SEVAC

Smart and Efficient Vehicle for Automatic Cleaning

IEEE/IBM SMARTER PLANET CHALLENGE 2013

We developed a smart garbage detection and collecting vehicle which will automatically search for garbage and clean it in smarter way.

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1. Project Description:

a. Motivation:

The 21st century sees robotics in everyday use. The automotive industry is full of robots that complete tasks often too difficult for humans to accomplish. Many assembly lines and manufacturing companies are manned by robots instead of people. The reasons for using robots are almost endless for example, robots are ideal for jobs that require repetitive, precise movements. Human workers get bored doing the same thing over and over, which can lead to fatigue, injuries and costly mistakes.

The main motivation to undertake this initiative is that there is increase in population thus increases in garbage creation. We propose a system which can collect the garbage automatically. The garbage collection may be indoor or may be outdoor.

b. Problem :

India is currently overrun with waste. Garbage spills over from bins, lines the streets, seeps into the water system, promotes the thriving insect population and aids in the rampant spread of disease. Currently, the country's waste management is so poorly regulated that some areas are even permitted to dump their trash directly in the streets. If you see present day robots used in waste collection, they need human assistance and also need large power as the vehicle is running on for long time.

Fig.1 Garbage spills over from bins.

Fig.2 Roads filled with trash.

c. Solution:

If we design the vehicle which will detect the garbage on its own and collect it in its reservoir, when storage will be full it will empty its reservoir at proper place where all waste management is taking place. In the future by powering all the systems of vehicle problem of wastage of fuel and human power will be reduced, so that the human power will be beneficial in waste management system.

d. Project Goals:

We decided to design a vehicle that will detect the garbage automatically and collect it without any human. Our project focuses on designing robot vehicle, mechanisms, circuitry on which all motors will be actuated. With the use of this emerging technology will lead to Smart Clean City.

2. Project details

I. Project Description :

The 'SEVAC' system consists of three major categories-

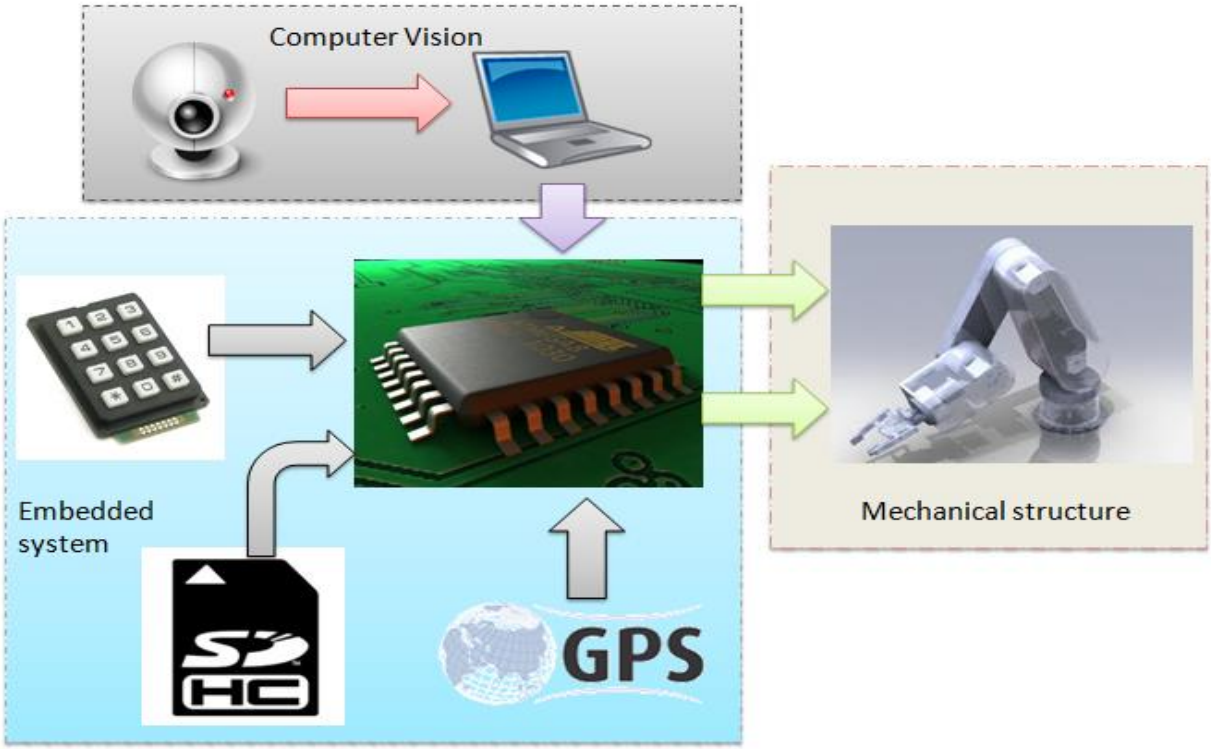

Fig 3: Block Diagram of SEVAC

1. Computer Vision
2. Embedded System
3. Mechanical Structure

Computer Vision Unit mainly comprises of a camera and a laptop. The camera records the vicinity and sends them to the laptop where image processing algorithms for garbage detection such as contour or texture may be running. When the garbage is detected it is mapped to x-y coordinates and is transmitted to the microcontroller in the embedded system unit using USB to serial communication.

Embedded System mainly comprises of a microcontroller, relay actuators for driving motors, LCD, GPS module, SD card and keypad. This whole system is powered by lead acid batteries. But it may also be powered by solar panel (if used in outdoor). The x-y coordinate received from laptop is processed by the controller and it actuates the locomotion motors and gripper motors. SD card is used to enter/save the local map using keypad. GPS module is used to send the location of the SEVAC to the monitoring system.

Mechanical Structure mainly comprise of a chassis for placing the laptop, electronics, batteries and the garbage. The gripper is to be designed so that it should have atleast 4 degrees of freedom to pick up garbage such as paper, bottles or cans.

Our project was tested indoors as well as outdoors for garbage detection algorithms which worked fine.

II. Innovation

We have developed a new algorithm for detection of efficient garbage detection. Well, the algorithm is simple. Firstly, the images of outside field are taken from camera. The primary idea is to use the RGB image to convert it to greyscale image. Then the ***histogram*** of converted image is taken. Histogram is the graph of number of pixels versus intensities. Then we sort the intensities in descending manner.

In the garbage containing image, there will be only a small portion of total image occupied by the garbage. From the sorted array of intensities the first three intensities are taken. From the chosen intensities, a mask matrix is made and then convolved it with greyscale image. The result of this convolution is that wherever the intensity of the pixel in the image matches with the mask, that pixel value will become zero. The outcome of this is the separated garbage image with lots of noise. So by introducing the noise filter, the noise from the image was removed. By joining the adjacent pixels of the detected garbage a rectangular box was created or plotted in order to show the detection of garbage. Then the total area of detected regions was calculated and the x-y coordinates of their centroid was taken. These coordinates were sent to embedded system for gripping mechanism actuation.

But we came across the situation where the region acquired by garbage is more than clean region where our algorithm was giving undesirable output. So we introduced ***contour algorithm*** in such cases the results were great.

Fig.4 Successful detection of garbage with noise removal

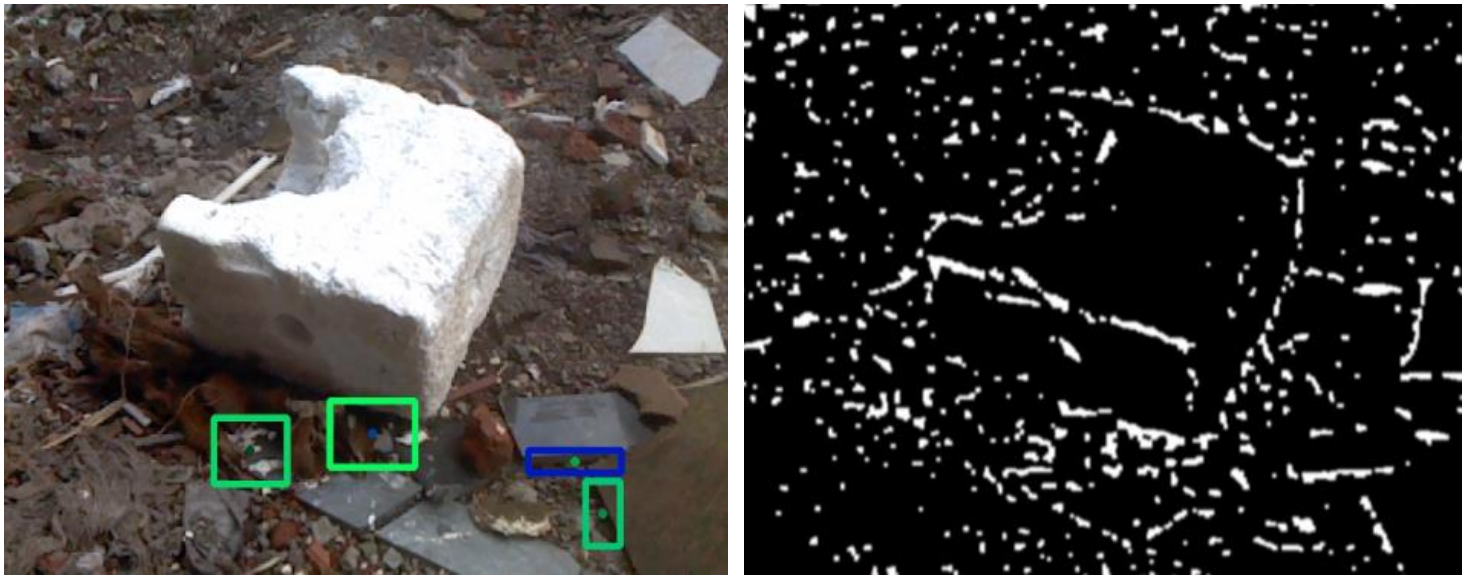

Fig.5 Even though the image was containing lots of noises the garbage was successfully detected

3. Project implementation details

The project mainly needs to have four sub-divisions.
(i)***Mechanical Structure*** – Vehicle and gripper
(ii) ***Electronics hardware*** – Microcontroller PCB, SD Card PCB, LCD and Keypad, Relay PCB for driving motors.
(iii) ***Embedded part*** – Interfacing of all the modules and PCB with laptop and microcontroller
(iv) ***Computer Vision part*** - garbage detection using Image processing algorithms like contour and histogram separation algorithm.
The implementation details for each of these four requirements are described in the following table :

Tasks	Activity	Require Material	time (hrs)	Major Skills
Mechanical Structure	1.To build a vehicle strong and stable chassis with adequate space for keeping the circuit and laptop and put garbage, with a proper locomotion motor mounting 2. To build a gripper which has about 4 degrees of freedom	Aluminium, Motors, Clamp, Bin, Wooden sheet	70	Bot Design and manufacturing
Electronics Hardware	Designing of PCBs of microcontroller and SD card interfacing circuit and Relay circuit for motor driving	Electronics components like relay, resistors, diodes, capacitors, transistors, SD Card holder, microcontroller, etc	40	Knowledge on basic electronics components, microcontroller and PCB designing rules
Computer Vision	Detect garbage using image processing techniques like contour or texture and then transmit the coordinates to the controller	Laptop with OpenCV and Camera(WebCam)	120	Open CV, basics and image processing techniques implementation, basics of C++
Embedded System	Interface with all the modules and laptop then make the controller take decision where to go for garbage collection	GPS module, Microcontroller PCB, LCD module, Keypad, SD Card PCB, USB to Serial Interface module,	120	Microcontroller IDE like AVR studio or Keil uVision. Knowledge on microcontroller, GPS module.

The total estimated development time is around 350 hours, which can be finished within one semester.

4. Team details

Team members – We have a five-person team all from Vishwakarma Institute of Technology. Details are as follows.

Name	Tel	Email	Major	Year
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Lead proposer: ***Akshay Ghadage***

5. Project Audience

The target student audience of the project is senior undergraduate and graduate students. Different parts of the project address the students who have background in image processing, machine learning, optimisation techniques and electrical circuits designing. After the testing of the vehicle it can be used daily life in cleaning the city by storing the map in its system, so Government Civil Department is also an audience of this project.

6. Citations:

[1] T. Randen and J. H. Husøy, "Filtering for texture classification: a comparative study," IEEE Trans. Pattern Anal. Machine Intell., vol. 21, no. 4, pp. 291-310, Apr. 1999.

[2] T. Thaiupathump and S. A. Kassam: "Square Contour Algorithm: A New Algorithm for Blind Equalization & Carrier Phase Recovery" Proc. IEEE Asilomar Conference on Signals, Systems and Computers, 2003. pp. 647-651.

[3] Rafael C.Gonzalez, Richard E.Woods, (2003) "Digital Image Processing" Pearson Education Pvt. Ltd, Second Edition, Delhi.

[4] K. S. Sim, C. P. Tso, and Y. Y. Tan, "Recursive sub image histogram equalization applied to gray scale images", Pattern Recognition Letters, Vol. 28, No. 10, pp. 1209-1221, 2007.

[5] Songtao Liu, Hongguan Chan, Shaoging Yang, "An effective filtering algorithm for salt-peper noises based on cellular automata", IEEE congress on image and signal processing,2008.

7. Endorsements

"This project is highly imaginative view of the ways robotics may change both our technology and our view of us. This project will bring new way of becoming part of our development. In future definitely this project will be part of human society that the immense power contained in it will help to make world develop in smarter way"

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