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TITLE: AUTONOMOUS FLOOR CLEANER

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Abstract

Automatic floor cleaner is a compact robotics system which provides floor cleaning service in room and big offices reducing human labor. Basically as a robot it eliminates human error and provide cleaning activity with much more efficiency. Traditionally floor is cleaned with the help of dry mop or wet mop using the hand as a potential tool. They have to scrub hard on the surface. The cleaning includes cleaning of various surfaces basically cement floors, highly polished wooden or marble floors. Among these floors the rough surface floor such as cement floor, mostly present in semi urban areas are covered with so much dust.

If we clean the floor manually then there is a possibility that the operator will leave some portion of the floor. Also due to manual labor involved this is time consuming and irritating to clean the floor. Also in big offices floor area is very huge and the people involved there for cleaning purpose cannot clean it much more efficiently. This is where the robot comes as an advantage. Also the robot is small and compact in size. So we can carry it and place it wherever we can on the house.

Index Terms: *Aurdino , Automation, Sweeping, Navigation, Bluetooth Module etc.*

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1. INTRODUCTION

Robot is an intelligent device having its own brain fed with computer logic so that it can do the work according to the algorithm designed. Autonomous movement of vehicle is guided by the logic controller designed. Robots plays an important role in each every field of life. It is used in industries, in households and in institutes. The robots are just becoming as intelligent as human now a days. Mostly an average human uses 2-3 robots per day in his day to day life. Mechanical control devices are used to control the flow or movement of materials or any other parts present in the device. Actuators are used for controlling a mechanism which ultimately

controls a part of the device.

Sensors are the sensing devices which transmit a signal and receives the signal and accordingly used to accumulate the various environment information which is ultimately fed to microcontroller for deciding the working of machines.

Microcontroller is the brain of robot where program is written and sensors are connected as input and actuators as output. The controlling of the robot is governed by various algorithms like fuzzy controller, machine learning based practices and artificial neural network based algorithms. Depending upon the environment value received to the controller it eliminates the

error and transits from one state to another. Basically there are two types of controllers ,one is continuous controller and another is PID based controller .Continuous controller is more direct and less effective while PID controller is more advanced and varies according to the current state and gives efficient result.

2.OBJECTIVES:

- To develop a machine that helps in easy and quick cleaning.
- To reduce human efforts.
- To save the time.
- To reduce the cost.
- To beautify the floor.
- To remove grit and sand which scratch and wear down the surface.
- To remove allergens, in particular dust.
- To make the environment sanitary
- To prevent injuries due to tripping or slipping. Injuries due to slips and trips on level floors are a major cause of accidental injury or death. Bad practice in floor cleaning is itself a major cause of accidents.

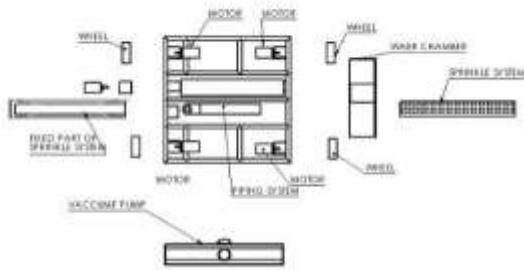# 3. CONSTRUCTION OF FLOOR CLEANING MACHINE

Fig-1: Name of the figure

As shown in fig no.: 1 The body of the robot has many small components. Like all robots it has sensors, microcontrollers and actuators and other components. It has 2 vacuum pumps connected in backside as well as front side of the robot. A 300 rpm DC motor is connected in the middle of the robot with the scrubber. A bearing is attached to the axle of the scrubber. 2 DC motors of 100 rpm are connected to the wheels. One microcontroller with 4 ultrasonic sensors is attached to it. This has 2 bread boards for circuit connection which ultimately can be replaced after welding.

4. DESIGN OF MACHINE

Paragraph The mechanical parts include the systems that if they work in proper sequence the floor will be cleaned. This is achieved by 4 processes. [1]

- Dry vacuum cleaning.
- Sprinkle of water or cleansing liquid on the surface.
- Scrubbing of surface by mops.
- Sucking of wet debris by roller dryer.

4.1. Dry vacuum pump

This is the process to clean the dust particles from the surface so that the load will be lessen for the purpose of other operation. If we remove this part there will be unnecessary load on scrubbing and wet sucking. This process is achieved by using a 12v DC vacuum pump. The inlet is divided into a number of holes so that dust all over the width can be sucked. The outlet is connected to a chamber that collects dry debris for disposal on a later case.[1]

4.2.Sprinkle of water or cleansing liquid on surface

Fig-2 :Sprinkling mechanism

Paragraph As shown in fig. :2 The challenge here is to spray liquid across the width of the machine with proper amount. The amount should vary according to the rotation or movement of the machine. While turning the spray should be less. This is achieved by using a motor in the water chamber. This motor controls the amount of water to be sprayed. The flow all over the width is achieved by a sprinkler mechanism.

4.3. Scrubber System

Fig- 3 :Scrubber system

As shown in fig:3 This is a mechanism to rub the floor repeatedly to clean all types of debris which may be oily or any sticky type. In this case one side of the scrubber is fixed to a motor via a hub which gives it a rotational motion leading to cleaning of surface. The other side of the scrubber is fixed to a ball bearing which gives support. [1]

4.4 Sucking of wet debris

This is the last step on this process. Here another vacuum pump is used to suck wet debris so that the floor will be dry. In this case also the vacuum is equally distributed over the width. The power of the pump is 12v dc. The face of the pipe is towards the front to increase efficiency of suction.

5. NAVIGATION SYSTEM

Navigation system of the robot is basically dependent on the sensors and microcontroller and algorithm fed to it. Basically the data acquisition system (here sensor) first collects the data from the environment and feeds to microcontroller .[2][4]The microcontroller uses 2 algorithms.

- Spiral motion algorithm
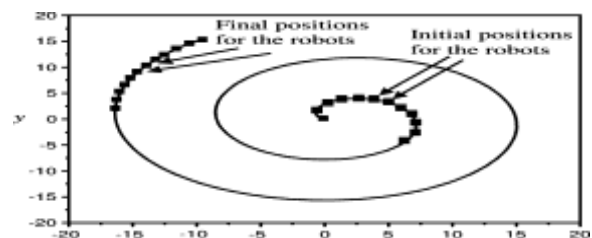- Random Straight path

5.1.Spiral path

Fig-4: Spiral motion

As shown in fig.:4 Basically after sensing the obstacle distance from outside environment, if the robot has sufficient space on its 4 sides it will move in spiral path at first half of its running.

The spiral path can be anti-clockwise and clockwise .The spiral path can be generated by the decreasing ratio of left motor encoder and right motor encoder [1]
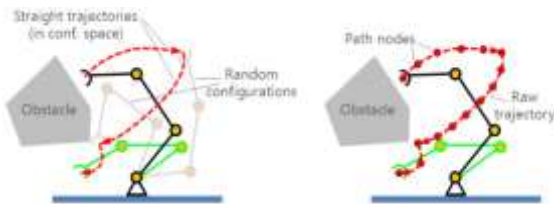
5.2. Random path

Fig-5: Random straight path

As shown in fig.:5 Basically random straight path searches from one node to another by the help of natural heuristic search. After the spiral motion the robot if detects a collision then it follows the edge of the wall until it gets enough free space for spiral motion again. After some moment if it doesn't get any specific clear area for spiral motion then it will move in random path for some time and the obstacle detection and avoidance system will be carried out by the help of ultrasonic sensors . After that robots stop rotating if the timer is over. In this process we can divide a particular area in the floor as grids and move accordingly so that it will have very confine control over the robot. So it will have grid based search over the floor for movement . Finally we implemented computer vision by the help of ultrasonic imaging and analyzing the image for the dust particles by the help of supervised learning and clustering the data . We have implemented here A search algorithm for motion planning . The breadth first search implemented here is very effective and provides efficient result for moving .[2]

6. CAUTOMATION & CONTROL OF MOBILE ROBOT

6.1 Automation
We have to automate the robot so that it will roam freely on the floor avoiding all the obstacles. We have to also provide a microcontroller in which we have to feed the code so that it will work as a brain of the robot. Also we have to give a proper power source and proper motor for regulating the sprinkling of the robot and motor driver for controlling the direction and speed of motor connected to wheel.

6.2 Sensor
This is an ultrasonic sensor of 40 kHz frequency specification. It requires power supply of 5 volt with working current specification as 15 mA .It detects around 13ft of distance. It triggers the pulses in the interval of 10 us. It has 4 terminals namely Vcc, trig, echo and GND pin .   Vcc = 5v Trig pin =connected to Arduino board PWM pin   Echo pin = connected to Arduino GND = negative terminal
Through trig pin we set the pulses and emit it to the environment and after emitting square waves the signals are received from the echo pin of this sensor module which ultimately fed to the Arduino board.

6.3 Ardino board

For this experiment purpose we are using Arduino due board. Arduino due board requires at 3.3. Volt. If we give more than 3.3, i.e. 5 volt to i/o pins it will damage the board. It is 32-bit ARM Core. CPU clock rate of this board is 84 MHz. It has SRAM of 92Kb and flash memory of 512 Kb. The microcontroller version of this board is AT91SAM3X8E. It has 54 digital I/O pins from which 12 has PWM output. It has 12 analog output pins from which 2 DAC present. We can give power to it either from the USB or through power jack from batteries. Pin 2 – 13 are 8 bit PWM output. Pins 0 and 1 are connected to the corresponding pins of the ATmega16U2 USB-to-TTL Serial chip.2 DAC pins provide analog outputs of 12 bit resolution through analogWrite() function. Reset button on the board is provided for resting the microcontroller board. There are 2 USB ports.one is native USB port and other one is programming USB port. We feed the program written in Arduino IDE to Arduino board through programming usb port through USB cable. The program written in Arduino IDE consists of two functions basically .One is loop() and other one is setup().

6.4 Motor Drive(L293D)

Fig-7: Motor drive (L293D)

As shown fig.:7 For this experiment purpose we used L293D motor driver. The schema of L293D is as following.
It is 16 pin structure based IC.This L293D motor driver IC has 4 input pins and 4 output pins and 2 enable pins and motor power supply of 7 volt.
- Vcc = 5 volt
- Vss = 7 volt

By this IC we can control 2 dc motors .This can provide maximum current of 600mA.Vcc can be extended upto 36 volt and beyond that it will hamper the board.

6.4 Ultrasonic sensor from transducer pairs

Fig--8 : Construction of ultrasonic sensor

As shown in fig.:8Ultrasonic range finder is a circuit for measuring distance by the help of ultrasonic sound. First the ultrasonic bust is transmitted from the transmitter and then

receiver receives the ultrasonic burst. The ultrasonic sound velocity is known in the medium as

- $c = 331,3 \ (m/s) * (1+T/273)1/2$
- $Di = 0.5 * C * (Tinitial-Tfinal)$

Where:

   Di   = Distance to Object
   C   = Speed of Sound
 T –initial = Time at which sonic wave is
               transmitted
 T -final = Time at which sonic wave is
          Received

Actually the speed of sonic wave varies with respect to temperature of medium. Overall attenuation in air depends upon: geometric spreading, molecular relaxation, boundaries, and refraction by non-homogeneous atmosphere, and diffraction by turbulence, conduction and shear viscosity losses. Attenuation also varies with respect to distance travelled by the sonic wave. In this experiment we are using two transducers of 40 kHz. Transducer is a device which converts one form of energy to electrical energy and electrical energy to another form of energy. It carries a piezoelectric material which does these energy conversion

7. ADAVANTAGES:

- It gives accurate results and eliminates possibility of manual error.
- It is very first and efficient and the control system used in industries are 100 times efficient than human work.
- In some part of the work areas it lessens the human efforts. Washing machine comes under this category.

8. DISADVANTAGES:

- After sometime we need to remove mop and change it by hands.
- For designing purpose if bed to ground distance is too short then it will not work there.
- Regular filing of water tank is needed.

9. COMMERCIAL POSSIBILITY

Paragraph Now in the automatic floor cleaner market iRobot and Scooba are playing major roles. They hold around 80% of the market. Their costs are around 25000 to 35000.Also the algorithms used by them are not most effective. They are using algorithms which approximately provides 70% accuracy. They are not using any image processing algorithms to run their robot. But the robot designed by us is cost efficient which will cost around 7500 .Also we can use camera lens for small dust particle detection, so that it will give more efficient decision in governing the motion of the particle which ultimately save considerable amount of power and reduce the timing with better efficiency and sensitivity. This will act like a pheromone like in ant algorithm..
In ant algorithm when pheromone density of ants in particular direction is denser all other ants follow that direction. Similarly when the robot will find the particular dust size on floor on one side of it and there are less on other 3 sides, it will

head towards dusty area if obstacle is not present. Time redundancy and power saving with low cost provides the best opportunity for marketing this consumer product.

10. CONCLUSION

The Product developed is definitely a very important product in robotics and floor cleaning area .The robots developed uses 2 vacuum pump which ultimately provides lots of vibration and power loss in the system. Also the algorithm implemented is not very effective. So there is definitely current scope for improvement and optimization till the most effective product is being developed. After optimizing the algorithm and taking it to the heuristic based search like bee algorithm it will be a great product and can revolutionize this industry. Definitely it has very huge potential. Also we can use 1 vacuum pump instead two so that it will be cost effective and very energy saving product with less vibration and much control over the robot. The robot having 33*30*8 cm in dimension is very compact in nature and can go beneath any furniture and bed. This is also very handy in portability. The scrubber of the robot now consists of small plastic fibers .But it can be further improved so that the surface area of the scrubber will come 90% in contact with the floor.

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