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# Design and Development of Robotic Vehicle for Isolation Ward

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**Abstract**

In response to the growing need for contactless healthcare delivery and enhanced hygiene in medical environments, this project presents the Design and Development of a Robot Vehicle for Isolation Ward. The proposed system is a mobile robotic platform equipped with an ESP32-CAM for live video streaming, a DC pump for sanitization, and two remotely controlled medicine boxes for delivering essential supplies to patients in isolation. Controlled via an IoT interface, the robot can move forward, backward, left, and right, allowing healthcare personnel to navigate it through the ward without physical contact. The DC pump can be activated through the IoT platform to spray disinfectant, ensuring a sanitized path during operation. The medicine boxes can also be opened and closed remotely, enabling the safe and hygienic delivery of medicines and supplies. An Arduino Uno serves as the central controller, interfacing with all components and executing commands received via IoT. This system minimizes the risk of infection for medical staff by enabling remote surveillance, sanitization, and supply delivery, making it a practical solution for managing healthcare Tasks in isolation wards and other high-risk environments.

**Keywords -** Isolation Ward Robot, ESP32-CAM, Arduino, IoT-based Robot, Sanitization Robot Medical Supply Delivery.

## 1. Literature Survey:

The COVID-19 pandemic significantly accelerated the development and deployment of robotic technologies in healthcare, particularly in isolation wards where minimizing direct human contact is critical. Robotic vehicles have been designed to assist with routine tasks such as delivering medicines, food, and medical supplies to patients, thereby reducing the risk of infection among healthcare workers.

Charisma and Pavithra introduced an IoT-based smart delivering robot aimed at supporting operations in isolation wards. Their system integrates real-time monitoring and remote control capabilities, allowing healthcare personnel to manage deliveries without entering high-risk zones. This system proved effective in reducing manual workload and exposure risk.

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A study titled "Design and Development of Robotic Vehicle for Isolation Ward" focuses on creating a remotely controlled robot equipped with a tray mechanism for transporting essential items. This design incorporates multiple motors—four for navigation and one for operating the tray lift—demonstrating a practical solution for contactless service delivery in healthcare environments.

The work "Mobile Robots for Isolation-Room Hospital Settings: A Scenario-Based Study" evaluates the usability and efficiency of robotic solutions in isolation rooms. The study highlights that mobile robots can perform repetitive logistics tasks with high reliability, improving both patient care and staff safety.

Another innovative approach is seen in "Innovative Medical Robotic Solution for Safe Medication Delivery", which explores robotic systems capable of autonomously navigating hospital environments. These systems aim to deliver timely care without compromising safety and demonstrate potential for scalability in larger healthcare setups.

A comprehensive review by **A**ssistive Robotic Systems in Nursing Care: A Scoping Review identifies the broader applications of robotic vehicles beyond isolation settings. It emphasizes their role in automating medication delivery, patient interaction, and even monitoring, thereby alleviating the burden on overworked medical personnel.

## 2. **Introduction**

The outbreak of contagious diseases such as COVID-19, SARS, and other viral infections has posed serious challenges to healthcare systems across the world. One of the major concerns during such pandemics is the safety of healthcare workers, especially those operating in isolation wards where exposure to infected patients is high. The need for minimizing human-to-human contact while ensuring proper delivery of medical services and hygiene maintenance has become critically important. This has led to a growing demand for automation and robotics in healthcare environments.

In such scenarios, robotic systems can play a vital role in reducing human involvement in high-risk zones by performing repetitive tasks like medicine delivery, sanitization, surveillance, and communication. This project focuses on the design and tailored for use in isolation wards. The robot is capable of delivering medicines, sanitizing areas, and providing live video feedback to medical personnel, all while being remotely controlled via IoT platforms.
Healthcare professionals are often required to make frequent visits to isolation wards, risking their health and lives. These visits may include tasks such as delivering medicine, checking patient conditions, and sanitizing the environment. Repeated and close physical interaction with infected patients increases the likelihood of virus transmission. Moreover, the constant need to wear personal protective equipment (PPE) adds to fatigue and reduces work efficiency. To address these challenges, there is a

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pressing need for a remotely operated robot vehicle that can carry out basic tasks such as medicine delivery, sanitization, and surveillance, thereby significantly minimizing the exposure of medical staff to infectious diseases. Such a solution must be low-cost, reliable, and easy to deploy in healthcare environments.

### 3. Methodology

This project talks about a robot vehicle that can help keep doctors and health workers safe from infected diseases. The robot is made using simple parts and doesn't cost much, so it's easy to build and use in hospitals or clinics.

### 4. Proposed System

The proposed system is a multifunctional robotic vehicle designed to operate inside isolation wards, minimizing human contact with patients and reducing the risk of infection transmission. The robot is powered by an Arduino Uno microcontroller, which acts as the brain of the entire setup, coordinating inputs and outputs from all connected components. The robot is equipped with ESP32-CAM, a Wi-Fi-enabled camera module that provides live video surveillance of the isolation ward area. This camera streams real-time footage through an IoT platform, allowing doctors or healthcare staff to remotely monitor patients and the robot's activities from a secure location. Using a web-based or mobile IoT interface, the robot's movement in four directions—forward, backward, left, and right—can be controlled remotely. This mobility ensures the robot can navigate through hospital corridors and reach patient bedsides effectively.

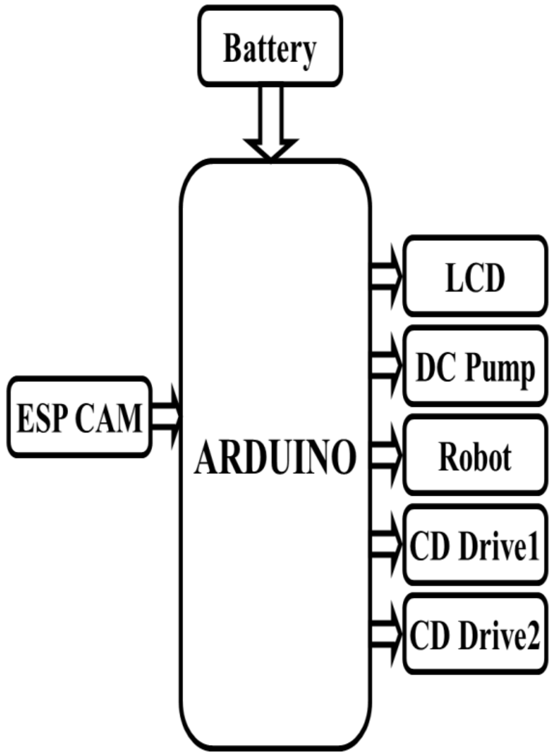


**Fig 1 : Block Diagram of Proposed System**

These boxes are fitted with servomotors and can be opened or closed remotely via IoT commands, allowing healthcare professionals to deliver medicines without direct contact. This feature provides a controlled and safe way to distribute multiple medications to patients on different schedules. Furthermore, the robot includes a DC pump mechanism connected to a small tank filled with disinfectant or sanitizer. Through the same IoT interface, users can turn the DC pump on or off remotely, enabling the robot to sprinkle sanitizer in its surrounding area as it moves. This feature is particularly useful for automatic surface disinfection, helping maintain hygiene in isolation zones without the need for human cleaners.

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## Description of Hardware Used

The major components used in the system are described in short here.

### I.ESP32-CAMERA

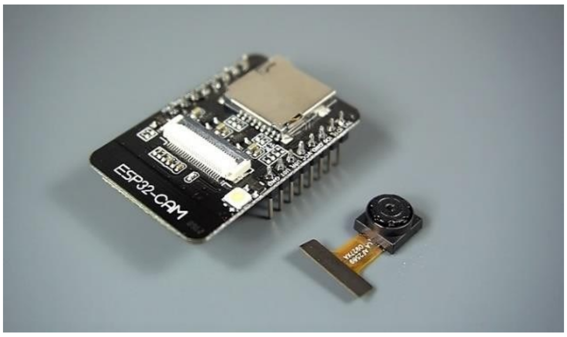


**Fig 2: ESP32-Camera**

ESP32-CAM is the latest small size camera module released by Essence. The module can work independently as the smallest system, with a size of only 27*40.5*4.5mm, and a deep sleep current as low as 6mA. It is an ideal solution for IoT applications .ESP32-CAM adopts DIP package and can be used directly by plugging in the bottom plate, realizing the rapid production of products, providing customers with high-reliability connection methods, which is convenient for application in various IoT hardware terminal occasions. The ESP32-CAM is a very small camera module with the ESP32-S chip that costs approximately Besides the OV2640 camera, and several GPIOs to connect peripherals, it also features a microSD card slot that can be useful to store images taken with the camera or to store files to serve to clients.

### ii.Arduino Uno (ATMEGA328P):

Arduino is a small computer that helps you build electronic projects. It is made up of two main parts: a physical board (called hardware) and a program on your computer (called software). You can write instructions using the software and then send those instructions to the Arduino board.


**Fig 3: Arduino Uno**

The board follows the instructions to control different devices, such as lights, motors, or sensors. This makes Arduino useful for many creative and practical projects. It is designed to be easy to use, even for beginners and students.
One of the most popular types of Arduino boards is the Arduino Uno. It has 14 pins where you can connect wires and devices. Out of those 14 pins, 6 can control things like motor speed or light brightness using a method called PWM (Pulse Width Modulation).
The Arduino Uno also has other helpful features. It includes places to plug in power, a USB cable to connect to your computer, a 16 MHz crystal for timing, and a reset button to restart the board if needed.

### iii.Relay Module:

A power relay module is like an electric switch that works using a magnet. This magnet is turned on by a small signal from a microcontroller, like an Arduino.

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When the magnet turns on, it opens or closes another circuit to control bigger devices.

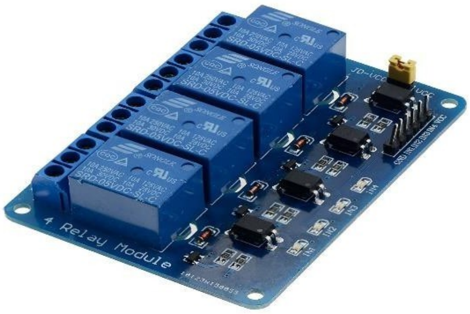


**Fig 4 : Relay Module**

A 6-channel relay module means it can control up to 6 devices. Each relay can handle up to 10 amps of current at 250 volts. It also has a special safety feature called an opto coupler, which protects 5.the control side (like the Arduino) from high voltage up to 2000 volts.

**Iv .D.C. Motor:**

The DC motor has two basic parts: the rotating part that is called the armature and the stationary part that includes coils of wire called the field coils. The stationary part is also called the stator.

**Fig 5 : DC Motor**

Figure shows a picture of a typical DC motor, Figure shows a picture of a DC armature, and Fig shows a picture of a typical stator. From the picture you can see the armature is made of coils of wire wrapped around the core, and the core has an extended shaft that rotates on bearings. You should also notice that the ends of each coil of wire on the armature are terminated at one end of the armature.

**Description of Software Used**

Arduino IDE software is used in this work. It is the open source software which is used to make Arduino based code and it was uploaded to an Arduino Uno board. As per need one can change the code easily in Arduino IDE.

# 5.Results

By integrating components such as the Arduino Uno, ESP32-CAM, DC pump, and IoT-controlled medicine boxes, the robot is capable of performing critical tasks like real-time surveillance, remote medicine delivery, and automated sanitization. These features collectively contribute to enhancing patient care while ensuring the safety of healthcare workers by reducing their exposure to infectious diseases. The system's flexibility, ease of control through IoT platforms, and modular design make it a valuable asset for hospitals, especially during pandemics or in bio-sensitive zones.

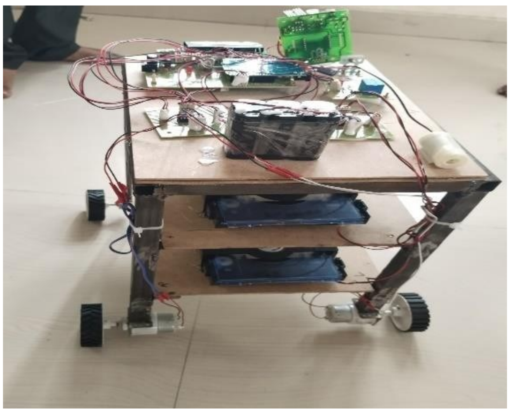

**Fig 6 : Project Image**

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The medicine boxes can also be opened and closed remotely, enabling the safe and hygienic delivery of medicines and supplies. An Arduino Uno serves as the central controller, interfacing with all components and executing commands received via IoT. This system minimizes the risk of infection for medical staff by enabling remote surveillance, sanitization, and supply delivery, making it a practical solution for managing healthcare tasks in isolation wards and other high-risk environments.

## 6. Conclusion

The development of the IoT-enabled robotic vehicle for isolation wards offers a practical and innovative solution to minimize direct human interaction in high-risk healthcare environments. By integrating components such as the Arduino Uno, ESP32-CAM, DC pump, and IoT-controlled medicine boxes, the robot is capable of performing critical tasks like real-time surveillance, remote medicine delivery, and automated sanitization. These features collectively contribute to enhancing patient care while ensuring the safety of healthcare workers by reducing their exposure to infectious diseases. The system's flexibility, ease of control through IoT platforms, and modular design make it a valuable asset for hospitals, especially during pandemics or in bio-sensitive zones. Overall, this project demonstrates the potential of combining robotics and IoT to support contactless healthcare services and sets a foundation for future advancements in smart hospital automation. [9], [12], [14]. These advancements aim to enhance reliability, extend communication range, and maintain high performance in dynamic marine environments.

## 7. Future Scope

The design and development of robotic vehicles for isolation wards hold significant future scope, especially in the fields of healthcare automation, infection control, and emergency response. As the demand for contactless services increases due to global health crises like pandemics, these robotic vehicles can play a crucial role in reducing human exposure to infectious diseases. They can be used for delivering medicines, food, and medical supplies, monitoring patient conditions, and even performing sanitation tasks within high-risk areas. With advancements in AI, IoT, and sensor technologies, these robots can become more intelligent, autonomous, and efficient. Their application can extend beyond hospitals to quarantine centres, old-age homes, and disaster-hit zones.

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