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Automating Cleanliness: A Comprehensive Review on Real-time Monitoring and Control Techniques for Floor Cleaning Robots

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Abstract

The smartest floor cleaning robot for home and office use is the automatic floor cleaner. The control mode is automatic. In addition, the robot saves time and energy by doing dry cleaning in parallel. The area of the room may determine how long cleaning takes. Consequently, the user may concentrate on his main activity, leaving the cleaning to the robot. Furthermore, our robot is less expensive than other robots. Everybody has cleaned by hand at some point in their daily life. Nonetheless, this is an effort to create an autonomous robot that would lessen the workload for people. Consequently, finishing the assigned task more precisely and effectively. The robot's algorithm guides it along an intelligent path, which makes it simple for the robot to detect and respond appropriately. To accomplish its goal, the cleaning process is carried out concurrently. It is not an easy task to investigate and construct an autonomous mobile robot and a manual phone application control prototype that can vacuum a room or even the full house. Some vacuum cleaners would be needed to take on such a task and finish it in the six weeks that the course would last.

Keywords: Robot with self-configuration, Automatic Floor Cleaning, Application Control, Artificial Intelligence, Cleaners.

INTRODUCTION

Our lives have changed and become better over time, and cleaning has always been a vital and significant aspect of them. The need for completely automatic floor cleaning robots has surged due to today's hectic lifestyle. Autonomous floor cleaning robots are primarily utilized in smart homes, offices, and residential spaces in developing nations. According to the global market study, there is a significant demand for the use of these robots in domestic settings with fully automated features and the least amount of human assistance. Although these robots currently have a very small market share of the global vacuum cleaner market, their acceptance and recognition are increasing quickly. Robots are useful in various fields, including domestic settings. The number of domestic robots has increased. Robots for vacuum cleaning are particularly well-known [3]. Only a select few of the many robots in existence can be specifically programmed to do human home tasks. Of those, a particular type of robot that is highly beneficial to all is the cleaning and mopping robot [4]. Recent years have seen a considerable advancement in cleaning robot technology, mostly due to increased market penetration and increased demand for improved

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cleaning efficacy. Nevertheless, given the geometric constraints of the platforms with respect to the cleaning stage, given the furniture and architecture, most of the robots struggle to cover the entire cleaning area. A cleaning robot is a simple autonomous robot that follows preset protocols and algorithms to clean a predetermined area.

The main goal of this robot is to reduce the amount of time that humans spend cleaning, which can take a long period [5]. These robots are applicable in offices, homes, factories, and other locations. These robots can be programmed to turn on at a specific time or can be turned on with a single button click [6]. The market is filled with numerous successful products. Every product has advantages and disadvantages. These products' primary issues are their high price and limited suitability for Indian consumers. Compared to tiles, these products are far more effective for wooden floors. Certain functional criteria that could enhance the robot's performance were overlooked because of their mechanical implications or inherent complexity. These autonomous or semi-autonomous robots carry out tasks that benefit both people and machinery. The following requirements were discovered to keep our robot as basic as possible while still accomplishing the original objectives, which were to create an autonomous vacuum cleaner robot that could randomly move across a room or a house with the least amount of human assistance:

Avoiding Obstacles
- Detection of collisions.
- Fan motor monitoring.
- Automatic system activation

Some of the anticipated actions that will be programmed into the robot are in line with these standards. Additional actions that will improve the robot's overall performance.

OBJECTIVE

The following sentences list the project's aims, which include:
- Making the machine cost-effective
- Reducing the maintenance costs associated with manually operated floor cleaning as much as possible.
- To offer a significant resolution to the issue of producing cleaner at a reasonable cost while employing regional resources.

LITERATURE REVIEW

The hTrihex platform, a self-reconfigurable adaptive robot that can achieve three alternative configurations, is described in the work of Parween et al. [1]. Using the hinged dissection theory of polyominoes, Prabakaran et al. demonstrated the development of hTetro, a unique reconfigurable floor cleaning robot inspired by Tetris. With the aim of maximising the coverage area, the created robot platform can change between any of the seven one-sided tetromino morphologies based on the sensed surroundings [2]. In order to create a mopping module inside the framework of a multifunctional floor cleaning robot, Hong et al. proposed a novel way to mop the floor using a sponge [3]. Gao et al. unveiled a robot that cleans floors and has Swedish wheels. It can be utilised in busy areas like homes, rail stations, airports, etc. Both autonomous and teleoperated modes of operation are possible for the robot [4]. In their investigation, Youngkak et al. used an RFID system to feel them, and they suggested a new disposition method that would put RFID tags on the floor and indoor objects [5]. The concept described by Prashanth et al. attempted to create a powerful and small device that could disassemble and inspect pipes in order to remove blockages [6]. The study by Yong-Joo et al outlines a little robot that may be used to clean floors at home and suggests a navigation algorithm that works well using a basic switch sensor. We enumerate the prerequisites that must be considered when creating a robot for cleaning floors at home. We design and build a cleaning robot based on the specifications, and we suggest a navigation algorithm that enables the robot to accurately alter its path in the absence of eyesight or

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range sensors [7]. The primary objective of the robot, created by Adithya et al., is to effectively mop and dust the floor of a designated room. The goal is to make the robot practical and affordable for society's economic classes. The robot is intended to operate for an hour [8]. Zhao et al. suggested a unique navigation strategy for an indoor cleaning robot. The cleaning robot's operational efficiency is enhanced by the integration of stereoscopic vision, wireless networking, human-machine interaction, and localization algorithms [9]. The challenge of assigning robots to the task of cleaning a vast area was demonstrated by Jeon et al. Map, environment, and robot are considered in the formulation of the challenge. It was suggested to use a control system for robot allocation [10]. The design and construction of an autonomous robot for polishing tiles, granite, marble, and other floors is the focus of Ramani et al. In this apparatus, one motor for the polishing disc and two motors for vehicle movement are powered by electricity that is stored in a battery [11]. Kukde et al used technological advancements to create a human-friendly cleaning robot that will improve human comfort and ease of living. Although there are already automated cleaning robots on the market, they do not operate in unison with people [12]. Muruganandhan et al. offered a straightforward and effective way to use the pulse width modulation approach to control the speed of a DC motor [13].

HARDWARE USED

Arduino

Arduino is an open-source computer hardware and software company, project, and user community that designs and manufactures single-board microcontrollers and microcontroller kits. It facilitates the creation of digital devices and interactive objects that are capable of sensing and controlling objects in both the physical and virtual worlds. A boot loader that is pre-programmed into Arduino microcontrollers makes it easier to upload programs to the on-chip flash memory. The Arduino UNO's optiboot bootloader is the one that runs by default.. Program code is transferred to boards over a serial link to a different computer. A level shifter circuit is built into some serial Arduino boards to translate signals between transistor-transistor logic (TTL) level and RS232 logic levels. The FTDI FT232 is one of the USB-to-serial adapter chips used to implement USB programming on current Arduino boards. Certain boards, like the Uno boards from later models, replace the FTDI chip with an AVR chip that is independent and has USB-to-serial firmware that can be reprogrammed via its own ICSP header [12]. The pins and other components of Arduino Uno R3 is shown in Figure 1.

Ultrasonic Sensor

The speed of ultrasonic waves surpasses that of audible sound, which is sound that is perceptible to humans. The two main components of ultrasonic sensors (Figure 2) are the transmitter, which generates sound using piezoelectric crystals, and the receiver, which detects sound after it has traveled to and from the target.

There is a simple idea underlying this module's operation. In the event of an impediment or object, it sends out an ultrasonic pulse at 40 kHz that travels through the atmosphere and back to the sensor. You may calculate distance by multiplying the sound speed by the travel duration. A fantastic way to detect clear objects is with ultrasonic sensors [14–15]. Ultrasonic sensors can identify the existence of items irrespective of their color, surface, or composition. Ultrasonic sensors determine a target's distance by timing the time it takes for the reflected waves to return to the sensor. This sensor is an electrical device that measures the distance to a target using ultrasonic sound waves and converts the sound waves' reflection into an electrical signal. We frequently use our sensors as proximity sensors. In addition to being used in manufacturing, ultrasonic sensors are also utilized in obstacle avoidance systems.

L293D Motor Shield

Using the L293D Motor Driver Shield (Figure 3) is one of the finest ways to control DC, Servo, and Stepper motors on a single board.

Two Servo motors, two Stepper motors, and four DC motors can all have their rotational direction and speed controlled by it. It's easy to connect to an Arduino Mega or UNO. For CNC projects and

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Arduino robotics, this shield is helpful. This module is comprised of the 74HC595 shift register IC and the two L293d dual-channel H-Bridge motor driver ICs. The L293D is a dual-channel H-Bridge motor driver. One stepper motor or two DC motors can be operated by a single integrated circuit. Peak output current per channel is 1.2 A, and bidirectional drive currents up to 600 mA are possible at voltages between 4.5 V and 36 V with the L293D [15]. There are two L293D motor driver ICs on the motor driver shield. Thus, one stepper motor or four DC motors can be controlled by the L293d shield.

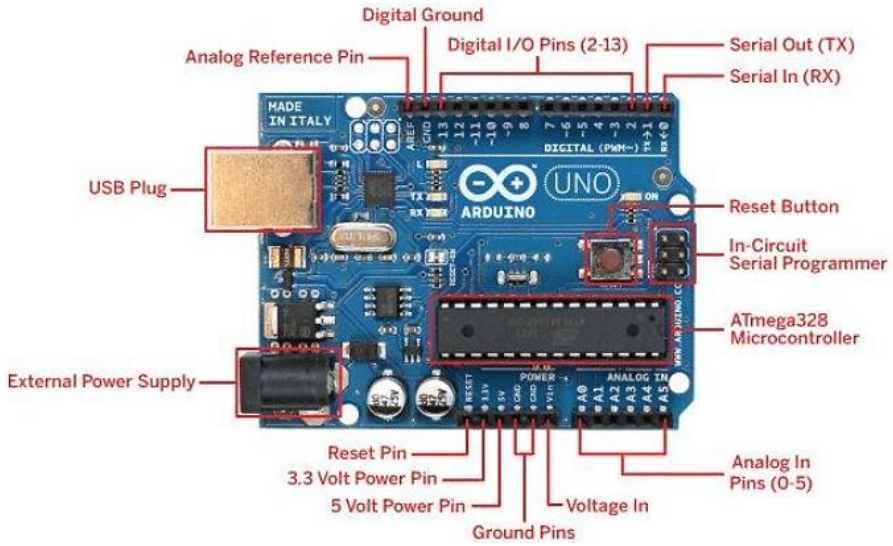

Figure 1. Arduino UNO R3.

Figure 2. Ultrasonic Sensor.

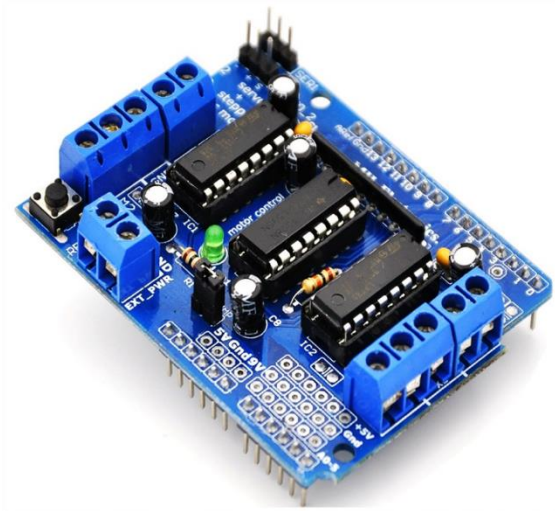

Figure 3. L93D motor shield.

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Figure 4. DC motor.

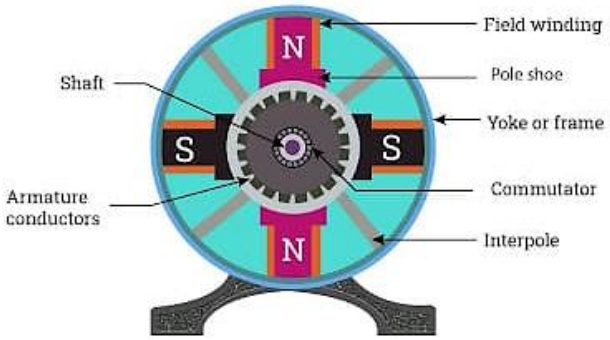

Figure 5. DC costruction parts.

DC Motor

Any rotary electrical motor that transforms direct current electrical energy into mechanical energy is referred to as a DC motor (Figure 4). Almost all varieties of DC motors contain an internal mechanism electromechanical or electronic that allows the motor's portion of the current to be periodically reversed. Since DC motors could be fueled by the direct-current lighting power distribution networks already in place, they were the first type of motor to be utilized extensively. A DC motor's speed can be adjusted throughout a broad range by varying the field windings' current strength or the motor's supply voltage. The universal motor may run on direct current even though it is a lightweight brushed motor used for portable power equipment and appliances. The armature coil is the rotating element, and the stator is the stationary part. DC motor Construction parts are shown in Figure 5. This involves connecting the armature coils which also comprise the brushes and commutators to the DC supply.

FLOWCHART AND WORKING

The Process flowchart of Floor vacuum cleaner is shown in Figure 6.

Working

The vacuum cleaning assembly of the automatic floor cleaner is cleverly designed to clean a designated area. The working principle is shown in Figure 7. To collect dirt as it goes over the surface, the vacuum cleaner is built on a circular piece of board with brushes connected at its side- and a-wheel underneath. The wheels that are attached to the platform can change direction thanks to a DC motor. DC motors can be driven directly if sufficient current is generated; otherwise, a motor driver is needed to supply a high current, up to 0.7 to 1.2 ampere. The driver in use has an H-Bridge configuration and is called L293D. The cleaner is portable and has 360-degree rotation. Basically, the objective of sensors is to establish a communication link between the digital device and the outside environment. Two ultrasonic sensors (HC-SR04) are included in the project to achieve this goal. One of them senses impediments or barriers in front of the cleaner's path, causing it to retrace its steps and change lanes; the other senses height, keeping the cleaner from toppling over. The brushless DC motor is connected to a self-built suction unit that rotates at a very fast speed. It is detachable, and dirt can be cleaned from it.

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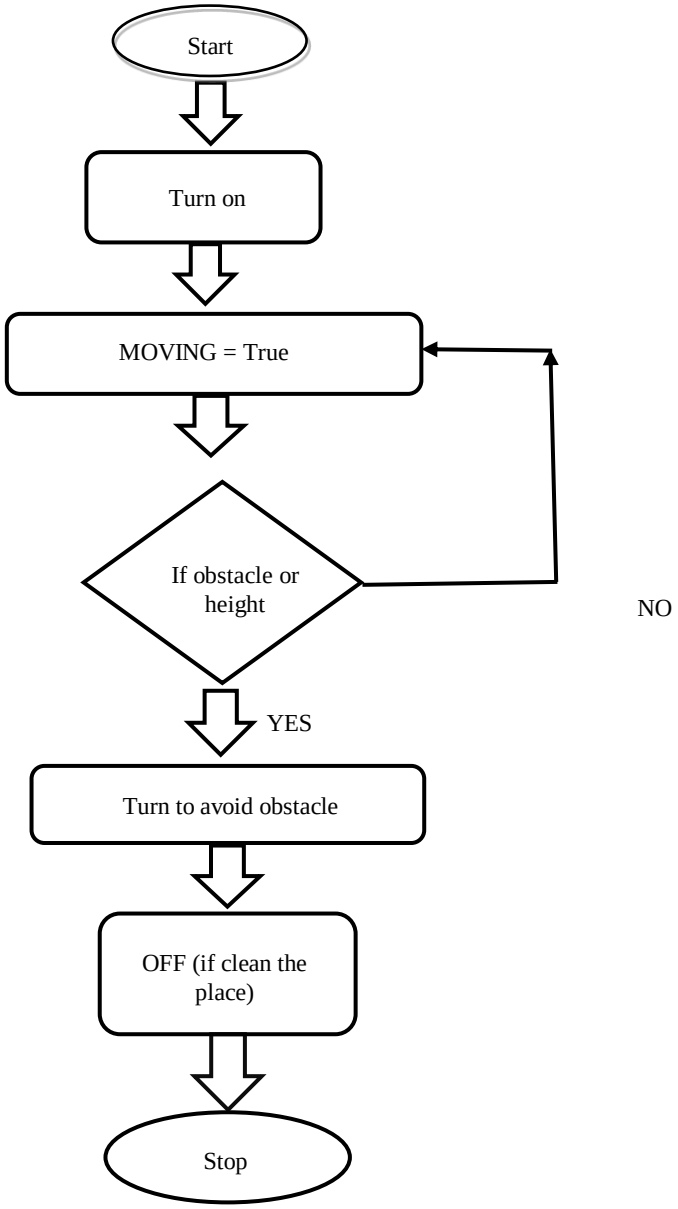

Figure 6. Flow chart of proposed system.

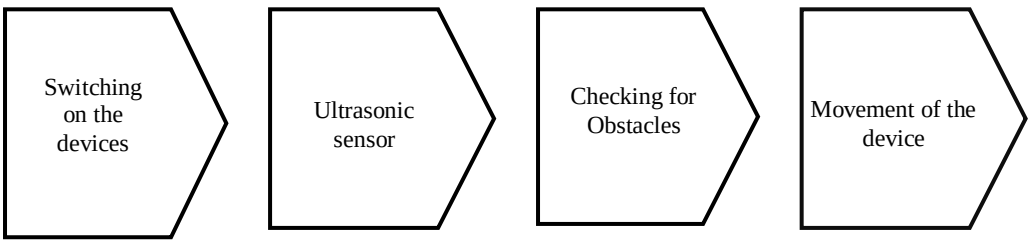

Figure 7. Working Principle.

To collect dust, an automatic floor cleaner robot is equipped with brushes on its sides. This robot has a suction mechanism that collects dust while it moves freely around the room and uses ultrasonic sensors to avoid obstructions and change direction. However, this robot's inability to clean a damp floor is a downside. Basically, plane floors are among the surfaces that are cleaned during the cleaning process. The design, development, and construction of a programmed cleaner robot model are presented in this work. This kind of robot carries out automatic tasks and has additional characteristics like an air vacuum

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dirt container and a choose and put mechanism. It is capable of water spraying, obstacle detecting, sucking, and cleaning. Moreover, manual method addition is possible. The Raspberry pi3 model controls all hardware and software functions.

CONCLUSION

The project uses devices and instruments that are readily available in the Indian market to present an overview of the construction of a basic robotic cleaner control system in a better and more straightforward manner. This robot was specifically created with contemporary technologies. Both manual and automatic operation is possible. It can automatically deplete itself and has scheduling capabilities.

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