INFORMATICS INSTITUTE OF TECHNOLOGY

Team: Tech Echo

Self-Reconfigurable Floor Cleaning Robot

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Self-Reconfigurable Floor Cleaning Robot.

1- Introduction

Cleaning the floor from dust is one of the routine activities carried out every day. This activity is not only at home but also in offices and shopping centers. Sometimes because the activity of cleaning the floor takes a long time then there are other activities that are overlooked. Floor cleaning activities in public spaces even must be done all the time is not enough to be scheduled in the morning or evening, this requires the janitor to always be always ready to clean the floor.
Various types of technology have been created to facilitate human activities in their work every day. One of them is the technology developed in robotics technology. Robots can replace human activities that regularly or occasionally must be done at unscheduled times. In terms of cleaning the floor, it is necessary to develop robots as a substitute for floor cleaning officers.

In 2002 in the United States a robot named Roomba was developed. Roomba's automatic robot vacuum cleaner is produced by iRobot. Introduced in September 2002, Roomba has several sensors that enable it to do the job of cleaning the floor. For example, Roomba can change direction when facing obstacles and detect dirty spots on the floor. But there are some things that need to be improved from Roomba's robot, which is because the robot's body is circular, there are some points on the corner of the floor that cannot be reached. Moreover, this Roomba robot can only suck up dust and does not have components that polish the floor so that there are still dirty stains on the floor left behind. Furthermore, the usage of AI systems to detect interruption poses a security (problem). Mundane activities such as remembering to charge the robot, emptying the dust bin, and filling up supplies (detergent, water) requires more time. Therefore, this project addresses and overcomes the above-mentioned day to day problems, providing solutions. This project delivers convenience and saves more time for people and can be accessed anytime and from anywhere via mobile application.

2- Problem statement

Floor cleaning is time consuming, mundane, and rigorous. How can this be automated so that I can rely on it.

3- Research Questions

3.1. What is the most effective way to ensure a time effective and minimum human interaction floor cleaning method?

3.2. How can we automate rigorous tasks such as cleaning every nook and corner of the house?

3.3. How can we automate mundane activities such as emptying the bin?

3.4. How do we automate the mundane activity of cleaning through the interruptions of wires and cables?

3.5. How do we skip the mundane task of getting the cleaning process started?

4- Comparison Table of Existing Solution

	Bosin B909	iRobot I7+(Roomba)	Self-Emptying dustbin robot vacuum cleaner (Q11)	iRobot I6+ (Roomba)	IMASS S6-LWT	Xiaomi mijia STY02 YM	IMASS M1-GBL	Smart Robot Vacuum Cleaner (OB8/OB8S/ OB11 /OB12/ES30 0/ES028)
4.1. Can automate cleaning process with minimum human interaction	✓	✓	✓	✓	✓	✓	✓	✓
4.2. Can automate rigorous tasks such as cleaning every nook and corner of the house.								
4.3. Can automate mundane activities such as emptying the bin.		✓	✓					
4.4. Can automate the mundane activity of cleaning through the interruptions of wires and cables.		✓						✓
4.5. Can skip the mundane task of getting the cleaning process started.		✓		✓	✓			

5- Research/Solution gap

5.1. What is the most effective way to ensure a time effective and minimum human interaction floor cleaning method?

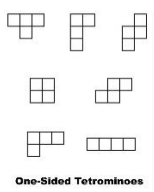
The most effective way to automate floor cleaning, with less time and reduced mundanity is automating floor cleaning through vacuum robot. The usage of robotics becomes the most effective way to reduce human interaction, where floor cleaning is done in a much effective way. From having mobile applications which maps the house layout, thereby cleaning the floor automatically, to turning on the robot by mere voice command. The use of robotics along side with AI gives the robot an advanced sense of efficient cleaning, making the shortest pathway.

5.2. How can we automate rigorous tasks such as cleaning every nook and corner of the house?

Regarding the mundanity of floor cleaning discussed in second research question, this project proposes the solution of a self-reconfigurable robot.

Self-reconfigurable robots are constructed of robotic modules that can be connected in many ways. These modules move in relationship to each other, which allows the robot as a whole to change shape. This shapeshifting makes it possible for the robots to adapt and optimize their shapes for different tasks. Thus, a self-reconfigurable robot can first assume the shape of a rolling track to cover distance quickly, then the shape of a snake to explore a narrow space, and finally the shape of a hexapod to carry an artifact back to the starting point. With this self-reconfigurable automated robot, cleaning the nooks and corners of the house, can be done efficiently, solving both the mundanity and the time effectivity of floor cleaning.

The proposed self-reconfigurable robot uses the principle of hinged dissection of polyominoes to transform itself into any of the seven one-sided tetramines, the Tetris pieces. (Similar technology is used in hTetro). Moreover, using the vSLAM technology, the robot would be able to navigate a room easily and efficiently, changing the body shape into one of the 7 body shape of the bot while moving through chairs or a coffee table, figuring out its own location as well as the location of surrounding objects.



5.3. How can we automate mundane activities such as emptying the bin?

Regarding the mundanity of emptying the waste collected discussed in the third research question, this project proposes the solution of an AI detectable self-emptying dust bin into a dust bin dock.

Self -configurable robot of our proposed project is composed of a self-emptying dust bin which empties the waste of the in-built dust collector, into the dust bin dock (present alongside with the charging dock). This proposed solution will make sure that the in-built dust collector is emptied right on time. Therefore, the users (customers) need not deal with the mundanity of remembering to empty the in-built dust collector as it fills ups or when the user (customer) decides. The bot uses its rotating spin brushes to push the dust inwards while the vacuum sucks the dirt into the in-built bin and when the bot navigates itself to the charging dock it (when filled up) it will empty the waste contents of the in-built bin into the dust bin dock. The novelty of this project lays with the robotic intelligence to empty its contents when filled up, as opposed to a static scheduled time. On occasions of unexpected waste collection, most in-market robots continue to collect the waste, causing damage or breakdown. The proposed project solution is an AI detection system which recognizes the waste collecting capacity fill, and if exceeds- guides itself to the dust bin dock, empties the in-built bin and continues the cleaning process. With minimum human (mundane) involvement.

5.4. How do we automate the mundane activity of cleaning through the interruptions of wires and cables?

This part of the research gap deals with providing a solution for expected real-time interruptions caused, which were not part of the mobile app house layout. Though a small and mundane problem this could cause detrimental effects (if the interrupted accessories is large, example: batteries, cigarette butts, cables and wires). The project proposes a real time AI imaging system(a) and sensors(b) when which detects such interruptions, successfully avoids it.

a) Ultra-fast AI

Ai imaging system uses visual data input from a 360-degree infrared camera of the bot and processes them to uniquely identify what is around the bot and pass impeded in the cleaning place. The navigation system works with faster speed and longer scanning range. The robot smartly deals with complicated surroundings and scans the entire floor meticulously.

b) Sensors

This bot consists of many sensors to help it to navigate such as,

- Mechanical sensor -To prevent falling off and collision and reshape the body of the robot.
- LIDAR technology- LiDAR measures the distance to an object (for example, a wall or chair leg) by illuminating the object with multiple transceivers. Each transceiver quickly emits pulsed light and measures the reflected pulses to determine position and distance.
- vSLAM technology- Visual SLAM is a more cost-effective approach that can utilize significantly map After mapping and localization via SLAM are complete, the robot can chart a navigation path.

5.5. How do we skip the mundane task of getting the cleaning process started?

Based on our project, as a solution we've introduced a voice recognition which uses our own, inbuilt voice assistant with a mobile application which is supported through all iOS and Android platforms.
Code word command system: User can program in their own codewords to complete the tasks. This is a simplified version of any other voice control robot. Uses easy to understand coding with easy algorithm. We are even to control the system using the application and give it certain actions to perform. As the robot is programmed it is available with the scheduling capabilities. Therefore, you can select which days of the week you want the bot to clean and at what time. As the cleaning routine is programmed it turn itself ON and OFF according to the situation. It can clean alone without human intervention, using this technology we can help those who have physical disabilities.

6- Comparison of proposed and existing solution

Proposed solution	Existing Solutions
Self-reconfigurable robot to automate rigorous tasks such as cleaning the nooks and corners of the house	None
Scheduling self-emptying bin to user's will to automate mundane activities such as emptying the bin.	Self-emptying bin after 30- 60 days (can't schedule)
More developed more accurate AI imaging system (vSLAM), Lidar sensors, mechanical sensors to automatically cleaning thorough the interruptions of wires and cables and avoid falling from stairs.	Every existing robot has some kind of technology but not accurate like ours.
More advanced inbuilt voice assistant with code word system and schedule task system from our app (both IOS and Android), Connectivity with Amazon Alexa, Google Home, Apple Home pod to make cleaning easier.	Mobile Apps, Remote controllers, some has the feature of Voice command with Amazon Alexa and Google assistant.

7- Project Scope

7.1. In-Scope

- Able to self-charge when battery is low.
- Ability to empty the waste from the in-built bin into bin dock.
- Ability to transform itself to fit in to nooks and corners maximizing cleaning.
- Ability to avoid sucking harmful objects.
- Ability to recognize and execute voice commands.
- Ability to empty the waste from the in-built bin into bin dock.
- Ability to transform itself to fit in to nooks and corners maximizing cleaning.
- Light in weight.
- Available in varied number of transformable block (4-7).
- Available in varied bin emptying dock sizes.
- Longer lasting battery power.
- Available in both black and white colors.
- Easy to remove apart for cleaning and maintenance purposes.

7.2. Out-of-Scope

- Cleaning hard wood floors.
- Cleaning stairways.
- Pet mishaps
- Offline voice assistant

8- Requirement Specification

8.1. Functional requirement

- Able to self-charge when battery is low.
- Ability to empty the waste from the in-built bin into bin dock.
- Ability to transform itself to fit in to nooks and corners maximizing cleaning.
- Ability to avoid sucking harmful objects.
- Ability to recognize and execute voice commands.
- Ability to shut off the camera shutter while not in use.
- Ability to use detergent and water for stubborn/deep stairs.

8.2. Non-functional requirement

- Effectiveness in time and cost.
- Light in weight.
- Available in varied number of transformable block (4-7).
- Available in varied bin emptying dock sizes.
- Longer lasting battery power.
- Available in both black and white colors.
- Easy to remove apart for cleaning and maintenance purposes.

9- Annex

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