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UVC Sterilization Robot Application for Covid-19 Based on Wireless Communication

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A B S T R A C T

In this research, a sterilization UVC robot will be designed and implemented using wireless communication. The robot can be controlled using a platform that can move the robot and is assisted by a camera to see the condition of the environment. ESP32-CAM is used to control robot via wireless communication and video assisted. The robot has two UVC lamps installed above to form a 360-degree light coverage area. The camera is at the front and is flanked by two lights to add lighting to get good video results. External antennas are used to increase the wireless communication range. The measurement results vis Wireshark obtained a delay value of 347 ms with a throughput of 358 kb/s. This value is included in the moderate category for data communication classification.

INTRODUCTION

The Covid-19 pandemic has shocked the world with its spread that is not easy to control. The spread of Covid-19 can occur through droplets from infected patients. This virus can survive in free space, causing a high number of infected people. Several methods were used to inhibit its spread, such as washing hands, using masks and maintaining social distancing. Weather is also one of the factors in the spread of the Covid-19 virus[1].

The problem with the Covid19 virus is that it is very easily spread from someone who has been infected to another. The size of the virus is minimal, and it is impossible to identify it directly[2]. Various methods are used to sterilize something from the virus, such as hand sanitizers, liquid disinfectants, and Ultraviolet light[3]. Ultraviolet rays have been shown to kill various viruses and bacteria. One type of Ultraviolet widely used in health in-room sterilization is Ultraviolet type C or called UVC[4], [5].

Sterilization is a way to prevent viruses and bacteria in equipment used by patients with the disease. Some viruses and bacteria can still live in the patient's equipment, which is very dangerous for a healthy person. Medical and experimental clinic proven Ultraviolet type C (UVC) to kill viruses and bacteria[6]–[10][6]–[10].

UVC utilization system has many limitedness in operation. Continuous, direct exposure to UVC light or in a tremendous intensity very dangerous to humans. It can cause damage to human eyes and skin. The short-term effect on the skin is redness or ulceration of the skin. At high levels of exposure, these burns can be severe. Long term exposure may cause cumulative damage to the skin depending on the intensity of the exposure. Long-term risks for significant cumulative exposure include premature ageing of the skin and skin cancer.

In this research, a sterilization UVC robot will be designed and implemented using wireless communication. The robot can be controlled using a platform that can move the robot and is assisted by a camera to see the condition of the environment.

METHOD

In general terms, ultraviolet lamps, often called UV lamps, are lighting products that produce ultraviolet light. Ultraviolet light itself has unique characteristics that can be applied in a vast field. Ultra Violet light itself, based on the length of the wave beam, can be classified into three primary levels, the shorter the light wave, the stronger the characteristics. Figure 1 shows the ultraviolet spectrum in the electromagnetic spectrum. Ultraviolet has a wavelength in the range of 100 - 400 nm regulated in the World Health Organization Global Solar UV Index. In this range, Ultraviolet is divided into three types: UVA (315–400 nm), UVB (280–315 nm) and UVC (200–280 nm).

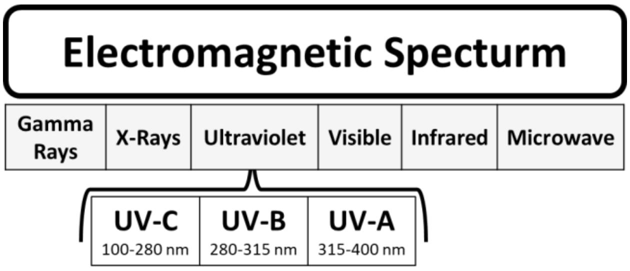

Figure 1. Ultraviolet Spectrum

UVC lamps available in the market have a wavelength of 253.7 nm (nanometer), this value is the wavelength range of type C Ultraviolet. These lamps have structures and electrical characteristics similar to those of general fluorescent lamps used for illumination but use ultraviolet ray glass, which efficiently transmits ultraviolet rays at 253.7nm which can be seen in Figure 2. Fluorescent lamps are a type of high-efficiency light source. Furthermore, the spectral quality can be controlled as desired. Although the physics of light production of such lamps is somewhat complex, they must be carefully designed and manufactured, and the fluorescent lamps are simple and easy to operate.

Figure 2. UVC Lamp

UVC Robot

In its use, sterilize the room using a UVC lamp without the presence of humans. The UVC robot is designed to be able to replace the role of humans through wireless communication. A microcontroller has a crucial role in the UVC Robot system. As shown in Figure 2, the microcontroller regulates all the components in the UVC robot, such as motors, cameras, turning on and off UVC lamps, and the WIFI communication module.

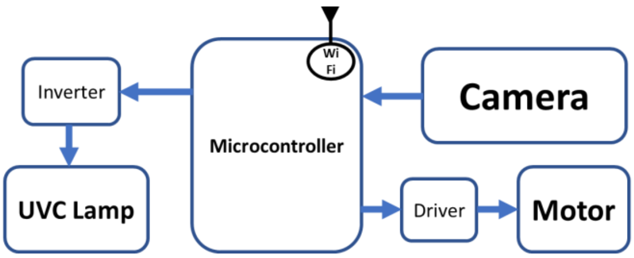

Figure 2. Schematic of UVC Robot

UVC Robot uses ESP32-CAM as a microcontroller. This module has a built-in camera package. In figure 3 can be shown ESP32-CAM board. This board has a low power 32-bit CPU, up to 160 MHz clock speed and built-in 520 KB SRAM, external 4 MPSRAM.

Figure 3. ESP32-CAM Board

ESP32-CAM can use a voltage of 3.3 V and 5 V., but it is recommended to use a voltage of 5 V to get good results. The camera module OV2640 uses fifteen pins and supports VGA image quality. A microSD card slot is also provided, and there are several GPIOs to connect peripherals.

The WIFI communication module is used to transmit data from the robot to the operator. The robot can move using a motor that the operator can control. Camera functions to help operators know environmental conditions. with this function, the robot can reach all areas in the room. Full specification ESP32-CAM can be shown in table 1.

Table 1. ESP32 -CAM Specification

Specification	Value
Package	DIP-16
SPI Flash	Default 32Mbit
RAM	520KB SRAM +4M PSRAM
Bluetooth	Bluetooth 4.2 BR/EDR and BLE standards
Wi-Fi	802.11 b/g/n/
Support interface	UART、SPI、I2C、PWM
Support TF card	Maximum support 4GB
IO port	9
UART Baud rate	Default 115200 bps
Image Output Format	JPEG (OV2640 support only), BMP, GRAYSCALE
Spectrum Range	2412 ~2484MHz
Power Supply Range	5V
Operating Temperature	-20 ℃ ~ 85 ℃
Storage Environment	-40 ℃ ~ 90 ℃, < 90%RH

The driving force on the robot uses an RS-545 motor with a gearbox that produces a torque of up to 10.8 Kg.cm at 60 RPM. Low RPM motor RS-545 can see in figure 4. RS-545 motor has operating voltage 5-15 and RPM no Load 16800.

Figure 4. Low RPM Motor RS-545

The drive system uses two motors connected to each wheel. The microcontroller regulates the motion of the motor based on the commands given by the operator. The microcontroller acts as a power regulator for the motor input with a voltage of 12 V. The motor control system of the microcontroller via IC L298 acts as a liaison between the microcontroller and the motor or known as a motor driver. Module L298 Dual H-Bridge Driver can see in figure 5.

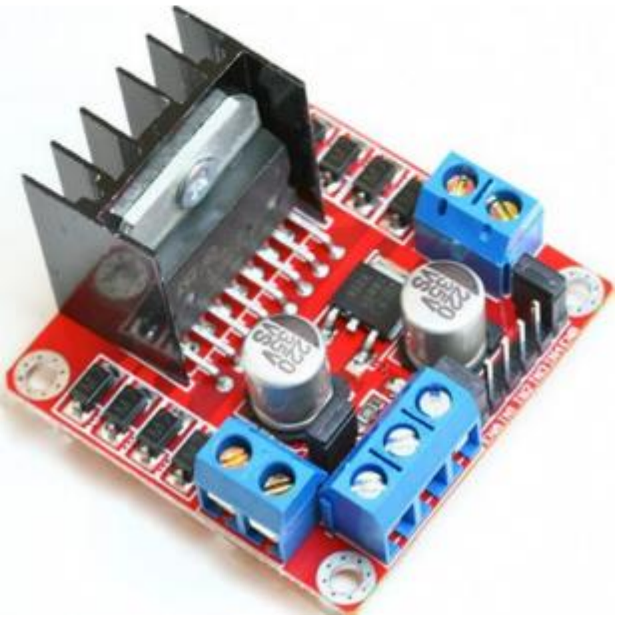

Figure 5. Module L298 Dual HBridge Driver

The L298 is a high-power version L293 motor driver IC. It is a high-voltage, high-current, dual full-bridge driver designed to accept standard TTL (Control Logic) logic levels and drive inductive loads such as relays, solenoids, DC and Stepper motors. Two startup inputs are provided to Switch the device on or off independently of the input signal. The lower transistor emitters of each bridge are connected, and a suitable external terminal can be used for the connection of the external sensing resistor.

Quality of Service (QoS)

Quality of service (QoS) refers to any technology that manages data traffic to reduce packet loss, latency and jitter on the network. QoS controls and manages network resources by assigning priority to specific data types on the network[11].

One of the main QoS factors of data communication is the delay in data transmission. Good communication needs to be paid attention to this delay must be kept almost constant, and below the specified limit, Delay Communication Data refer to table 2.

Table 2. Delay Communication Data

Category	Delay
Very Good	<150 ms
Good	150 ms - 300 ms
Moderate	300 ms - 450 ms
Poor	>450 ms

RESULTS AND DISCUSSION

UVC Sterilization Robot Application has been implemented and approved for its function, as shown in Figure 6. The robot has two UVC lamps installed above to form a 360-degree light coverage area. The camera is at the front and is flanked by two lights to add lighting to get good video results. External antennas are used to increase the wireless communication range.

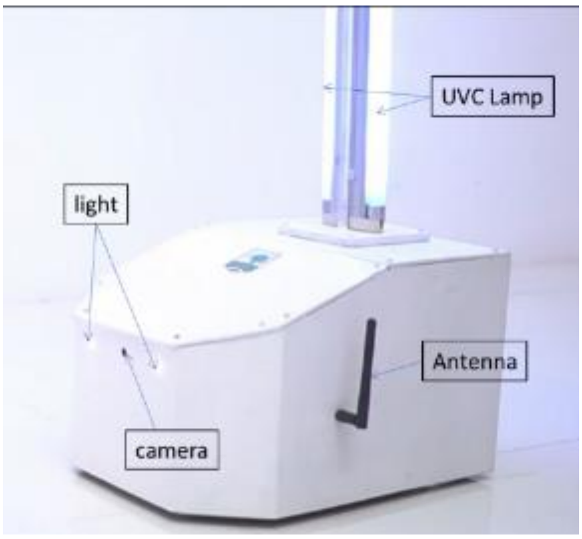

Figure 6. Robot UVC Sterilization

All electronic components are on the inside, consisting of a battery as a power supply, motor driver and UVC Lamp driver, as refer to in figure 7. The battery uses a Valve Regulated Lead-Acid Battery with a capacity of 7.2 Ah and a voltage of 12 V. The VRLA battery has a pressure relief valve that will activate when the hydrogen gas has exceeded the allowable pressure limit in the battery while it is in the charging process.

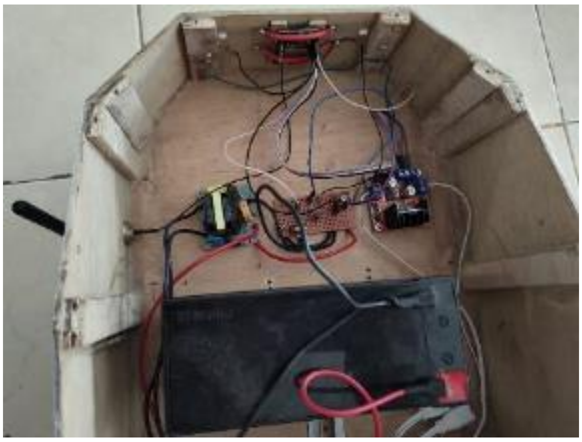

Figure 7. Electronic Component

All functions of the robot can be accessed via a web client, as shown in Figure 8. The video captured by the camera can also be seen on the web display to make it easier for the operator to move the robot in a closed room.

Figure 8. Web Client Screen

Below the video display, seven buttons can be used to control the robot. The button has a function, as can be seen in table 3.

Table 3. Button Function

Button	Function
Forward	Robot comes forward
Left	Robot turn left
Stop	Robot stop move
Right	Robot turn right
Reverse	Robot comes backwards
Lampu ON	UVC Lamp ON
Lampu OFF	UVC Lamp OFF

The robot is connected to a WLAN network so that clients on the same network can access the ESP32-CAM server via the IP obtained in the network. They are streaming video communication through port 81, while the HTTP function uses port 80.

The performance of the data communication system between the ESP32-CAM server and the client is done using Wireshark software. The results of measurements using the Wireshark software can be seen in Figure 9. The measurement results obtained a delay value of 347 ms with a throughput of 358 kb/s.

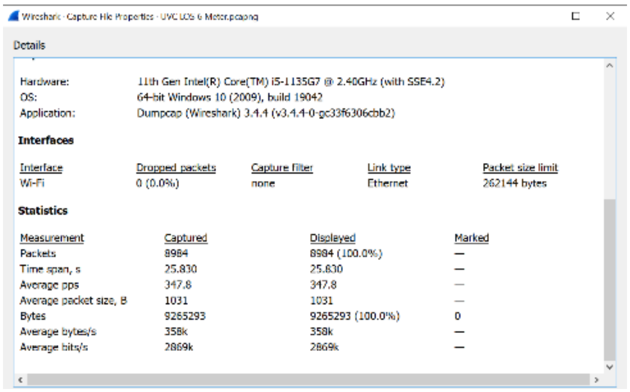

Figure 9. Wireshark Result

CONCLUSIONS

UVC Sterilization Robot Application Based on Wireless Communication has been successfully designed and implemented. The measurement results vis Wireshark obtained a delay value of 347 ms with a throughput of 358 kb/s. This value is included in the moderate category for data communication classification.

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