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Design of Autonomous Line-Following Robot for Sterilization Process

Ponram R[1], VijayaKumar E[2], Naveenkumar V[3], WesleyMosesSamdoss S[4]

[1] *UG - Mechatronics Engineering, Kamaraj College of Engineering and Technology, Madurai, Tamil Nadu*

[2] *UG - Mechatronics Engineering, Kamaraj College of Engineering and Technology, Madurai, Tamil Nadu*

[3] *UG - Mechatronics Engineering, Kamaraj College of Engineering and Technology, Madurai, Tamil Nadu*

[4] *Assistant Professor, Mechatronics Engineering, Kamaraj College of Engineering and Technology, Madurai, Tamil Nadu*

ABSTRACT

Manual sterilization processes can be time-consuming and labour intensive. Sterilizing equipment and surfaces manually can take a lot of time and effort, especially if the warehouse is large and there are many items to sterilize. Manual sterilization processes can be dangerous if proper safety measures are not taken. For example, workers may be exposed to harsh chemicals can cause burning of the eyes, nose, throat and respiratory tract and can result in blindness and lung damage due to the presence of hypochlorite and quaternary ammonia compounds in the chemicals used for sterilization process. This project presents a novel approach for the sterilization of surfaces using a line follower robot with Bluetooth control, employing a mopping method. The robot is designed to navigate a pre-determined path using a IR sensor and sterilize the surface by mopping it with a disinfectant solution. The robot is equipped with a Bluetooth module that allows it to be controlled remotely using a mobile application. Overall, line follower robots offer a safe, efficient, and consistent solution for the sterilization process, making them an ideal choice for various industries, including healthcare, food processing, and warehousing.

Keywords—Line Following Robot, Pre-determined path, Bluetooth Control, Mopping, Sterilization Process.

1. Introduction:

Manual disinfection is a process that removes or reduces harmful microorganisms from a surface or object by physical or chemical means. Manual disinfection usually involves the use of a disinfectant, such as bleach, alcohol, or hydrogen peroxide, and can be done by hand or using specialized equipment. While manual disinfection can be effective, it can also be time-consuming and labour-intensive, especially in environments where there are many objects or surfaces that need to be disinfected In recent years, there has been increasing interest in the use of robots and automation as an alternative to disinfections.

One of these solutions is to use line robots. These robots are designed to navigate along a predetermined path using sensors and machine learning algorithms. Linear robots can be programmed to perform various tasks, including disinfection. By using line robots for disinfection, the process can be done quickly and efficiently with minimal human intervention. In addition, line robots can be programmed to operate in a variety of environments, including hospitals, laboratories, and other environments where sterilization is critical. Overall, while manual disinfection remains an important tool in the fight against harmful microorganisms, the use of line robots offers a promising alternative that could help Streamline the sterilization process and improve overall safety and efficiency. Regenerate feedback

2. Experimental Methods or Methodology:

The methodology of a line following robot in the sterilization process typically involves the following steps:

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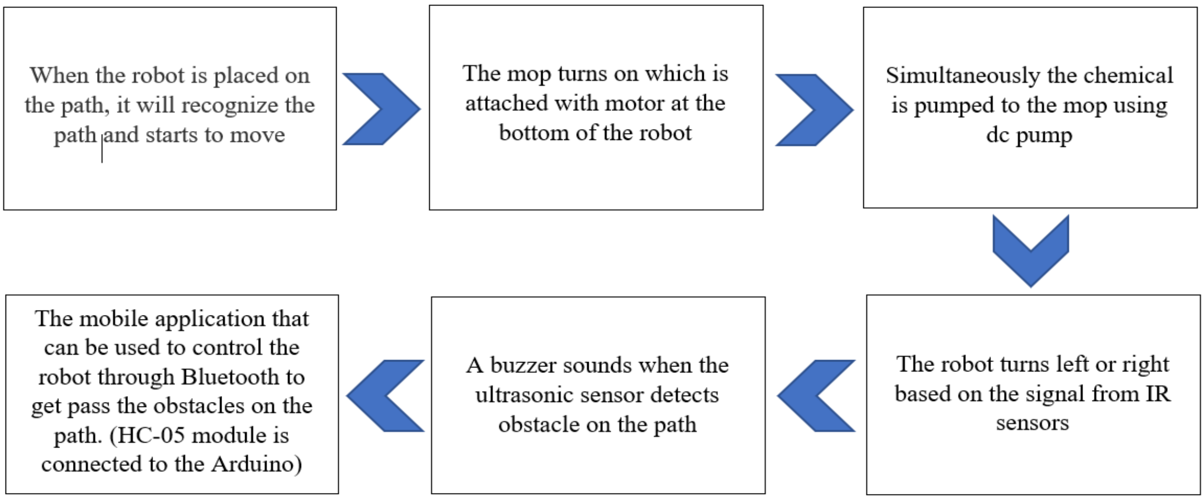
Preparation: The robot is equipped with sensors, such as infrared sensors, that enable it to detect the path it needs to follow. Additionally, the robot is loaded with sterilization materials, such as disinfectant mop, that it will use to sterilize surfaces.
Navigation: The robot is programmed to follow a predetermined path, usually marked by a coloured line on the floor. As the robot moves along the path, it uses its sensors to detect the line and adjust its movements accordingly.
Sterilization: As the robot moves along the path, it applies the sterilization materials to surfaces within its reach. The disinfectant chemical which is stored within the tank fixed at the robot, Which is pumped to the mop with the help of 6V micro dc pump through silicon tube. Then the mop sterilizes the floor with the sterilizing chemicals.
Controlling: The robot is equipped with an Ultrasonic sensor which is used to detect whether there is any obstacle on the path. The buzzer sounds when the ultrasonic sensor detects an obstacle in the path. Then the application we specially build for this robot-built feature is that we will be able to switch the robot to either manual or auto mode. Manual mode can be used to get past the obstacle. Later, we can switch to auto mode.
Completion: Once the robot has completed its sterilization mission, it may return to a designated location for recharging or maintenance.
Overall, the methodology of a line following robot in the sterilization process involves careful planning, programming, and controlling to ensure that surfaces are effectively sterilized and that the robot operates safely and efficiently in its environment.



2.1. Line Follower Robot Algorithm

1. Initialize the robot and sensors.
2. Read the sensor values to determine the position of the line. The two IR sensors should be placed on either side of the line.
3. If both sensors detect the line, the robot is on track and should continue moving forward.
4. If the right sensor detects the line but not the left, the robot is veering to the right and should adjust its path by turning slightly to the left.
5. If the left sensor detects the line but not the right, the robot is veering to the left and should adjust its path by turning slightly to the right.
6. If neither sensor detects the line, the robot is off track and should stop or reverse its direction until it can detect the line again.
7. Repeat steps 2-6 continuously to keep the robot on track and following the line.

This is a basic algorithm that can be modified and optimized depending on the specific needs of the line follower robot and its environment.

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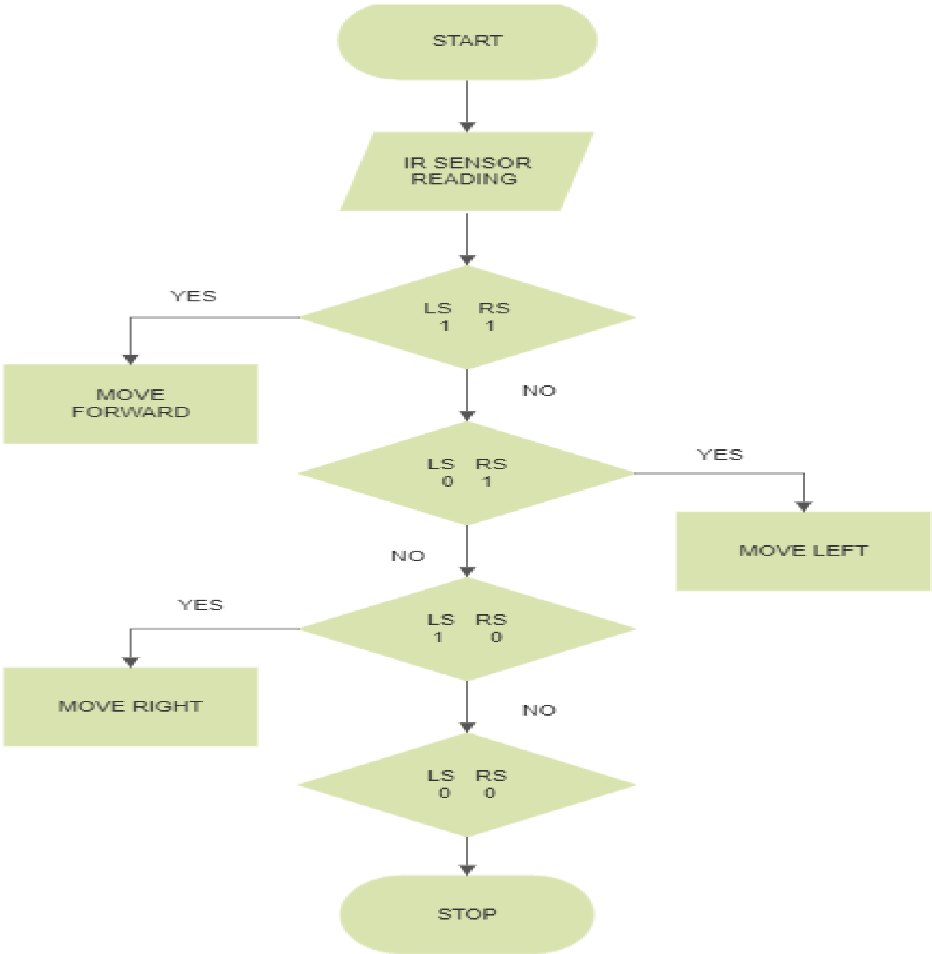

3. Results and Discussion

3.1. Quaternary Ammonium Compound:

Quaternary ammonium compounds (QAC) are commonly used as disinfectants due to their antimicrobial properties and were the first biocides used before phenolic products or Nitrogen. Their common structure consists of one or more quaternary ammonium linked by four side substituents. Their amphoteric structure allows them to intercalate onto microbial surfaces, creating a porous and unstable film, which explains their antimicrobial activity against bacteria, fungi and viruses. . Therefore, QACs are found in many areas, such as household products, drugs, hygiene products, cosmetics, agricultural or industrial products, but are also used in medical practice as substances. disinfectants and antiseptics and in healthcare settings where they are used to clean floors and walls. . Exposure to CAQ has been implicated by many authors in occupational asthma in healthcare workers or professional workers. They are also thought to play a role in contact dermatitis (CD) and urticaria in workers who use cosmetics such as hairdressers or healthcare workers, prompting regulatory authorities to recommend recommendations for these products. However, the distinction between stimulant and sensitizing properties of chemicals is complex and, therefore, the sensitizing properties of CAQs remain controversial. Furthermore, the exact mechanisms underlying the possible sensitization effect are still being investigated and to date, only a few studies have documented an immunological mechanism. Furthermore, CAQ has been suggested to be responsible for sensitizing neuromuscular blocking agents (NMBAs) through cross-reactivity. This hypothesis is supported by a higher proportion of quaternary ammonium-specific IgE (QA) in occupationally exposed populations, such as hairdressers, cleaners, or healthcare workers, suggesting that sensitivity Sensitization occurs with structurally similar compounds present in the environment. This review

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summarizes the latest knowledge about CAQ and its role in hypersensitivity. After describing the different CAQs, their structures, and uses, the most relevant studies on the effects of CAQs on the immune system will be reviewed and discussed.

3.2. QAC as a Disinfectant:

Quaternary ammonium compounds (commonly called quats or QACs) are cationic surfactants (surfactants) that combine bactericidal and virucidal activity (usually enveloped only by viruses) with bactericidal activity. It can be washed well, so it can be washed clean. Other classes of surfactants such as anionic, nonionic and amphoteric surfactants (in terms of their overall charge) exhibit some degree of antimicrobial activity depending on the specific biocide, whereas cationic (and some amphoteric) surfactants have the highest antimicrobial activity. Examples include hexadecyltrimethylammonium, chlorhexidine, and benzalkonium chloride. As with any biocide, the activity of CAQ-based formulations is highly dependent on the type of biocide used and the specific formulation. Since their main mechanism of action is structural/functional disruption of cell membranes, they generally exhibit bactericidal and bactericidal activity, with additional activity observed against enveloped viruses. Wrap. CAQ is also a potent microstat (containing microspores), but only a limited number of formulations claim activity against mycobacteria (perhaps in combination with other formulations to penetrate mycobacterial cell wall structures). by improving the Activity against mycobacterial envelope non-viral bacteria. Activity can be affected by water hardness (when used to dilute concentrates), fats, and anionic surfactants. QAC has a pleasant smell, is non-corrosive to surfaces and has low toxicity. They are commonly used as general non-critical surface cleaners/disinfectants, including the removal of heavy soils. QAC and other surfactants are also used as preservatives (such as paints and cosmetics). Some QACs and amphoterics are also used as low-concentration disinfectants. Biguanides, especially chlorhexidine (chlorhexidine gluconate, CHG) and polymeric biguanides (eg Vantocil) are most commonly used. CHG is used in products such as antibacterial soaps (such as Hibiclens), mouthwashes, wound dressings, and contact lens solutions. In these applications, in addition to its direct antimicrobial activity, CHG has the added advantage of being less irritating and less adherent to skin and mucous membranes, while maintaining low antimicrobial concentrations after application (hence long-term or "significant" antimicrobial protection). In addition to disinfection applications, bioguanide polymers are also used as general disinfectants and water disinfectants (replacement of chlorine). Overall, the antibacterial activity of CHG and polymers is similar to that of other QACs, although the antifungal activity itself is limited and can be enhanced with formulation, but has antifungal and cytostatic effects. Death at low concentrations. Similar to CAQ, the cell membrane is a major target for antibacterial activity, especially his CHG activity is well studied. They carry a positive charge and are rapidly attracted to the surface of the cell wall, where they are disrupted by initial disruption of surface structures, penetration into cell membranes, direct intercalation and interactions with phospholipids. Structure/function (including cytoplasmic extravasation). components); these effects lead to cell death and loss of enveloped virus viability. .

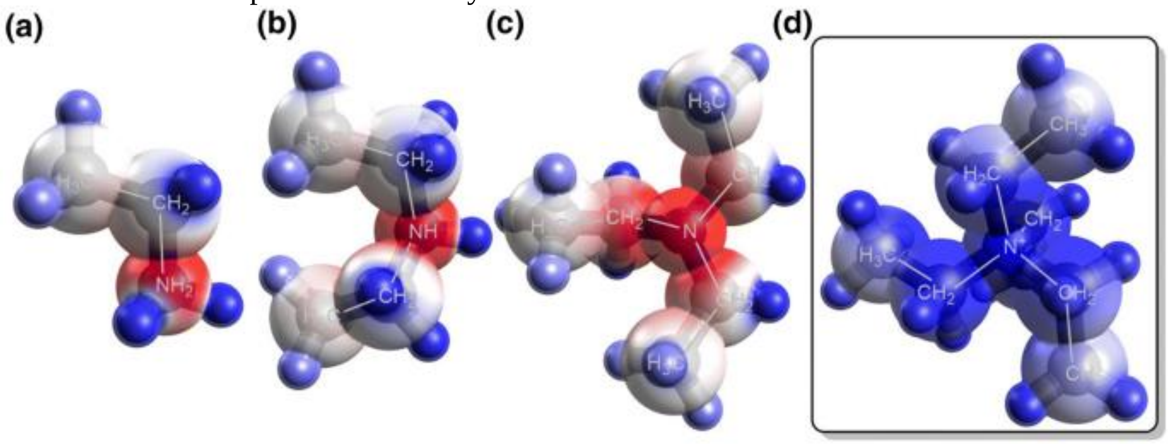

Fig.1. Molecular Structure of QAC

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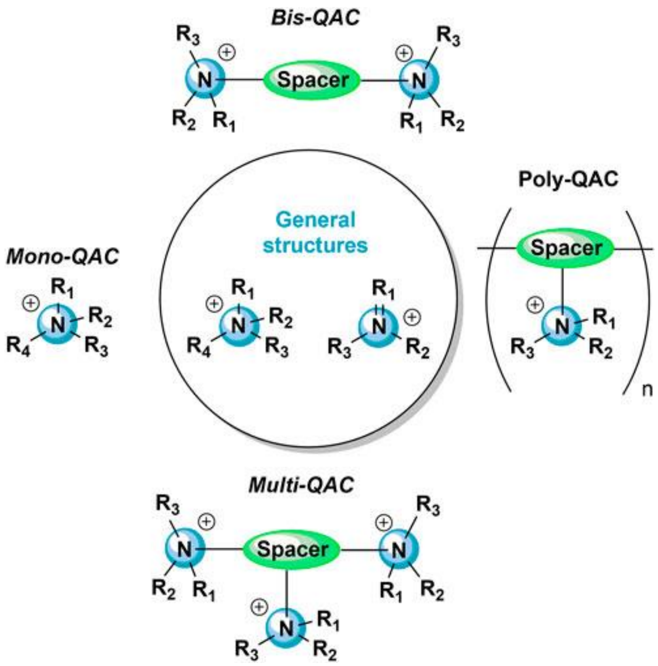
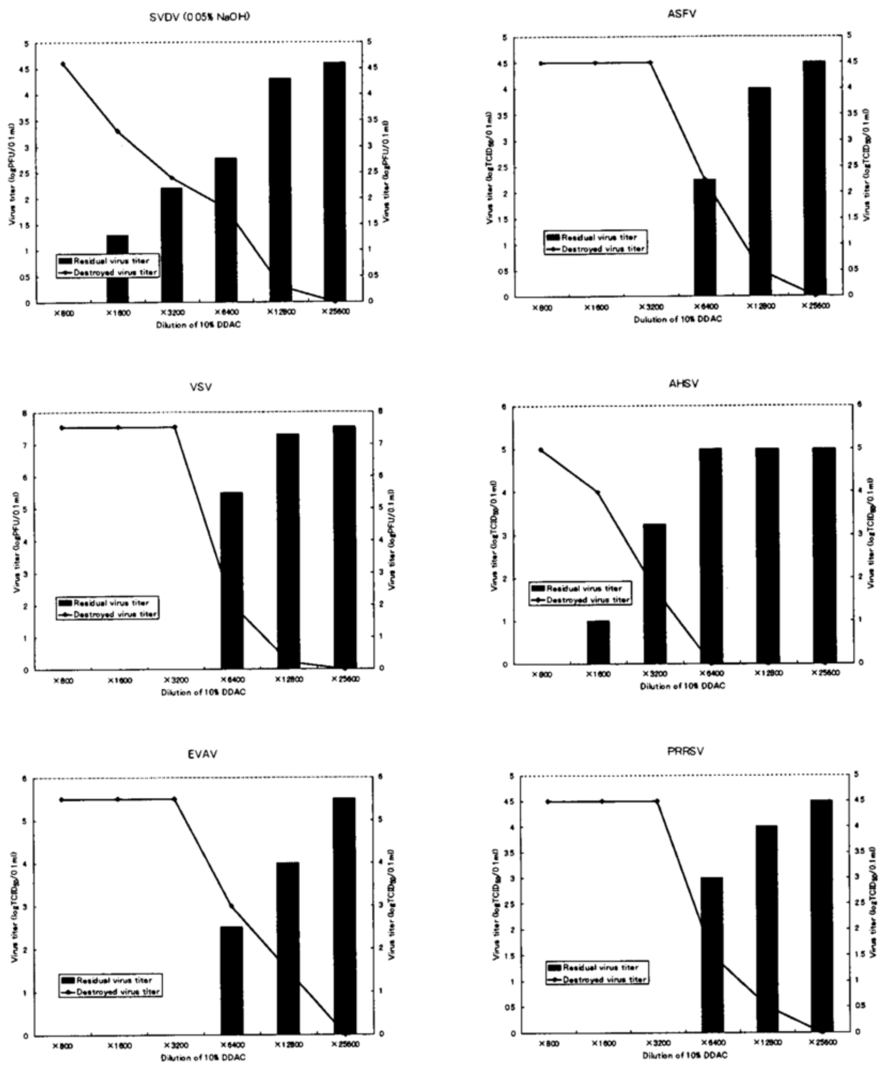


Fig.2.Quaternary Ammonium Compound in Hypersensitivity Reaction

3.3. Effect of QAC:



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3.4. Simulation:

CoppeliaSim is a flexible simulation software that can be used to simulate a variety of robots and automation systems. It is commonly used for research and development purposes, as well as for educational purposes. One of the applications of CoppeliaSim is to simulate a robot following a chain. Line Tracking Robot is a type of mobile robot designed to follow lines on the ground. It is commonly used in industrial automation, robotics competitions, and other applications that require precise control of robot movements. Rowing robots often use a combination of sensors, such as infrared sensors, to detect rows and adjust their movements accordingly.

To simulate a robot walking in a straight line in CoppeliaSim, you will need to create a virtual environment that includes a robot model, a line model, and sensors for line detection. CoppeliaSim offers a variety of pre-built models and sensors that can be used to create row-by-row robot simulations.

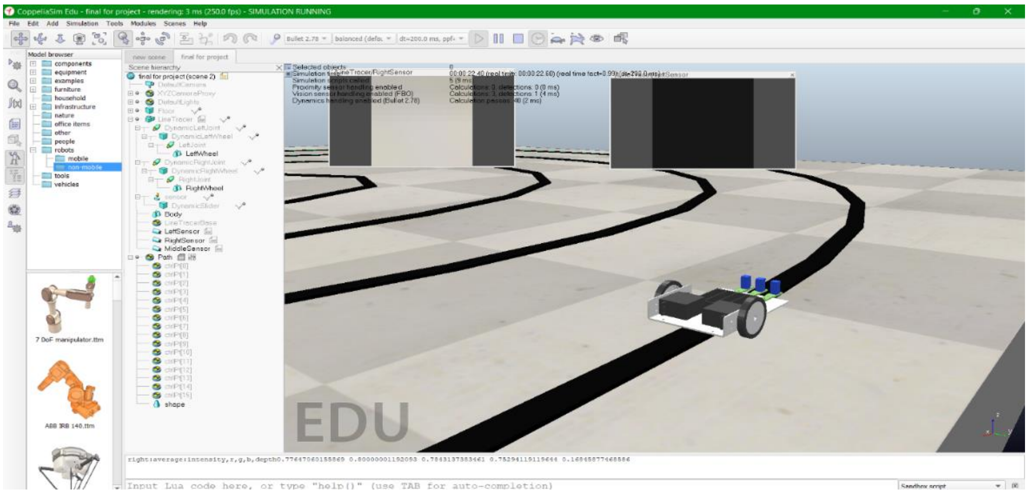

Fig.3.Simulation using Coppeliasim

The first step in creating a straight-line robot simulation in CoppeliaSim is to create a model of the robot. This can be done by importing a 3D model of the robot or by using CoppeliaSim's built-in modeling tools to create a custom robot model. Once the robot model is created, you can add sensors to detect the road. CoppeliaSim offers several sensors that can be used to detect lines, including a distance sensor and a vision sensor. Proximity sensors are commonly used to detect obstacles, but they can also be used to detect lines by placing the sensor close to the ground. On the other hand, vision sensors can be used to detect lines using image processing techniques.

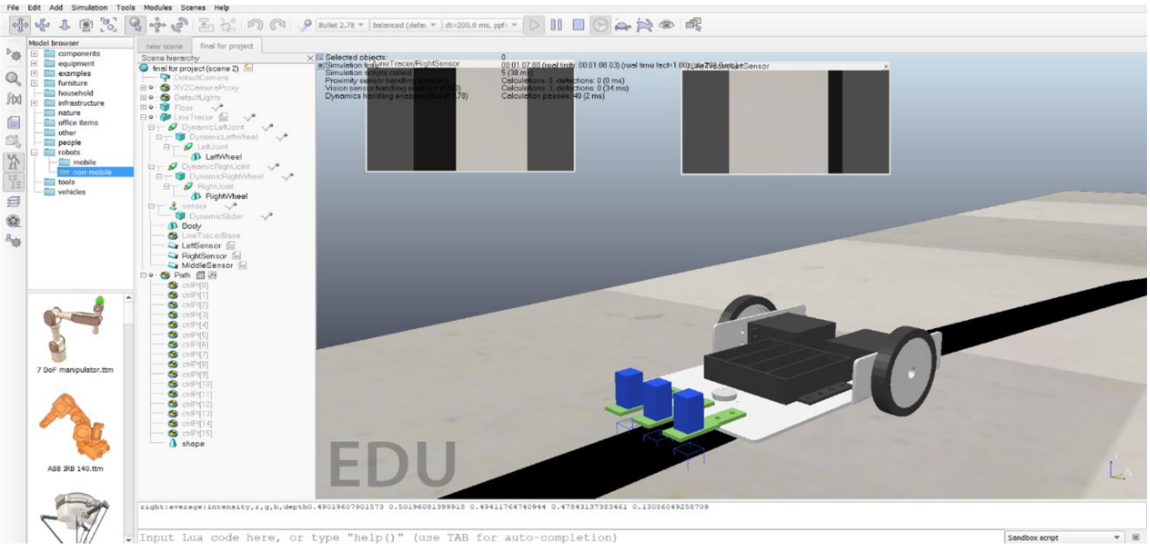

Fig.4.Simulation using Coppeliasim

To simulate a line, you can create a line pattern using a simple shape, such as a line or curve. You can then add color to the line that the robot's sensors can detect. When the robot's sensors detect the line, the robot can adjust its movement to follow the line. Once you've modeled the robot, added sensors to detect the road, and modeled it, you can use CoppeliaSim's built-in physics engine to simulate the robot's movements. You can also program the robot's behavior in a variety of programming languages, including Lua, Python, and C++. This allows you to test and refine the robot's behavior in a virtual environment before deploying it in the real world. In short, CoppeliaSim is powerful simulation software that can be used to simulate a wide variety of robots and automation systems, including line robots. By creating a virtual environment that includes a robot model, a road model, and sensors for road detection, you can test and refine the robot's behavior in a safe and controlled environment. control.

CONCLUSION:

In conclusion, the line follower robot for the sterilization process has the potential to be a valuable tool in disinfecting large areas quickly and efficiently. Its sensors ensure complete coverage of the area to be disinfected.

The results of testing the line follower robot in a controlled environment were promising, showing a significant reduction in bacterial and viral contamination on surfaces in a mock-up hospital ward. The robot was able to follow a predetermined path, avoiding obstacles and covering all surfaces that needed disinfection.

The line follower robot for the sterilization process also has the advantage of being safe for personnel in the area. Its sensors detect obstacles and prevent collisions, reducing the risk of accidents.

However, there are some limitations to the robot. It may not be able to reach certain areas, such as corners and tight spaces, and there may be challenges in programming it to follow complex paths.

Overall, the line follower robot for sterilization processes has the potential to be a valuable tool in disinfection efforts in hospitals, laboratories, and other settings. Further research and development can help to improve the robot's effectiveness and address its limitations, making it an even more promising tool for disinfection.

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