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AI Based Autonomous Room Cleaning Bot

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***Abstract* – Daily, technology is growing at a rapid pace. We use machines even for simple jobs like monitoring, cleaning, etc. It is almost as if we depend on them, rely on them, and have an unprecedented urge to always have one on hand. For example, one of the most commonly used machines we have become so attached to the mobile phone. Everywhere we look, we can see people wandering around with their eyes glued to their screens or holding their devices next to their ears and having a conversation with whoever is on the other side of the line. We have almost completely substituted all the earlier forms of communication, transportation, and other aspects of our society with the creation of newer, more industrial methods and apparatuses. This has brought in modern methods and devices for various tasks in various fields. Most of these jobs are done with the help of machines to save time and labor costs. Our idea is one such project which mainly focuses on saving time and money, and also doing its work to maximum efficiency. This robot is fully automated which makes use of the concept of object detection and room mapping to move around the room and clean the floor.**

Keywords – Fully automated cleaning, object detection, unreachable spots, time-saving, efficiency.

I. INTRODUCTION

"Cleanliness is next to Godliness". It is one of the most important aspects of our lives to be clean and also to keep our surroundings clean. To be more precise, one has to keep his/her personal space clean enough to not only ensure health but also to boost up his mental ability to be more positive and energetic to do his tasks round the clock. But these days, people have no time for their basic duties (for example: cleaning their room or personal space) as they are so busy with their other work. Also cleaning the floor or a given space from time to time is possible even if it is not done on a daily. What about the unreachable spots in the space like under the bed, couch, wardrobe, etc.?

There are many earlier existing floor cleaning devices that have their own pros and cons. While our project mainly focuses on automation and ensures complete cleaning of the given space.

II. COMPARISON TO EARLIER SYSTEMS

Technology has seen a drastic change in the past few decades. Most of the cleaning systems were manually controlled, while only a very few were automated ones. The manually controlled ones took a lot of time when compared to normal cleaning, as it has to be always monitored by someone all the time. While, the automated ones made it easy for humans to get the job done easily, but were not as efficient as expected. Also, it was noted that these devices failed to access the unreachable spots and also to get around the room avoiding the obstacles on their way.

Taking all the above cons into consideration, we have designed a new system which not only ensures maximum efficiency but also is time-saving. We have designed a robot that works using the concepts of object detection and room mapping. The concept of room mapping helps the bot to find its path among the complex room structures, while the concept of object detection helps the bot to identify the dust particles as well as to identify the obstacles on its way and move without any interference. Once the bot is in a position to start its work, it identifies the dust particles and then sucks them into its garbage collector using the 12V fan, which is fixed in a bottom-up way so as to pull the dust particles inside. All the collected garbage is collected in the container and can be disposed of at any time by just removing the container from the bot. The entire cleaning process is done all alone by the bot without any human intervention except for the bot to be switched on and off and to dispose of the waste.

III. HARDWARE COMPONENTS

The main hardware components of this bot are as follows;

- Raspberry Pi module
- L293D Motor Driver
- 12V Fan
- 5v Motor
- 18650 Batteries

A. .Raspberry Pi camera module

Basically, the Raspberry Pi is a credit-card sized computer that plugs into a computer monitor or TV and uses a standard input device like a keyboard and mouse. It is a capable and portable little device that enables us to explore computing and learn how to program in languages like Python and Scratch. It is a versatile device as it is capable of doing everything that you expect a normal desktop computer to do.

The Raspberry Pi (Fig. 1) also has an additional camera module. It is a camera that can be used to take pictures and high-definition video. Raspberry Pi , being the central unit of the system, takes the necessary decision and controls the motor driver based on the footage from the camera. Some of the salient features of the Pi camera module are as follows:

- Camera Resolution – 5MP
- HD video recording – 1080p @30fps, 720 p @60fps, 960 p @45fps and so on.
- It can capture wide, motionless images of resolution 2592x1944 pixels.

Fig. 1. R Pi Module with cam

B. L293D Motor Driver

A motor driver (Fig. 2) is an integrated circuit chip that is usually used to control motors in autonomous robots. The motor driver acts as an interface between R Pi and the motors. The most commonly used motor driver ICs are from the L293 series such as the L293D, L293NE, etc. These ICs are designed to control 2 DC motors simultaneously with full potential. L293D consists of two H-bridge that are installed for 2 motors. H-bridge is an electrical circuit for controlling a low current rated motor. The L293D has 16 pins. This motor driver is controlled by the R Pi module. The motor driver in turn controls the speed and movement of the motors that are attached to the bot.

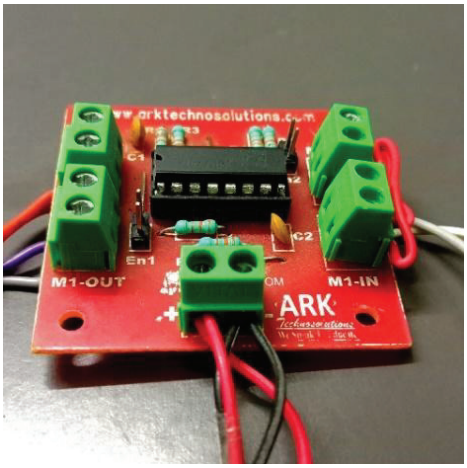

Fig. 2. 5V Motor Driver

C. 12V Fan

12V 8025 cooling fan (Fig. 3) is a 3-inch fan that operates at 12V, with dimensions of 80x80mmx25mm. The fan spins at ≈2600 RPM and can move approximately 30 CFM. The fan is placed in the reverse manner so that it acts as a vaccum suction device. This way the bot is able to suck the dust particles from the surface. The dust particles that are pulled in are moved to a separate chamber.

Fig. 3. 12V Fan

IV. SOFTWARE AND PROGRAMMING

OpenCV is a huge open-source library that is meant for computer vision, machine learning, and image processing. OpenCV supports a wide variety of programming languages like Python, C++, Java, etc making it easy for us to learn all the deep learning concepts. We have opted for Python as the python framework is more user-friendly and efficient compared to any other framework.

The bot makes use of the same R Pi cam for both room mapping and object detection, (Fig. 4). The bot is programmed in such a way first it makes a map of its own on the data collected through the camera. Then, it creates a map, (Fig. 5) out of it and starts moving around the given space with the help of the map it created. During its motion around the given space, the bot identifies the dust particles as well as the obstacles on its way.

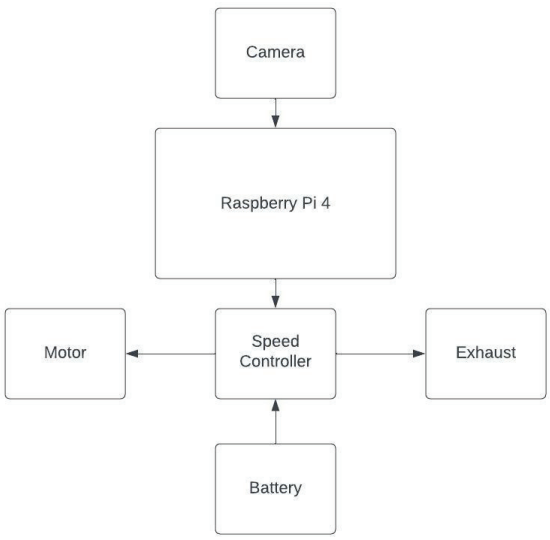

Fig. 4. Block Diagram of the bot

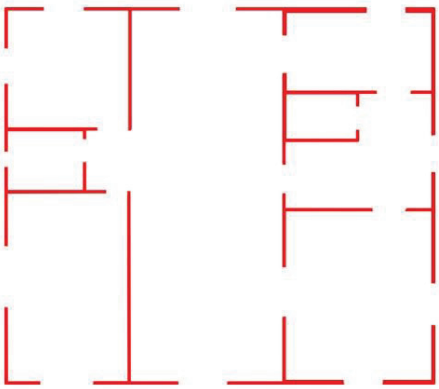

Fig. 5. Basic room mapping outline

The entire code has been designed in Visual Studio Code, for ease to modify the code as per the location. The location can be either a normal living room or an entire home. The bot is designed and programmed according to it. We have used the SLAM (Simultaneous Localisation and Mapping) algorithm, which is one of the most efficient algorithms for room mapping. Also, we have done the same with the R Pi cam itself, instead of using a sensor, e.g., a LIDAR sensor, which is quite costly. And the design of our bot is so small, about 2 inches from the normal floor level. So implementing a sensor would alter the design and make it difficult for the bot to access the unreachable spots.

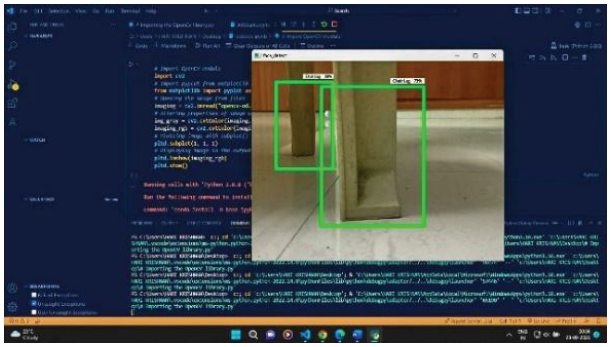

Fig. 6. Object Detection

The bot is programmed to identify the usual household articles like chairs, couches, bed, etc, (Fig. 6). The bot not only identifies objects but also pet animals, and the people in the house in real time just to differentiate between the living and non-living things.

V. THE MODEL

The entire circuit of the bot has been designed as shown in Fig. 7. The height of the bot is not more than 1.5 inches. It is designed so as to access the unreachable spots in the room. The bot has a flash in front of it to give the bot a clear vision at dark spots. It has a garbage collecting chamber of the dimensions 6.5cmx6cm. The 12V fan sucks all the dust particles into this chamber. To ensure the proper functioning of the fan and to avoid it from getting damaged by small things like stone or small plastic waste, a small metallic mesh has been placed at the interface of the fan and the garbage collecting chamber. The front tip of the bot is mounted with a carter wheel to let the bot move in 360°. Two wheels have been attached on either side of the bot which initiates its movement. Some of the salient features of the bot that makes it unique from the earlier systems are:

- Easily programmable
- Portable
- More efficient than the earlier systems as the bot is fully automated
- Having a height of not more than 1.5 inches, it is so easy for the bot to access the unreachable spots.

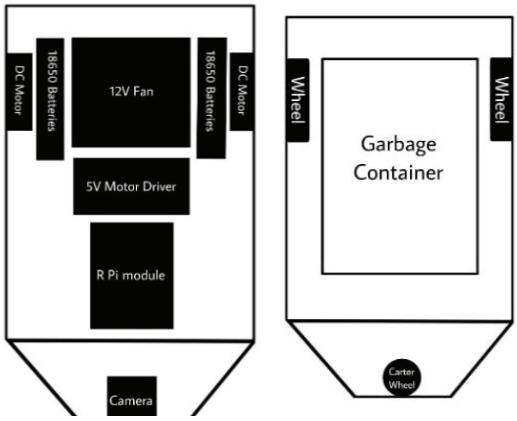

Fig. 7. Top and bottom view of the bot

VI. CONCLUSION

Our AI-based Autonomous Room cleaning produced outstanding outputs as compared to the earlier systems. It has proved to be more efficient both in terms of cleaning and time-saving.

TABLE I.

Parameters	Earlier Systems	Our System
Efficiency	Max up to 75%	Up to 95%
Power	Can work for less than an hour	Can work up to 2 hours
Programming	Once done cannot be modified	Can be easily modified as per the requirement
Size	Though handy, not small enough to access the unreachable spots	Handy and has a height of less than 1.5 inches making it easy for the bot to access the unreachable spots.

VII. FUTURE DEVELOPMENTS

As far as now the bot does only the cleaning work on its own. It requires human intervention only to get it switched on and off, to get the collected garbage disposed of, and to recharge the bot. In the future, this bot is to be designed in such a way that it requires no human intervention even for the above-mentioned tasks. The bot will be doing all the work on its own. It will schedule the work on its own on a timely basis and do the cleaning work. It will recharge on its own with the help of a mini charging unit which will be installed on the wall such that the bot can reach it. Also, it will be designed to dispose of the garbage collected in the chamber on its own. This bot will be used in different places where man has no access to reach the spot, for example, cleaning radioactive waste in nuclear power plants, which is considered to be one of the hazardous jobs. The entire bot

can be modified in terms of hardware and programming wherever it is to be used.

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