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Design of Mobile Robot Wall Follower Using Microcontroller Using Fuzzy Logic Algorithms

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ABSTRACT

Designing and implementing artificial intelligence for car robots is not easy, but with the development of technology, many methods can be used to support the creation of artificial intelligence. The type of control is also very diverse, depending on the object to be created. One of the technologies that can be used to combine these capabilities is fuzzy logic. Where the use of fuzzy logic technology has now developed rapidly and widely in various applications, ranging from information analysis to industrial processes, electronic equipment and others. In this research, logic control design is implemented on the wall follower robot car. Full logic to make movement decision making that combines multiple input data with capabilities, with the decision making technique, the robot wall follower can have the ability to move along the wall stable. This study aims to produce a fuzzy logic design that can be implemented on a wall follower robot car so that when the robot car moves, it can navigate the wall stably. The final result of this research is a logic control design that can be implemented on a wall follower robot car made using wall follower algorithm and Sugeno fuzzy logic to make decisions on the control of the robot car wheel so that when the robot car moves down the wall, the robot car can adjust the distance to the wall to keep it constant.

1. Introduction

Rapid technological developments create a need for technology is growing. Various ways done to facilitate the man to do a job, one of which is by using artificial intelligence or artificial intelligence (AI) on the robot used for industrial purposes, especially for work that is hazardous and difficult. This was done to facilitate the work of man, when the work performed requires a high enough precision, the robot is an intelligent solution, especially when the job has a substantial risk to human safety.

Designing and implementing artificial intelligence to mobile robot is not easy, but with the development of technology, many methods that can be used to support the creation of artificial intelligence. Type of control is very varied, depending on the object to be created.

Artificial intelligence robot cars that exist today as it has been applied to the robot BRAM (Beginer's Autonomous Mobile Robot), is still partial and work serially or hierarchy that have a disadvantage in terms of processes simultaneously. So the need to develop the technology decision-making movement that combines multiple data input capabilities that are owned, with the decision-making techniques, Wall Follower Mobile robots have the ability to move stable following the path of the wall and keep a distance of stability against the wall.

One among the technologies that can be used to combine these abilities is a fuzzy logic. Where the use of fuzzy logic technology today has grown rapidly and expanded in various applications, ranging from the analysis of the information to industrial processes, equipment and other electronics. In recent years, fuzzy logic has become a basic material for the design of mobile robot

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technology, as well as having economic value in itself, after the development of the capabilities of the robot.

Therefore, in this study will be made of a design and implementation of fuzzy logic control in the wall follower mobile robot to make decisions from a variety of existing entries. For the moment the input used is the ability to move along the wall with a steady distance to the wall and maintain stability when moving.

2. Literature

A. Robot

"The robot is a mechanical device that can perform physical tasks, using either human supervision and control, or using a program that has been defined beforehand. Robots are typically used for heavy-duty, dangerous, repetitive and dirty jobs. Most robots used in industry, for example for cleaning up toxic waste, water Dawah exploration and space. But along with the development, the robot has begun to enter the field of entertainment and education, household auxiliaries, such as vacuum cleaners and lawn mowers "[1].

B. Wall Following

"A robot requires reference to be able to move from one location to another, One way to do this is to follow the line, another way is to use the existing wall around us to guide the robot to move from one location to another. This robot uses a proximity sensor to perform this job. This robot can be designed to follow the wall on the left or on the right side "[1].

C. Microcontroller Atmega 16

"The microcontroller is a complete computer system in a single chip (chip). The microcontroller is more than just a microprocessor as already exist or contains ROM (Read-Only Memory), RAM (Read-Write Memory), some standard input and output, and some peripherals such as counter / timer, ADC (Analog to Digital converters), DACs (Digital to Analog converter) and serial communications. One microcontroller which is widely used today is AVR microcontroller. AVR is RISC microcontroller (Reduce Instuction Set Compute) 8 bits based on the Harvard architecture. In general, AVR microcontroller can be classified into 3 groups, namely families AT90Sxx, ATMega and ATtiny. Basically what distinguishes each class is a memory, peripherals, and its "[4].

D. Ultrasonic transducers

"Ultrasonic Sensor is one of the main components in the measurement of the distance because through this ultrasonic sensor module obtain distance information which would then be read by the microcontroller and finally displayed through the viewer. Ultrasonic sensors are widely used for sensing the object and the environment "[5].

3. Research methods

The method used for research in this thesis consists of some of the activities carried out as follows:

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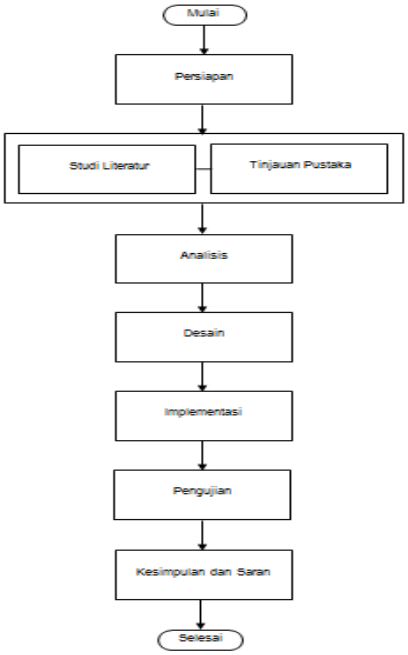

Fig 1. Research Methodology

Here is an explanation of the methodology of the research methodology settlement on the diagram in the final work.

a) Preparation

At the stage of preparation of a series kegiatansebelum start data collection and processing. In this stage arranged things that have to do with the effectiveness goal in the final project time.

b) Study of literature

At this stage of the process to find a reference theories relevant to the case or the problems found. These references may be sought from books, journals, research reports, and websites on the internet.

c) Literature review

At this stage of the process for review of the previous studies that there are similarities object or problems, very possibly have anything to do with research that is being done. Such research may include research reports, journals, or thesis.

d) analysis

At this stage of the process which systematically outlines the main points of the problems faced.

e) Design / Design

At this stage of the process regarding the design of fuzzy logic controller and the mobile robot system to be created.

f) Implementation

At this stage, usually called stages of construction. At this stage of the system design is implemented in the form of program codes to be a function of the fuzzy logic system that can control the robot car.

g) examination

At this stage of the process by which a system or component is executed under certain conditions, which results in the observed or recorded, for later evaluation.

h) Conclusions and recommendations

At this stage of the process to draw conclusions and advice on what to do during the work Final. Basic conclusions and suggestions which are the results of analysis and discussion.

4. Results and Discussion

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a. System design

Here's a system design in the design of wall follower mobile robot shown in image 2. below this.

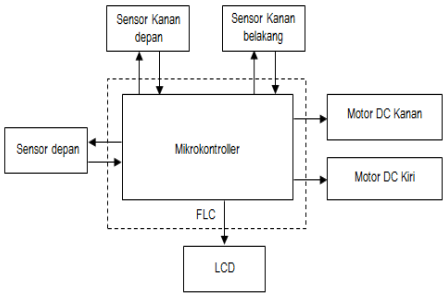

Fig 2. Block diagram of the system

Below is an explanation of some of the components used in the design of the wall follower mobile robot system.

1) Mikrokontrollerdigunakan to control all of the existing system on the robot car.
2) FLCdigunakan to control and perform the process of fuzzy logic so that the desired output in accordance with what has been prescribed.
3) Depandigunakan sensor to obtain the value of distance hurdles ahead.
4) Right Sensor Depandigunakan to get the right distance value of future obstacles.
5) Right Rear Sensor is used to get the value of the right rear obstacle distance.
6) Left DC motors used to drive the left wheel on the car robot.
7) Right DC motors used to drive the robot right wheel on the car.
8) LCD is used to display a variety of things visually.

b. Design of Fuzzy Logic

In the design of fuzzy logic, fuzzy model used is fuzzy Sugeno algorithm then the car robot movement along the wall are incorporated into and made a fuzzy form of program code that is inserted into the microcontroller. The design consists of a fuzzy logic membership functions, rule base and defuzzification.

In this research, the value of linguistic variables in fuzzy sets are based on distance categories are close, normal and far. Fuzzy sets are created there are two sets are used for input on the front right of the ultrasonic sensor and ultrasonic sensor inputs on the rear right.

The following is the membership function input (input) ultrasonic sensor shown in Figure 3 below.

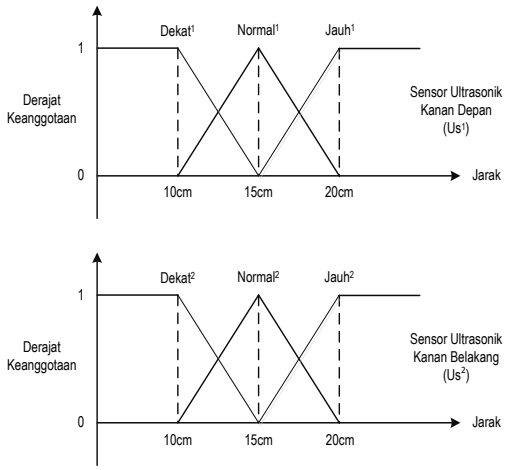

Fig 3. The ultrasonic sensor input membership functions

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In Figure 3 above fuzzy set is made, the membership of fuzzy set is determined by the degree of membership, which determines the level of appropriateness of each member with a predetermined membership function in fuzzy set above. Basis of the rules above the value of linguistic variable based on distance, which for the unit using the unit cm.

Here is an algorithm on the basis of fuzzy rules are designed to control rotation of the motor in the wheel wall follower mobile robot shown in Figure 4 below.

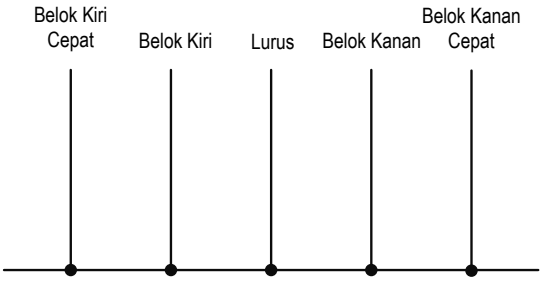

Fig 4. The ultrasonic sensor output membership functions

From the above algorithm generated output (output) the membership function. The output value of the velocity values will be used to regulate the speed of the motor robotmobil wall follower. Below is the basis of the rules that generate the output value is used to set the pace at the mobile robot shown in Figure 5 below.

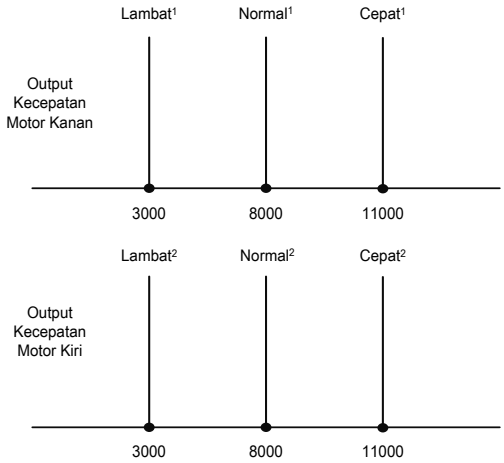

Fig 5. Derivative ultrasonic sensor output membership functions

Here's a rule fuzzy rule base used for the output of the ultrasonic sensor values shown in Table 1 below.

Table 1.
fuzzy rule

Us¹ \ Us²	Dekat¹	Normal¹	Jauh¹
Dekat²	Belok Kiri Cepat	Belok Kanan	Belok Kanan Cepat
Normal²	Belok Kiri	Lurus	Belok Kanan
Jauh²	Belok Kiri Cepat	Belok Kiri Cepat	Belok Kanan Cepat

c. Hardware Implementation

On the implementation of the kerasrobot car wall follower widely used in the company industi for car delivery person, to society is also used for security in the four wheel drive vehicles to the distance around it, and for the students used to race a robot contest artificial intelligence carried out both nationally and internationally.

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d. Hardware Interface

Hardware interface is an interface on the wall follower mobile robot shown in some pictures below are as follows.

Here is an interface on the mobile robot follower wall visible from the side shown in Figure 6 below.

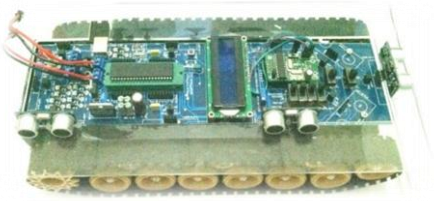

Fig 6. Robot car wall follower

e. Testing Ultrasonic Transducer

In this test, conducted ultrasonic distance measurement sensors with the actual distance using a ruler. Testing is done by ultrasonic sensors distance measurement sensor front right and back right sensor with the same reflective surface but with a different angle layout. The first test with 0 ° angle lies against the reflective surface. Next sensor tested with angle 10o, 15o, 20o. Determination of the angle made with the help of a protractor. The range of the measured distance is between 10-29 cm.

In ultrasonic testing that has been done, the test data obtained at the front right sensor presented in graphical form. The graph of the test results are shown in Figure 7 below.

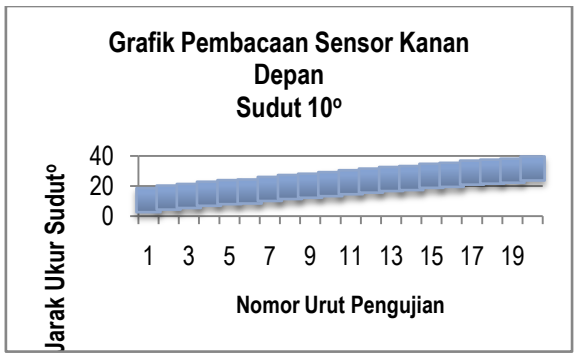

Fig 7. Graph sensor readings on the right front corner of 10o

Based on the chart above, it can be observed linearity ultrasonic sensor data, there is a reading error. Error ultrasonic sensor readings caused by the reflection of sound waves that are not perfect. The reflection of the emitted waves can not be received well by the receiver or late detection of reflected waves. In addition, the sensor also has a reading distance limitations with reflective fields that are too close. Although none of which is completely linear but at an angle readings indicate better results. Where at some distance angle measurement error is not too far away.

f. Testing Motion

The purpose of testing is to determine the level of motion precision robot movement at the time along the wall. Testing of ultrasonic sensors is done using the robot vision in motion and taking measurements at distances how cm wall follower mobile robot can move straight.

In this test, measurement robot movement with a flat surface and straight. Testing the robot movement on state car is done with a different angle layout then the car robot movable robot seen how far the car can move straight. Determination of the angle made with the help of a protractor. The range of the measured distance is between 0 ° to 10 ° and between 0 ° to -10 °.

In motion testing that has been done, the data obtained test results are presented in graphical form. The graph of the test results are shown in Figure 8. below.

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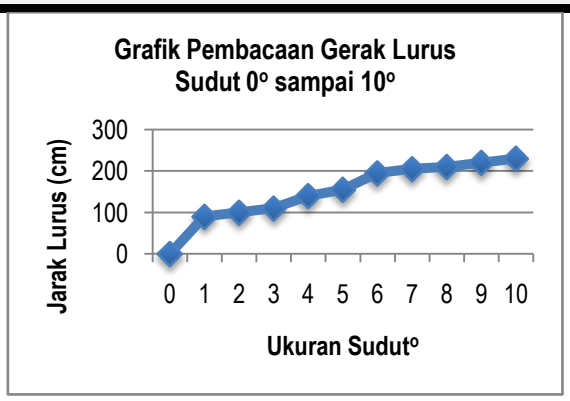

Fig 8. Graph readings straight motion at an angle of 0 ° to 10 °

Analysis of the test motion using a sensor that is the straight distance that can not be much different because it takes time to position correction and also grounding track slippery so that the movement of the robot can be inhibited, and also the use of PWM changing due to the use of battery resources are increasingly which can lead to reduced wheel spin to slow even further.

5. Conclusion

The conclusion of the design and implementation of wall follower mobile robot using fuzzy logic controller, which are as follows:

a. Wall follower mobile robot designed using several component parts, namely components inputs, processes and outputs. Where the component input using an ultrasonic transducer is used as the sensing medium to determine the distance to objects in the vicinity. Then to make the process of using fuzzy logic applied to the components of the microcontroller. Then for the output component using dc motors are used as media drive and LCD is used as a medium of information and distance values wheel rotation speed.
b. The design of fuzzy logic created using Sugeno fuzzy logic where the value of linguistic variables in fuzzy sets are based on distance categories are close, normal and far with a value close distance of 10cm, the normal 15 cm and 20 cm away.
c. Robot car wall follower can be stabilized at the time of the move, by adjusting the rotation speed of the wheels of the car, where the set speed is fuzzy logic. Starting from ultrasonic sensors provide input values robot car distance to the wall, then fuzzy logic and fuzzy process issued in the form of value velocity values are used to set the rotation speed of the wheels of the car.
d. The design logic fuzzydiimplementasikan into the microcontroller on the robot mobilyang used to control the robot car follower wall.

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