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# IOT based Design and Construction of a Self-Directed Cleaning Robot for National Highway Authority of India

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**ABSTRACT:** In this article, Domestic robots are entering homes and people daily lives, but it's yet an immature market. However, growth is predicted and adoption of domestic robots is evolving. There are a lot of robotic floor cleaners available on the market. The purpose of this project is to design and develop a vacuum cleaner robot that would collect the dust particles and store it into the chamber. Street sweepers have been employed in cities since sanitation and waste removal became a priority. Street-sweeping person would use a broom and shovel to clean off litter, animal waste and filth that accumulated on streets [6]. In this model road sweepers are equipped with water tanks and sprayers used to loosen particles and reduce dust. The brooms gather debris into a main collection area from which it is vacuumed and pumped into a collection bin or hopper. So that we designed an effective module for maintaining a clean highway road with a help of unmanned vehicle robot. Traditional machine used for highway cleaning makes a human carry themselves a vacuum unit and dispersive unit for cleaning and the other machines which are automated are finding fault in running through, Portable and lightweight, automatic operation that can clean all the highways road. [8] To build the electrical and mechanical part of the cleaning robot integrated with solar panel and battery. Other behaviours that will increase the overall performance of the robot, such as self-calibration of the sensors and navigation with some memory (not completely random) were also considered.

**KEYWORDS:** Wireless sensor, Arduino UNO, Debris tracking, obstacle identification and Detection.

### I. INTRODUCTION

The Autonomous wireless cleaning machine are very special domain in the field of robotics. This technology has evolved over the years and has found their applications in many fields. There are autonomous cleaning machine that can run on land, air and inside water but all has different design considerations. There are three main areas to be considered for constructing an autonomous highway cleaning vehicle. They are the obstacle avoidance, vehicle steering system and position detection system to find its source and destination. In this project we focus on the identifies obstacle and avoidance obstacle problem of an autonomous cleaning robot. We have studied current techniques and methods existing in the obstacle avoidances to propose our method of obstacle detection and with that we have designed a new algorithm to support the new methodology. We tried to keep the algorithm as simple as possible to make sure the execution of the algorithm consumes fewer resources as much as possible. The work is to build an unmanned cleaning robot with collision detection and avoidance algorithm, working with a combination of fixed and moving ultrasonic sensors to find the obstacles. The inputs from both sensors are considered by the decision making algorithm to decide the direction and rate of movement of vehicle. The vehicle motion is controlled by the motors which in turn are controlled by the motor control algorithm. The inputs to the system is given from the ultrasonic sensors which act as the eyes of this algorithm. The ultrasonic sensor setup consists of two sensors one fixed

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and the other moving to find the obstacle distance and the size of the obstacle respectively. [7]One of the sensor's transmitters is moved using a motor but the receiver is kept fixed. An autonomous guided vehicle is a moving robot which can move on its own without any external control. The vehicle is built with the intelligence to decide the path to be taken to reach the destination. The vehicle usually is equipped with hardware to find its position hence it can detect the destination. [21]This project doesn't worry about the destination to be reached but proposes an algorithm to find the best path to reach the destination. The sensors are used to find the obstacles that come in the way of the vehicle navigation. In this project we propose an algorithm with which the decision making skills of the vehicles are increased. The main objective of this project is to provide a solution for the problem occurring in national highways while keeping it low cost. In this work the robot has been designed for the environmental purpose.

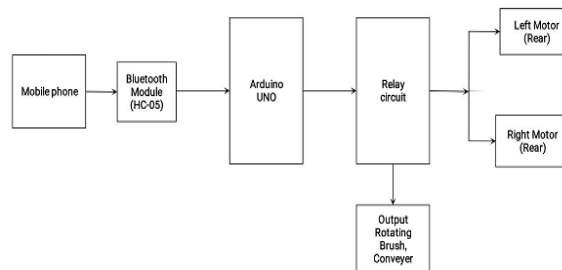


Figure 1. Block Diagram of NHA Cleaning Robot

## II. LITERATURE SURVEY

The robotic vacuum cleaner is an autonomous electronic device that is programmed to clean specific area through a vacuum cleaning assembly. Some of the available products can brush around sharp edges and corners while others include a number of additional features such as wet mopping rather than vacuuming. This helps in cleaning flat surfaces with ease of wireless sensor network. [1]. A vacuum cleaner robot, generally called a robovac, is an autonomous robot that is controlled by intelligent program. Autonomous vacuum cleaning robot will perform task like sweeping and vacuuming in a single pass. The DVR-1 vacuum cleaning robot consists of two DC motor operated wheels that allow 360 degree rotation, a castor wheel, side spinning brushes, a front bumper and a miniature vacuum pump. Sensors in the bumper are used for generating binary information of obstacle detection then they are processed by some controlling algorithms. These algorithms are used for path planning and navigation. The robot's bumper prevents them from bumping into walls and furniture by reversing or changing path accordingly. [2] common robot cleaner uses complete coverage path planning with a map gotten by simultaneous localization and mapping and it only contains geometrical information. For effective cleaning task, a cleaning robot should consider not only the geometrical map but also domestic properties and a user's preference. This paper suggests an experience based cleaning algorithm of a robot cleaner. Experiences of concentrated cleaning commands from a user and ones of failures during cleaning because of obstacles which cannot be detected like electric wire are stored as data. [4] They are used to find areas which should be avoided and or should be cleaned with concentration. To estimate the areas' shape, kernel density estimation is used. This density is used to find property area with threshold. After finding the areas, the robot determines cleaning order among them. [6] As a further work, it will be tested in simulation and be applied to a real cleaning robot which uses SLAM as a next step.

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**Table1.1** Comparison table of different types of robot

Robot Name	Manufacturer	Type of use	Technology
1.Scooba	iRobot	Wet washing of floor	IR with virtual wall accessories
2.Braava	iRobot,KITE CH,Sony	Floor mopping for hard surfaces/dry clean	IR with virtual wall accessories for industrial cleaning
3.Aguabot	Milagrow	Wet mopping and dry cleaning	Various sensors (obstacle,optical, Accelrometer)
4.Exilient RVC	Exilient	Wet mopping and dry cleaning	6 <sup>th</sup> sense,robotic scheduling,charging,uv cleaning,all cleaning modes.

### III. METHODOLOGY

Usually robots of this kind can cost more making it an unaffordable choice. At the same time this economical robotic floor cleaner has been designed mainly keeping the price margin in mind. As a result most efficient cleaning system is developed to attain perfect cleaning. Each of use and simple interface makes this project a most useful device in this busy and smart world. With the aim of keeping our robot as simple as possible, while able to perform the initial goals, that is vacuum cleaner robot is able to clean National Highways.



**Figure 2.** Road Accident Debris in National High Way

#### COMPONENTS:

##### A. CHASSIS

The base of the body comprises of aluminium bars, two metal geared motors aluminium angular brackets and aluminium holders for two lead acid batteries of 12v and 4.5Ah rating. These motors are independently powered and mounted so that the motors can move along its axis easily and bear more weight as compared to chain mechanism. Cleaning assembly includes a DC geared motor, sprockets for moving chain from geared motor to rotating brush and two aluminium rods for supporting vacuum cleaner mechanism and dirt compartment. [3] This DC geared

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motor has been fitted on one side of aluminium holders and sprockets installed with it which have been fitted into shaft of motor. All components are installed on lower and robot would be stable and bottom of the chase we add conveyor belt to collect dust particles into chamber.



Figure 3. Chassis Assembly Side view

### B. BRUSHING

Brushing mechanism consist of one rolling brush, two aluminium holders, and one conveyor belt one rolling brush mounted on aluminium holders with bearings inside them. [9] This mechanism is attached through mild steel strip to the base of robot. Brush is used to broom the dirt particles into the vacuum chamber and conveyor is use to move dust particles to a chamber.



Figure 4. Brush Assembly

### C. ARDUINO

The Arduino UNO is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The board has 14 Digital pins, 6 Analog pins, and programmable with the Arduino IDE (Integrated Development Environment) via a type B USB cable. It can be powered by a USB cable or by an external 9 volt battery, though it accepts voltages between 7 and 20 volts. It is also similar to the Arduino Nano and Leonardo. The hardware reference design is distributed under a Creative Commons Attribution Share-Alike 2.5 license and is available on the Arduino website. Layout and production files for some versions of the hardware are also available. "Uno" means one in Italian and was chosen to mark the release of Arduino Software (IDE) 1.0. [1] The Uno board and version 1.0 of Arduino Software (IDE) were the reference versions of Arduino, now evolved to newer releases. The Uno board is the first in a series of USB Arduino boards, and the reference model for the Arduino platform. The ATmega328 on the Arduino

Uno comes preprogrammed with a bootloader that allows uploading new code to it without the use of an external hardware programmer. It communicates using the original STK500 protocol. The Uno also differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it uses the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter.

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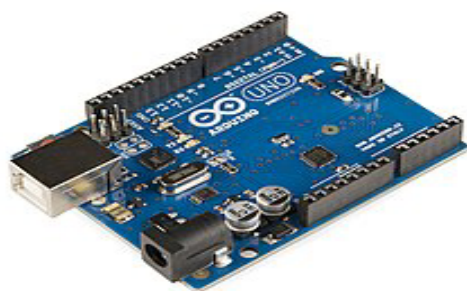


Figure 5. Arduino Uno Board

### D.VACCUM CLEANER

Vacuum cleaning and dirt disposal mechanism consist of vacuum motor, steel holders for fixing motor, aluminium brackets and aluminium strips. steel sheet has been molded in such a shape that it gave a shape of the robot. aluminium straps is also molded into a shape just like steel sheet but of bigger size [13] conveyor belt is attached to results in narrow tunnel from front side and board compartment at back side. narrow tunnel is necessary for better suction of dirt and board compartment. vacuum cleaner battery holder is spot welded to support 12V, 4.5Ah battery.

### E.MOTOR CONTROLLER

Motor controller commonly known as H-bridge, are used for the driving motors in both direction that is clockwise and counter clockwise with current rating of 15A [19]. This controller consist of two parts. first part is to energize relay through arduino controller and drive motors while second part is for controlling the speed of the motors. relay are used for switching purposes while transistors are used for speed control. relay used in this circuit have 12V dc coil and 15 A current while lead acid battery of a 12V and 4.5Ah rating. this is a condition in which diode is put in reverse state between battery terminals and is commonly known as free-wheeling diode. at de-energizing of relay huge voltage is produced in backward state can damaged other components so to avoid this damage a diode in fly back configuration is used along with relay. this circuit is powered up through separate battery connected through ON/OFF switch and fuse to provide protection and a red LED glowing if the circuit is disconnected.



Figure 6. L293 Motor Driver

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The L293D is a monolithic, integrated, high voltage, high current and has 4 channel drivers. Basically this means using this chip one could use at most four DC motors and provide power supplies of up to 36V. Figure 5.3 is the Motor Driver L293D. The L293D chip uses H-Bridge. Motor drivers act as current amplifiers since they take a low-current control signal and provide a higher-current signal. This higher current signal is used to drive the motors. In its common mode of operation, two DC motors can be driven simultaneously, both in forward and reverse direction. The H-Bridge is typically an electrical circuit that enables a voltage to be applied across a load in either direction to an output e.g. motor. This means that just reversing the direction of current leads to reversing of the direction of motor. The motor operations of two motors can be controlled by input logic at pins 2 & 7 and 10 & 15. Input logic 00 or 11 will stop the corresponding motor. Logic 01 and 10 will rotate it in clockwise and anticlockwise directions, respectively. Enable pins 1 and 9 (corresponding to the two motors) must be high for motors to start operating. When an enable input is high, the associated driver gets enabled. As a result, the outputs become active and work in phase with their inputs. [12] Similarly, when the enable input is low, that driver is disabled, and their outputs are off and in the high-impedance state.

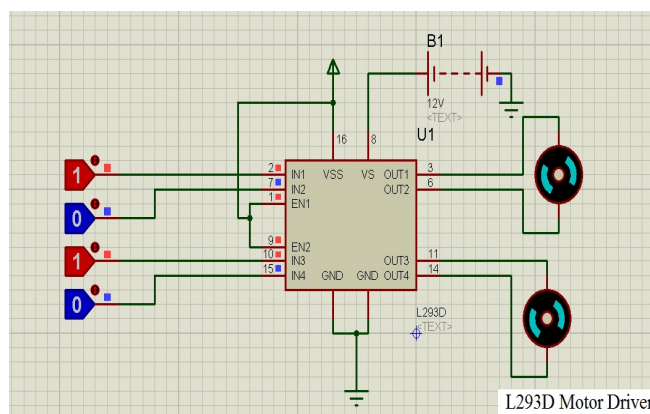


Figure 7. Snap Short of Proteus output DC Motor Speed Control.

### F.VACCUM ON/OFF BUTTON

An on/off button specific for the control of vaccum unit .this button works exactly similar to brush button.however,this both bottons do not affect working of each other at any instant.

### G.WIRELESS CAMERA

Wireless security cameras function best when there is a clear line of sight between the camera(s) and the receiver. Outdoors, and with clear line of sight, digital wireless cameras typically have a range between 250 and 450 feet. Indoors, the range can be limited to 100 to 150 feet. Cubical walls, drywall, glass, and windows generally do not degrade wireless signal strength. Brick, concrete floors, and walls degrade signal strength. [26]Trees that are in the line of sight of the wireless camera and receiver may impact signal strength.

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**Figure 8.** Wireless Web Camera

The signal range also depends on whether there are competing signals using the same frequency as the camera. For example, signals from cordless phones or routers may affect signal strength. When this happens, the camera image may freeze, or appear "choppy". Typical solution involves locking the channel that wireless router operates on.

## IV. DISCUSSION ABOUT ROBOTIC OPERATION

The objective of this project is to make a vacuum cleaning robot which is fully semi-autonomous and manual featured with user friendly interface. [24]This is able to clean and brush the disposal off.it can be used in semi automatic and manual modes as per uses will.when there is a need of this product ,it gets started and cleans the particular area the manual mode is to save the energy of the robot.customers are provided with user friendly interface to operate the robot without any difficulty.the evaluation shows that or project is cost effective and reliable.it works with less energy consumption.it results as the project is user friendly.The ultrasonic sensor consists of a transmitter and a receiver. [28]The sensor is operated by giving a pulse signal to the transmitter and then the mode of operation of sensor is changed to reception for a calculated amount of time and the sensors waits to receive the reflected signal during this period. If a signal is received then there are obstacle detected on the way, if no signal is received then there are no obstacles on the way and the sensor again switches to receiver mode. [30]The below are the steps followed in the operation of the sensors:When the vehicle is turned on the battery powers up the microcontroller The microcontroller turns on the stationary ultrasonic sensor and then turns checks for obstacle by waiting for the signal from sensor.If no obstacle is found then the turns on the motors to propel the vehicle forward.The vehicle keeps moving on its destined path until an obstacle is detected on the way by the stationary sensor pairs. The stationary sensors are turned off and the sensor mounted on the stepper motor and the stepper motor is turned on to scan the region dictated by the software.The stepper motor moves step by step with the angles per step and the total number of steps as configured in the software. [14]The sensor stands in the receiver mode for configured amount time of at each step to get the interrupt from the sensor on detection of an obstacle.[18]If an obstacle is detected a particular bit in the bit field is set to one. The position of bits corresponds to the step number of the rotating ultrasonic sensor mounted on the stepper motor.The same is followed for all the steps and the bit field is updated, 0 indicates no obstacle and 1 indicates presence of an obstacle.The current algorithm is designed with only one step and thus it covers two sectors.When an obstacle is detected only in the first sector then the vehicle turned by an angle of 15 degrees right.If an obstacle is found in the both the sectors then the vehicle is turned by 30 degrees right.If an obstacle is found only in the second sector then vehicle is turned 15 degrees left.If no obstacle is found by the moving sensor then the vehicle is not maneuvered.[22]To turn the vehicle right the left wheel is rotated in the reverse direction and for turning the vehicle left the right wheel is rotated in the reverse direction.

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## COMPARISON OF EXISTING AND PROPOSED ALGORITHM

The comparison of algorithm is done with the distance covered by the same vehicle under the same environment. The obstacle pattern presented is kept same in both the cases and the distance covered by the vehicle is compared. The lesser the distance travelled the more efficient is the algorithm.

Obstacle Pattern 1:

- Obstacle 1: Present only in the both sector
- Obstacle 2: Present only in the both sector
- Obstacle 3: Present only in the both sector
- Obstacle 4: Present only in the both sector

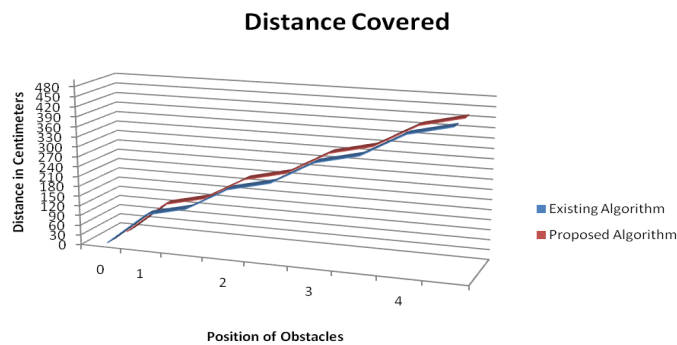


Figure 9: Comparison of Algorithm with Distance for Obstacle Pattern 1

In the above obstacle pattern the vehicle running with existing algorithm has travelled a distance of 430 cm to avoid the 4 obstacle but the vehicle controlled with the proposed algorithm has taken only 430 cm to avoid the obstacle. Thus it shows the vehicle controlled with proposed algorithm is equally efficient in this case.

Obstacle Pattern 2:

- Obstacle 1: Present only in the first sector
- Obstacle 2: Present only in the second sector
- Obstacle 3: Present only in the both sector
- Obstacle 4: Present only in the first sector

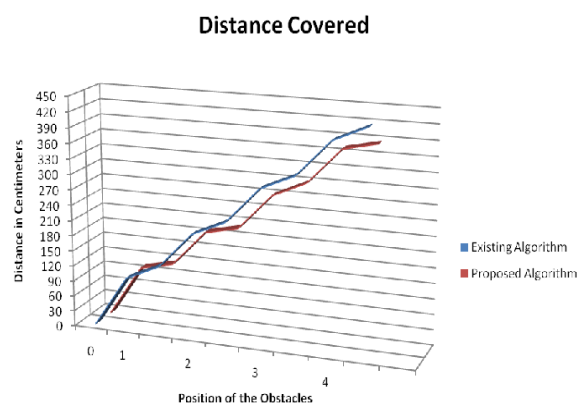


Figure 10. Comparison of Algorithm with Distance for Obstacle Pattern 2



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In the above obstacle pattern the vehicle running with existing algorithm has travelled a distance of 430 cm to avoid the 4 obstacle but the vehicle controlled with the proposed algorithm has taken only 385cm to avoid the obstacle. [29] Thus it shows the vehicle controlled with proposed algorithm is 10% more efficient than the existing algorithm in this case.

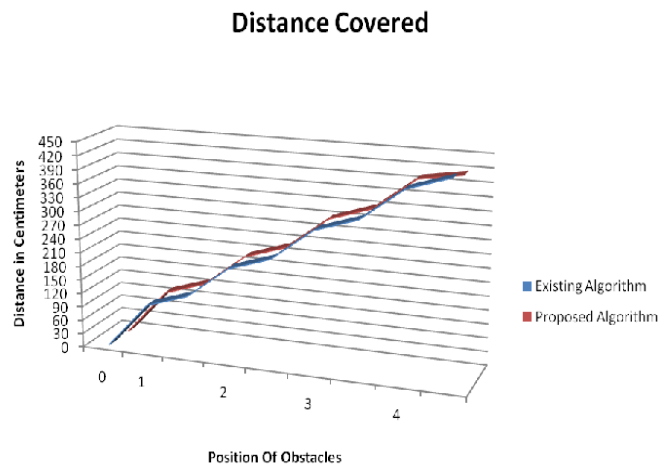
Obstacle Pattern 2:

Obstacle 1: Present only in the both sector

Obstacle 2: Present only in the both sector

Obstacle 3: Present only in the both sector

Obstacle 4: Present only in the first sector



**Figure 11** Comparison of Algorithm with Distance for Obstacle Pattern 3

In the above obstacle pattern the vehicle running with existing algorithm has travelled a distance of 430 cm to avoid the 4 obstacle but the vehicle controlled with the proposed algorithm has taken only 415cm to avoid the obstacle. [30] Thus it shows the vehicle controlled with proposed algorithm is 3% more efficient than the existing algorithm.

## V. CONCLUSION

This paper shows that the implementation of IEEE standard 1621 IEEE standard for User Interface Elements in Power Control of Electronic Devices Employed in Consumer environments in terms of smart national highway cleaning robot. The paper shows a simple and a better approach to provide an overview of design of a simple robotic cleaners control. This robot is specially made on the basis of modern technology [10] it has all the features which are required for the vacuum cleaner. It can work semi automatically. This is locally manufactured smart vacuum cleaner with all the features up to the standards of IEEE, and android app has been used to make it little more user friendly it can also be used for the industries where cleaning with the help of human is toxic, vacuum cleaner can easily be used.

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