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Design of Smart Robot Prototype Automatic Garbage Disposal Based on Arduino at Mega

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A B S T R A C T

The purpose of this research is to design a prototype for an automatic waste disposal robot based on Arduino AT Mega. The background of this research is rapid pace of technology in the era of digitalization where Artificial Intelligence is a field of science that is currently of great interest to many people, especially in the digital generation. The thing that we need to know is many human job almost replaced by automated machines or robotic technology. Nowadays, robots are used to make human work easier, such as throwing away piles of rubbish to the main waste disposer. This prototype of smart automatic waste disposal robot was designed and created as a human aid in the field of cleaning. The input process is carried out as an integration process between Arduino, HCSR 04 sensor, and Infra Red Line Tracking sensor. For create Arduino, HCSR 04, and Line Tracking sensors can work optimally, the main thing is carry out the configuration process using a board and jumper cables as well as LED lights to ensure whether the sensors and other supporting tools are integrated with the Arduino

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INTRODUCTION

The industrial revolution 4.0 is a very rapid technological development, it can affect all aspects of human life both physically and biologically. The industrial revolution is an opportunity but also a big challenge where humans not only compete with each other but also with machines and robots. Robots have a much higher level of efficiency. In this way, the era of disruption has the biggest challenge, namely encouraging people to have a knowledge-based spirit of innovation and the need for human capital with creativity and innovation.

Sensor is device that can receive physical input from the environment, measure it and convert it into data that can be interpreted by humans and machines. Most of the sensors are electronic (can be converted into electronic data) but some sensors are simpler, namely mercury thermometers, therefore the sensors work not based on commands or instructions from the system or humans but they receive triggers from outside. As for the working process of the prototype Arduino-based automatic waste disposal smart robot, when the trash container will open, the HCSR 04 sensor can detect the presence of objects and can detect the full level of trash. At that time, the HCSR 04 sensor will transfer data to Arduino and Arduino will transfer data to the LCD so that this LCD will provide information. notification "Robot Ready" and when the robot is in this state, the Arduino will transfer data to the limit sensor so that the prototype arm will move upwards. When the prototype arm moves upwards, in this condition the prototype will trace the tracking path and walk to the destination point.

The definition of intelligent here is very relative where the use of AI in the controller is carried out to obtain the dynamic characteristics of the controller intelligently. This is said that classical controller is not yet intelligent because it has not been able to accommodate non-linearity properties or dynamic changes in the robot system itself. In example is load changes or environmental disturbances. In the other applications, AI can be used to help the process of identifying robot system models, environmental models or disturbances, and models of robot tasks such as making trajectory plans which in the AI concept are not used directly into the controller but are more indirect. (Piwatno, 2005).

LITERATURE REVIEW

The development of this prototype has also been confirmed by other experts, according to Mulyani (2017:26) "Prototyping is a system development technique that uses a prototype to describe the system, so that the user or owner of the system has an idea of the system that will be implemented later according to Otto Fajrianto (2016:55) "A prototype is defined as a tool that provides ideas for creators and potential users about how a system functions in its complete form, and the process for producing a prototype is called prototyping"

The purpose of create this prototype is as an innovation from the development of digitalization which can later be useful as a human aid, especially in aspects of life in improving the quality of environmental cleanliness so that it is maintained. And it is hoped that in the future the prototype that has been created can be implemented with other technologies according to the needs of the wider community, such as adding IoT technology or using a navigation

system so that this prototype can continue to develop according to technological needs and developments.

METHODOLOGY

This research was carried out using several methods including:

1. Data collection: Several techniques were used to collect data in this research, including:

a. Observation
   This technique is carried out by direct observation of the running system

b. Interview
   Using the interview method, researchers can find out the materials (Bill of Materials) which will later be designed both in terms of mechanics and build which will be used in developing the software system.

c. Literature
   Data collection was carried out directly from other sources such as journals and several other reference books.

2. Software Analysis and Design

In this process, researchers analysed several systems that would be used, especially in terms of hardware and software, which would later be needed in the design process for the prototype of this smart automatic waste disposal robot.

3. Software Creation

Before making a prototype, researchers also need to create a design that is used with the AutoCAD 3D app so that all components can be seen clearly and in detail.

4. Hardware and Software System Testing

In this stage the research team tested the system using the black box method from the results of the configuration process between the Arduino which was used as the main build and several other supporting actuators and sensors.

5. Writing the Final Report

The final step is to make a final report as a result of the research process in making an automatic waste disposal smart robot based on the Arduino AT Mega.

It was explained by several experts (Adi Fitria and Yesi Gusti, 2016) that the Arduino AT Mega is an electronic board that contains the AT Mega 2560 microcontroller which is a chip that functionally acts like a computer. This device can be used to create electronic circuits from simple to complex. By adding certain components, this device can be used for remote monitoring via the internet.

RESULTS AND DISCUSSIONS

Prototype Design for Automatic Garbage Disposal Smart Robot

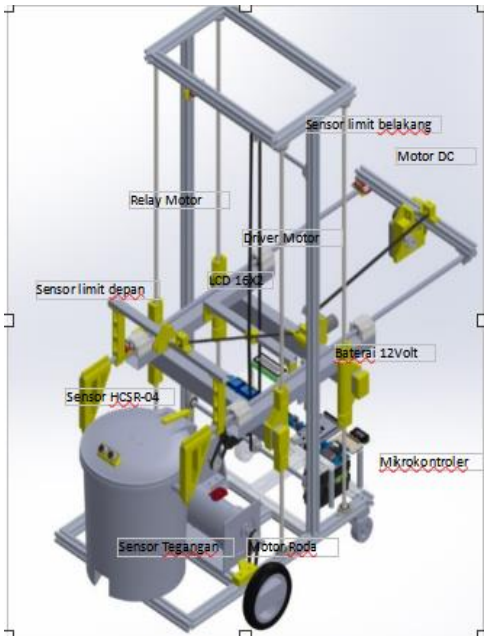

Figure 1. Design Plan before it is Executed in Making the Prototype

The design image created with AutoCAD can make it easier to provide an overview of the working functions of the prototype itself as well as the installation of actuators, sensors and Arduino which will be used and integrated.

Testing the Sensors that will be Used in the Prototype

In testing ultrasonic sensors, a tiger pin is used to activate the transmitter so that it can emit ultrasonic waves, which can be done by applying a voltage of 5 volts to the pin for microseconds. As for the test results for the production of distance sensors and level sensors which have precision values between real measurements and programmed measurement results, they can be seen in the distance sensor test table in the trash can.

Table 1. Proximity Sensor Testing in Trash Cans

No	Distance programmed with detection ≥ 4 cm and ≤ 50 cm	Trash Can Cover Status
1	4 cm	Open
2	8 cm	Open
3	12 cm	Open
4	14 cm	Open
5	16 cm	Open
6	20 cm	Open
7	24 cm	Open

8	28 cm	Open
9	32 cm	Open
10	36 cm	Open
11	40 cm	Open
12	44 cm	Open
13	48 cm	Open
14	50 cm	Open
15	54 cm	Not Open
16	58 cm	Not open
17	62 cm	Not open
18	66 cm	Not open
19	72 cm	Not open
20	86 cm	Not open

From the results of the table above, it can be concluded that the trash will open within seconds at a distance of ≥ 4 cm and ≤ 50 cm. If it exceeds a distance of ≤ 50 cm then the trash can cover cannot open automatically because the sensor waves received are not precise.

Arm Limit Sensor Testing

Where the limit sensor is used to move the robot arm, this limit sensor testing aims to synchronize the program in real time when testing the function of the limit sensor used on the prototype. Here is a table of limit sensor test results that have been interfaced with the Arduino program.

Table 2. Sensor Limit Test Results

No	Front Limit Sensor	Rear Limit Sensor	Upper Limit Sensor	Lower Limit Sensor	Condition
1	Logic 0	Logic 1	Logic 1	Logic 1	The condition of the robot is silent and ready to detect the presence of a waste disposal object.
2	Logic 1	Logic 1	Logic 1	Logic 1	The position of the arm will be raised first, then the robot arm will be pushed back and then pulled down again, this is to ensure that the trash can is not hit by the front body of the robot.
3	Logic 1	Logic 1	Logic 0	Logic 1	The arm is in the upper position so that the arm is shifted backwards until the rear arm is pushed back

Line Tracking Sensor Testing

In this line tracking test, a tracking sensor is needed which is used in the robot's movement to determine the direction the robot is moving. This line tracking sensor test aims to synchronize the program with real time when testing the function of the tracking sensor used, where the logic used in the Arduino IDE uses logic 1 which means that the robot is not active and logic 0 where the robot can move in the specified direction.

Table 3. Line Tracking Sensor Test Results

No	Black Tracks					Line Tracking Testing
	Leftmost Sensor	**Left Sensor**	**Central Sensor**	**Right Sensor**	**Rightmost Sensor**	**Action Description**
1	Logic 0	Logic 1	Logic 1	Logic 1	Logic 1	The robot is in the rightmost position of the black line so that the robot is turned more quickly to the left to be in the middle position again.
2	Logic 1	Logic 0	Logic 1	Logic 1	Logic 1	The condition of the robot is only to turn left slightly so that the robot's position returns to the middle of the lane.
3	Logic 1	Logic 1	Logic 0	Logic 1	Logic 1	Then the robot's position moves forward.
4	Logic 1	Logic 1	Logic 1	Logic 0	Logic 1	The condition of the robot is only to turn to the right slightly so that the robot's position returns to the

						middle of the lane.
5	Logic 1	Logic 1	Logic 1	Logic 1	Logic 0	The robot is in the leftmost position of the black line so that the robot is turned more quickly to the right to be in the middle position again.

Tracking Sensor Testing

The wheel motor with the tracking sensor installed is used to move the robot to determine the direction of the robot, where the tracking sensor testing aims to synchronize the program with real time when testing the function of the tracking sensor used in the prototype. The percentage provisions that have been determined are that values above ≥ 50% of the robot's PWM are said to be moving fast and values below ≤ 50% are said to be moving slowly.

Table 4. Sensor Tracking Test Results

	Track Sensor Left To Right					Motor Speed		
No	**Leftmost Sensor**	**Left Sensor**	**Middle Sensor**	**Right Sensor**	**Rightmost Sensor**	**Left Motor**	**Right Motor**	**Information**
1	Logic 0	Logic 1	Logic 1	Logic 1	Logic 1	Moves very slowly with a PWM value of 27%.	Fast moving with PWM value of 98%.	Direction: Turn left quickly
2	Logic 1	Logic 0	Logic 1	Logic 1	Logic 1	Moves forward and very slowly to the left with a PWM value of 39%.	Move forward and turn left slightly with a PWM value of 98%.	The direction of movement is slightly tilted to the left
3	Logic 1	Logic 1	Logic 0	Logic 1	Logic 1	Move forward and move fast with a PWM value of 98%	Move forward and move fast with a PWM value of 98%	Direction of movement is straight
4	Logic 1	Logic 1	Logic 1	Logic 0	Logic 1	Move forward and turn right slightly with PWM value 98%	Moves forward and very slowly to the right with a PWM value of 39%	The direction of movement is slightly tilted to the right
5	Logic 1	Logic 1	Logic 1	Logic 1	Logic 0	Moves very fast with PWM	Very slow moving with	The direction of moveme

						value of 98%	PWM value of 27%	nt is a quick right turn
6	Logic 1	Logic 1	Logic 1	Logic 1	Logic 1	Stops with PWM value 0%	Stops with PWM value 0%	The robot's position has reached its destinatio n

Overall System Testing

From the test results of each sensor and the movement tool used, the test results can be seen in the Prototype Test Results Table.

Table 5. Prototype Testing Results

No	Testing	Process and Output	Function Results	
			In accordance	It is not in accordance with
1	Front Limit Sensor	Detects the maximum recoil limit of the arm	√	
2	Rear Limit Sensor	Detects the maximum forward limit of the arm	√	
3	Upper Limit Sensor	Detects the maximum limit of upward movement of the arm	√	
4	Lower Limit Sensor	Detects the maximum limit of downward arm movement	√	
5	Detection sensors	Detect objects when dumping trash	√	
6	Sensor level	Detecting the height of the waste level	√	
7	Sensor tracking	Give input to the Arduino regarding the position of the robot along a predetermined path	√	
8	LCD	Displays robot status	√	
9	Driver motor DC	Controlling the speed and direction of rotation of the robot wheel	√	
10	Motor Lifting Up and Down Arm	For the process of going up and down the robot arm	√	

11	Servo motors	Open and close the trash can	√
12	DC motor forward and reverse arm	To move the robot arm back and forth	√

Prototype Travel Time Test Analysis Results

After testing the sensors and actuators used on the prototype, the next stage was to test the travel time, which was carried out 10 times, where the tolerance that had been determined for the robot's performance was 3 minutes at a distance of 7.5 meters. And the work performance of this robot can be categorized as follows:

1. If the robot can cover a distance of 7.5 meters in = 3 minutes then it is said to be good.
2. If the robot can cover a distance of 7.5 meters in < 3 minutes then it is said to be very good.
3. If the robot can cover a distance of 7.5 meters in > 3 minutes then it is said to be very bad. Following are the results of the travel time test analysis which can be seen in the travel time test results table.

Table 6. Travel Time Test Results

No	**Testing**		**Difference in Average Travel Time (*minutes*)**
	Desired travel time	**Travel time obtained in the field**	
1	3 minute	3.13 minute	0.13
2	3 minute	3.09 minute	0.15
3	3 minute	2.10 minute	-0.08
4	3 minute	2.15 minute	-0.85
5	3 minute	3.15 minute	0.15
6	3 minute	2.31 minute	-0.69
7	3 minute	3.37 minute	0.37
8	3 minute	2.40 minute	-0.6
9	3 minute	2.45 minute	-0.55
10	3 minute	2.50 minute	-0.5
Total Difference Value			**0.8**

CONCLUSIONS AND RECOMMENDATIONS

Based on the results of research and discussion regarding the design of a smart automatic waste disposal robot prototype that uses a microcontroller:

The application of the black box method in testing sensors used such as ultrasonic sensors, line tracking sensors and forward and backward arm limit sensors as well as actuator tools and several actuator tools that have been tested in the field have an average value of 0.8 minutes with a distance of 7.5 meters, which means that if it is compared with the predetermined time difference provisions which have a standard of approximately 3 minutes with a distance of 7.5 meters, it can be concluded that the robot's performance is good.

And based on the results of research and discussion regarding the design of a smart automatic waste disposal robot prototype using a microcontroller, here are several suggestions that can be taken into consideration when making a robot prototype with other functions, including:

1. Improve the prototype robot that can walk without a tracking path, compass or GPS navigation can be added. Then, the addition GPS at a microcontroller, the robot can walk over obstacles
2. From the results of travel time testing carried out using theoretical calculations, so that the robot can run stably, the tire wheels can be replaced using real rubber, then an optical sensor and rpm tachometer can be added which are installed on the motor wheel.

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