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GACOBOT Navigation System for Distribution Solid Waste to Temporary Dumpsite

Wahyu GUNAWAN[1], Aditya P. P. PRASETYO[2*], Siti NURMAINI[3], RENDYANSYAH[4], and Sri Desy SISWANTI[5]

[1,2,3,4,5]*Department of Computer Systems, Faculty of Computer Science, Sriwijaya University, Indonesia*
**Corresponding author: aditrecca@gmail.com*

ABSTRACT
Gacobot is garbage collection and deliver the garbage to the temporary dumpsite and a robot which is an integration of mobile robotic systems and non-mobile robot, that robot such as a car robot systems and robotic manipulator as garbage grabber system. GACOBOT system also integrates an ultrasonic sensor and navigation systems as GACOBOT support systems, process waste dumps by conditioning the front ultrasonic sensor, then adjust grabber garbage and put it in a trash receptacle while the robot is installed by robots. The process of garbage disposal at temporary dumpsite has managed to pass the barrier and to the point that has been set. The process of garbage disposal using pattern
Keywords: *garbage collector, navigation system, distribution solid waste, temporary dumpsite*

Introduction

The presence of waste is one of the problems faced by the community. The existence of unwanted trash when connected by a factor of hygiene, health, comfort and beauty (aesthetics). The floods are usually due to too much garbage[1]. One of the factors that affect the environment is the problem of disposal and waste management. Garbage is the waste material as a result of human activity which is a material that has no further use[2].

Distribution of household waste that is less periodical is one cause of the accumulation of waste. Lack of human consciousness in the distribution of household waste that cause natural disasters. Therefore, a system or institution to distribute the necessary household waste, such as general cleaning staff, who every day take and distribute household waste to landfills public, human limitations in terms of health is one of the obstacles for the regular distribution of waste. To handle such cases, required a system that can replace the human role in the distribution of household waste tangga.Indonesian translation.

Waste management concept Reuse- Reduce-Recycling (3R) is an integrated solid waste management and community-based eco-friendly in an effort to reduce waste since at source[3], Temporary Dumpsite is a facility that is located close to residential or commercial areas, processing center (such as waste to energy plants) or composting facility. Sometimes temporary dumpsite also provides waste sorting and recycling facilities[4].

This Fuzzy-kohonen Network (FKN) technique is utilized, to integrate supervised learning skills and the basic rules of Fuzzy logic. This technique explains that it reduces to order these experiences to achieve the required spatial and temporal reasoning properties by using memory-based reasoning. The strategy is that Mobile robots must have the ability to recognize and memorize the environment, build the desired mapping between the perception of human knowledge and the exact movements of the Mobile robot [5]

Robot is a tool that can alleviate human labor, design a robot that can distribute the waste at one venue to another location can overcome the accumulation of household waste. Robot system is expected to carry a certain load and carry them from the case of car-like robot or a mobile robot that has a 4-drive system that is ideal for lifting in a way that seimbang.Indonesian translation.

Robot was created as a tool of human beings. By looking at the greater role of the robot, this required new methods for the improvement of the car robot technology[6]

Currently the mobile robot technology has developed very rapidly. Many mobile robotic technology applications used in everyday life. Such as clean room robot [7], the bomb squad [8], an intelligent wheelchair [9], and Freight Forwarder in factories or hospitals [10]. A mobile robot requires navigation system so that it can move from one place to another. Intelligent robot moves must of course be able to recognize the situation.

Literature review

2.1. Ultrasonic Sensor

The ultrasonic sensor is a sensor that transforms the physical quantities (sound) into electrical quantities. In this sensor ultrasonic wave generated by an object called piezoelectric. This will produce a piezoelectric ultrasonic waves with a frequency of 40 kHz when an oscillator is applied to the object. Ultrasonic sensors commonly used for such a disclosure does not touch as diverse as distance measurement applications. This tool is generally emit ultrasonic sound waves toward a target behind the reflecting wave towards the sensor. The system measures the time required for transmitting the waves to return kesensor and calculate the target range by using the speed of sound in the medium. The circuit constituent ultrasonic sensor consists of a transmitter, reiceiver, and comparator [11].

Figure 1. Physical form of Ultrasonic sensor

2.2. DC Motor

DC (Direct Current) Motor is a basic electromagnetic equipment which serves to convert electrical power into mechanical power that design originally introduced by Michael faraday more than a century ago. DC motors are controlled by determining the direction and speed of rotation. DC motor rotation direction is the direction of the clockwise (Clock Wise / CW) or counter clockwise to clockwise (Counter Clock Wise / CCW), which depend on the polar relationship given in a DC motor. DC motor speed is set by the amount of current supplied [12].

Figure 2. Physical form of DC motors

2.3. Arduino module

Arduino Uno R3 are the minimum system board AVR microcontroller based ATmega328P types. Arduino Uno R3 has 14 digital input / output (6 of which can be used for PWM outputs), 6 analog inputs, 16 MHz crystal oscillator, a USB connection, a power jack, ICSP header and a reset button. The physical form and pin layout of the Arduino Uno R3 can be seen in Figure 3 with the following characteristics [13].

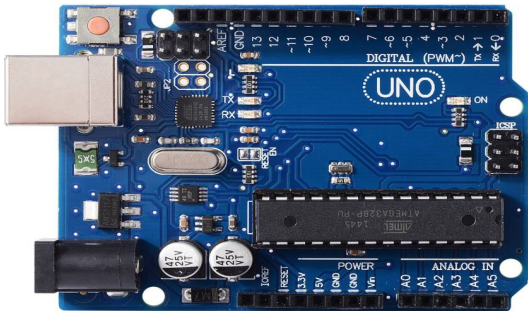

Figure 3. Physical form of Arduino module

2.4. Servo Motor

Servo motor is a motor with a closed feedback system in which the position of the motor will be communicated back to the control circuit in the servo motor [14]. Servo motor consists of a motor, a set of gear, and potentiometer control circuit. The potentiometer serves to determine the angle of rotation servo limit. While the angle of the servo motor axis is set based on the pulse width of the signal sent through the legs of the motor cable.

Figure 4. Physical form of Servo motor

Servo motors used are servo motors Tower Pro MG995. This servo motor is a servo motor types standard 180° are only able to move in both directions clockwise and anti-clockwise (CW and CCW) with each deflection angle reaches 90° so that the total deflection angle of the centre-right-left is 180°. Operational servo motor is controlled by an angle, where the long corner that can be used from 0° to 180°. When the servo motor with a given angle of 90° then the servo reaches 90 ° movement (neutral), when given angle 0° then the servo position 0° (CCW) and when given angle servo 1800 then post the contents of 180° (CW).

2.5. XBee Pro

XBee-Pro device is an RF module which is designed with the IEEE 802.15.4 standard protocol and in accordance with the simple requirement for wireless sensor networks. XBee-Pro only requires low energy to operate and small physical dimensions so practical placements. This module operates at 2.4 GHz frequency range. Figure 2.7 Forms & Pin XBee-Pro Image, Communication XBee Pro series[15].

Figure 5. Physical form of XBee Pro

2.6. Fuzzy Kohonen Network (FKN)

Artificial neural networks (ANN) and fuzzy logic are two different methods used to present human intelligence in working on data processing, although the implementation of these approaches has a different perspective. As a stand-alone system, two methods have unique features and limitations of their own contradictions.

ANN has the ability to learn, but cannot explain the reasoning process that is carried out. While Fuzzy logic has no learning ability, it can explain the reasoning process that is carried out based on rules in the knowledge base. Therefore, each method only has the ability to solve one aspect of a problem, but cannot provide a total solution.

Until now, a lot of interesting research has been done to integrate between ANN and Fuzzy logic. The result of the integration of both generating new methods of artificial intelligence, called Neuro-Fuzzy. Neuro-fuzzy method is basically using the fuzzy logic that comes from ANN learning algorithm to determine the basic parameters in the data sample. Neuro-fuzzy methods generally provide a better solution than each individual component.

FKN is one type of neuro-fuzzy methods that are the result of integration between fuzzy logic and ANN Kohonen [16]. Kohonen has the advantage of learning in pattern recognition, while Fuzzy logic plays a role in managing the process inputs and outputs of the current Kohonen pattern recognition translates into a process of reasoning based on predefined rules.

FKN is the result of the development of methods FKCN (fuzzy Kohonen Clustering Network). One of the weaknesses in the methods FKCN is a long training time to find weights that meet the performance [17]. So to overcome this learning process was simplified before without supervision for supervised, known as FKN method [18]. It is said to be supervised because the weights used are not changed and replaced with fixed weights are determined based on expert knowledge in terms of using the rules in fuzzy logic, so that the training process can be eliminated. This is the basis of the technique FKN.

In FKN technique, the weight gained from changing patterns of the prototype to the input patterns [19]. Pattern derived from experiments using some sample data and ultimately appropriate weight to be obtained. After determining the weights, there will be a number of prototype pattern that presents some variation in pattern classification.

After the FKN weights are known, weights can be invoked directly when the actual data has been entered, this is what is called the learning process in the FKN method. Without the training process and only doing this learning process is the difference between the FKN method and the FKCN method.

METHOD

Hardware design GACOBOT

At this stage, the Mobile Robot manufactured or assembled to be fitted with ultrasonic sensors. Mobile robot is also equipped with a 2-axis manipulator system based on the manipulator connected with Grip Tip. This Mobile Robot is also equipped with 1 garbage container in the middle of the robot and moves using 1 servo. Mobile robots move using a DC motor and servo motors. In this study, Mobile robot designed to resemble a four-wheeled vehicle with the same system and mechanism, four-wheel drive with 2 rear wheel as a driver and two front wheels and the control centre manipulator system designed to lift the litter box and distribute them. Figure 6 shows the design of a GACOBOT. Schematic design of the hardware in the GACOBOT is shown in Figure 7. And in figure 8 shows the physical form of the GACOBOT that has been made

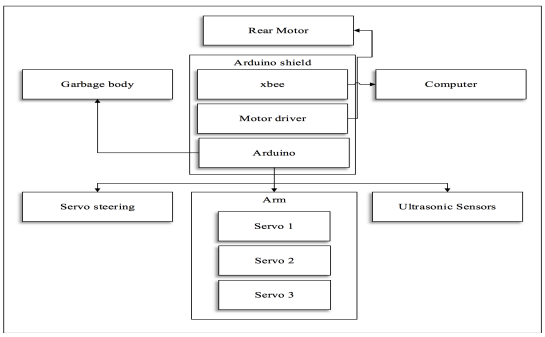

Figure 6. GOCOBOT hardware design scheme

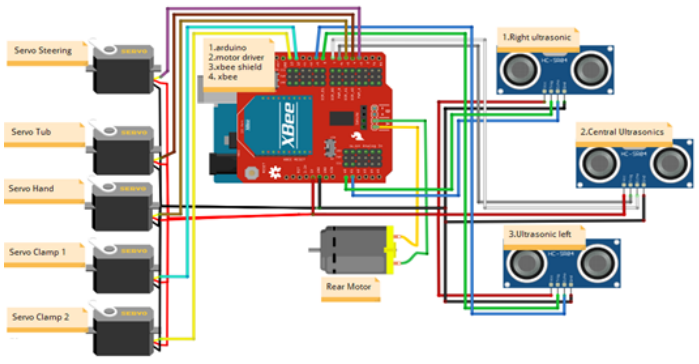

Figure 7. GACOBOT fritzing design

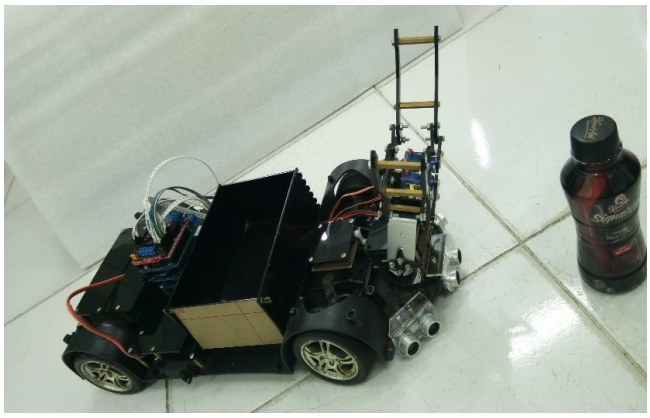

Figure 8. Physical form of GACOBOT

3.2. GACOBOT Software Design

FKN algorithm design consists of several steps, namely (1) the quantization value of the proximity sensor, (2) the classification of environmental trends, (3) the membership function and rule base, and (4) the output speed of a DC motor. All these steps will be explained through flowcharts, algorithms, and an explanation for easier understanding. FKN flowchart of the algorithm can be seen in Figure 9.

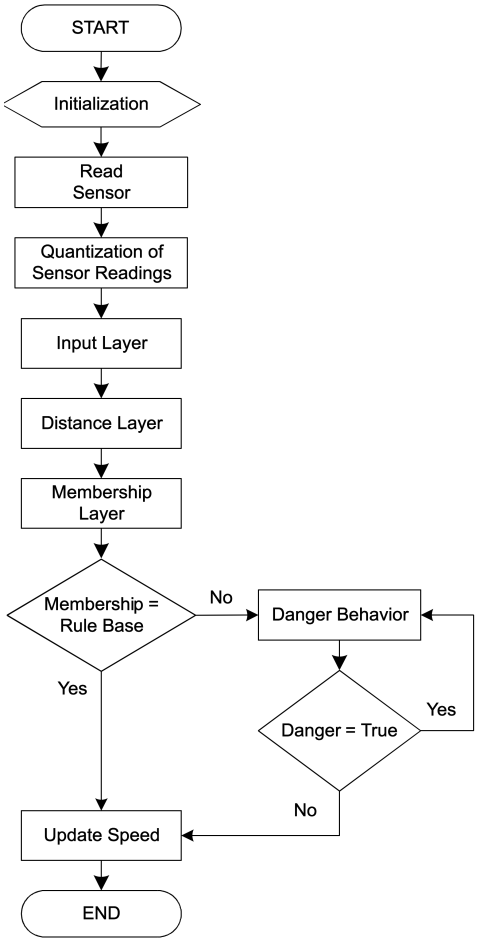

Figure 9. Flowchart of FKN algorithm

Based on the figure 9, it is known that prior to further processing algorithm FKN measured value of sensor readings will be the first to score heavily. The weight value of each sensor will be on environmental trends that will be compared with the pattern that has been implanted in a robot agent and will be processed through three layers of FKN. If a pattern is recognized, the robot agent will move according to the reference speed of implanted. However, if the pattern is not recognized, it will be considered to be in the danger area.

3.3. Environmental Classification Algorithm Design

Environmental classification required by the robot as a form of pattern recognition. 7 types of classification configuration constraints used in this study are shown in figure 10. The result of combining the fuzzification process and the combination of 7 pattern classification in this FKN caused us to not consider other constraints configuration which is the main purpose of the membership layer. This results in very little control rules (control rules) as compared with the conventional fuzzy control method [20].

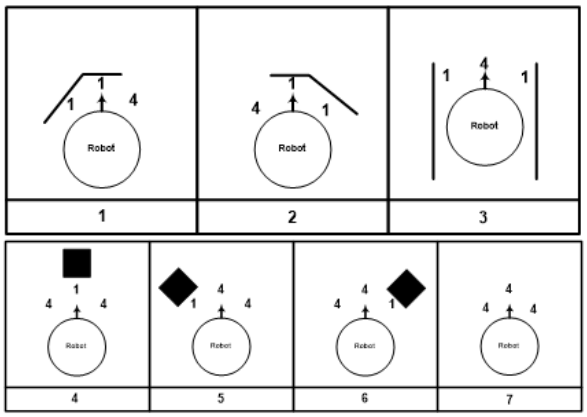

Figure 10. FKN environmental classification

Testing and Analysis

At this stage in doing GACOBOT overall testing device includes testing of sensors, dc motors, servo motors and XBee. Tests carried out in an open environment, where the stacking hurdles and a target of (Temporary Dumpsite). Where GACOBOT going towards the target by passing the hurdles that have been created in that environment. GACOBOT test environment can be seen in Figure 11 below.

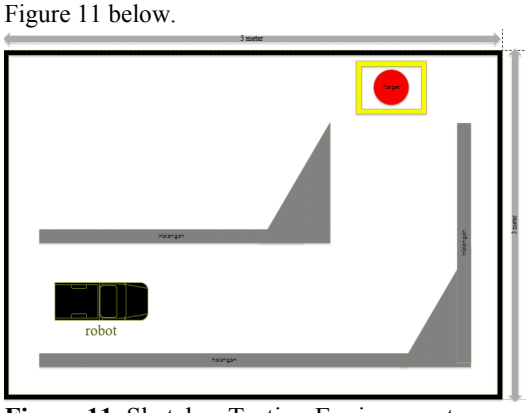

Figure 11. Sketches Testing Environment

Testing the movement of the robot to the target is carried out in that environment and monitored using an xbee module that sends data from the robot to the monitoring computer. The results of the data from testing the robot to the target can be seen in table 1 below

.

Table 1. Testing Robot Movement Toward Target

Left Sensor (cm)	Sensor middle (cm)	Right Sensor (cm)	Servo Angle (°)	Sensor Weights	PWM Motors	Servo angle on dump (°)
19	52	19	90	2 4 2	100	0
17	48	18	90	2 4 2	100	0
17	45	17	90	2 4 2	100	0
18	44	18	90	2 4 2	100	0
18	41	17	90	2 4 2	100	0
18	39	19	90	2 4 2	100	0
18	37	19	90	2 4 2	100	0
19	35	18	90	2 4 2	100	0
19	32	17	90	2 4 2	100	0
19	20	18	90	2 3 2	100	0
63	18	17	120	4 2 2	75	0
60	19	19	120	4 2 2	75	0
61	24	19	120	4 3 2	75	0
24	44	17	120	3 4 2	75	0
19	40	19	90	2 4 2	100	0
19	37	18	90	2 4 2	100	0
17	36	18	90	2 4 2	100	0
18	33	17	90	2 4 2	100	0
18	29	17	90	2 4 2	100	0
19	25	19	90	2 3 2	75	0
18	20	19	90	2 3 2	75	0
19	19	19	90	2 2 2	0	90
19	18	17	90	2 2 2	0	90

Based on table 1 where when the pattern is detected or in other words the sensor reads value [2 2 2], GACOBOT will stop and will put trash on the target (Temporary Dumpsite) that has been found or determined in the environment.

From these tests where GACOBOT can go to or move towards targets that have been determined in the

environment. From this test also can be obtained other results in the form of robot movement tracts originating from the analysis of GACOBOT movements in the test data generated (sensor readings and motor movements). The form of the trajectory can be seen in Figure 12 below.

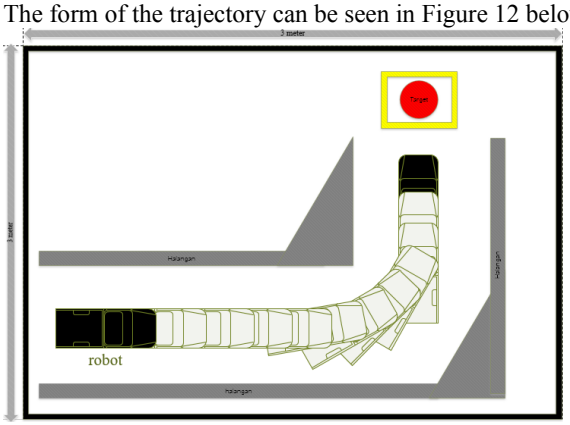

Figure 12. Trajectory Testing Results

It can be seen in Figure 12 that the movement of the robot looks good and smooth, because GACOBOT has recognized the movement to be performed based on the classification of the embedded pattern recognition. Embedded patterns have 2 functions, namely to avoid obstacles and execute when finding targets.

CONCLUSION

From the results of the tests that have been carried out, it was concluded that the application of GACOBOT to find the target (Temporary Dumpsite) of the temporary place of construction with the environment that has been designed, has been successfully implemented and produces good performance. This is supported by the small error resulting from measuring distance to the object and the success of the pattern recognition method that has been implanted. So that the control system of the servo motor and DC motor that was made can be integrated and successfully recognize the intended target.

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