Autonomous Floor Cleaning Robot (Navigation)

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***Abstract*: The project aims to build vision based autonomous robot prototype using Raspberry Pi as a processing chip. An HD camera along with middleware communication is used to provide necessary data from the real world to the robot. The robo is capable of reaching the trained destination safely and intelligently thus avoiding the risk of human errors. Many existing algorithms like Edge detection, obstacle detection are combined together to provide the necessary control to the robot. Robot can follow the path stored in log file and save client's time by working autonomously. The robot can also be used to clean a specific area of a room by controlling it from laptop with a Graphical User Interface (GUI) in Visual Studio (Python language) via wi-fi connectivity. Electronic circuitry (including motor controllers, vacuum cleaner controller, and brushing motor controller.**

***Keywords*: Detection, motor, raspberry pi, motor driver, camera, batteries, mic & innovations**

I. INTRODUCTION

Robots are a package of systems which include mechanical, electrical, computing and automation fields of technology which can be used to perform various tasks in industrial and domestic use. And with increasing developments in this field robots can now be controlled with lesser direct human intervention to achieve a more natural interaction with machines. A way to accomplish such is to control a robot via voice commands. This allows the user to free up their hands and work on other tasks. Some basic applications of robots utilizing voice recognition are to support people with disability, executing preset commands etc. In daily life such robots can be used for navigation and for control guidance to a certain position for cleanliness. The robot can either maintain preset linear speed or can be have variable speed on flat surfaces. The voice recognition is maintained with help of a micro controller; a Raspberry pi. Five basic commands are used to steer the robot that are forward, right, left, backward and stop to guide the robot. Building on these, a few more commands allow the robot to change speed or perform a particular movement.
Based on the input of the object present the client navigates the robot in the surrounding, these movements are stored in log file. Further if there is a need to move the robot in the same path as before in the same area, the robot can follow the path stored in log file and save client's time by working autonomously.

A camera can be mounted in the front of vehicle to take real time images; and a fast processor can be use to automatically detect lanes according to image processing algorithms. This paper is based on algorithm development using canny edge detector and Houge transform. The algorithm is implemented on OpenCV and Python. The Raspberry Pi is used for real time processing of image. The new idea of this method is to use natural road edge, as well as the yellow strip for road information acquisition. In the algorithm we use both pixel feature and the frame feature to identify the road edge which is referred to as the whole road module.

II. HISTORY AND EVOLUTION

Edge detection is a type of image segmentation techniques which determines the presence of an edge or line in an image and outlines them in an appropriate way. The main purpose of edge detection is to simplify the image data in order to minimize the amount of data to be processed. Generally, an edge is defined as the boundary pixels that connect two separate regions with changing image amplitude attributes such as different constant luminance and tristimulus values in an image Robots are a package of systems which include mechanical, electrical, computing and automation fields of technology which can be used to perform various tasks in industrial and domestic use. And with increasing developments in this field robots can now be controlled with lesser direct human intervention to achieve a more natural interaction with machines.

III. ROBOT SYSTEM

The traditional Canny edge detection method is widely used in gray image processing. However, this traditional algorithm is unable to deal with color images and the parameters in the algorithm are difficult to be determined adaptively. In this paper, an improved Canny algorithm is proposed to detect edges in color image. Lane detection through image processing is one of the major tasks. A camera can be mounted in the front of vehicle to take real time images; and a fast processor can be use to automatically detect lanes according to image processing algorithms. This paper is based on algorithm development using canny edge detector and Houge transform. The algorithm is implemented on OpenCV and Python. The Raspberry Pi is used for real time processing of image. The new idea of this method is to use natural road edge, as well as the yellow strip for road information acquisition. In the algorithm we use both pixel feature and the frame feature to identify the road edge which is referred to as the whole road module. By accessing Log File based on the input of the object present the client navigates the robot in the surrounding, these movements are stored in log file. Further if there is a need to move the robot in the same path as before in the same area, the robot can follow the path stored in log file and save client's time by working autonomously.

Natural Language Processing is implemented by means of which robot is controlled using human language. Initially the robot was trained offline using Snowboy Hotward Detection. This module was time consuming and gave no reliable outputs. Keeping this limitation in mind, Online google engine was used to detect human voice.

IV. ALGORITHM
V.

i. CANNY EDGE DETECTOR

In 1986 John F. Canny has developed an algorithm to find edges in an image called Canny edge detector [21, 22]. The Canny edge detector is a very popular edge detection operator. It uses multi-stage algorithm to detect various range of edges in images. The stages used by algorithm are as follows:

ii. NOISE REDUCTION

Since edge detection is susceptible to noise in the image, first step is to remove the noise in the image with a 5x5 Gaussian filter.

iii. FINDING INTENSITY GRADIANT

Smoothened image is then filtered with a Sobel kernel in both horizontal and vertical direction to get first derivative in horizontal direction (Gx) and vertical direction (Gy). From these two images, we can find edge gradient and direction for each pixel as follows: Gradient direction is always perpendicular to edges. It is rounded to one of four angles representing vertical, horizontal and two diagonal directions.

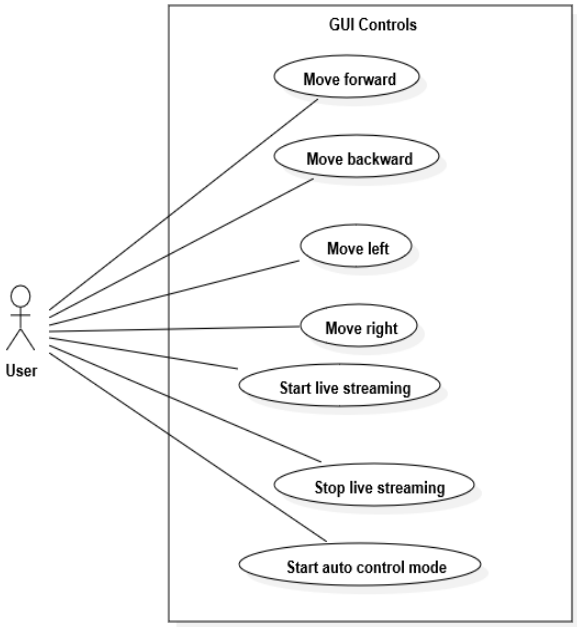
iv. 4. HYSTERYSIS THRESHOLDING

v. This stage decides which are all edges are really edges and which are not. For this, we need two threshold values, minVal and maxVal. Any edges with intensity gradient more than maxVal are sure to be edges and those below minVal are sure to be non-edges, so discarded. Those who lie between these two thresholds are classified edges or non-edges based on their connectivity. If they are connected to "sure-edge" pixels, they are considered to be part of edges. Otherwise, they are also discarded.

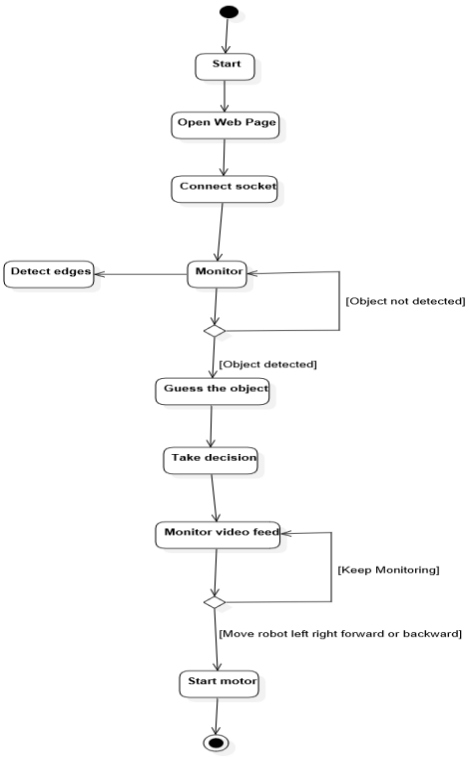
vi. HAUGH TRANSFORM

Hough transform is a very useful tool to identify lines and shape of an object. Edge detectors like canny edge detector or Sobel edge detector defines edges of an object. Hough transform is used to fill pixels between edges to produce shape of object.

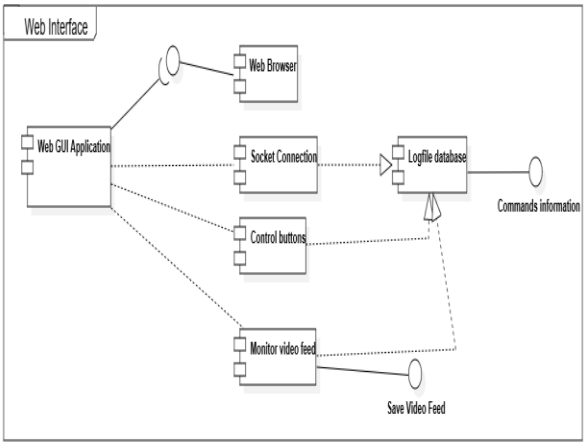
Usecase Diagram



Activity Diagram



Block Diagram



VI. IMPLIMENTATION

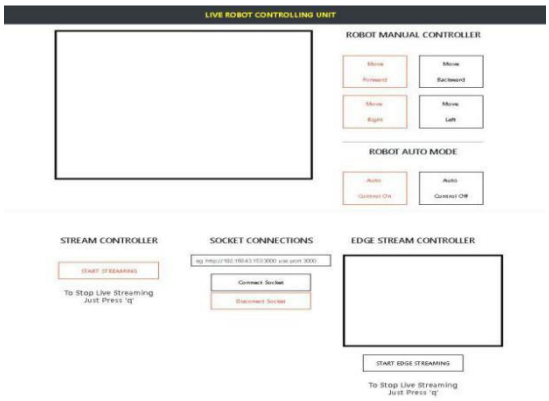


Fig 1.2

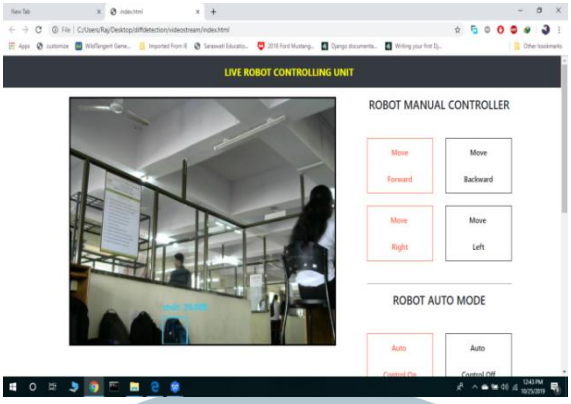


Fig 1.3

i. The Server runs on the Raspberry pi and Client Side runs on the desktop.
ii. The communication is established by using socket.io and http modules of nodejs.
iii. A network is connected on which both the devices run and hence the IP address is used for communication.
iv. In live streaming the frames captured are converted into text. They are then further sent to network on the Client Side.
v. On the Client Side the text is decoded and presented in an Image Format.
vi.

VII. DESCRIPTION OF IMPORTANT COMPONENTS & RESULTS

a. Raspberry Pi 3 - is a development board in PI series. It can be considered as a single board computer that works on LINUX operating system. The board not only has tons of features it also has terrific processing speed making it suitable for advanced applications. PI board is specifically designed for hobbyist and engineers who are interested in LINUX systems and IOT (Internet of Things).

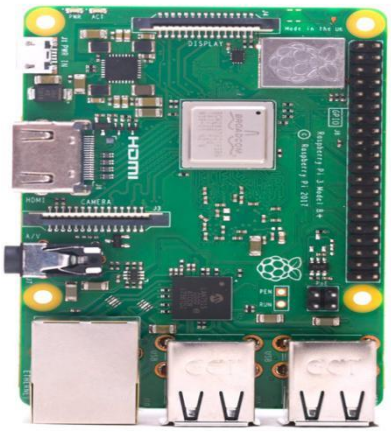


fig.1.3

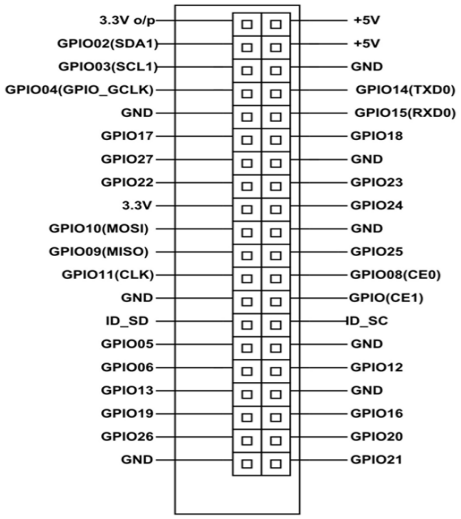


Fig 1.4

b. L293D Motor Driver - There are 4 input pins for l293d, pin 2,7 on the left and pin 15 ,10 on the right as shown on the pin diagram. Left input pins will regulate the rotation of motor connected across left side and right input for motor on the right

hand side. The motors are rotated on the basis of the inputs provided across the input pins as LOGIC 0 or LOGIC 1. For rotating the motor in clockwise direction the input pins has to be provided with Logic 1 and Logic 0.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. Similarly, when the enable input is low, that driver is disabled, and their outputs are off and in the high-impedance state.

Fig 1.5

c. DC geared motor: DC geared motors have gear box pre-attached to them which is used in a variety of robotic applications. They have drill holes in middle of the shaft measuring approximately 3mm, making it very simple to connect it to wheels or any other assembly.

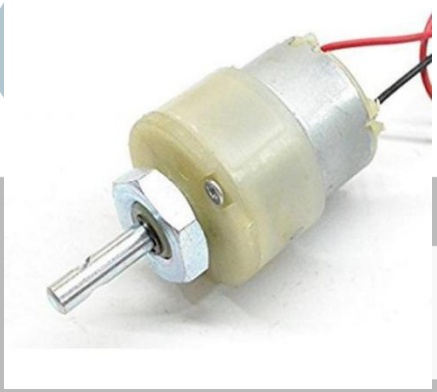


Fig 1.6

d. Camera - Expand your video chatting experience with this Logitech C310 HD Webcam. It allows you to video conference, make Skype calls, video chat, capture yourself, upload these images on social media websites and do more with its 5 MP Lens that gives impressive HD image quality. Fix this aesthetic C310 Webcam with its Universal Clip on your PC and enjoy video chats with friends and family. It is compatible with 1 GHz processor, 32/64-bit Windows 7/Windows Vista/Windows 8, at least 512 MB RAM and 200 MB hard disk. For connectivity, the preferred option is USB 2.0 though USB 1.1 port serves.

Fig 1.7

CONCLUSION

The proposed robot is designed with the motive of helping the people to clean homes daily. This helps preventing them from getting affected by serious diseases. It is high time that this robot should be implemented to clean all over the world. Moreover, this robot will help people to clean their household/workplace daily. This will not lead to unemployment of sewage workers but will just make the job easier and healthier for them. When this robot would be implemented in real time, it will save thousands of poor people's lives who come forward to clean the drainage just to earn few bucks a day. In this modern society, a human cleaning the sewage waste shows that very less attention has been given to those people's lives due to their poverty. Hence, this robot helps to have a clean and hygienic drain systems everywhere.

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6. Smart Floor Cleaning Robot (CLEAR)
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