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Shuchi 1.0: Robotic System For Automatic Segregation of Waste & Floor Cleaning

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Abstract

The advancements made in technology of robotics have made the existence of humankind simpler and comfortable. This work aims at developing a robot for waste collection, segregation and floor cleaning for domestic purpose. The robot expedites and eases the floor cleaning process by employing wireless technologies. Robot movement is controlled by the end-user through an Android application. The Shuchi 1.0 model can also be configured to work in the semi-autonomous mode, requiring minimum intervention from the end-user. The system is fitted with sensors to detect the obstacles then changes the course of its path, mounted with a camera and LCD screen to ensure its effective working. It is also equipped with an automatic waste segregator, which overcomes the need for manual segregation, thus having a positive impact on health and the environment. With these Shuchi 1.0 working features, it seeks to realize the goal of the Swachh Bharat Abhiyan by capitalizing on the technologies of IoT and Robotics.

1. Introduction

The world is into an automation era. Complex operations are made automated to simplify diverse tasks hence the benefits of automation can also be applied for simple household tasks (Varsha et al.). Robot is an intelligent device having its own brain, fed with computer logic, which works according to the designed algorithm. Universally the houses, offices, streets, industries etc., are cleaned with the help of brooms which need more human power and time.

The new technology is emerging day to day the robots can be deployed for cleaning purpose. At present the cleaning robots are very costly and only some of them offer the facility of dry cleaning as well as wet cleaning. These robots work on semi- or fully autonomous mode to perform services for well-being of humans. Waste collection and floor cleaning robot has been intended for home and offices. In India, house cleaning robots are very rarely used because a high cost where common man cannot afford (Vyas et al. Mapari et al.). The main motive behind this work is to provide a considerable clarification of the issues of cleanliness by producing a cleaner robot. It uses local resources, thus keeping the cost low. In current days, inside as well as outside cleaning is becoming a significant role in our life. So, it is planned to design such an autonomous system at a low cost.

This enforces to design equipped robot with the following features: Obstacle avoidance, floor cleaning including dry and wet cleaning, status display, and semi-automatic system. These specifications are programmed in the proposed robotic system. It's also equipped with an automated waste segregation, the low price and easy to at homes. Here it facilitates the sending of wastes directly for processing of waste (Amitha et al.). Automatic waste segregator is designed to sort the waste into two main categories i.e., dry waste and wet waste make waste management more successful (Rakib et al.). Sensors are fixed to monitor the waste collection method. The sensors would be located in all the dust bins. The usual method used for segregating waste in India is through rag pickers, which is time-consuming and can have adverse effects on the health of the people who are exposed to such wastes. Hence, a system is being developed to minimize risk to the surroundings and personal health. These all parameters have been taken into account while designing a fully automatic floor cleaner. Due to rapid urbanization and increased population in many countries, a vast measure of waste has been produced (Ahamad et al.). Presently, the waste segregation is done manually by installing different bins for collecting different types of waste (Patil et al. Ajay et al. Kumar et al.). Waste management is a big problem to be solved both locally and globally because of undesirable solid wastes from human and animal activities emerging continuously. One of the solutions in collecting the waste from the bins located in different areas is through IoT technology. The existing waste management system is not as capable as expected. It has been considered a challenging task, which has to be progressed with advanced technologies in recent years (Prof et al.). By considering all these points, we build a robot which is capable of both wet cleaning and dry cleaning.

1.1. Robotic Cleaners

Today, robotic cleaners have gained all the attention in robotics research due to their effectiveness in guiding humans in floor cleaning applications at various sectors like homes, hotels, restaurants, offices, indoor sports, hospitals, workshops, warehouses and universities etc. (Joshi et al. Rashid et al. Hong et al.). Robot is an electromechanical machine and used for various purposes in industrial and domestic applications. Robot appliances are entering the consumer market, since the introduction of iRobots. Many related appliances from various companies have been followed. Initially, the main focus was on having a cleaning device. As the time passed many improvements were made and more efficient appliances were developed (Kaur and Abrol). In the current years robots have emerged as part of each and every field such as industries, households and institutes (Asafa et al.). Mostly, an average human uses 2-3 robots per day in his day-to-day life. Microcontroller is the mind of a robot where a program is composed and sensors are fixed as input and actuators as a result.In IoT every modern technology is connected to an object and sensors are sensing the devices which send and receive the signal and to collect diverse data which is ultimately fed to a microcontroller for decisive working of machines.

1.2. Objectives

- The main objective of this work is to make a semi-automated segregation of waste and floor cleaning wireless robot.
- To provide a robotic system at lower cost.
- To incorporate a cleaning mechanism, this involves taking alternative paths to avoid obstacles.
- To overcome the environmental risks associated with
- To collect and segregate the dry and wet waste.

1.3. Issues and Challenges

- Suitable only for flat surfaces: The Robot only moves along the enclosed flat surface, if the ground is uneven the calculation and logic won't apply in Auto mode.
- Delay in video streaming: The video stream will be relayed through the internet by the blynk cloud, which will cause delay in streaming the video.
- Semi-automated: It will clean only one room per cleaning cycle and should be manually moved to the other area where next cleaning is needed. Certain areas might be skipped due to obstacles, so it should be cleaned in manual mode.

- Network speed: The robot needs continuous and high-speed internet connection to work and high-speed internet for the streaming of live video.

- Fixed Starting point: It needs to be placed at the corners only to work efficiently in Auto mode else certain areas will be skipped.

- Segregation of waste: Only dry and wet based segregation is possible currently. As the segregation is based on moisture of the waste collection.

1.4. Problem Statement

This work aim is to develop a robot for cleaning, segregation and collection purposes, thereby eliminating the need for manual cleaning and subsequently bring about a positive change in health and the environment. It is configured to operate in both auto and manual mode and caters to the need of cleaning both wet and dry waste.

1.5. Capabilities of Shuchi 1.0

- It is having the capability of considering both wet and dry floors in cleaning.

- It can be used at homes, offices, hospitals, colleges, railway station, auditoriums, malls and cinema halls for cleaning purpose.

- It is used clean the inaccessible areas like underneath the sofa bed and the table.

- The robot can be deployed in hazardous places, where human deployment is infeasible.

- It can reduce the human effort in monitoring process of cleaning.

- Saves on labour costs and time, as a single tool can do the effort of many labourers in lesser time.

- It is cost around 70% less than the similar other product in the market.

- Small particles can be picked up efficiently.

1.6. Existing System

The existing floor cleaners are bulky and manual cleaner, which will take more duration for cleaning and very nosy. They cannot segregate the waste. The smaller automatic vacuum cleaners are slower in cleaning the required regular maintenance and maintenance cost is high.

2. Working Model of shuchi 1.0

A semi-automated robot is being developed for cleaning and waste collection on surfaces. It can be deployed in places ranging from private (For example: Homes) to the public (For example: Railway Station, Hospitals etc.). The android application can be used to manage the robot directions, such as forward, right, left, and backward and waste lifting and segregation. It senses the obstacles using an ultrasonic sensor and sends the value to the Arduino board. The speed of the robot can be reduced automatically due to the sensing of the obstacles.

2.1. Shuchi 1.0 Block Diagram

The main components of this working system are Arduino, sensors and motor assembly interacting with each other as shown in Figure 1:

LCD Display: The LCD Module is used to Display the Status of the robot if its Cleaning or Stopped, will display if any obstacles are detected and if it's in Auto mode or Manual Mode.

Camera Module: The camera Module is used to stream the video to the user so that they can check the view process or use it to control the Robot when it is in manual mode.

Proximity Sensor: Used to detect any obstacles in the path by detecting the distance and avoiding the collusion.

Node MCU: Used to connect the controller to the internet and process the inputs given by the user and send the appropriate signals to the controller.

Android Phone: Used to connect to the robot using an App and control or monitor the cleaning process.

Arduino: This is a microcontroller used to process all the information from the sensors and the instructions from the user through the app and control the robot.

Motor controller: Used to control the speed and direction of the motor and provide the power supply to them.

Robotic Arm for Cleaning: Used to hold and control the mops used for cleaning.

Power Supply: To provide Power to both Arduino and the motor controller.

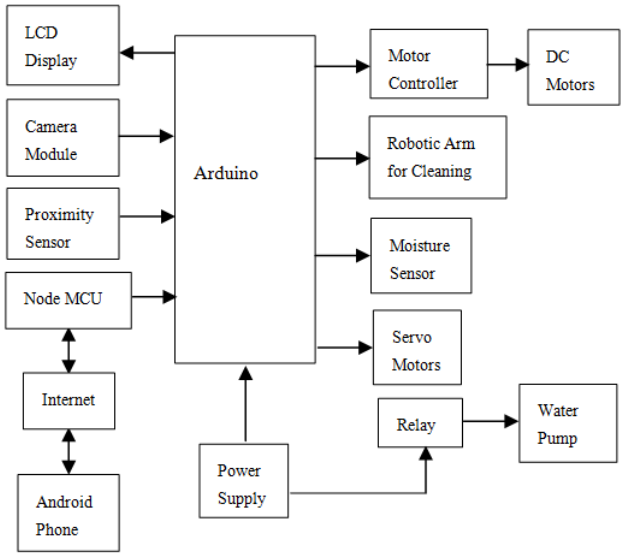

FIGURE 1. Shuchi 1.0 Block Diagram

Relay: Used to control the water pump.

Servo Motor: To control, on which side the waste has to be put in the dustbin based on dry or wet.

Moisture Sensor: To detect the type of waste, whether it's wet or dry.

DC Motor: These are Bi directional rotating motors used to control the moment of the robot.

Water Pump: Used to sprinkle the water for cleaning the floor.

2.2. Flow of Work

The sequence of implementing the Shuchi 1.0 working model is shown in below in Figure 2 and 3 in the form of flow work.

Connect to Application: Once the user turns on the robot it will connect through the internet and connect to the mobile application.

Check for Manual or Auto mode: After connecting to the App the user can choose to operate it in manual or automatic mode. This information is sent to the robot through the App.

Start Camera module: The camera module will be on and starts to transmit the live video to the user which he can use to monitor the process.

Start cleaning motor: The motors which have the cleaning head attached to it will run and start the cleaning process.

Start water sprinkler: This will sprinkle the water in a controlled manner using the water pump for more effective cleaning.

Check for obstacles: In Auto mode the robot detects the obstacle ahead of it using the proximity sensor and moves accordingly.

Change the directions: To moves in zigzag pattern.

Get directions from the user: In manual mode the user gives the control of the robot and gives, directions through the App.

Pick and place: Picking up the waste and placing it in the intermediate bin.

Detect wet or dry: Once the waste is placed in intermediated bin, using the moisture sensor to detect wet or dry waste and dumping them in their respective compartment.

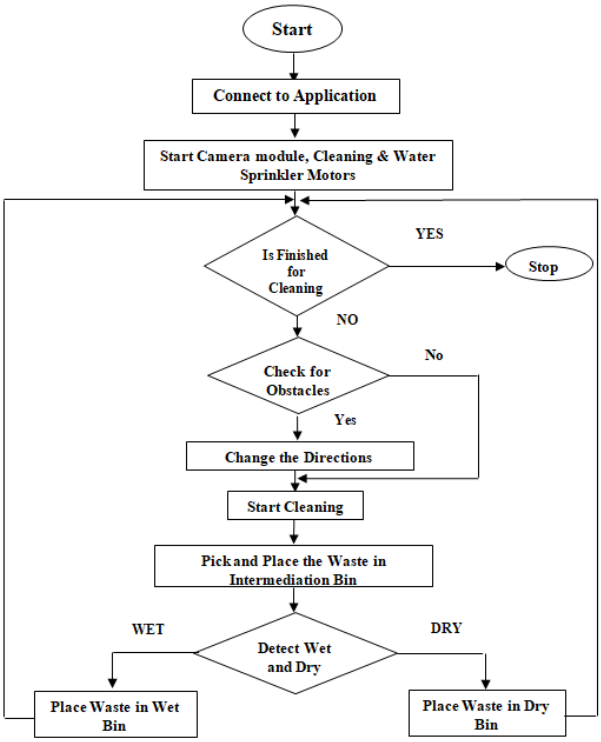

FIGURE 2. Flow Work of Auto Mode

3. Experimental results of Shuchi 1.0

In Manual mode, all the actions are controlled by the user and the robot works accordingly. The live stream of the process is seen in the App, which guides the user for direction. The waste materials are picked by pressing the button in the App, and later it is divided into wet or dry automatically with 85% accuracy. In auto mode the robot start to work

TABLE 1. Floor Cleaning Robot Comparison with Previous Work

S. NO	FEATURES	PREVIOUS WORK	PRESENT WORK
1	Cost	More than 15,000.	Rs.8,000
2	Keypad	Not available	Available to operate robot through mobile application and for mode selections
3	WIFI module	Not available	Available for wireless communication
4	Automatic water sprinkling	No	Yes
5	LCD	Not available	Available for displaying results and mode selections
6	Camera	Not available	Available for live streaming video
7	Ultrasonic Proximity Sensors	No	Yes. For obstacle detection and avoidance
8	Mode of operation	Only automatic	Automatic and manual both

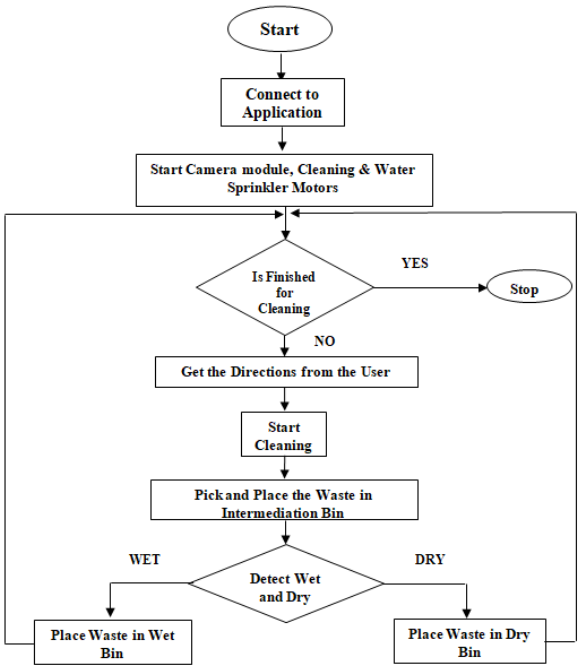

FIGURE 3. Flow Work of Manual Mode

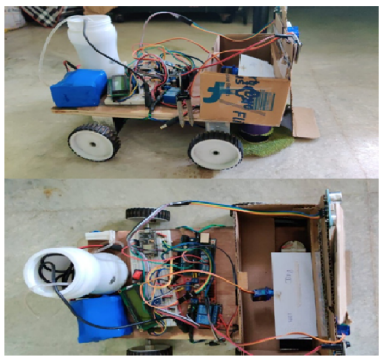

FIGURE 4. Designed Model of Robot

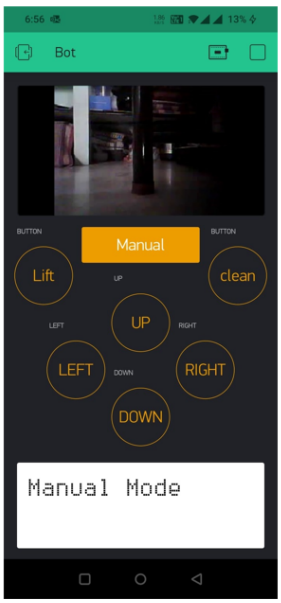

FIGURE 5. Manual Mode Robot Controller in Blynk App

from left corner, if there is any obstacle is detected in between the path it changes the direction and moves in a zigzag pattern. In zigzag pattern, first it moves straight until the end of the corner is reached or obstacle is detected in this case then it changes to opposite direction and continues to moves until end of corner or any obstacle is detected. The robot will move in zigzag pattern to clean the room and stops at the opposite end of the corner, sufficient amount

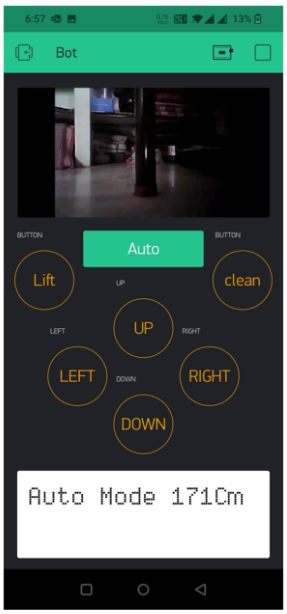

FIGURE 6. Auto Mode Robot Controller in Blynk App

of the room is cleaned efficiently. When any obstacle is detected along the path the robot will detect it and move to the next path. It lifts the waste when anywhere obstacle is detected. It divides the waste into wet or dry automatically. The user can monitor the whole process in the app.

In this section, the floor cleaning robot comparison with previous work are shown in the Table 1.

4. Conclusion

This paper presents the implementation of a waste collection and floor cleaning System driven by the device. The model is configured to work in both automatic and manual modes, built by using IoT technology. This robot can be used for the domestic purpose and industry purpose cleaning with less human intervention or no human intervention. The inbuilt android application and Arduino board are used to manage the robot directions. Via internet module and send/receive the analogous data to the robot. Thus, less human effort with more frequent waste collection and floor cleaning resulting in overall cleanliness of the surrounding. In the future, we can develop robots with more distance sensors which can detect and work on uneven surfaces. The same can be extended to segregate the waste based on biodegradable and non-biodegradable using IoT application or AI. The system can be made fully automatic by automatically measuring the dimensions of the room. Vacuum can be added for efficient cleaning.

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