

# **Design and Assembly of Time-Efficient Floor Disinfecting Robot Using Artificial Intelligence**

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## **Abstract**

Modern households are becoming automated with the development of smart cleaning robots applied in many fields with the known environment itself only because of difficulty in analyzing unknown paths, the cleaning robot due to its semi-autonomous nature cannot be monitored without the presence of human interference. The purpose of the project is to disinfect the floor in households, colleges, hospitals, etc., fully autonomously for delivering convenience and reducing time spent by developing a prototype model of a floor disinfecting robot using artificial intelligence. The proposed system initiates by designing a 3D model in the designing software for assembling the required components in the 3D printed hardware model. In an assigned path, turning ON of the device and UV LED strip for floor disinfecting are performed automatically using a supervised learning algorithm and scheduling program respectively. Appearance of obstacles within the path are detected and captured through external sensors and Pi camera for safety monitoring of the device. All the software and hardware operations of the device are tested and controlled by integrating with a Raspberry Pi microcomputer. For a user to get acknowledgment about the device performing tasks such as autonomous movement of the robot within the path, activation and deactivation of UV LED, obstacle detection is intimated to the user by sending an online message through a WhatsApp notification.

## **Keywords**

Disinfection, Artificial Intelligence, UV LED Strip, WhatsApp Notification and Scheduling Task.

## **1. Introduction**

A Robot is an electro-mechanical machine that is used for various purposes in industrial and domestic applications. Based on the application many home appliances from various industries have been developed. Initially, the main focus was on having a cleaning device. As time flies more improvements in robotic devices were made and more efficient electronic appliances were developed. Cleaning is an essential need of this generation. Basically, in colleges and hospitals for floor cleaning regularly different techniques are used to clean the different types of surfaces. The world today is governed by automation. When complex operations are made automated to simplify tasks, the benefits of automation can also be tapped to perform simple household tasks. One such task is cleaning. Cleaning, though undermined for its nature of work, is extremely vital. Cleanliness will get a healthy life.

In recent years, robotic cleaners have taken major attention in robotics research due to their effectiveness in assisting humans in-floor cleaning applications at various places such as homes, hotels, restaurants, offices, hospitals, workshops, warehouses, universities, etc. The robotic cleaners are classified based on their cleaning expertise like floor mopping, dry vacuum cleaning, etc. Xiaomi, Realme, Dyson, etc., are the automatic cleaning robots used for the purpose of dry vacuuming and wet mopping that are existed in the present market.

Earlier, many people used to take care of surfaces by using disinfectant tools such as hot boiling water, chlorine bleach, Ethanol isopropyl alcohol, microfiber cloth, disinfecting wipes, etc. Use of these leads to employing special servants, maids, or cleaning staff and may increase the cost of buying those disinfectant tools, and may increase workload. However, these traditional methods cannot be considered efficient methods for disinfection purposes instead use UV Light to kill various germs, bacteria, and viruses like covid, omicron, etc., and the environment sanitary can be done which was proven by WHO (World Health Organization) itself. So, making use of technical methods for purpose of disinfection by replacing conventional methods can be considered an effective method in terms of inactivation of infectious agents, cost, and workload.

The main aim of the project is to develop a system in which the user's workload is reduced by saving time due to the autonomous operation of the device from starting the disinfecting process to completion by designing a prototype model and assembling the essential components in the 3D printed model. Initializing and termination

of the disinfection task are performed automatically by Scheduling the UV LED strip. The movement of the device is performed autonomously by detecting obstacles within the assigned path using Artificial intelligence learning methods. Every process performed by the robot is intimated to the user for the purpose of getting acknowledgment about the task done automatically by the device through online notification.

## **2. Construction of the Proposed Model**

### **2.1 Design of the Proposed Model**

The proposed model of disinfecting robot is designed in a solid works software (Figure 1, Figure 2 and Figure 3). The designed

model is divided into 3 parts for feasible design representation. They are: i) Ground Floor ii) Upper Floor and iii) Covering Cap.

Dimensions of the Ground Floor are considered as 170 x 150 x 25mm.

Dimensions of the Upper Floor are considered as 170 x 150 x 25mm.

Dimensions of the Covering Cap are considered as 170 x 150 x 2mm.

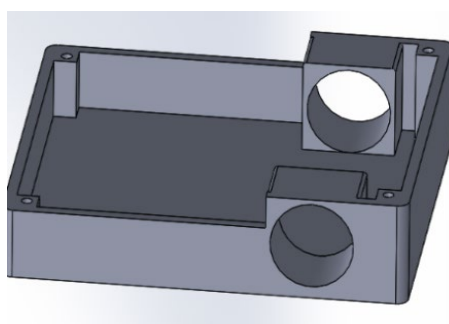


Figure 1. Ground Floor

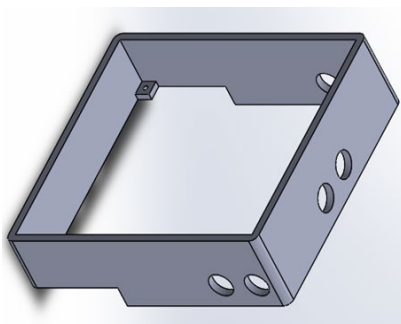


Figure 2. Upper Floor

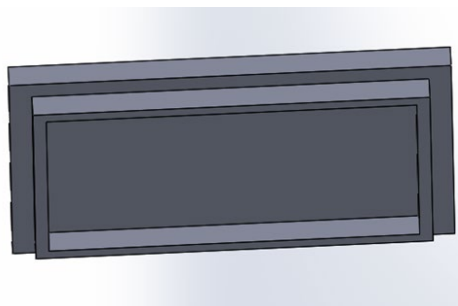


Figure 3. Closing Cap for Body Design

### **2.2 Assembly of the Proposed Model**

Development of the system begins with a 3D print of the designed model through fused deposition modelling technique using poly lactic acid material.

Dimensions of the full assembled model is 170 x 150 x 50mm (Figure 4).

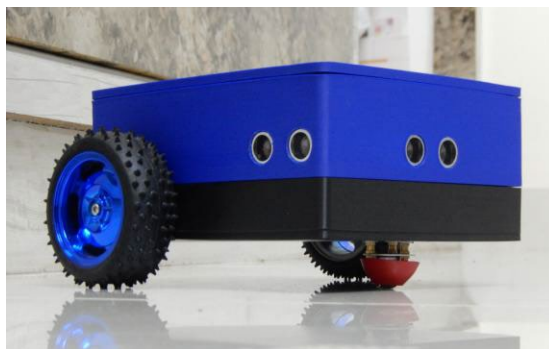


Figure 4. Full Assembly of the 3D Model

The Ground Floor is selected for placing the components such as motor driver, motor encoder with wheels, battery pack with Battery Management System, UV LED Strip, and Omnidirectional Caster Wheel.

The Upper Floor is selected for placing the components such as Ultrasonic sensors and Raspberry Pi.

### **3. Hardware Description**

#### **3.1 Components Testing**

Planned objectives are accomplished through various component testing such as:

- a) Motor wheel encoder and motor driver are integrated with Raspberry Pi as shown in Figure 5 for the purpose of path movement of the device.
- b) UV LED Strip is integrated with Raspberry Pi as shown in Figure 6 for the purpose of scheduling task and floor disinfection through UV LED.
- c) Ultrasonic sensor and Pi camera are integrated with Raspberry Pi as shown in Figure 7 for the purpose of Obstacle detection.
- d) Li-ion battery is integrated with battery level indicator as shown in Figure 8 for the purpose of specifying the indication of battery level of the device.

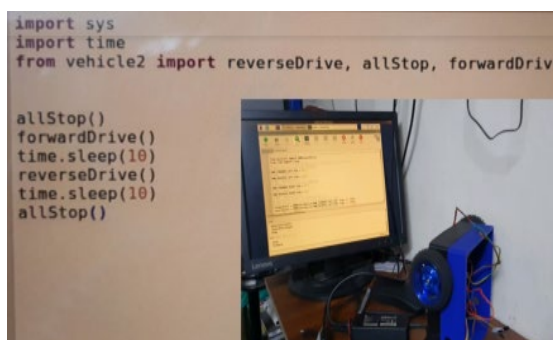


Figure 5. Testing of Wheels through Motor using Python IDE



Figure 6. Testing of UV LED Glow through Scheduled Task

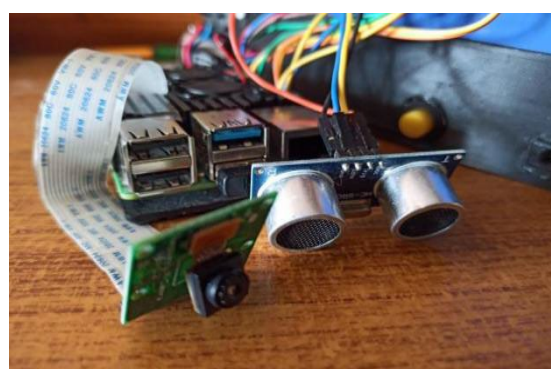


Figure 7. Testing by Integration of Ultrasonic Sensor and Pi Camera with Raspberry Pi



Figure 8. Battery Level Indication

### **3.2 Block Diagram of Floor Disinfecting Robot**

In the Block Diagram of the floor disinfecting robot shown in Figure 9 a controller such as Raspberry Pi is used which is considered as the heart of the device for giving instructions to each and every component operation. Ultrasonic sensors and Pi cameras are considered as a vision of the device, where safety monitoring of the device can be maintained by detecting and classifying obstacles within the assigned path.

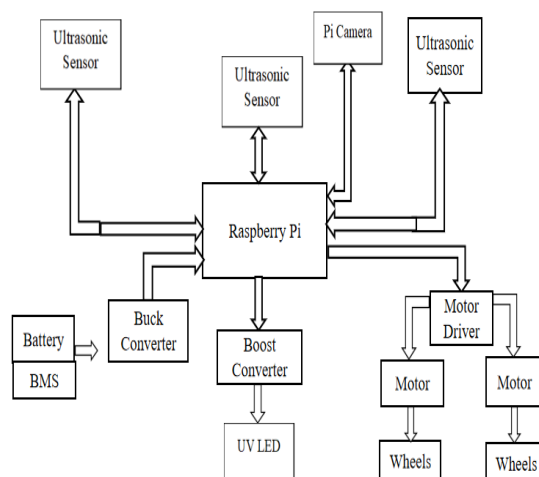


Figure 9. Floor Disinfecting Robot Interface

The encoder and motor driver are considered as movement of the device, which follows the instructed commands for maintaining the accurate flow of the device within the path. Battery and BMS are considered as energy of the system, where supply is provided for certain components for increasing and decreasing the voltage by using Step-up (boost) and Step-down (buck) converter respectively. UV LED strip is considered the main task of the device used for disinfection purposes here the UV rays inactivate the germs, viruses, and bacteria present on the floor.

### 3.3 Circuit Diagram of Floor Disinfecting Robot

Based on the block diagram, a circuit diagram of the floor disinfecting device has been designed using fritzing software shown in Figure 10

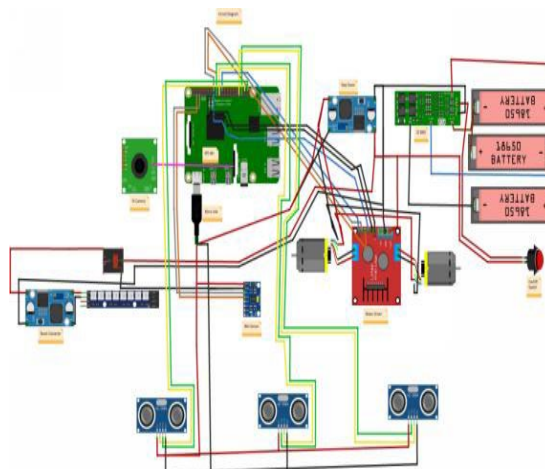


Figure 10. Circuit Diagram of Floor Disinfecting Device

## 4. Working Methodology

### 4.1 Flowchart of Complete Task

According to the scheduled time, the UV LED strip and motor wheels of the robot gets activated for initiating the disinfecting task in the assigned path (Figure 11). The device moves forward autonomously based on the pre-defined commands (i.e., forward & U-turn) in the path. During the movement of robot, it checks if any obstacle is present or not within the path. If any obstacle is present, the device holds its movement based on output of ultrasonic sensors and then Pi camera captures the detected obstacle. The detected obstacle is defined as static or dynamic using computer vision technology and intimated to the user through WhatsApp notification.

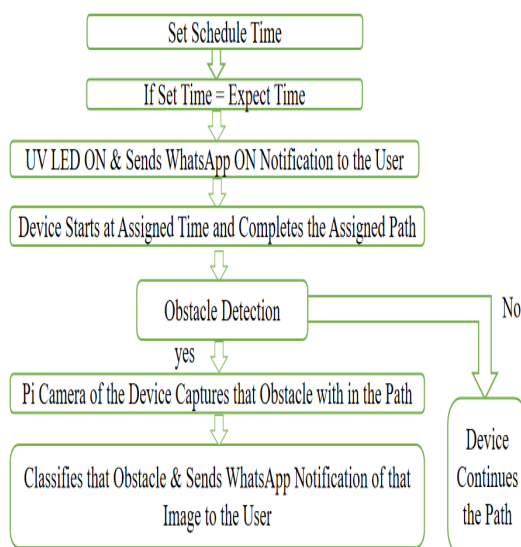


Figure 11. Complete Task of the Robot

The device can be able to avoid the obstacle and continues the path or else the user can be able to take away the obstacle within the path. After completion of one line within a path, next line of path can be initiated by making a U-turn & moves forward. Similarly, total pattern is completed by disinfecting the assigned area which can be square or rectangle shape. After completion of the disinfection task in the assigned path, the repetition of movement of device & Disinfecting process within the same path can be avoided with the help of supervised learning algorithm through python programming.

## 4.2 Calculations

### Average Speed Calculations:

$$\text{Speed} = \text{Distance} / \text{Time}$$

Time taken by the device to travel 1 Metre is 8 Seconds  
 Therefore, Speed of the Device (in secs) = 1.2 Metre / 20 Seconds

$$\text{Speed} = 0.125 \text{ Meter} / \text{Seconds}$$

### Power Supply Calculations:

$$\text{Power (watts)} = \text{Voltage} * \text{Ampere}$$

Power Supply to the UV LED Strip is 24V, Input current = 1 Ampere

$$\text{Output Power} = 24 \text{ Watts}$$

## 5. Results of the Complete Task

### Result 1: Scheduling of the UV LED Strip

UV LED is turned ON at predefined time before activation of the path (Figure 12 and Figure 13).  
 UV LED is turned OFF after completion of disinfecting process.



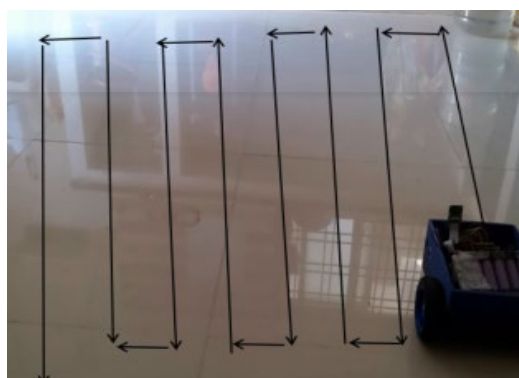
Figure 12. Before Scheduled time UV LED Strip is Turned OFF



Figure 13. After Scheduled time UV LED Strip is Turned ON

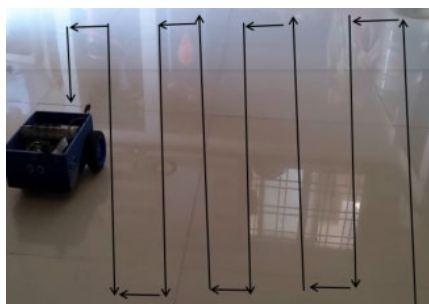
### Result 2: Path Completion of the Device

Starting point and ending point of the device movement is completed based on the pre-defined length and width to cover the assigned path (Figure 14 and Figure 15).



Ending Point Starting Point

Figure 14. Device is at Starting Point of the Path



Ending Point Starting Point

Figure 15. Device is at Ending Point of the Path

### **Result 3: Captured Images of Obstacles Detected**

Detected objects within the path during testing process are:

- (i) Bowl Detection score is 56%
- (ii) Person's hand Detection score is 53%
- (iii) Dog Toy Detection score is 71%
- (iv) Person's Leg Detection score is 61% and Vase Detection score is 56%.

Bowl-56% (Figure 16), Person – 61% (Figure 17), Vase-56% (Figure 18), Person-53% (Figure 19), Dog – 71%,



Figure 16. Bowl Detected



Figure 17. Person's Hand Detected

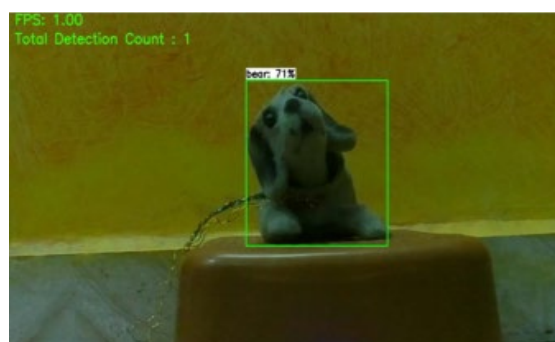


Figure 18. Dog Toy Detected





Figure 19. Person's Leg and Vase Detected

## 6. Applications

The Proposed Floor Disinfecting Robot is mainly designed for inactivation of germs, bacteria and virus through ultraviolet rays of UV LED Strip on any type of surfaces like Household, Hospitals, Malls, University buildings, Industries etc.,

## 7. Conclusions

In the proposed project, Design and Assembly of Time-Efficient Floor Disinfecting Robot using Artificial Intelligence has been implemented in which the device is designed and assembled with less weight and portable for easy to carry. Scheduling of the UV LED is provided in the device for performing the daily Routine task of Disinfection. Disinfecting by UV - C LED is considered for inactivation of virus and bacteria on surfaces. Time efficient is justified by defining specific length and width in the code in which the device follows and completes the assigned path by avoiding the repetition of disinfected area. Supervised Learning is a concept of AI which allows the device to classify the obstacles by capturing the images using computer vision technology with in the path and communicates with the user by sending WhatsApp notification about the classified images for virtual intimation of the path.

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## Biographies

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