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Teleoperation System for v-Based Sterilization Robot

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Abstract. In December 2019, an outbreak of pneumonia of an unknown etiology emerged in Wuhan, China. A new coronavirus was identified as the cause, which has named 2019-nCoV by the World Health Organization (WHO). January 25, 2020, a total of 1975 cases have been confirmed nationwide with another 2684 cases suspected of being caused by 2019-nCoV / Covid-19. The case in Indonesia was first discovered on March 1, 2020. Based on a study on emerging cases, WHO equated prevention/crisis in the number of sufferers with Middle-East Respiratory Syndrome (MERS) and Severe Acute Respiratory Syndrome (SARS). WHO confirms that human-to-human virus transmission can occur through droplets, contact, and fomites (the source of infection from inanimate objects). Fomites can be various objects that are touched in daily activities, such as door handles, train handles, chairs, tables, etc. So this research aims to present a solution by using robots for sterilization based on ultraviolet lamps. The robot is designed with a differential drive system and is connected to a computer via a telemetry device. An FPV camera is mounted on the front of the robot to aid operator vision for remote control. The output shows that the room sterilization process can be done remotely without the need for physical contact.

1. Introduction

December 2019 saw an outbreak of pneumonia of a previously unknown etiology in Wuhan, China. A new coronavirus was identified as the virus that causes it, which was later named 2019 by the World Health Organization (WHO). January 25, 2020, a total of 1975 cases have been confirmed nationwide with another 2684 cases suspected to be caused by 2019-nCov / Covid-19 [9]. On January 31, the first 2 cases of a novel coronavirus in Britain, [10] the first 2 cases in Russia, [11], and the first cases in Sweden and Spain were reported. Canada reports the 4th case. The case in Indonesia itself was first discovered on March 1, 2020, while currently, the cases found in Indonesia have reached 893 [12]. Looking at the emerging cases, WHO equates prevention/crisis in the number of sufferers with Middle-East Respiratory Syndrome (MERS) and Severe Acute Respiratory Syndrome (SARS), human-to-human transmission occurs through droplets, contact, and fomites (sources of infection from inanimate objects) [1].

Fomites or sources of inanimate objects transmission are one of the 2019-nCoV transmission media, so this research aims to present a solution in the form of using robots for sterilization. The hope of this research can ensure that it does not fall into the Fomites category. Research on the use of robots for

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hazardous environments was carried out, among others, by [2] [3] [4] [5] [6]. Meanwhile, the type of robot used in this research is a type of robot with a differentiated drive as research conducted by [x] [8]. It's just that the front of the robot uses Omni wheels so that maneuvers can be done more flexibly.

The developed robot can be operated manually using a joystick. The robot is connected to a PC (Ground Station) operator using a 900MHz telemetry module. The robot is also equipped with an FPV Camera so that room images can also be accessed on the PC screen at the Ground Station. Based on the odometry system with a rotary encoder sensor mounted on the bottom of the robot, the robot can also be operated semi-automatically to perform sterilization evenly and sequentially in the room. So that the sterilization process is expected to be even and comprehensive, in the end, the spread through the 2019-nCoV fomites can be brought together.

2. Related Work

Mobile Robot is a type of robot with a wheel drive system that can be controlled manually or automatically[14], either wired or wirelessly [2]. Research conducted [2] [4] developed a teleoperation robot that is used for an unsafe environment (hazard), then a similar study was also conducted by [3] [6] [13]. The novelty of this research is a three-wheeled robot like the research conducted by [15] [8], the selection of this type aims to produce a more dynamic movement. However, with a special function to sterilize the room using UV at a low price with the title "Design of UV-Light-Based Room Sterilization Robot for Combating the Covid-19 Virus Outbreak"

AGV is a mobile robot that can move automatically[16] without using an operator. In its movement, AGV uses a depth camera as a sensor to read movement and direct it according to the user's wishes. The movement of the AGV is determined from the combination of sensor readings and a software program that will be implemented on an AGV drive which is usually a wheel or leg. In the manufacturing sector, AGV has been widely used in the distribution process. AGV has a function similar to lift-trucks, which is to deliver goods from a location to a specific location. The AGV used in this final project consists of 3 wheels, 2 front wheels act as driving wheels, and 1 rear wheel as turning wheels.

3. System Design

3.1. Hardware Design

The robot is designed with a differential drive system. The rear drive uses 2 PG36 motors. The front wheels of the robot use omni wheels to make it easier to maneuver the robot on uneven floors. The top of the robot is installed with a 38 Watt UV C lamp. This lamp uses a power supply from the battery which is then converted to AC voltage using an inverter. An FPV camera is installed on the front of the robot. This is to assist the operator in controlling the robot remotely. The design of the UV sterilizer robot that is made is shown in Figure 1.

To be able to control the actuator, an ATMega328 microcontroller is connected to the laptop. ATMega328 is an 8 bit microcontroller with a maximum clock of 16MHz. The microcontroller is responsible for translating the instruction data from the laptop to PWM pulses for 2 PG36 motors. BTS 7960 module is used as a PG36 motor driver. The sensor power supply and the driving motor use a 3S lipo battery respectively. For the microcontroller power supply using a 5v voltage derived from the 2S lipo battery. The microcontroller is connected to the PC using 433 MHz wireless telemetry. The schematic of the circuit used in the AGV is shown in Figure 2.

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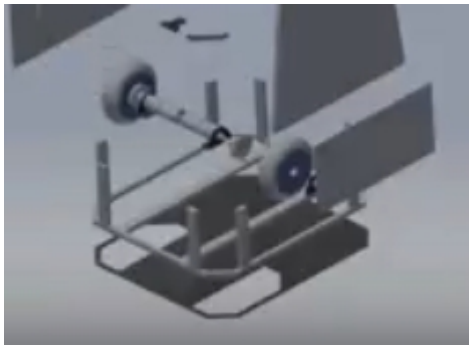

Figure 1. Robot design

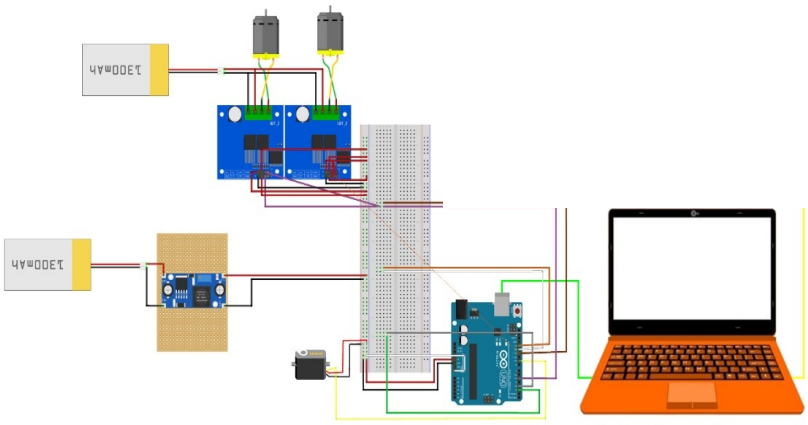

Figure 2. Diagram Block system

3.2. Software Design

There are 2 programming languages used in software design. The first is the use of Visual Basic for the GUI at the ground station. This GUI is used to control the robot wirelessly. Control is done by using the keyboard on the PC Ground Station. The design for the application is shown in Figure 3.

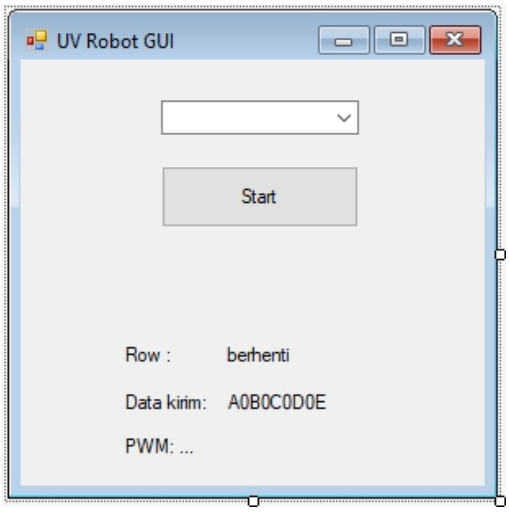

Figure 3 GUI for UV Robot

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The second is programming the Arduino IDE for microcontrollers. The microcontroller converts the data sent by the PC into PWM data for the servo and motor drivers. The data protocol sent by the PC is shown in Figure 4. The data is a combination of data on the direction of rotation and speed of the PG36 motor, as well as the condition of the UV lamp. If the value of the UV Relay status is 1, the UV lamp will turn on, and vice versa. Furthermore, the data is broken down into 5 variable values by the microcontroller. The programming flowchart for the microcontroller and PC is shown in Figure 5.

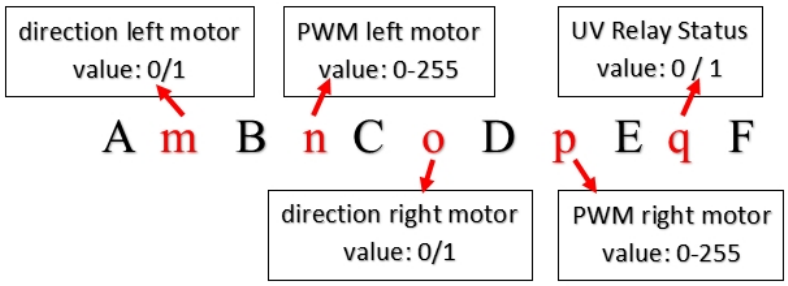

Figure 4. Data serial protocol

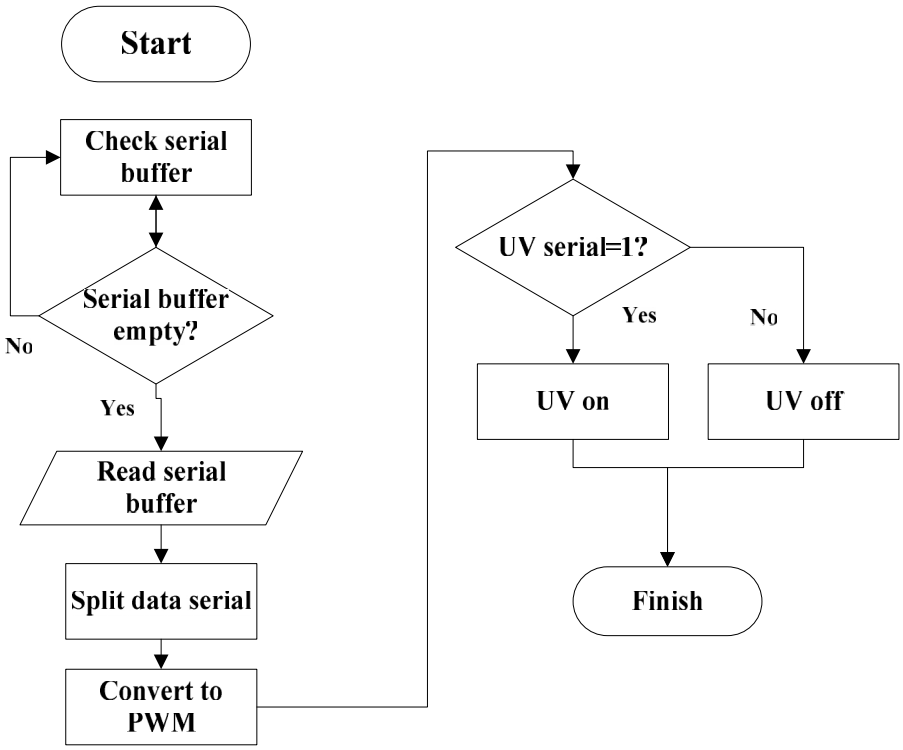

Figure 5 Flowchart System

4. Result and Discussion

4.1. System Realization

The front wheel of the robot uses omni wheels with a diameter of 15cm. While the rear uses 15cm diameter rubber wheels. The rear wheel is coupled to the motor directly using an 8 inch hub. This is so that the robot can maneuver on uneven floor areas. Figure 6 is a display of the realization of the robot body. The robot is designed to be able to carry an additional load of 15 kg. Robot material uses ACP so it is strong and light.

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The UV lamp is installed on the robot body which is made from ACP. The difference in speed of the left motor and the right motor will result in different robot maneuvering directions. FPV cameras can be accessed using the built-in Windows camera application facilities. The operator only needs to see the condition of the image displayed on the screen to control the robot. The button mapping for the control system is shown in table 1.

Figure 6. UV robot

Table 1. Keyboard mapping

Key	Function
Arrow Up	Move Forward
Arrow Down	Move Backward
Arrow Left	Turn Left
Arrow Right	Turn Right
Arrow Up+Left	Spin Left
Arrow Up+Right	Spin Right

4.2. Testing result

Testing is done by tracking objects in the laboratory. The track used for testing is shown in Figure 7. The test results show that the system can maneuver according to the trajectory passed. The normal walking speed of the robot is about 2 m / s. The longest distance between the operator and the robot during the test is 30 meters. The operator controls the robot from the room to avoid UV radiation which is harmful to the skin. Figure 8 is a display of the application when it is run. The power supply of the UV lamp in the form of a battery with a capacity of 7.2Ah can be used to operate for 15 minutes. Figure 9 is a collection of photos when the robot is tested.

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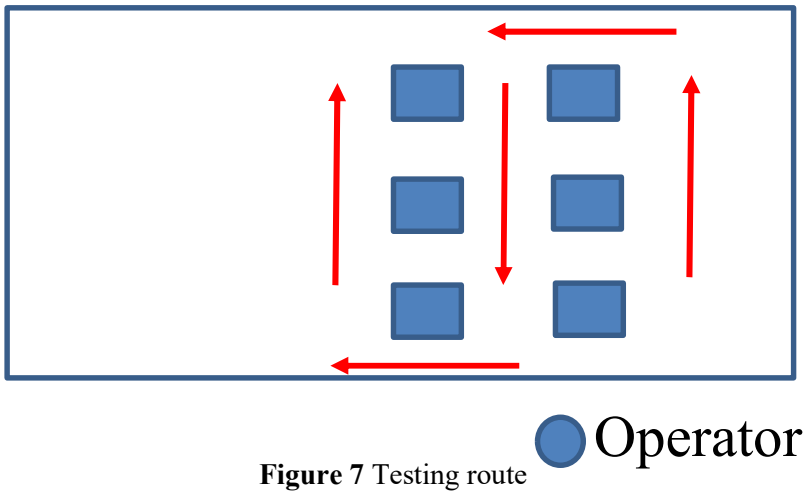

Figure 7 Testing route

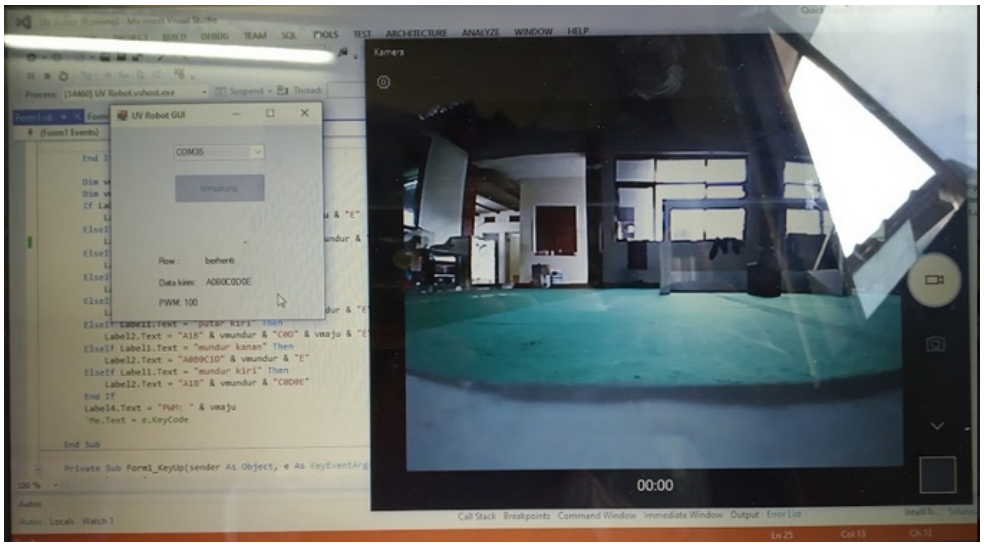

Figure 8 GUI view

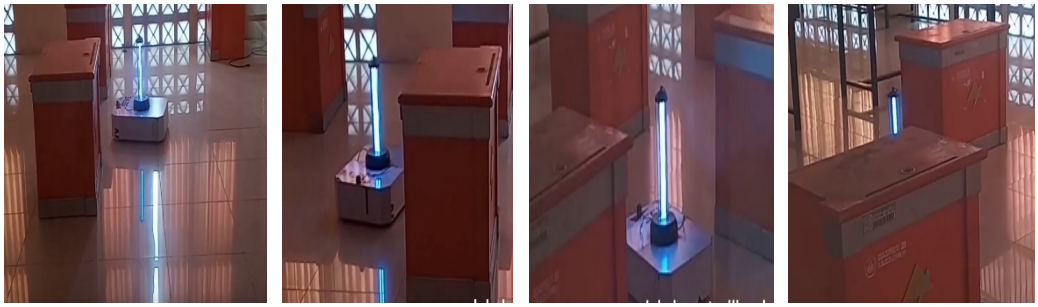

Figure 9 Testing condition

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5. Conclusion

The development of the Covid-19 pandemic has slowed things down. The imposition of social restrictions makes some activities impossible to do offline. In this research, a robot equipped with a UV lamp was successfully created. The robot can be operated wirelessly from a distance. The resulting system response shows the robot's performance can work well. In this case, the research output can be used to carry out UV lamp-based sterilization effectively.

Acknowledgment

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