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Development of Mobile Sanitizing Robot in Operation Rooms

Nur Auni Adam[1], Rosli Omar[1]*

[1]Faculty of Electrical and Electronic Engineering,
Universiti Tun Hussein Onn Malaysia, 86400 Parit Raja, MALAYSIA

*Corresponding Author Designation

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Abstract: Nowadays, technology gives a huge positive impact in dealing with the covid-19 pandemic. Accordingly, the field of robotics and control automation has become a phenomenon due to the availability of robot technology that can help human daily activities. Thanks to the robots that are able to replace human tasks to perform human work fast and effectively. This report outlines how to build a mobile sanitizing robot in the operating room to reduce the staff of doctors and nurses' burden during duty. In this project, the robot is developed using electronic components such as Arduino Mega 2560, L298N Motor Driver, IR Sensor Module and Ultrasonic Sensor Module. Precisely, this robot uses UV-C rays to replace liquid sanitation. The mode used in this project is automatic mode. The automatic mode used is based on the concept of Line Following. UV-C has a short-wave frequency with a peak wavelength of 253.7nm. However, there are improvements needed to improve and optimize the functionality of this robot. For example, the duration of Irradiation of UV-C rays and the speed of the motor can be changed so that the duration of movement can be controlled.

Keywords: Line Following, Mobile Sanitizing, UV-C Rays,

1. Introduction

Coronavirus disease 2019 (Covid-19) has been around since 2019. It is highly infectious caused by SARS-CoV-2 virus. People at any age who are suffered from covid-19 could become seriously ill or die. On the other hand, due to the Covid-19 pandemic, there are many issues arise such as limited places for quarantine people, limited places to perform the medical operation and limited manpower. In order to address the afore-mentioned issues, the application of robotics technology is one of the viable options [1].

Science and technology have become wider in variety area and field. Their main purpose is to assist human in completing their daily activities and solving problems. For instance, mobile robots have been used in many applications to increase productivities by performing tasks such as moving and transporting payloads. Nowadays, mobile robots can be found in many places such as hospital, office and home to name a few [2].

Corresponding author: roslio@uthm.edu.my

Due to the advancement robotics technologies nowadays, this project will propose a mobile sanitizing robot to overcome the issues as a result of Covid19. This robot will be used to sanitize the medical equipment in hospitals regularly during and after every operation. Manually sanitizing all the equipment and places requires plenty of time and energy. Therefore, by having the mobile sanitizing robot, the burden of the nurses and doctors who manually sanitize the equipment during and after the operation could be reduced. In some circumstances, patients to be operated are found positive Covid-19 but it is unknown. So, the front-liners have to constantly sanitize and sterilize the equipment. Also, with the existence of mobile sanitizing robot the risk of Covid19 infections could be reduced.

In this paper, the mobile sanitizing robot will use ultraviolet light which has short-wave frequency with a peak wavelength of 253.7nm for super-strong sterilization. This will 99.99% destroy the DNA structure of bacteria and viruses [3].

2. Materials and Methods

In this section is focusing on the materials and method used that applied at this project.

2.1 Materials

Materials used in this project are Arduino Mega 2560 as Microcontroller, L298N Motor Driver Module as Motor Driver, DC Motor, 7.4V of Lithium polymer battery, UVC Led to sanitize the room, resistor of 220Ω, switch, Ultrasonic Sensor Module to avoid the obstacle and IR Sensor Module to light up the UVC Led in room and detect black line for line following concept, two wheel and two castor wheel for obtaining the smooth movement. Table 1 displays the component and quantity that used in this project.

Table 1: The component and quantity that used.

Component	Quantity
Controller: Arduino Mega 2560	1
Motor Driver: L298N Motor Driver Module	1
UVC Led	8
Resistor: 220Ω	8
7.4V Lithium Polymer Battery	1
Ultrasonic Sensor Module	1
IR Proximity Sensor	5

2.2 Methods

This section describes the method to achieve the objectives of the project. The process and stages during the design and implementation of the project will be described thoroughly. Thus, it includes flowchart and block diagram that will explain the process to complete the project. Moreover. there are two methods used in this project which is system development and hardware development.

2.2.1 Systems Development Method

Figure 1 shows the flowchart of system development for this project.

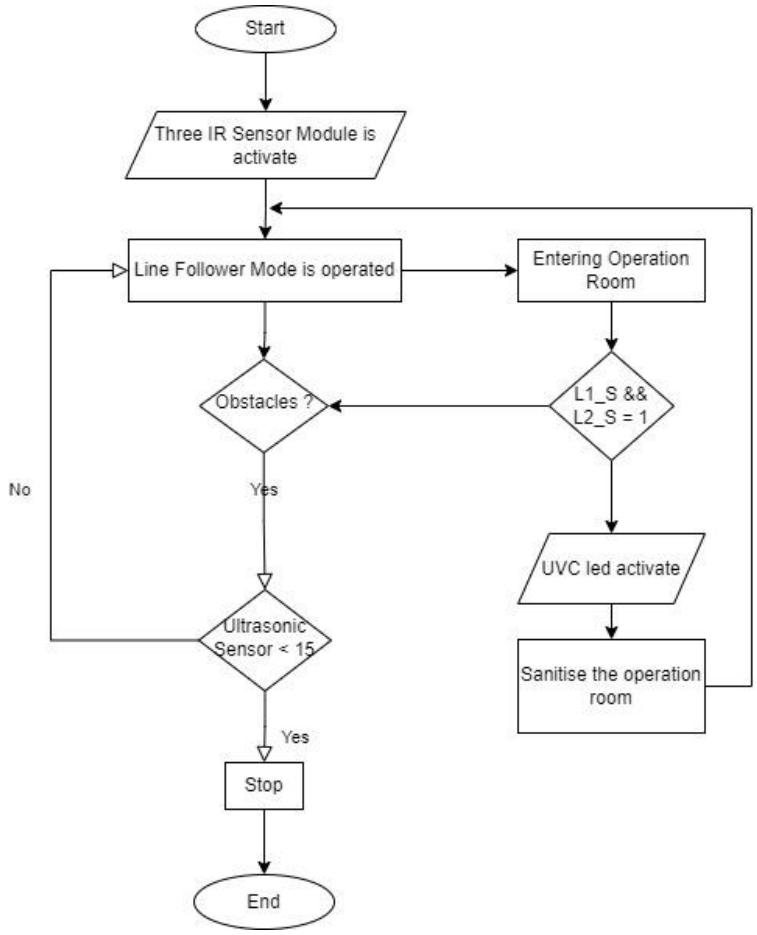

Figure 1: System Development Flowchart.

In systems development, the author built two systems which are line following operation and avoidance operation. UVC Led will always turn on to sanitize the operation room when the robot is entering the operation room. After that, the sanitize robot will be move with one of the operation modes. If there does not have any obstacles, the robot will continue in line following operation but if there has obstacles, the robot will stop. To detect the obstacle, we set the distance at 15. As in Figure 1, L1_S and L2_S is indicated to IR Sensor that specialize to detect black line in the operation room. Therefore, the sanitize robot is design with more than 8 UVC Led which divided into 2 UVC led at right, left, back and front. This is because of the area of operation room is big and we want to eliminate the bacteria in high speed thus the operation will conduct safely. Also, the possibility of incident will be decrease and the limited manpower can be more efficient.

2.2.2 Hardware Development Method

In hardware development, IR Sensor will be connected to the pin A0, A1, A2, 11 and 12 meanwhile the Ultrasonic Sensor will be connected to pin A3 and A4. Also, the L298N motor driver is connected to the Arduino Mega 2560 and DC motor. Other than that, the UVC Led is assembled into parallel circuit. Table 2 is displaying the pin connection of the component and Figure 2 depicts the flowchart of hardware development. If there has some mistake with the connection it may lead to damage the hardware or the hardware is unable to proceed to some stage.

Table 2: The connection pin and component

No.	Component	Pin
1.	UVC Led	51
2.	Ultrasonic	
	- Trigger	A4
	- Echo	A3
	- Ground	GND
3.	IR Proximity Sensor	
	- R_S	A0
	- M_S	A1
	- L_S	A2
	- L1_S	12
	- L2_S	11
	- Ground	GND
	- Vin	5V
4.	Speed Motor	
	- Speed motor A	10
	- Speed motor B	9
5.	Motor	
	- Motor A (+ve)	2
	- Motor A (-ve)	3
	- Motor B (+ve)	4
	- Motor B (-ve)	5

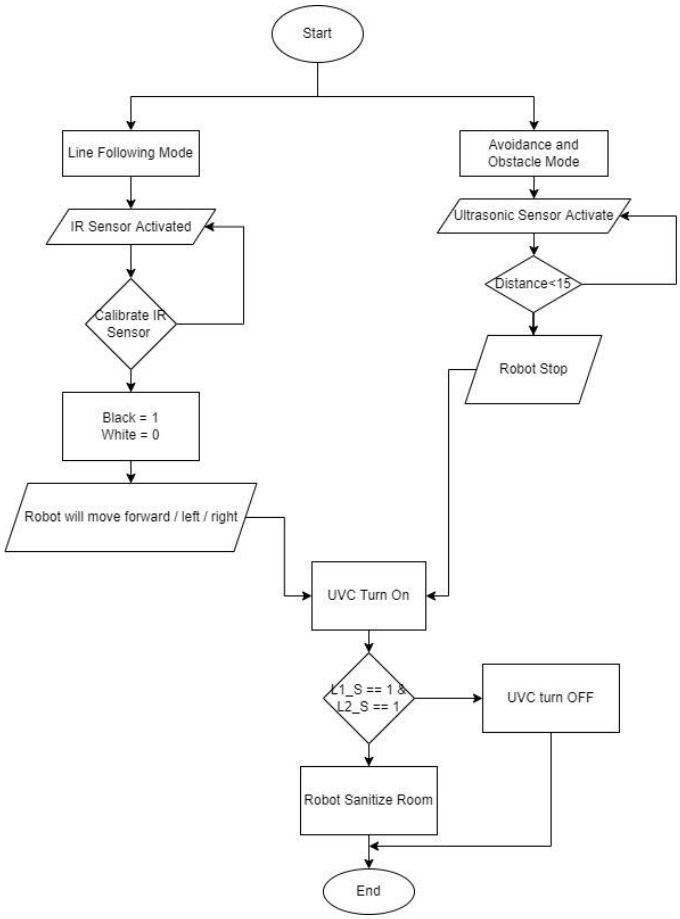

Figure 2: Hardware Development of Flowchart.

In hardware development, there has two modes which are line following and avoidance and obstacle mode. Line following mode use three sensors to detect the black line. After upload the coding into the Arduino Mega 2560, the IR Sensor need to be calibrated. The calibration is done by the IR sensor which two led is turn on when it detects white line and one led turn on at IR Sensor will indicates the IR Sensor detect black line. Then, the robot will be following the program which is turn to right or left or front. Second mode is avoidance and obstacle mode, it uses the ultrasonic sensor module to detect the obstacle in front of it. The distance between the sensor and object must be 15 below. This is because set distance program to 15 below. In order to know the second mode is activated or not, the robot must stop when the obstacle is in front of it. Next, the robot in sanitizing room which need to turn on UVC Led so two IR sensor is attached to give the information turn on to the UVC Led. Finally, the last part in hardware development is testing. This part is the most crucial because it need a plenty of time. Moreover, the black tape used is not specialise for the line following, thus it may give an error during simulation.

3. Results and Discussion

It will describe the result and discussion of the project. This includes the overall animation, simulation and hardware prototype results. The results include design of sanitizing robot obtained, animation of sanitizing robot and all results that related to the microcontroller and hardware system response. To develop mobile sanitizing in operation rooms, there are 3 steps that need to solve:

a) Identify the features and function of mobile sanitizing robot.
b) Upload the coding Arduino.
c) Attach and connect the hardware.

3.1 Identify the features and function of mobile sanitizing robot.

Figure 3 shows the initial sketching of sanitizing robot on A4 paper and Table 3 explain the features and function.

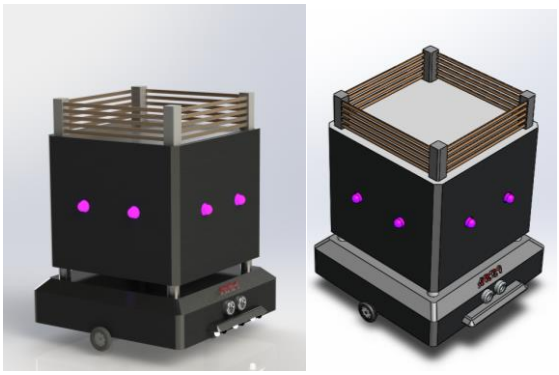

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Figure 3: Mobile Sanitizing Robot's design in SolidWork 2019.

Table 3: Features and Function of Components Used.

Features	Function
Arduino Mega 2560	It has 54 digital input/output pins (of which 14 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button.
UVC Led	To sanitize the operation room
Rack at top	For placing the equipment of the operation.
Two tyres and rollers	It can rotate 0 degree until 360 degree and balance the ground of robot due to two wheels.
Ultrasonic Sensor	Detects the obstacles in front of the robot.
IR Sensor Module	Detects infrared radiation to sense black line
L298N Motor Driver	Running two DC motors at the same time. Also, the direction of motors can be controlled independently. (h bridge)
7.4V lithium polymer Battery	It is rechargeable thus it can charge with 4056 charging
Castor Wheel	For smooth movement
N20 Metal Gear Motor	It is small and have sufficient torque

3.2 Upload the coding Arduino.

The result of software development is collected based on serial monitor and the maximum bytes that show after compiling and uploading the coding. Figure 4 depicts the output of the result after compiling and uploading the coding.

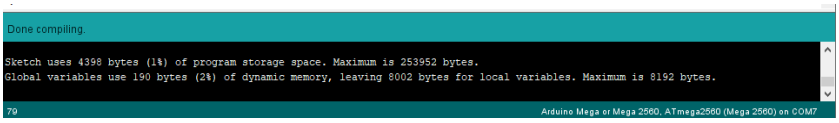

Figure 4: Output Result on Arduino IDE.

Due to the movement and coding, the Table 4 and Table 5 displays the input of IR Proximity sensor and the output. Output 1 for the movement of the robot and Output 2 is the UVC Led.

Table 4: The result of output 1.

IR Sensor (L_S)	IR Sensor (M_S)	IR Sensor (R_S)	Output 1
Low	Low	Low	Free
Low	Low	High	Turn Right
Low	High	High	Turn Right
Low	High	Low	Forward
High	Low	High	Stop
High	High	High	Stop
High	High	Low	Turn Left
High	Low	Low	Turn Left

Table 5: The results of output 2.

IR Sensor (L1_S)	IR Sensor (L2_S)	Output 2
Low	Low	Off
Low	High	Off
High	High	On
High	Low	Off

3.3 Attach and connect the hardware.

Firstly, Arduino Mega 2560 and L298N Motor Driver is placed on the top of the chassis meanwhile the lithium-polymer battery at between of two chassis. Then, three IR proximity sensor is glued and tape on stick and ultrasonic sensor module at front face and top of the chassis. In order to place the Arduino mega 2560 and L298N Motor Driver, the screwdriver is used. Also, to make jumper in one connection, the electrical masking tape is used. Figure 5 illustrates the robot that semi-installation.

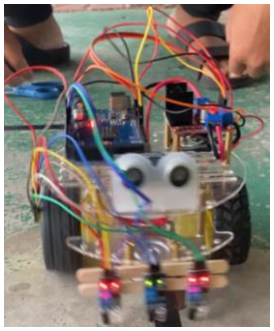

Figure 5: The semi-installation of the robot.

Before do the testing and troubleshoot, the calibration of IR proximity sensor is needed. The calibrates done with two led on IR proximity sensor is light up when it detects the white line meanwhile one led on IR proximity sensor is light up when it detects black line. For the connection between UVC led and resistor for not making it burnt. With the design the circuit on Proteus, we could simulate first whether the resistor is suitable with the UVC Led. Figure 6 illustrates the 8 UVC Led is assembled with 220Ω. The battery used in Figure 6 is 9V.

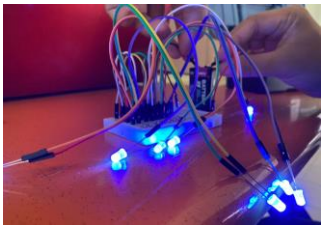

Figure 6: The installation of UVC Led and 220Ω.

Next, the UVC Led and 220Ω is connected to the microcontroller which is Arduino Mega 2560. Figure 7 shows the UVC Led is connected to the robot.

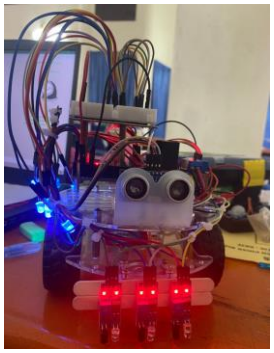

Figure 7: The installation of UVC Led and 220Ω on robot.

The full installation is done like Figure 8. The full installation is done with the body cover and additional rack on top of the robot. The body cover was made from black cardboard and to cover the IR proximity sensor that detect the line following, the black cardboard is design into rectangle and the calibrate of IR sensor is open for easy to calibrate in the future. The rack of top of robot is designed to place the things.

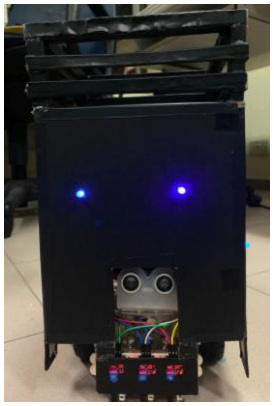

Figure 8: The full installation of the robot.

Last but not least, the circuit is made from Black Electrical PVC Tape, box and Mahjong Paper Box is use for the base and Mahjong Paper for cover the box. Black Electrical PVC Tape for making the black line. This is because to make the robot move in line following, it needed black line and white line to simulate it. Figure 9 is depicting the circuit of sanitizing robot. In the circuit, it designed has only one room operation to be demonstrate.

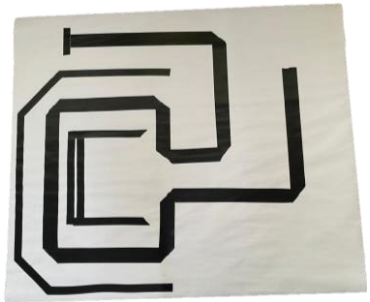

Figure 9: The circuit of the sanitizing robot.

4. Conclusion

In conclusion, the objectives proposed in this paper have been achieved as the hardware developed is able to sanitize the operation with the UVC Led is on when entering the operation room. The hardware also can follow the black line which the line following concept is applied. Last is the hardware stop when there is obstacle in front of it. At this part, the avoidance and obstacle are applied and it succeed.

Acknowledgement

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