UV-C ENHANCED AUTOMATIC SANITIZATION ROBOT

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Abstract: In this paper, we introduce a Sanitization Robot Vehicle with UV light prototype using Arduino technology. This project outlines the changing landscape of robotics within healthcare and related fields, focusing on addressing the challenges posed by the novel corona virus disease. The primary objective of these robots is to reduce interpersonal contact while enhancing cleaning, sterilization, and overall support in medical settings like hospitals and quarantine facilities. By doing so, they play a crucial role in safeguarding medical personnel and actively contributing to pandemic management, thereby minimizing risks to their lives. The robot is outfitted with a range of sensors, UV-C light and disinfectant sprayers that enable it to detect high-touch surfaces and implement sanitization procedures efficiently.

Index Terms - Arduino, DC Pump, Disinfectant sprayers, Sanitization robot, UV-C light.

I. INTRODUCTION

The purpose of a UV light-equipped sanitizing robot is to automate the cleaning and disinfection process in diverse spaces such as hospitals, offices, and public areas. These robots employ technologies like UV-C light, chemical disinfectants, or other methods to eradicate harmful pathogens like bacteria and viruses. By doing so, they contribute to maintaining a safe and hygienic environment while minimizing the risk of human exposure to contaminants.

In today's fast-paced world, maintaining cleanliness and hygiene in public spaces has become more crucial than ever. Introducing the Automatic Sanitizing Robot, an innovative solution poised to transform sanitation practices across diverse environments. This state-of-the-art robot leverages advanced technology and operational efficiency to deliver comprehensive sanitization solutions.

II. OBJECTIVES

- Design and Development: Lead the design and development of an Advanced Smart Sanitizing Robot featuring integrated capabilities for autonomous navigation and comprehensive sanitization.
- Sanitization Methods: Research and apply effective sanitization methods, such as UV-C light exposure and spraying systems, to ensure thorough and efficient cleaning across various environments.
- Mechatronics Integration: Utilize mechatronics principles for the seamless integration of mechanical, electronic, and computer systems to enhance the overall performance and efficiency of the Smart Sanitizing Robot.

III. LITERATURE REVIEW

Zukowski et al. (2018) introduced a humanoid medical assistant and companion robot specifically designed for children's hospitals. Their focus was on the robot's ability to engage with children through facial recognition, storytelling, and educational videos displayed on its chest screen. Named 'Bobot,' this robot autonomously navigates patient rooms, conducts basic diagnostic tests like temperature and pulse rate measurements, and streams live video to healthcare professionals, serving as a comforting companion for young patients.

Vyshnavi's project titled "UV Disinfection Robot with Automatic Switching on Human Detection" (2020) utilizes UV light due to its germicidal properties, specifically targeting bacteria and viruses. However, UV light can also be harmful to humans. To ensure the robot operates safely without human intervention, an innovative UV Robot was developed and implemented, following a predefined path.The UV Robot is equipped with three 20W UV lamps that emit light in all directions. To mitigate the risk to humans, multiple components are integrated into the system. An Arduino system, coupled with a PIR sensor, is positioned atop the robot to detect any human presence. The robot stands at a height of 123 centimeters and weighs approximately 6.5 kilograms.

In another study by Zukowski et al. (2018), a temperature measurement system was implemented for a humanoid medical robot assistant. Their experiments with infrared thermometers and thermal imagers revealed limitations in using the infrared thermometer alone for accurate temperature readings. To address this, they developed a hybrid framework combining infrared thermometers with thermal cameras for precise temperature estimation and detection of individuals in proximity to the robot.

Chempolil et al. (2021) developed a prototype using Arduino UNO to assist hospital nurses. This model aims to reduce nurse interaction with patient-handled devices, enabling data transfer through audio systems or nurse-initiated instructions, especially in isolated wards. They incorporated a temperature sensor to activate a UVC lamp for room sterilization, ensuring a safe environment.

Biswas et al. (2020) introduced an autonomous robot designed to assist doctors by following instructions from a safe distance using distance sensors. This robot's touch less operations and UV sterilization system contribute to maintaining a hygienic environment while accompanying healthcare professionals during medical procedures.

IV. Methodology
4. Block diagram
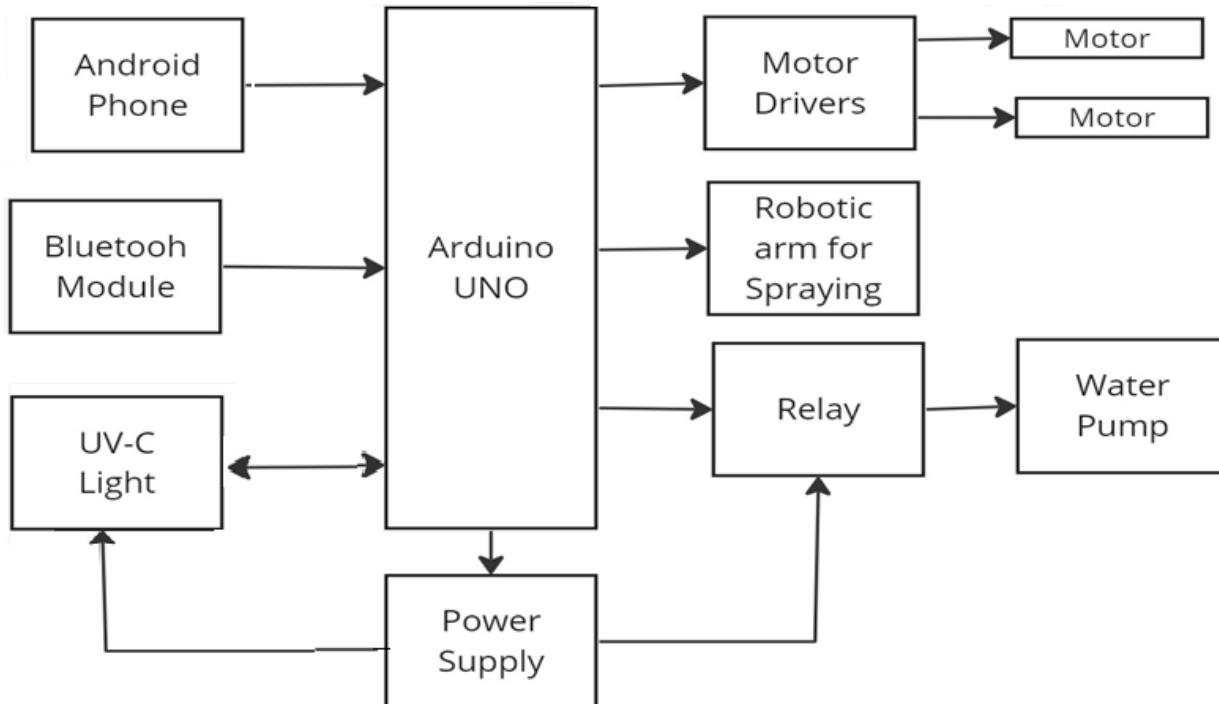
4.1 Components description:

The robot is structured into two primary sections:

Navigation Section: This section encompasses the control and navigation systems of the robot. It includes components such as microcontrollers, sensors, actuators, and communication modules. It is responsible for executing commands, processing sensor data, and ensuring the robot's movement and functionality.

Sanitization Section: This section is dedicated to the sanitization functions of the robot. It comprises sanitization equipment such as UV-C lamps, disinfectant sprayers, or other cleaning mechanisms. The sanitization section is designed to effectively disinfect and sanitize targeted areas according to predefined protocols and instructions.

4.1.1. Navigation Part-

Arduino Microcontroller
The micro-controller block of the system utilizes Arduino, an open-source prototyping platform comprising both hardware and software IDE. This platform is instrumental in uploading the program code to the physical board.

Specifically, the Arduino Uno is employed, which is a microcontroller board powered by the ATmega328P Microchip. It features 14 digital I/O pins, with 6 of these pins designated for PWM outputs and another 6 for analog inputs. Additionally, it incorporates a 16 MHz ceramic resonator, essential for generating the ATmega328P's clock signal.

Bluetooth
The HC-05 wireless module is a full-duplex communication device designed for transferring data between mobile phones and microcontrollers. This module enables wireless control via an Android application. Communication is established using USART at a baud rate of 9600, making it compatible with microcontrollers that support USART (Serial communication).

The HC-05 module features 6 pins, Enable pin, Vcc (power supply),GND (ground),Tx and Rx pins (for transmitting and receiving data),Button switch (used for configuration or pairing),State pin (provides status information, such as connection status)

Motor driver

This block interfaces with the robot's motors and actuators, providing the necessary control signals to regulate their speed, direction, and movement. The motor driver block ensures precise and efficient control of the robot's locomotion and functional mechanisms.

DC Motor

DC motors are utilized for the movement of the robot and are connected to the motor driver. When a trigger signal is sent to the motor driver, the motor moves accordingly at the specified speed.

Servo Motor

A servo motor is a rotary actuator that provides precise control over angular position, acceleration, and velocity. In the design, the servo motor is used to control the turning of the robot.

4.1.2. Sanitization Part-

Disinfectant Liquid Storage with Pipe:

This component involves a vessel containing liquid disinfectant, which is effective in combating diseases caused by bacteria and viruses by neutralizing them. A pipe is connected to this vessel, facilitating the flow of disinfectant to the DC pump.

DC Pump

The DC pump utilizes power from a battery to spray the liquid disinfectant. It can operate at various voltages depending on the specific application. The DC pump functions on centrifugal force to propel the liquid disinfectant, ensuring thorough and efficient coverage during the sanitization process.

UV light

Disinfection starts the moment the robot is turned ON. After the disinfection of a particular place is complete, the robot moves to the next directed position by following the line marked. This process continues till the disinfection of the entire room or place is complete. During the disinfection process, if a human or an animal approaches the operating area, then a command is sent to turn OFF the UV lights automatically. The data sensed by the PIR sensors is processed by the microcontroller and a message is sent to the robot. The robot remains in the same position if disinfection is not completed. After a delay of few seconds, the PIR sensors checks for the presence of human, in general, detects infrared radiation from surrounding area of specific range . As soon as the PIR sensors detects that there is no person or an animal in its range, robot resumes-- which means the UV light gets turned ON automatically and finishes the process. After the complete disinfection of a room or a place, the robot can be scheduled for disinfecting another room or can be turned off

Relays

Relays function as switches that can open and close circuits either electromechanically or electronically. They manage one electrical circuit by manipulating contacts within another circuit.

4.2 Working Methodology

4.3.1) Flow Chart Remote Control Mode
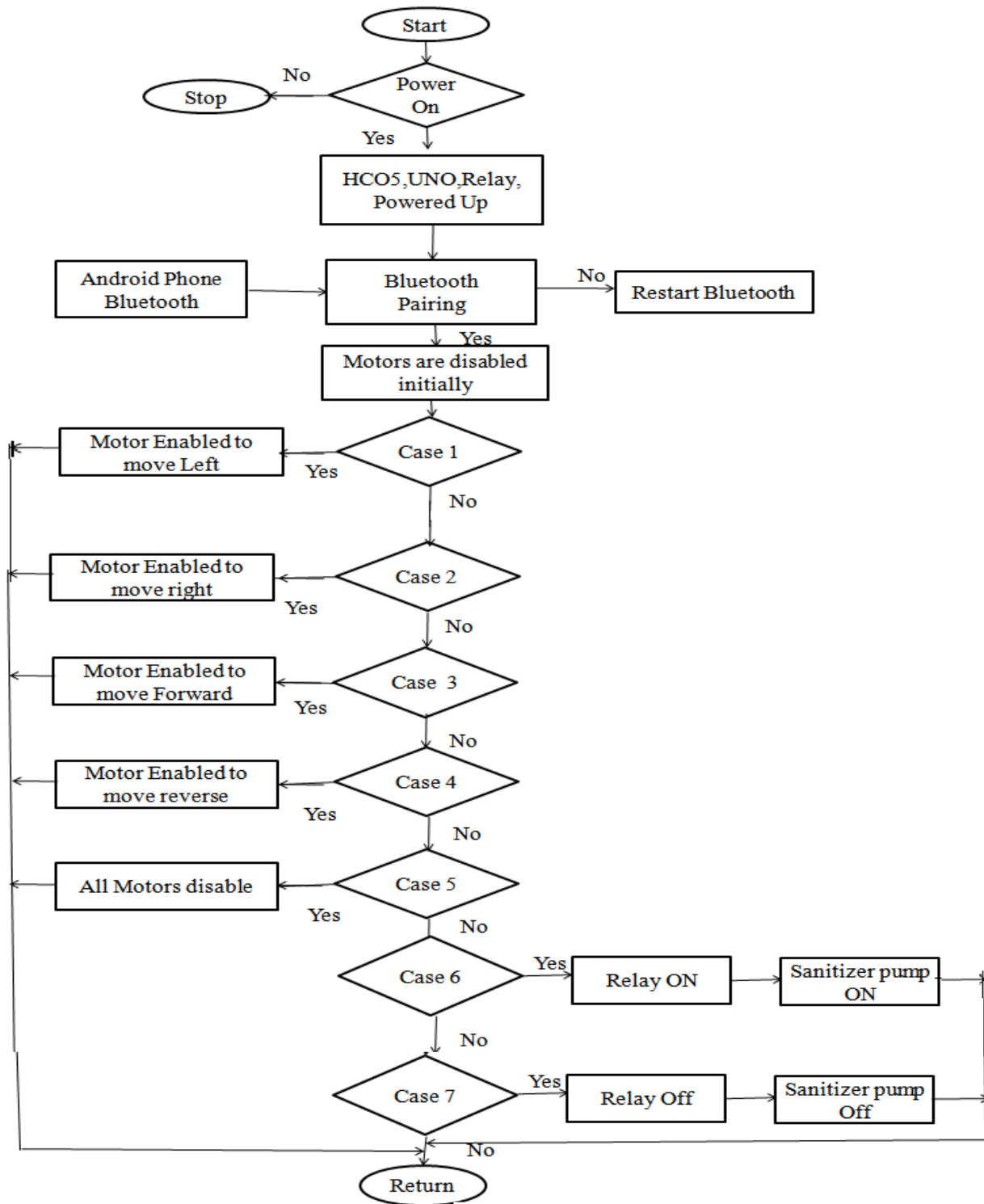
The Bluetooth-controlled robot operates based on the button pressed in the Android Bluetooth mobile app. To begin using this project, you must first download a Bluetooth app from the Google Play Store. After installation, any Bluetooth app capable of sending data can be used.

- When the forward button is pressed in the Bluetooth controller app, the robot starts moving forward and continues in that direction until it receives a new command. In this mode, both motors rotate clockwise.
- When the backward button is pressed in the Bluetooth controller app, the robot starts moving in reverse and continues in that direction until it receives a new command. In this mode, both motors, rotate counterclockwise.

- When the left button is pressed in the Bluetooth controller app, the robot starts moving to the left and continues in that direction until it receives a new command. In this scenario, the front motor rotates counterclockwise while second motor rotates clockwise.
- When the right button is pressed in the Bluetooth controller app, the robot starts moving to the right and continues in that direction until it receives a new command. In this scenario, the front motor rotates clockwise, while second motor rotates counterclockwise. Pressing the stop button halts the robot's movement.

V. RESULTS AND DISCUSSION

The project details the development and deployment of a robotic platform designed for disinfecting single-plant indoor environments, such as offices, apartments, and houses, among others. This cost-effective and easy-to-construct platform serves as an additional measure in the fight against viruses and bacteria with type C ultraviolet radiation.

The prototype was successfully tested by remotely controlling it to sanitize a room without the operator needing to touch any objects within the vicinity. Implementing this prototype will help prevent the spread of the deadly virus and ensure the safety of frontline workers. These results validate its potential for widespread adoption and effective disinfection in diverse indoor settings.

V. ACKNOWLEDGMENT

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