

SOLAR-POWERED VACUUM CLEANER ROBOT (ROBOCLEAN) AS INNOVATIVE WAY TO ACTUALIZE SUSTAINABLE ENERGY TOWARDS SUSTAINABLE DEVELOPMENT GOALS

Andika Prima Sandi

Faculty of Engineering Universitas Gadjah Mada
Nuclear and Physical Engineering
andikaprimasandi89@gmail.com

Purwaditya Purwana

Faculty of Social and Political Science Universitas Gadjah Mada
International Relations
yuwanapurwaditya@gmail.com

Abstract - Nowadays, globalization era brings many changes into all sectors. There are various positive and negative implications which is embedded with convenience that has been offered. Meanwhile, there are still many problems in the world that have not been solved with this current development. Then, the sustainable development concept are coming as a solution. It contains 17 targets with three pillars. Actually, the goal of sustainable development is for creating the sustainable modernization and bringing further betternesses for the future. One of solution that is be able to be offered is creating robot which could make people's work be easier to be done. The robot can cleans the floor automatically. The robot can helps people to do one kind of homework efficiently so it doesn't take a long time. The vacuum cleaner robot gets power from solar energy. The name of the robot is ROBOCLEAN. With the robot, the problems of health, energy, environment, economy and welfare which is the main aspects inside sustainable development are be able to be solved. How robot is working and how to create solar-powered vacuum cleaner robot and the ability of the robot will be the main topic in discussion. Another thing that is in the spotlight is the logics between robot vacuum cleaner with sustainable energy and sustainable development.

Keywords : vacuum cleaner robot, solar energy, sustainable development

I. INTRODUCTION

1. Background

The development of modern era drives us to do jobs effectively and efficiently. Even there are many kind of paltry activities that are oftenly we are being lazy to do them, such as cleaning the home floor. Dirty floors are usually caused by dust, hair loss, animal fur, and others. According to the Minister of Health Decree No.

1405/menkes/SK/XI/2002 about environmental health requirements in office and industry was explained that maximum dust content on 8 hours is 0.15 mg/m³ [1]. Dust content in a working environment could affect human's health. The disturbance of health due to dust-caused disease is causing decreasing of lung's capacity. Unfortunately, social welfare is declining as parallel as health of society[2].

The Social Development Goals that has been promoted by the United Nations have 17 goals. Sonny Harry B. Harmadi said that even though the SDG has more goals than MDG (just 8 goals), but we could divide them into three main pillars. The first pillar is about social aspect such as health, education, and gender equality. The second one is about development of economy, like poverty, infrastructure and economic growth. Thirdly, they focus to efforts in way to serve and conserve natural resources and nature quality as well. It will be wasteful because the globalization is supported with development of technology in electronics science [3]. Those three pillars can be realized with the vacuum cleaner robot. It also uses the renewable and friendly energy. At the end, it could increases the economic activities od society when it would has been manufacturing.

The problems above is the main foundation of the idea for creating the solar-powered vacuum cleaner robot with using Arduino UNO microprocessor that would has been moved by driver motor and ultrasonic sensor. The ultrasonic sensor has function as distance pointer when the robot moves and turns to avoid bump from any objects around it. The robot has one wheel on the middle of its board and two wheels on the right and left.

2. Research Question

From the problem that has been explained above, there are some weaknesses of solar-powered vacuum cleaner robot. It is about how is the working and processes of creating the robot. And it is also about how is the capability of the robot when it would be operated. Importantly, the

correlative logics between the production of the solar-powered vacuum cleaner robot and the Sustainable Development Goals must be constructed as well appropriately.

3. The Goals

The purpose of creating solar-powered vacuum cleaner robot is to ease

people in way to clean up the floor automatically by using Arduino UNO-based microcontroller technology for obtaining solar energy as one of renewable and sustainable energy. Last but not least, this effort is for supporting society to reach sustainable development goals progressively in responsible way.

4. The Benefits

There are benefits from vacuum cleaner robot, such as to help people to clean the floor easily and automatically, realize sustainable development program, and obtaining the renewable energy.

II. THEORETICAL BASIS

1. The Automatic Floor-cleaning Robot

The automatic floor cleaning robot is

an automatic cleaning tool that aims to ease people in cleaning the floor from dust or dirt. The expected goal of using the tool is it could facilitate people in cleaning the floor and as a convenient tool that to be used in daily life. In the present market, we have oftenly found many similar tools, such as vacum cleaner, floor polisher, mop, broom, and etc. But, the automatic floor cleaning robot is created differently because it is be able to be working automatically. The robot is controlled by sophisticated ultrasonic sensor that could serve as a pointer of distance of the robot in motion to avoid destructive collisions.

2. Robot Mechanics

Mechanics is science that has been studying the moving of objects after they gained significant energy from outside. The designing of mechanic object is very crucial effort to make sure that the object would have been moving as well as designer's want.

3. The Output Devices

a. DC Motor

DC Motor is motor which is using DC voltage source as its power and coverts the electric power to be mechanical power. These component work with

electromagnetic theory. When the voltage source would have been given, its magnetic field in stator is resulted. The magnetic field would be moving the rotor and surely it can be used to spin other device such as the gear. Velocity of DC motor is determined by magnitude of the voltage.



Picture 1. DC Motor

If the supply of DC motor voltage were stopped, magnetic field is vanish, and reverse electric current would be resulted simultaneously. The reverse current must be handled in order to does not give damages to Arduino UNO. The way to prevent those accident is with putting diode precisely, because diode can only conducts the current to one direction. With diode, the reverse current can be blocked. The voltage source that is to be used by the DC motor needs to be taken from an external source, such as a battery or regulator, instead of Arduino UNO. Arduino UNO is not designed to supply voltage to DC motor. The pins of Arduino UNO can only provide 60mA electric current, while the motor needs about 500mA to reach maximum rotation.

b. L298N Motor Driver

The L298N Motor Driver is a motor driver that is used to control the speed and direction of motor movement, especially in line follower robot/line tracer. The advantages of this L298N motor driver is quite precise in controlling the DC motor. Moreover, the motor driver itself is easy to be controlled. L298N Motor Driver is able enough to control two DC motor. So, to control the L298N motor driver is required 6 pins microcontroller. Two pins as enable pin, one pin for first motor, and the last one for second motor. Then, the remaining four pins else is used to regulate the speed of these motors [4].



Picture 2. L298N Motor Driver

The schematic of L298N motor driver circuit should be added some more components in order to be working. The first one is a series of regulators that are at the top of the schematic. And the second one is a series of motor driver supporter in the form of several diodes. The output of this circuit is in the form of two pins for each motor. In principle, the L298N motor driver circuit is able to adjust the voltage and current so the speed and direction of the motor can be controllably adjusted.

4. Controller Device

Controller device is an electronic device that can apply appropriately the designer's concept. With using this device, then the robot can operate automatically.

a. Microcontroller

Microcontroller is a complete microprocessor system that is existed in a chip. Microcontroller is different from the versatile microprocessor that can be used in a PC, because in a microcontroller generally also has a minimal system support components microprocessor, the memory and I/O interface, while in the microprocessor is only with the CPU alone.

b. Arduino UNO

Arduino UNO is one of the Arduino labeled products which is actually an electronic board that is

containing an ATmega 328 microcontroller (a piece that functionally acts like a computer). Such devices can be utilized to realize electronic circuits from simple to complex one. With the addition of certain components, this device is able to be used for remote monitoring via the internet [5].



Picture 3. Arduino UNO

The Arduino Uno contains a microprocessor (an Atmel AVR) and it is equipped with a 16 MHz oscillator (which enables time-based operation to be executed appropriately), and a 5 volt regulator (voltage generator). While the pins are available on the board. Pin 0 until 13 is used for analog signals. Arduino Uno is also equipped with 2 kB static random-access memory (SRAM) to hold data, 32 kB flash memory, and erasable programmable read-only memory (EEPROM) to store programs.

5. The Input Devices

For operating the device functionally and automatically, it is necessary to enter input as command that can be processed by microcontroller to do certain job. These inputs are coming from input devices or sensors. Many types of inputs are often found on mechatronic devices and robots that are used to give certain restrictions. One of the components is an ultrasonic sensor that is used as a distance input.

a. Ultrasonic Sensor

Ultrasonic is one of type of sound or vibration with too high frequency. Even human can not hear it. The measure of ultrasonic vibrates is greater than 20 kiloHertz. Ultrasonic can also be described simply as a wave above the sound wave frequency. Ultrasonic sensors are the ultimate sensor for navigation and avoidance of obstruction. Ultrasonic sensor that has to be used in the robot is HC-SR04 type.



Picture 4. The HC-SR04 Sensor Ultrasonic sensors is assembled

on the front of the robot, making it visible as the eye of the robot. This sensor will measure the distance from the

objects around it. If the detected distance is very close, it can be concluded that there is an object which is very close to the sensor. So the robot must avoid the object by turning or maneuvering to the other directions [6].

6. The Added Device

Besides the special devices, there are also several devices that has been used to complement the function of the tool. Those devices is called the added device. They are power supply and jumper cables.

a. Power Supply

Power supply is hardware that is capable for supplying power or voltage directly from the source of voltage to the other electrical voltage. Power supply is usually used for the computer as a conductor of electrical voltage directly to the components or other hardware in the computer, such as hard drives, fans, motherboards, and so forth. The power supply gains electrical input from the alternating current (AC) voltage and converts it into direct current (DC), then power supply distributes it to the various hardware in the computer set.

In general way, power supply is tool of electric voltage converter in computer that is be able to change the AC current to DC current. Therefore, in every computer that exists today, the power supply is a hardware that is most needed to run the computer,. If the power supply does not exist or can not be used, then the computer is not be able to be activated. This power supply uses five batteries with specifications of 1.2 V per battery. So we got 6 V of power supply. But, the power supply that is used in the robot is in the form of mini module of solar panel 6 V 1 W 200 mA.



Picture 5. Mini Solar Cell Module

b. Jumper Cable

The jumper cable is used to conducts

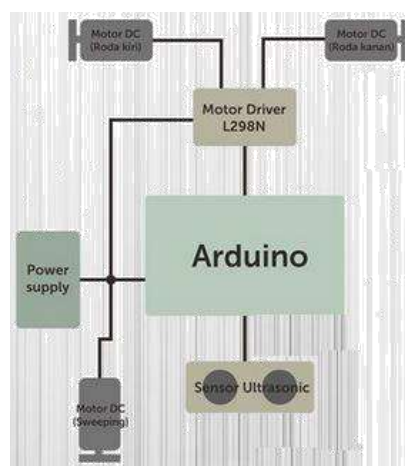
from one to another devices so they can be a fully integrated devices in one organized job as a tool.



Picture 6. Jumper Cable

III. DESIGN AND CONSTRUCTION

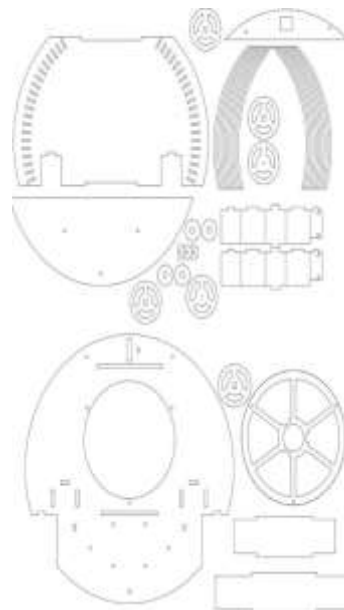
1. Schematic Chart of Circuits



Picture 7. Schematic Chart of Circuit

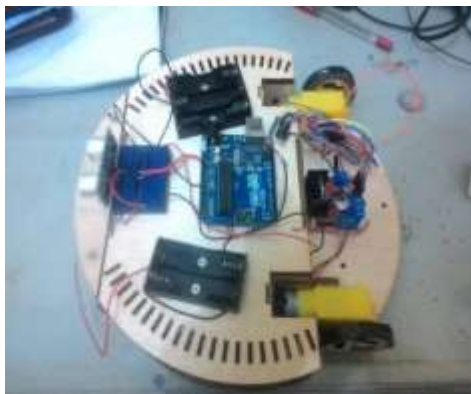
2. Designing of Hardware

a. Designing Structure of the Robot



Picture 8. Designing Structure of the Robot

b. Circuit of Vacuum Cleaner Robot



Picture 9. Vacuum Cleaner Robot

The picture above is the full circuit of all components.

3. Program Design

a. Arduino Program

These code below is the commands in Arduino.

```
// ROBOCLEAN

// vacuum cleaner automatic robot menggunakan
sensor ultrasonic

const int trigPin = 11; // deklarasikan pin trigger

const int echoPin = 12; // dan echo

untuk dihubungkan ke arduino void

setup()

{

Serial.begin(9600);

pinMode(4,OUTPUT); // pin 4 - 9

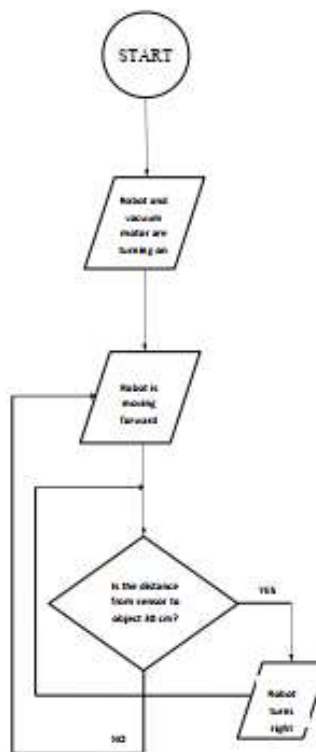
merupakan output

pinMode(5,OUTPUT); // yang

dihubungkan ke motordriver pinMode(6,OUTPUT);
pinMode(7,OUTPUT); pinMode(8,OUTPUT);
pinMode(9,OUTPUT); }

void loop()
```

4. Flowchart of Working of the Vacuum Cleaner Robot



CHAPTER IV

DISCUSSION

1. Testing on Device

The purposes of the tes is to know how is capability of the Vacuum Cleaner Robot in cleaning and sucking the dust and pieces of paper or tissue, so the Robot can not sucks the dirts which is too big and heavy. The voltage on it is 5 V which is controlled by a driver. The table below has been showing us about the results of testing Vaccum Cleaner Robot:

N o	Trashes
1	Dust
2	Pieces of Paper
3	Hair and Animal Hair
4	Grain of Rice
5	Sugar, Salt and other particles

Tablel 1. The trashes that are be able to be sucked

2. Testing on Components

a. Testiing on Power Supply

In the power supply section, we use solar cells and 5 batteries that have 1.2 V. Total voltage that can be produced by batteries is 6 V which is the minimum voltage that is required by DC motors for th vacuum and for L298N as motor controller. Solar cells is innovation of Vacuum Cleaner Robot that uses sustainable and responsible energy. The working principle can be recharged by using solar energy. Solar energy is one type of renewable energy. The battery power supply is used to reserve the voltage of energy from solar cells because the solar cells that we use is may not the good quality. However, if the robot would have been given good

solar cell, the robot vacuum cleaner does not require batteries anymore.

b. Testing on Arduino UNO at IDE Programs that has been inputed in

Arduino UNO IDE was tested by compiling and uploading them to the board. After the program is uploaded to the arduino board, the program has been running properly if the ultrasonic sensor detects distance of object where are more than 30 cm, it will causes both DC motors for the wheels move forward. While the ultrasonic sensor detects distance of objects less than 30 cm, it will causes a DC motor moves the wheel forward and the other one moves backwards.

c. Testing on Arduino UNO in the Robot

After the program is uploaded to the arduino board and assembled into the robot as shown in section 3.2.2, then if the ultrasonic sensor reads the distance value which is more than 30 cm, the robot will moves forward. And if the distance of objects is less than 30 cm, the robot will turns to right. And when the distance in front of it is more than 30 cm, the robot will moves forward.

d. Testing on Whole Device

In the overall test, the test is addressed to the batteries. By using 6 V on 5 robots, we will be able to clean the room for ± 30 minutes.

3. Tool Analysis

a. The Present Condition of the Tool

The Vacuum Cleaner Robot that we have made at the present time only uses the minimum value to turn is about 30

cm. So, if there is dirt that are at the ends of the wall or room, they can not be sucked by our robot. Furthermore, the robot that we created is only programmed to always turn right. Therefore, there are possibility that the room will not be completely clean.

b. Development of Vacuum Cleaner Robot

To upgrade some current weaknesses of the robot, our first development will focuses on the vacuum. In the robot that directly use the DC motor as this fan, we will put a box that vacuum could sucks the air maximally from outside and we will also add a tool that can be like a hose or the like that should be able to increases the distance of suction by vacuum so it could be sucking any dusts and dirt on the edge of the wall. In addition, to increasing the added distance of this hose, we will also be able to make a vacuum to suck the larger waste, so that the variation of waste that can be sucked will be more diverse. For the program in the future, we will create a program that would be embedded in arduino. It would have made the robot turns to the left or right randomly if there are obstacles in front of it. The random turning is expected to clean whole space of the room. Further developments that we put our focuses on it is in the sensors to measure the height of surface. Perhaps when the robot passes through the hole. The sensors that would be installed are color sensors. The sensors will read the deeper surface as dark color when the surface's height is not the same. Color sensors will work with ultrasonic sensors or better known as 'diversity.'

4. Vacuum Cleaner Robot and the Sustainable Development

The correlation between solar-powered vacuum cleaner robot with sustainable development is the realization of prosperity and decent living for human being. This robot is be able to supports all of effort in way to created more clean and healthy society in this modern era. Furthermore, the hygienic environment would creates comfortability for people.

When people are busy and do not have enough of time to clean up their house, the robot comes as automatic-smart tool that is be able to provide any convenience to help them. The energy source that is used by vacuum cleaner robot is not giving bad impact for sustainable environment. The source of power from the sun is one of renewable and rechargeable. And industrially manufacturing vacuum cleaer robot is very useful to improve the sustainable economy in Indonesian society.

CONCLUSION

1. Conclusion

Vacuum cleaner robot is be able to clean dusts and dirt around efficiently and automatically in the operation. Various diseases are caused by dust, animal fur, and other particles can be cleaned by the robot. The source of power that has been used is coming from solar energy. Thus, the robot is environmentally friendly and obtaining sustainable energy. development sectors can be supported by this robot vacuum cleaner. The production of robot can be reaching all significant sectors such as welfare, economic, industrial, health, and social dimension.

2. Recommendation

- a. The vacuum cleaner robot is still in development ways. Thus, it needs better designing and constructing from the previous prototype.
- b. The vacuum cleaner robot uses solar energy. It could be produced by Indonesian people to provide sustainable development for the society.

REFERENCE

- [1] GINA.(2010). Global Strategy for Asthma Management and Prevention, GINA.Ontario. Available at www.ginasthma.com
- [2] Kartasmita, Cissy B. Epidemiologi asma anak dalam Buku Ajar Respirologi Anak.Jakarta:Badan Penerbit IDAI;2010.vol.71-84.
- [3] Harry B,Sonny.KOMPAS.2016.Sustainable Development Goal.Jakarta.
- [4] Dejan Nedelvoski (2015. 26 Juli) . Ultrasonic Sensor HC-SR04 and Arduino <http://howtomechatronics.com/tutorials/arduino/ultrasonic-sensor-hc-sr04/>
- [5] Indoware (2017.08 September). L298N Driver Modul. Acces at 10 September 2017 available at : <http://www.indoware.com/produk-2242-l298n--driver-modul.html>
- [6] Komponen Aktuator (2014. 21 Oktober). Motor DC. Acces at 9 September 2017 available at : <http://zoniaelektro.net/motor-dc/>