Autonomous Cleaning Robot

Ashish chaple Sujata Bhaskarwar Ashay Bhaskarwar Sadhana Chidarwar

ABSTRACT
Autonomous Cleaning Robot will perform task like sweeping, vacuum cleaning, scrubbing in a single pass. All mechanisms will work simultaneously.Autonomous floor cleaning robot consist of two DC motor operated wheels, a castor wheel, flat brushes, roller brushes, miniature vacuum pump, water level indicator, miniature centrifugal pump, water sprayer, cleaning mop, water tubes and garbage container. In ACR circuit, sensors are used for obstacle detection which is used in path planning and navigation. Real Time Clock (RTC) is used to set ON/OFF time for cleaningand is displayed on Graphical LCD. A 14.4V rechargeable battery is used as power supply. Battery level indicator is used to detect the level of the battery.

Keywords
IR TSOP sensors, DC motors, Brushes, Microcontroller , RTC

1. INTRODUCTION AND MOTIVATION
Robotics research has been around from long ago. However robots as a home appliance emerged recently and as the people needs grew, which has resulted in the growth of the market. Home appliance robotics research is becoming active more than ever.

As people want to get way from tedious everyday cleaning job, this Autonomous Cleaning Robot named ACR will be of immense use. There are several big bulky cleaning machines in the market for industrial use. But they are not autonomously operated and also they only do a specific function of cleaning. We set a goal to come out with a system which navigates while avoiding obstacles, walls and finds its way. Also the robot will haveall the functions of floor cleaning like sweeping, vacuum cleaning, scrubbing with detergent solution and soaking. This is the unique property of our robot. At the same time, the size should be compact enough for the use in household and small offices. It will clean entire area most efficiently and quickly. The robot auto-starts at the time set by the user and stops when the entire cleaning of entire area is done.

1.1 Overview:
We are It's a complete autonomous robot, does work by itself; IR sensors are used to avoid obstacles. This robot will do sweeping, vacuum cleaning, scrubbing in single pass of robot. All mechanisms are working simultaneously. We have used raster scanning for path planning algorithm of the robot. GLCD and buttons are used for the user interfacing.

1.2 General Specifications :-
- Battery operated floor cleaning robot for indoor use.
- Microcontroller is the main control unit.
- Sweeping, vacuum cleaning, scrubbing mechanisms.
- Autonomous movement with obstacle avoidance.
- Simultaneous working of all mechanism.
- Battery level indicator.
- Real time clock to set on/off time for cleaning a room.
- Water pump is used for constant and continues water flow
- Cliff sensors are used to avoid fall from steps.
- Dustbin for the collection of garbage.

1.3 Technical Specifications :-
- Drive: All 6 DC motors work on 12V.
- NiMH battery 5 A/hr. 14.4 volts
- Cleaning width: 300mm
- Speed of robot: 15 cm/sec
- Weight of robot: 6 kg
- Dimensions [L*B*H]: 350*300*100mm
- 128x64 GLCD to display time required for cleaning.
- Switches for user interface to start/stop and select mode mechanisms

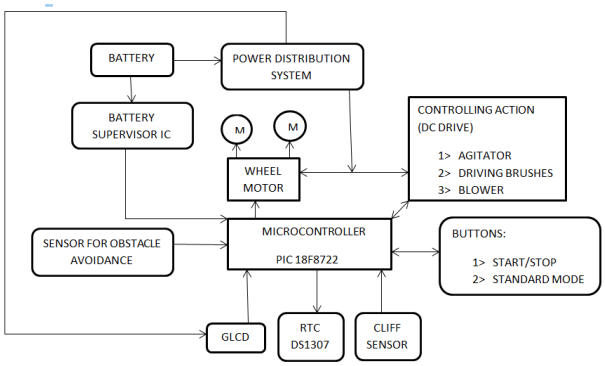


Fig 1: ACR Block Diagram

2. EXPLANATION OF BLOCK DIAGRAM :
In ACR circuit, we have used microcontroller PIC18F8722. IR TSOP sensors are used for avoiding obstacles and using this data for path planning and navigation. Cliff sensors are used to avoid fall from steps. Rechargeable battery is used as the power supply of the entire bot. Battery supervisor gives the exact level of the charge of the battery.

Power distribution circuit distributes required volts to all the components of the robot. Real Time Clock (RTC) is used to display the time, and to set ON/OFF time of the robot.

GLCD is used for user interface, it displays real time, time to start the robot and a welcome screen. In addition it also

displays modes of operation. Touch panel is mounted over it, making the combination as touch screen. Selections of the options are made more users friendly. This has reduced number of buttons to be used.

Side brushes are mounted on the front corners of the robot, brushes are rotated by DC motors. Two Agitator brushes are mounted slightly touching each other rotating in opposite direction by DC motors. Blower/vacuum pump sucks dirt into the dustbin.

Two Buttons are provided as user interface 1st to ON/OFF the robot and 2nd to run in standard mode.

3. PLACEMENT OF SENSORS

The pattern in which the sensors are placed:

- front sensors
- side sensors
- 2 cliff sensor (below robot)
- 1 back sensor

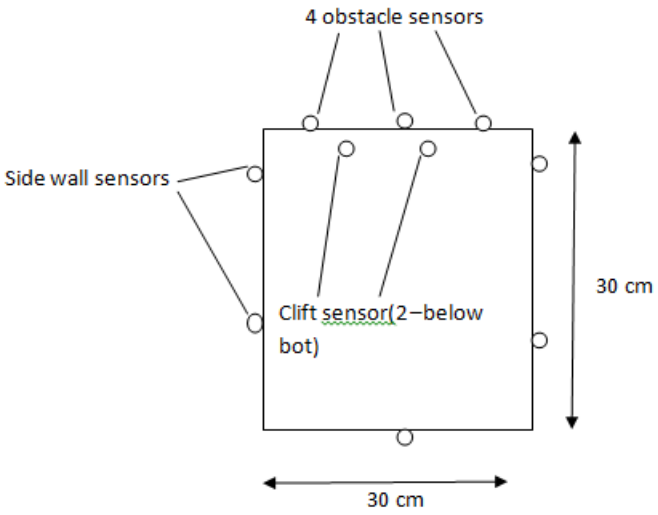


Fig 2: sensor placement

4. WORKING:

Microcontroller is the main control unit of the entire bot, program is coded into it. It controls switching ON/OFF of components. Microcontroller takes data from the sensors and gives response accordingly. Initially, robot is in a dormant state, start buttons is to be pressed for the starting all the cleaning mechanism and robot moves forward. As obstacles come in front of the robot, sensors detect the obstacles and give the data to the controller. Once this controller processes the data, it responds with right or left. The turning direction of the robot is according to the raster scanning algorithm used.

The two **Side brushes** which are mounted on the corner of robotrevolve at 250 rpm and bring the garbage in front of the agitator brush. Side brush is very useful in corner cleaning as the robot cannot reach to corners efficiently. The two agitator brushes rotate at 1000 rpm in the anti-clock wise direction, this motion results in picking up of any garbage on the way. This garbage is directed directly to the dustbin, where the garbage is collected. The space between Container and roller brush is bridged by a rubber ramp. The roller brush push debris up ramp where they gain upward momentum and thrown into container, the total assembly has a mounting frame to mount on robot. Motors are connected to a motor driver and then controlled by a controller.

Water pump keep the flow of water constant and continues, this keeps cleaning mop always wet. As the robot moves mop is dragged on the floor, resulting in intense cleaning of the floor. Appropriate amount of weight is kept on the mop for more efficient cleaning of the floor.

There are **two modes** of cleaning:

1st is standard mode

2nd is intense cleaning mode.

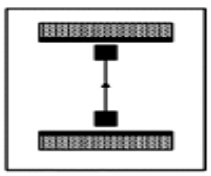
In standard mode of cleaning, a regular algorithm is followed with cover unit area only once. Robot will cover one particular area only once. In some case we may require cleaning more than once for such case the robot can be made run in intense cleaning mode. In this mode robot will clean a particular region more than once by repeating the pass more times. This repeating passes will effect in intense cleaning. User can select these modes on the touchscreen or can directly press the standard mode button.

Two wheel motors are used to drive wheels of the robot; the third wheel is the caster wheel in front. Optical encoder is used for the 90 degree turn of the robot to right or left. Optical encoder counts the number of pulses to reach 90 degree turn of the robot.

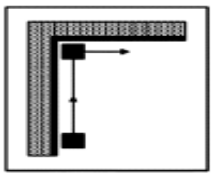
Touch panel have a facility of touch pad to set a time to start its cleaning.Using touch panels user can also select the mode of operations, shutdown time and also switch alarm ON/OFF.

In low power condition microcontroller turns off dc motors used for front brushes, agitator brushes and sensors, and low power indicator will turn ON.

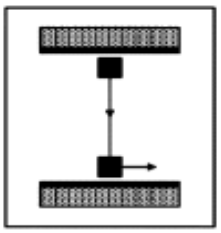
The Six Templates:-



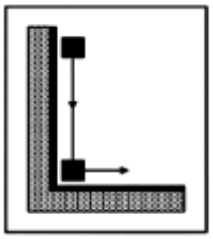
FN (Front Navigation)



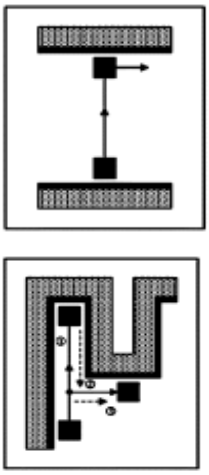
RT (Right Turn)



ELT (Empty Left Turn)



LT (Left Turn)



ERT (Empty Right Turn) BT (Back Trace)

Fig 3: Different Templates

5. SOFTWARE ASPECTS

The topological coverage algorithm is organized as a finite state machine with three states –boundary, normal and travel. The boundary statehandles the situation where the robot is on a cell boundary. The algorithm always starts in thisstate. This is because the coverage process begins from a corner of the environment, whichis a cell boundary of the initial cell. The first corner found will then become the initial cell boundary,when the robot completes exploring the cell boundary, execution of the topological coveragealgorithm switches to the travel state. The robot searches its topological map and moves to theselected uncovered cell. When it arrives at the selected cell, the algorithm enters the normalstate. This state controls the robot to follow a zigzag path to cover all the surface area in thecell.

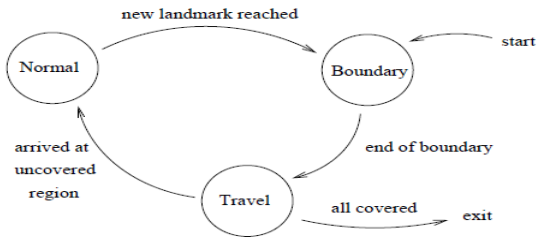


Fig 4: State Transition Diagram

As we are using a microcontroller we need to use the resources which are in microcontroller. For that we need to define the PIN to be used for the specific purpose.

For e.g. SCL and SCI for the I2c protocols, these PINs should dedicatedly be used for this purpose

5.1 Path Planning Algorithm:

- The proposed algorithm describes a complete coverage path planning forAutonomous robot in enclosed environment.
- A **topological** based approach is used to control the path execution.
- The algorithm is based on following three steps:

Step 1: Wall following navigation

At first, the robot performs the wall following obtaining the contour and size of the indoor environment.

Step 2: Travel State

When robot in travel state it assigns uncovered points. Travel state is also available when going from one sub region to another sub region.

Step 3: Normal State

This state occurs when side sensors are not working. In this robot moves in **Zigzag** pattern

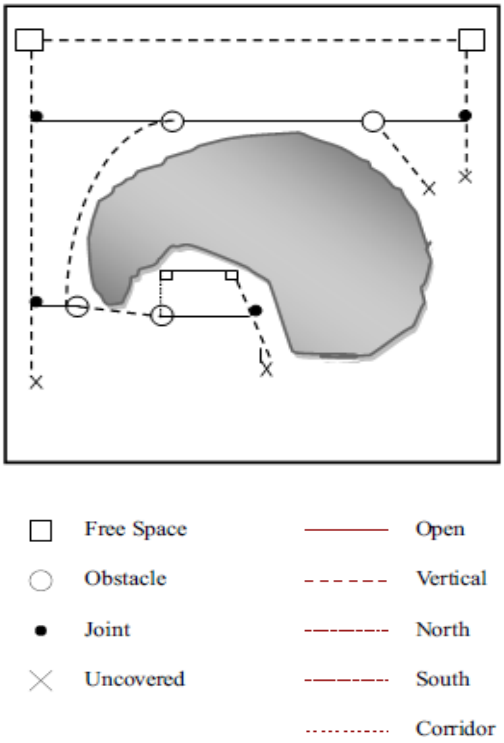


Fig 5: Mapping Through Topological

The five types of edges are open,vertical, north, south and corridor (See Fig 5). Open edges are horizontal edges that have no obstacles aboveor below them. Vertical edges are for the right and left boundaries of a cell. North and south arehorizontal edges that are immediately below or above an obstacle respectively. Corridor edgesare ones with obstacles on both sides.

6. CONCLUSION

In conclusion we would say that this robot is of great use to the society and it satisfies all the conditions of being of no harm. This robot will do all the desired features with good efficiency. The application of this robot is: café, house, college labs, offices, clinics etc.,the algorithm used is the most efficient and fast way of covering entire area. With the advancement in technology this will definitely prove to be of immense important. There is great future score in the robot and also in this type of application

7. REFERENCES

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