Smart Vacuum Cleaner Robot using Wireless Sensor Networks

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Abstract— Cleaning is the most Important thing in our world. The Robot Vacuum Cleaner is suitable for cleaning of different flooring (Bottle, tile, laminate, wood, short hair carpet) and it is able to clean up dirt almost as any conventional vacuum cleaner. It is a device that automatically (without your help) cleans the floor. Robot vacuum cleaner is small and compact. Robot Vacuum Cleaner is equipped with rotating brushes to lift dirt from the floor, one side brush for sweeping corners and a small vacuum cleaning unit. This device has an infrared sensor that secures its movement and orientation in a room–allows distinguishing the stairs or hollows. This Robot is to be Control by the Mobile Phone Using DTMF Module. And its having the display Segment for the purpose of message confirmation.

Key words: Cleaning, Control Unit, Display Unit, Mobile Phone, Sensing Devices, DTMF

I. INTRODUCTION

We decided to design and build a robot capable of vacuum to the floor of a room or area, without any human interaction, other than just starting the unit. We realized the need for a cheap and convenient product that can be easily used to vacuum a room on its own, saving a person valuable time. The robot is programmed to sense the direction of a collision with an obstacle using an onboard accelerometer. If the robotic vacuum hits an object head-on, it backs up and changes direction. If an obstacle is hit at an off-angle, the robotic vacuum turns away from the direction of the impact. The robotic vacuum's movement is based upon a random walk around a room, which theoretically will cover the entire area of a room given enough time. The robot is programmed to drive straight until an obstacle is hit. At that point, it will turn and continue driving straight until another obstacle is hit. And then the counting of the large amount of particle is display on the Seven Segment. The detecting or sensing of the particle information is to be shown in the LCD display screen.

II. METHODOLOGIES

The Vacuum cleaning is the Sensing module of the Ultrasonic Sensor, the ray theory of the ultrasonic ray producing the obstacle and its detecting the edge, center, corner of the Obstacle.

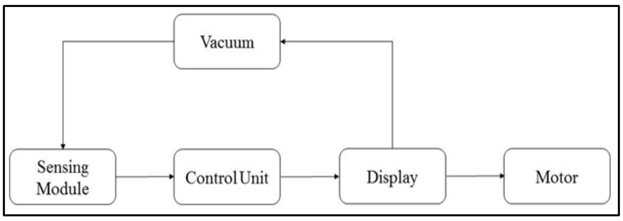

Fig. 1: Vacuum Cleaning

III. MODULE DESCRIPTION

A. Sensing Module

It is to sense the obstacle on a particular path of direction through which the robot moves. Here we use IR sensor with ultrasonic radiation to find out the obstacles simultaneously in all directions. Obstacle detection can be classified into two types:

- Ranged-based obstacle detection.
- Appearance-based obstacle detection.

We can calculate the distance of the obstacle.

$$\text{Distance} = \text{speed x time} \quad (1)$$

1) Object Size Measurements

The horizontal and vertical distance of the rays can see is constant at a particular distance. The angle of vision is known, then we can find the area if we know the distance.

$$\boxed{h = 2x\tan\left(\frac{\theta}{2}\right)} \quad (2)$$

x = distance between camera and object.
h = horizontal viewing length on a 2D plane perpendicular to x.
Θ = horizontal field of view

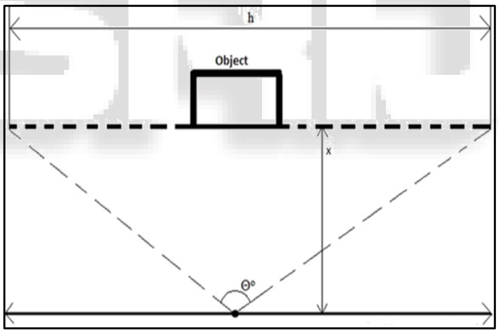

Fig. 2: Field of View

For vertical measurements, we use the same procedure with different values; the angle of vision becomes (alpha, α). The equation for vertical distance is:

$$\boxed{v = 2x\tan\left(\frac{\alpha}{2}\right)} \quad (3)$$

The similarity of the equation becomes as,

$$\boxed{\frac{s}{n} = \frac{t}{v}} \quad (4)$$

Where s is the vertical height of the object image in terms of pixel and t is the vertical length of the object in real life.

B. Control Unit

A control unit (CU) handles all processor control signals. It directs all input and output flow, fetches code for instructions from micro programs and directs other units and models by providing control and timing signals. A CU component is considered the processor brain because it issues orders to just about everything and ensures correct instruction execution.

C. Display Device

It is an output device for presentation of information in visual or tactile form (the latter used for example in tactile electronic displays for blind people). When the input information is supplied as an electrical signal, the display is called an electronic display. Here we use LCD and the seven segment display device.

D. Vacuum Tubes

The simplest vacuum tube, the diode, contains only a heater, a heated electron-emitting cathode (the filament itself acts as the cathode in some diodes), and a plate (anode). Current can only flow in one direction through the device between the two electrodes, as electrons emitted by the cathode travel through the tube and are collected by the anode. Adding one or more control grids within the tube allows the current between the cathode and a node to be controlled by the voltage on the grid or grids. Tubes with grids can be used for many purposes, including amplification, rectification, switching, oscillation, and display.

E. Motor

The motor we use here is stepper motor. A stepper motor is an electromechanical device which converts electrical pulses into discrete mechanical movements. The shaft or spindle of a stepper motor rotates in discrete step increments when electrical command pulses are applied to it in the proper sequence.

F. Proposed System

We propose a sensor fusion technique which is less costly both in terms of economically and computationally, that will allow an autonomous robot to detect an obstacle, find the distance and also measure the size of the obstacle. The ultrasonic sensor will always release ultrasonic wave. If the wave collides with an obstacle in front of the robot, the wave will bounce back to the sensor. The ultrasonic sensor detects objects by emitting a short ultrasonic burst and then "listening" for the echo. Under control of a host microcontroller (trigger pulse), the sensor emits a short 40 kHz (ultrasonic) burst.

1) Hardware Implementation of Smart Vacuum Cleaner Robot

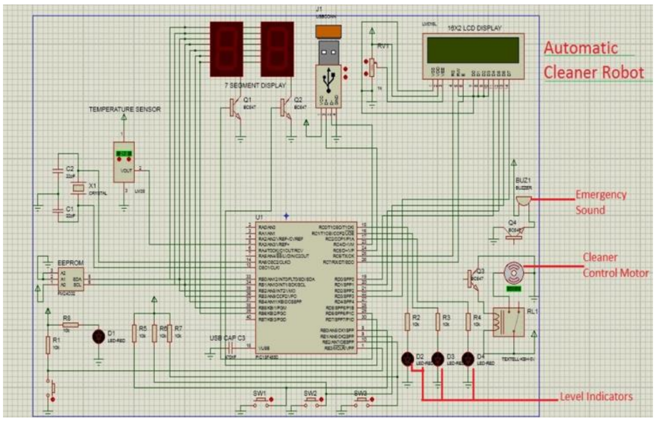

Fig. 3: Hardware Implementation of Smart Vacuum Cleaner Robot

IV. ADVANTAGES

A robotic vacuum cleaner is a disk-shaped, small but powerful automatic vacuum cleaner fitted with sensors. It can be programmed to vacuum clean your floors and rugs when you are busy doing something else.

A. Saves Time

In such a scenario, cleaning becomes a time-consuming and exhausting task, especially in larger homes. A robotic vacuum cleaner does all the work by itself and requires no supervision. By investing in one of these machines, you can save yourself a lot of time and effort.

B. Ideal for People with Mobility Issues

People with disabilities or mobility issues can look at robotic vacuum cleaners as an alternative to expensive housekeeping services. The machine can be set to clean as often as required, while requiring minimal maintenance.

C. Advanced Features

Higher end models of robotic vacuum cleaners allow you to achieve a better clean. Some features include large dust bags that will last for multiple cleaning sessions, advanced sensors that can detect changes in surface and the ability to transition between bare floor and carpets.

D. Includes Options for Automatic Recharging

Once the robotic vacuum cleaner completes it task, it will go back to its docking station. If it is running low on battery, it can automatically recharge itself as well.

E. Able to Go under Furniture and Around Corners

The small, disk shape of the robotic vacuum cleaner gives it great maneuverability and flexibility. It can reach all the corners and undersides of furniture that a normal vacuum cleaner cannot reach.

V. RESULT

Our system receives the information about how far the object is, object width, object, and object height. It's easy to remove or replace the dust particles and large amount of wasted Particles. In each second the system receives six sets of reading about the object. We ran the program for 50 seconds for each experiment. We used objects of different dimensions for each experiment. We got 290 reading about the distance and size of the object. There were some rough values, which were outliers and we ignored them for better accuracy.

VI. CONCLUSION AND FUTURE WORK

The future prospect of the project includes improving the accuracy of the system. We will use more efficient processing techniques and algorithms to reduce the computational complexity and to detect and measure the size of an object more accurately. Different algorithms will allow us to work on different domain, so we would be able detect, identify and track objects better.

We can introduce machine learning, so that the robot can learn by itself and navigate around without colliding with obstacles. The robot will learn to identify obstacles and objects.

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