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Review for Autonomous Robotic Vacuum Cleaners

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Abstract:

As we progress in technology, humans have started to automate trivial tasks to save time and effort. In the lastcouple of years, automated robotic cleaners have become a major focus in robotics research due to their efficiency and advancements in helping humans. Generally, robotic cleaners are characterized by their cleaning expertise. Some robots use obstacle avoidance using proximity sensors while others use laser mapping techniques.This paper reviews multiple technologies,sensors and devices used in various past robotic vacuum cleaners to identify which robotic technologies are the most cost-efficient whilst having better cleaning performance.

Keywords **—Robot,LIDAR, Raspberry Pi, Arduino, Vacuum Cleaning, Obstacle Avoidance,ARVC**

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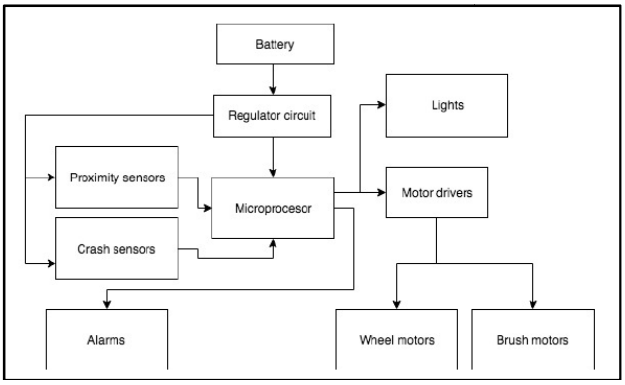
I. INTRODUCTION

In the last few decades there has been a tremendous growth in the use of robots in household activities. Floor cleaning is one of the perfunctory activities which is time consuming. Strives are made in scientific research to make this task as easy and efficient as possible.This type of advancement would help reduce the time and increase efficiency of cleaning. Human intervention and errors caused due to humans are eliminated. The papers that we have reviewed have shown a variety of technologies used for implementation and designing of robotic vacuum cleaners. These include IOT(Internet of Things), microcontrollers like Arduino, Atmega, 8051 and microprocessors like Raspberry Pi.

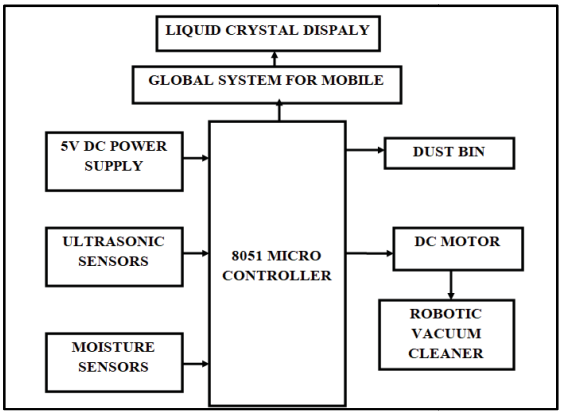
II. DESCRIPTION OF SYSTEM

A. Block Diagram

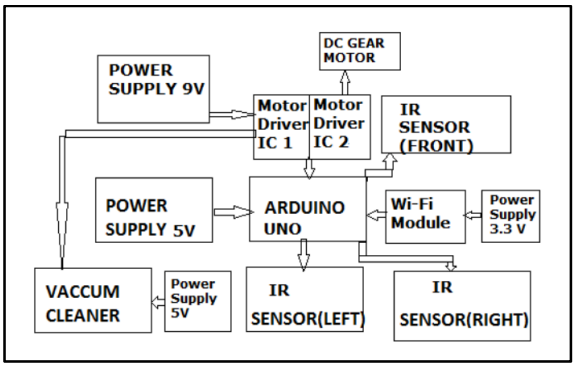
In [1,11], the robot is the basic model for an autonomous robotic vacuum cleaner. The system is controlled by 'Arduino Leanardo'. The automated navigation is done through ultrasonic sensors, which helps map an obstacle-free route. The inputs from the proximity sensors are processed and used as feedback for the brush motors. Similarly, crash sensors are used for wheel motors.



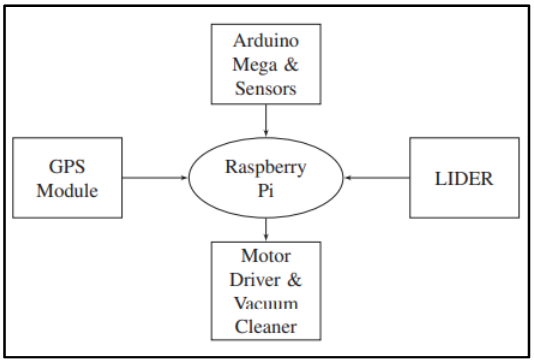
[2] uses IOT technology with microcontroller 8051 as its central component along with a smart bin and vacuum cleaner. It functions to segregate waste using 8051 in conjunction with a moisture sensor along with the vacuum cleaning process. Ultrasonic sensors are used for detecting whether the dustbins are at full capacity. GSM module is employed for sending SMS text to the authorized user when the bins are filled.



In[3], the author has designed a vacuum cleaner using Arduino, wi-fi module ESP8266EX as the primary controllers. Proximity sensors are used for mapping and path generation of the robot as the power is given to the vacuum cleaner it turns on the motor drivers and moves forward if a obstacle is detected along the path in between 3cm a commands is given to reverse the motor operation and move in the opposite direction



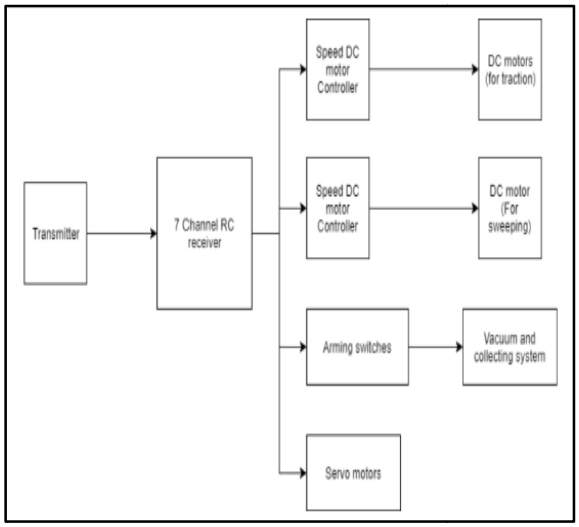
In [4], the authors have designed a vacuum system using Raspberry Pi and Arduino in unison as their primary controllers. LIDAR is used for mapping and Proximity sensors are used for path generation of the robot.GPS module is also used for positioning of the robot as the authors have made a robot that has an autonomous process for the recharge of the battery namely 'auto docking and charging process'. This eliminates human assistance completely making the robot entirely autonomous.



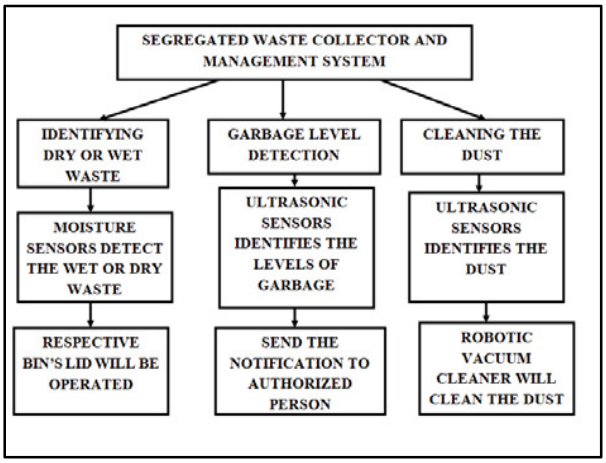
B. Electronic System

In [1], a transmitter is connected to a 7 channel RC receiver. The 7 channel RC receiver is connected to two speed DC motor controllers, arming switches and servo motors. The DC motor controllers control a few DC motors for traction and

few for sweeping. The aiming switches control the vacuum and controlling system. The servo motors are used for rotation of ultrasonic sensors for mapping.



In [2] Microcontroller 8051 is connected to all the components using connecting wires. 5 Volt DC power is supplied to the controller which is then distributed to individual components of GSM(Global System for Mobile), DC motors and the Sensors for their individual working.The sensors continuously send the measurements to the controller at constant intervals.Ultrasonic Sensors transceiver module (Transmitter + Receiver). The frequency of the ways which are transmitted through this sensor is greater than 20 KHz. The sensor uses time lapses between the sending and receiving of the ultrasonic pulse to calculate the distance to a target. It intercepts the waves reflected by the obstacles.Moisture sensor measures the dielectric constant of the dust to generate information about the moisture content as dry dust has much more dielectric value than water.

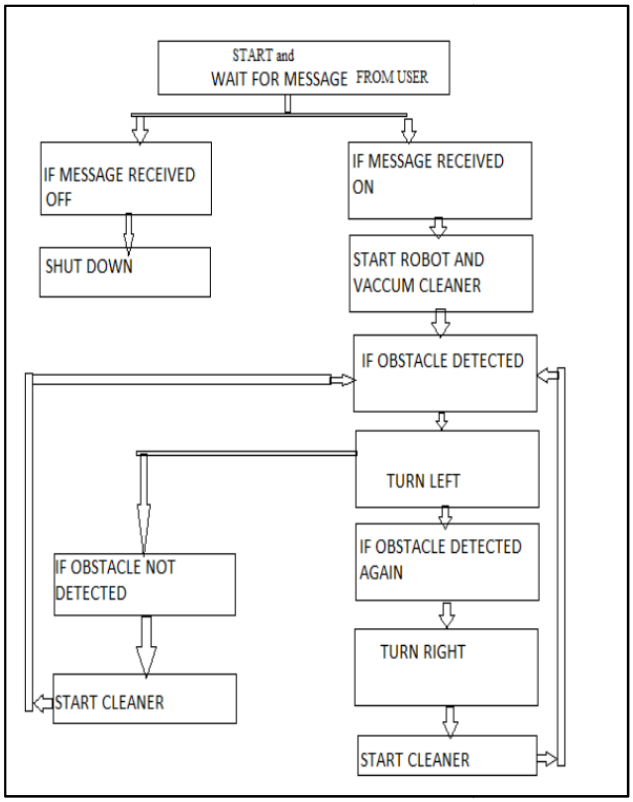


In[3], the authors describe that the user can start the vacuum cleaner by using the www.adafruit.io account id connected to the vacuum cleaner. This is done using a wi-fi module connected to the robotic vacuum cleaner.When the status update is received from server robot and vacuum cleaner will start.When obstacle is in vicinity then robot will start moving left, if obstacle is again detected then robot start moving right and then vacuum cleaner will start.When cleaning the area if robot detects an obstacle it again move left, right and so on.This is author describe the working of vacuum cleaner which is given in the above flow chart.

Saha et.al. [7], proposed a solution for garbage monitoring and clearance problems. System is equipped with RGB led lights which are attached with the bins, it acts as the indicator of the garbage level of the bin. When garbage level in the bin reaches the maximum level, the alert message will be sent to the authorized party and clearance process will be activated. Android applications are designed to communicate information.

Rao et.al. [8], proposed the smart waste management system which is capable of

collecting the status of dustbins which are placed at different localities of the city. Once the dustbin is full, the concerned authority will take the necessary action to clean up the dustbin. The garbage level is detected by ultrasonic sensors, and information about the status of the dustbin will be given to concerned authorities by using the Blynk app. The particulars about the dustbin can be accessed by the concerned authority



In [4], the author has constructed the vacuum system using a low power DC motor which rotates an omni-directional fan that creates a vacuum and intakes the dirt with air inside.In addition to that, the cleaning system includes another two DC geared motors connected to two rotating brush which has the primary operation of moving the dirt to the centre position of the bot.[9] A suction pipe is placed at the centre. Four proximity sensors are used for obstacle avoidance

III. EXPERIMENTATION AND RESULTS

In [1], three experiments (15 for each) were conducted based on their prototype. [5,6]In the first experiment, basic functionalities of components were checked. The electrical, mechanical and control parts were tested to check the working of the robot. Proper functioning is indicated by "1", "3" is the maximum value that can be achieved, which means all the parts of the system work efficiently. The results for this experiment were 100%, meaning all the parts were working efficiently. The second experiment test for the cleaning capacity of the robot. In this experiment, the robot is manually controlled and a certain amount of trash is placed in a controlled space. The efficiency can be calculated by:

$$\text{cleaning} = \frac{\text{weight of content on the system}}{\text{total content weight}} * 100$$

The results of this experiment varied between 2-68%. In the third experiment, the collision avoidance capability of the robot is measured using the formula:

$$\text{Collision} = \frac{\text{number of collision}}{\text{number of obstacles}} * 100$$

The results of this experiment varied between 20-50%. Overall, the robot system performed at the maximum efficiency of 68% in a controlled environment.

In [2] 'The Segregated Waste Collector with Robotic Vacuum Cleaner' consisting of a smart bin and vacuum cleaner successfully manages to clean the room by leveraging IOT(Internet of Things) technology. It classifies the waste and opens up the corresponding bin for disposal,correctly identifies the levels of the dustbins and sends the SMS

whenever required to the registered mobile Number.

In [4] There are two packs of ten cells of 3.7V and 3600 mAh Li-ion batteries in which 10 cells are connected in series making 37V and two packs are connected in parallel which help in increasing current rating. These two battery packs, connected in parallel give 7200mAh i.e7.2Ah with an input power rating of 266.4Wh. The power consumed by the vacuum system is 30W and for 4 DC geared motors is 72W giving us a total consumption of the robot at 102W. If fully charged, the robot can function continuously for 3.7 hours. But the fully autonomous process for recharging (autonomous docking) means that the battery life doesn't matter.

IV. CONCLUSIONS

After reviewing the above mentioned papers we can say that automated robotic vacuum cleaners have gone through a lot of modern development processes where new technologies have been applied and tested for their operations like Arduino and Raspberry Pi. Through IOT integration of these technologies with modern sensors and motors has led to time saving and a better cleaning process at lower cost. The drawback here is that these aren't fully automated and require some kind of human intervention. This can be mitigated through the use of modern computer science technologies such as Artificial Intelligence and Machine Learning. Although Algorithms are used in some for optimization, it is not close to what ML can offer.[10] Through Machine learning technologies like Object detection we can further optimize their performance.

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