Any changes to these variables will trigger the robot bunker's reaction to theft. Therefore the robot bunker model is able to be applied in securing/ protecting robots from thieves. In the Future research can focus on implementing robot bunker in the real life.

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