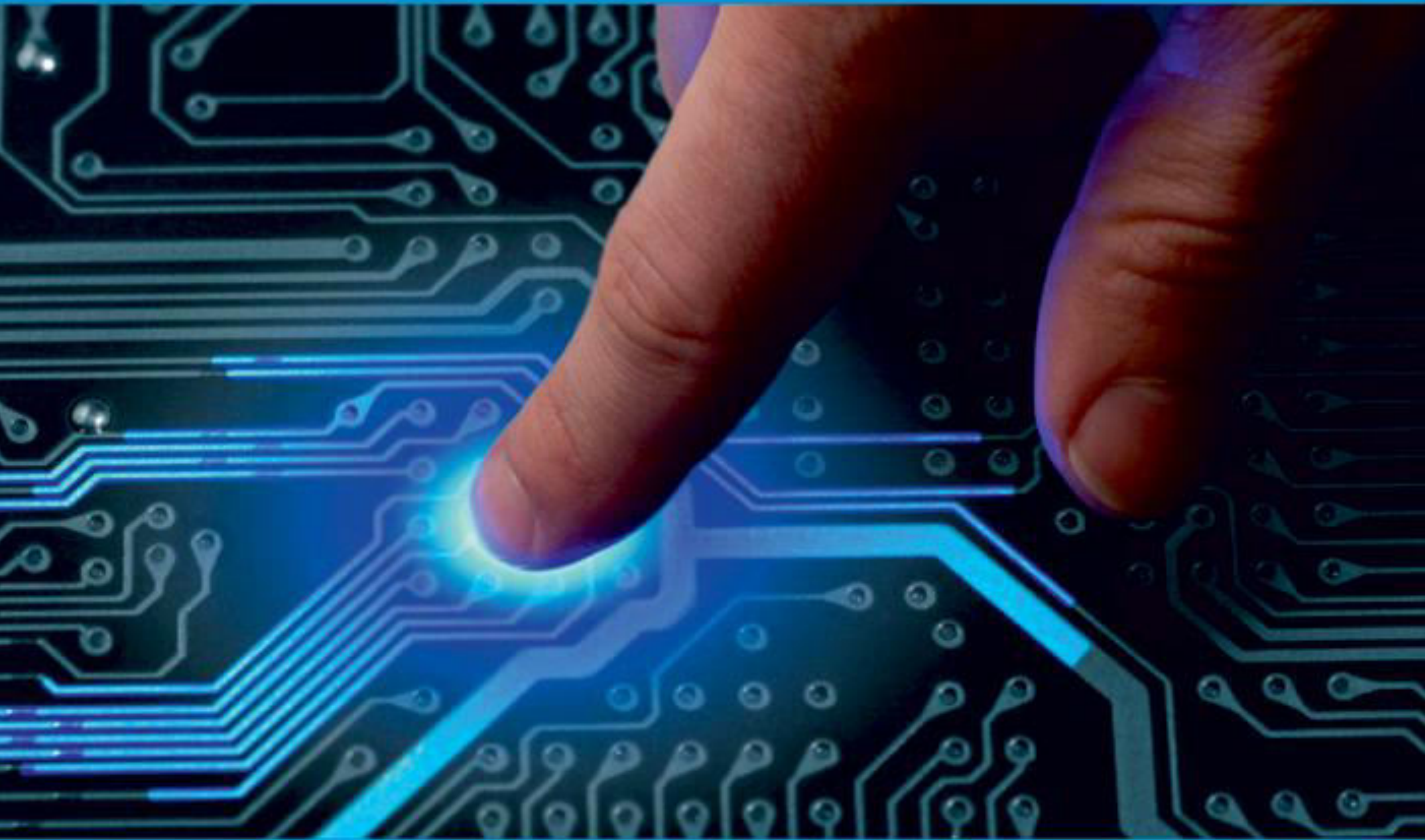
IJIRCCE

e-ISSN: 2320-9801 | p-ISSN: 2320-9798



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN COMPUTER & COMMUNICATION ENGINEERING

Volume 12, Issue 3, March 2024

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

Impact Factor: 8.379

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 8.379 | Monthly Peer Reviewed & Referred Journal |

|| Volume 12, Issue 3, March 2024 ||

| DOI: 10.15680/IJIRCCE.2024.1203148 |

Development of Smart Sanitizing Robot with Medicine Transport System

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ABSTRACT: This paper presents the development of a smart sanitizing robot integrated with a medicine transport system, designed to address critical challenges in healthcare facilities, particularly in the context of infection control and efficient medication delivery. The robot combines advanced sanitization capabilities with autonomous navigation and intelligent sensing technologies to effectively sanitize high-touch surfaces and minimize the risk of cross-contamination. Additionally, it features a medicine transport system that facilitates the safe and accurate delivery of medications within the facility. Through the integration of these functionalities, the smart sanitizing robot offers a comprehensive solution to enhance healthcare workflows, improve patient safety, and optimize facility management. This research highlights the potential of robotics and automation in revolutionizing healthcare delivery and underscores the importance of innovation in addressing evolving healthcare needs.

KEYWORDS*:* Health Pandemic situation, Sanitizer spray , Arduino Uno , Smartphone Function etc.

I. INTRODUCTION

In the face of increasingly complex healthcare challenges, the integration of robotics and automation has emerged as a promising solution to enhance efficiency and safety within healthcare facilities. One such innovation is the development of a smart sanitizing robot equipped with a medicine transport system. This paper introduces the concept and design of this groundbreaking technology, aimed at revolutionizing infection control and medication delivery in healthcare settings.

Healthcare-associated infections (HAIs) pose a significant threat to patient safety and contribute to increased healthcare costs. Traditional methods of sanitization and disinfection are often labor-intensive, time-consuming, and prone to human error. Moreover, the manual transportation of medications within facilities can lead to delays, errors, and inefficiencies in patient care.

To address these challenges, researchers and engineers have developed a multifunctional robot capable of autonomously sanitizing surfaces and transporting medications. By leveraging advanced robotics, artificial intelligence, and sensor technologies, this smart sanitizing robot offers a comprehensive solution to enhance infection control measures while streamlining medication delivery processes.

This paper explores the design principles, functionality, and potential applications of the smart sanitizing robot with a focus on its impact on healthcare operations and patient outcomes. Through a combination of literature review, conceptual framework, and case studies, we aim to demonstrate the transformative potential of this technology in improving healthcare delivery and reducing the burden of HAIs and medication errors.

In the subsequent sections, we delve into the specific features and capabilities of the smart sanitizing robot, highlighting its key components, operational modes, and potential benefits for healthcare facilities. Additionally, we discuss challenges and considerations related to implementation, including regulatory compliance, cost-effectiveness, and user acceptance.

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II. PROBLEM STATEMENT

Healthcare facilities face numerous challenges in maintaining a safe and hygienic environment while efficiently managing medication delivery. Traditional methods of sanitization often fall short in effectively targeting high-touch surfaces, leading to an increased risk of infectious disease transmission. Moreover, the manual transportation of medications within facilities can be time-consuming, error-prone, and labor-intensive, potentially compromising patient care and staff productivity.

To address these challenges, there is a pressing need for innovative solutions that integrate advanced sanitization capabilities with efficient medication transport systems. A smart sanitizing robot with a medicine transport system presents a promising approach to mitigate the risks associated with infection transmission and streamline medication delivery processes. By combining cutting-edge robotics, autonomous navigation, and intelligent sensing technologies, such a system has the potential to revolutionize healthcare workflows, enhance patient safety, and optimize resource utilization in healthcare settings.

III. BLOCK DIAGRAM

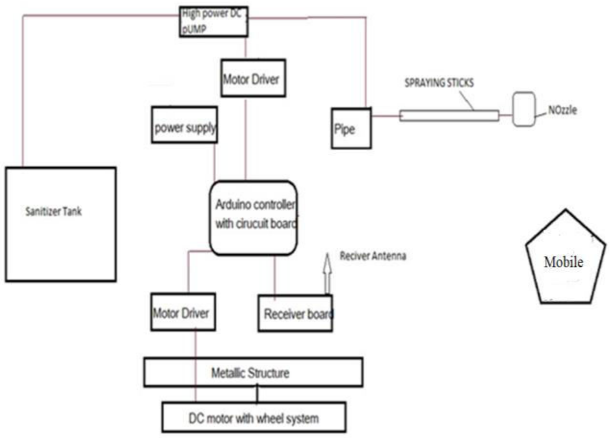

Fig. 1. Block Diagram

IV. SYSTEM ARCHITECTURE

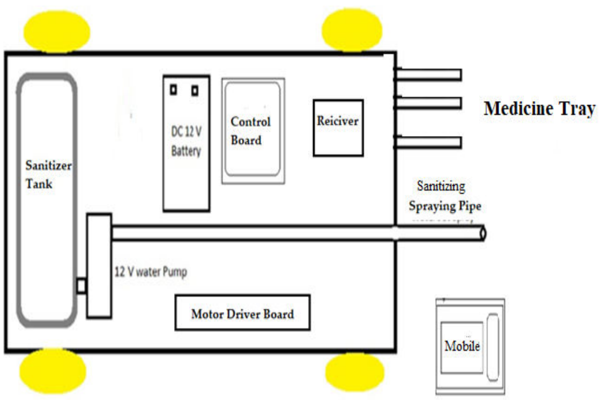

Fig. 2. System Architecture

International Journal of Innovative Research in Computer and Communication Engineering

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1. Working

- The main goal of this project is to design a Smart sanitizing robot for health pandemic condition, and save the life of our front line warriors. By using remote operation.
- This robot is loaded with a sanitizer tank and a High-speed pump controlled through wireless communication to sprinkle. For the desired operation, an Arduino microcontroller is used.
- At the transmitter end, push buttons are used to send commands to the receiver end to control the robotic movement, either in forward, backward, right or left and 360 direction movement.
- The remote control that has the benefit of adequate range up to 30 meters with apposite antenna, while the decoder decode before feeding it to another microcontroller to drive DC motors via motor driver IC for necessary work. .
- A sanitizer tank along with water pump and control board is mounted on the robot body and its operation is carried out from the microcontroller output through appropriate signal from the transmitting end.
- There is wireless camera attached at the front portion of robot. We can see the live footage of surroundings and spray according to it.
- Robot is powered with 12v battery, and it is charged with 12v adopter for uninterrupted of power.
- This robot also transports various medicine and medical equipment's inside the corona ward or any other location. This make robot a multifunction performer.

2. System flow diagram

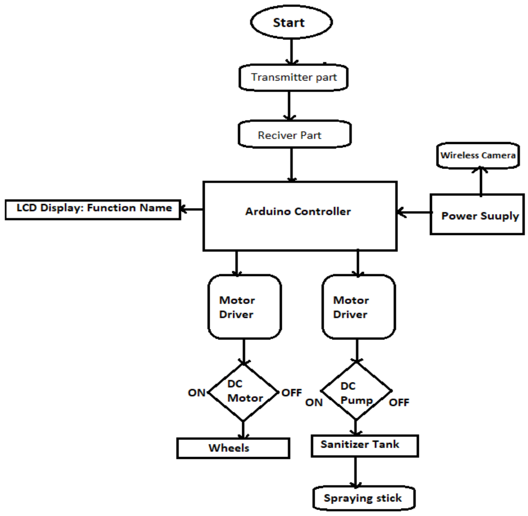

Fig.3. System flow diagram

3. Components Specification

- Adapter
- Battery
- Power supply unit
- Bluetooth module
- Arduino controller
- LCD Display
- Motor Driver
- DC Motor
- Relay Board
- Dc water pump
- Wheels
- Frame
- Others

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- ***Arduino Uno*** **(12v)**

The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits.

- ***LCD Display (5v)***

A liquid crystal display (LCD) is a thin, flat panel used for electronically displaying information such as text, images, and moving pictures.
LCD stands for Liquid Crystal Display. LCD is finding wide spread use replacing LEDs (seven segment LEDs or other multi segment LEDs).

- ***Relay Board (12v)***

A relay is usually an electromechanical device that is actuated by an electrical current. The current flowing in one circuit causes the opening or closing of another circuit. Relays are like remote control switches and are used in many applications because of their relative simplicity, long life, and proven high reliability.

- ***DC Water Pump***

Operates on 12V supply
The Speed Control circuit technology is able to stabilize the voltage changes and load changes, water flow is very stable.
In particular, it is suitable for users who have the demand for a steady flow.

- ***12 v Battery***

12 V , 2 Amp Battery is high power battery easily handle all the function.

Main things are to collect electrical energy from solar panel and provide to various components For running specific function.

- ***Bluetooth module (HC-05)***

The **HC-05** is a very cool module which can add two-way (full-duplex) wireless functionality to your projects. You can use this module to communicate between two microcontrollers like Arduino or communicate with any device with Bluetooth functionality like a Phone or Laptop.

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- ***DC motor***

DC motor is an electrical machine that utilizes electric power resulting in mechanical power output. Normally the motor output is a rotational motion of the shaft. The input may be direct current supply or alternating supply. But in case of DC motor direct current is used.

- ***Motor Driver IC (L293D)***

L293D is a dual H-bridge motor driver integrated circuit (IC). Motor drivers act as current amplifiers since they take a low-current control signal and provide a higher-current signal.
This higher current signal is used to drive the motors. L293D contains two inbuilt H-bridge driver circuits.

Circuit Diagram :

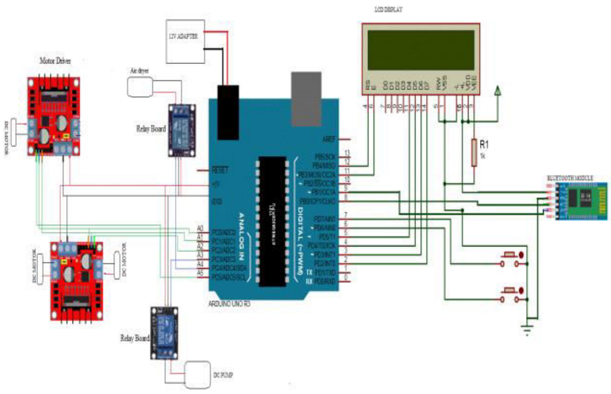

Fig. 2. Circuit Diagram

4. Mechanical Design

The robot uses DOIT chassis with the T100 kind. The two chassis are then assembled and expanded with four bars of aluminum alloy to accommodate the chassis dimensions to 48 cm in length and 24 cm in width. The chassis, which can carry loads of up to 5 kg, has a specified torque of 9.5 kgNan, made of aluminum alloy material, weighs 0.65 kg, and a trackwheel made of engineering plastic. This chassis includes two DC motors with 9 V voltage specifications, currently loaded by 1200 mA, and a loading speed of 100 rpm.

The placement of each component in the board system should take into account the relative weight of the robots. Apart from the position of the sprayer, the tank, and the pump are also very important for proper and high pressure. The location of the battery and the main control robot are placed in the back so that they are away from potential exposure to liquid spray. FPV cameras are mounted on the back so that they can monitor the movements of the robots and spray them properly. With this specification of the machine, the robot can transport more than 1-liter disinfectant, DC pumps, batteries, and electrical circuits.

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Figure.3. Project Image

V. RESULTS AND DISCUSSIONS

This section focuses on the outcome and analysis of a moving robot. The design effects in terms of mechanical, electrical, performance, and sensory learning are well described in this section.

a. Mechanical chassis and track wheels

As explained in the previous chapter, this robot is four wheels drive machine. The chassis is composed of rods and wheels made of aluminium alloy type 5070. As showed in Figure 6, each wheel has three jagged wheels, one of which is driven directly by the motor and two others to position the trackwheel so it will stay still in the frame. The trackwheel material used is engineered plastic with each adjustable lattice. The frame of the robot is connected by aluminium alloy bars 3 mm thick. Above the frame is given an acrylic sheet with a thickness of 5 mm to place the water tank and electrical components such as pumps, batteries, and controllers. At the front of the frame, the acrylic slab is made to tilt to prevent the front motor from being sprayed with liquid droplets.

b. Power consumption

Every electrical component transported by this robot has a power consumption borne by a three-cell LiPo battery. The list of components current consumption is as follows; DC motors are 120 0mA each, and DC pumps are 1200 mA, FPV cameras are 510 mA, Arduino Mega 2560 around 100 mA, a micro servo is 250 mA each, then sensors and drivers can be ignored. The mathematical representation to calculate the total power needed can be described using (1).

$$P_{total} = \sum_{i=0}^{i} (V_i \times I_i) \qquad (1)$$

Vi is the voltage of each component, and *Ii* is the current of each component, respectively.

The total power expressed by *Ptotal* . The total power is the sum of the voltage and current multiplications of each component used. Hence, the total power needed by the robot is around 63,442 W.

$$T_{operate} = \frac{V_{battery} \times I_{battery}}{P_{total}} \times 80\% \qquad (2)$$

With a LiPo battery V_battery = 8000 mAh and I_battery = 11.1 V, the robot can operate for more than an hour with the pump operate. The calculation above, when compared with actual measurements in the field, does not show significant differences in results. A fully operated robot with running conditions and the pump running causes a decrease in battery voltage from 11.4 V to 8.8 V for approximately 56 minutes. When the cell's voltage touches 3 V, the alarm turns on, and the robot operation is stopped. This is caused by unbalanced battery cell charging, so even when emptying, it is also unbalanced. Cell 1 has been degraded and has the lowest cell voltage. So, it can be overcome by using a battery charger that has a good balancer feature.

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c. Design Calculations

(i) *Sprinkler flow rate*
Theoretical
Q=k √ p
p=20 psi
k=5.6
Q=5.6 √20
Q= 25 GPM
Q=Flow Rate (GPM), P=Operating PSI of head/Outlet
K=K Factor of Head/outlet

(ii) *Analysis*
For 1 litre, the flow rate of the Sprinkler is 476seconds.
For the project the flow rate of the sprinkler is 200 seconds.
The area of the sanitizer covered is 600mm.
The acquired Flow rate is 17GPM

(iii) *Motor Specifications*

Speed = 200 RPM,
Voltage = 12V,
Power = 100W
Torque of the motor
Torque = (P X 60) / (2 x 3.14 x N)
Torque = (100 X 60) / (2 x 3.14 x 100)
Torque = 9.554 Nm,
Torque =9.554 x 103 Nmm

(iv*) Battery life calculation*
Robot working hours for one full charge.
Batter capacity = 12v 7Ah (Ampere Hours)
Total device consumption = 520ma (mill ampere)
Battery Life = Battery Capacity in mAh / Load Current in mA
= 7000mAh/520ma
= 13.46 Hours

d. Remote Operating System

Wheel-primarily based robots regularly experience trouble while visiting through complicated terrain together with steps and limitations in area [10]. To keep away from this trouble, visual structures and far flung wheelchair packages are used on mobile robots. The running precept of the automatic sanitizer sprinkler robot is much like that of a television far off control. when you press a button at the faraway, it obeys the input sign thru the app. to start with, the input statistics reaches the Bluetooth module, then the sign goes to the Arduino module. The Arduino machine transmits commands to the motor pressure. at some stage in blowing the cylinder back and front, air enters and contains the disinfectant outdoor the tank.

FORWARD-F
Forwarding the F button allows the robotic to move ahead whilst the person gives the F command in terminal mode.
BACKWARD-B
The lower back feature button permits the robot to opposite while the consumer gives a B command in terminal mode

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LEFT-L
at the left is a function used within the Loop block that permits the robot to move left whilst the user gives the L command in terminal mode.
RIGHT –R
on the right is a Loop block characteristic that allows the robot to move proper while the user offers the L command in terminal mode.
PUMP START-O
Pump start utilized in Loop block lets in the pump to begin while the person gives an O command inside the final mode.
PUMP STOP-G
Pump top used in Loop block allows stop pumping when consumer offers G command in terminal mode.
STOP-S
ST in terminal mode will send a positive frequency to the Bluetooth module and the robotic will forestall mechanically.

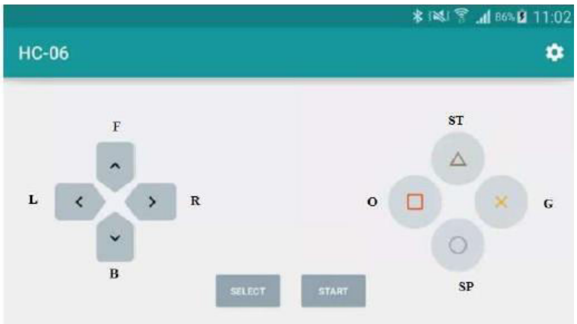

Figure 4. Mobile Controller mode

5. Advantages

(i) It is Non contactable.
(ii) Protect from any health Pandemic situation .
(iii) Wireless technology.
(iv) Design is compact.
(v) Easy to operate and installation
(vi) Available in different sizes.
(vii) User friendly.
(viii) Maintenance is low.

6. Disadvantages

(i) Skill Person needed
(ii) Fire hazards

7. Applications

(i) It can be used hospitals.
(ii) Used in public locations
(iii) Also used in School & colleges
(iv) Use in Airports.
(v) Used in hotel and restaurants.
(vi) Shopping malls.
(vii) Banks.

VI. CONCLUSION

In conclusion, the development of a smart sanitizing robot with a medicine transport system represents a significant advancement in healthcare technology. By integrating sanitization capabilities with efficient medicine

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delivery, this innovation addresses crucial needs in healthcare facilities, especially in the context of infectious disease control. The robot's autonomous navigation and intelligent sensing capabilities enhance operational efficiency while minimizing human contact, thereby reducing the risk of cross-contamination. Furthermore, its ability to transport medicines safely and accurately streamlines healthcare workflows, improving patient care and overall facility management. As technology continues to evolve, such advancements hold promise for revolutionizing healthcare delivery, promoting safety, and enhancing patient outcomes.

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