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Real Time Traffic Signs and Obstacle Detection in Self-Driving Car

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Abstract: ***The motivation behind this research work is to improve car safety and efficiency.The concept of self driving cars is heard from years, it has not come into usage in many countries because of the lack of complete intelligence in the vehicle. Some of the modern vehicles provide partially automated specifications such as keeping the car within its lane, speed controls or emergency braking..According to statistics most of the accidents occur due to lack of instant response to traffic signs and obstacles ahead. In case of self driving car this problem can be addressed by detecting the traffic signals using high end camera. Real time traffic sign detection model accomplishes its objective by identifying the traffic signals and obstacles. A high end camera is used to capture the image, raspberry pi 3 is used as hardware and open computer vision library is used to process the image and identify the patterns in the image to properly detect the signals. Ultra sonic distance sensor is used to identify the obstacles.***

Keywords: Raspberry Pi, median filter, Hough circles, k means clustering, Edge detection.

I. INTRODUCTION

The United Nations estimates that between 2010 and 2020 the number of deaths due to road accidents will increase by upto 50% that is about 1.9 million people. To reverse this trend, the UN established, in 2011, the 1st, "Decade of action for safety". By the middle of the century, specifically we will witness a revolutionary change in the means of transportation. Although safety is important too. Most of the road accidents are caused by human factor like fatigue or failing to adapt to road conditions. Human probability of making mistakes is much greater than the computer. So another great advantage with a properly functioning autonomous vehicle is that accurately making decisions there by reducing the accidents rate drastically.

Therefore detecting traffic signs is an essential step for self driving car. This project aims to develop a prototype for recognition of traffic signs and controlling the vehicle accordingly. The algorithm developed in this work is tested and processed using a Raspberry Pi board.

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The input- output models such as camera, ultrasonic distance sensor, H-bridge drivers, motors and chassis of the model are integrated together to perform as a single unit.

II. LITERATURE REVIEW

Self driving cars has the capacity to revolutionize the urban transportation by providing sustained, safe, convenient and congestion free mobility on roads[5].
"Ubiquitous computing" has paved the way for creating smarter, faster, low power and smaller computer systems which can be easily embedded into automotive ECUs. The main advantage of autonomous vehicles is that driving , often feels tedious and stressful activity can be replaced by relaxing, reading books and attending video conferences for busy business people[1].
Aiming at standardizing different traffic signs in different countries, an international treaty commonly known as Vienna convention on road signs and signals [6], was agreed in 1968. The Vienna convention classified the traffic signs into eight categories, designated from A-H[3] as shown in following table.

Table 1.1: Types of traffic signs

	Danger/warning signs(A)
	Priority signs (B)
	Prohibitory or restrictive signs(C)
	Mandatory signs(D)
	Special regulation signs(E)
	Information facilities or service signs(F)
	Direction, position or indication signs(G)
	Additional panels (H)

III. BLOCK DIAGRAM

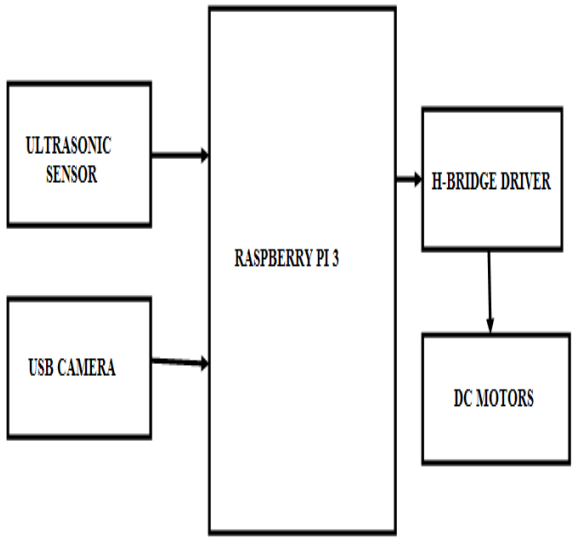


Fig 3.1: Block diagram of proposed model

USB Camera (VX800) : It contains a VGA video sensor for clear image which can adjust even in low-light condition. It has fixed focus and automatic image adjustment with resolution of 0.31 mega pixel i.e. . 640*480 pixel and 59 degree diagonal field of view.

Processing Unit(Rpi 3 B+) : Raspberry pi is used as processing unit since it is low cost, portable and credit card sized computer. Rpi 3 B+ is used in the project which is advanced version of B with increased GPIO pins and reduction in full sized SDcard to micro SD slot.

H-Bridge Driver and motors: L293D is a quadruple high current half-H drivers. It provide bidirectional drive currents of up to 600-mA at voltages from 4.5 V to 36 V. Dc motors of 60rpm are Used.

Ultrasonic sensor: Ultrasonic distance sensor is used for obstacle detection. It emits sound waves with a frequency higher than humar ear can hear and receives back the echo whenever a obstacle is detected. The distance at which the obstacle is detected is calculated by using the formula

Distance = speed*time/2

IV. METHODOLOGY

Input image is acquired via USB camera and it is received by the processing unit. Using open source computer vision libraries in python, acquired image is processed in several steps to detect and identify traffic signs.

A) Image acquisition :

Image information is captured by the image sensor which is made of millions of tiny squares arranged in a grid pattern called pixels. USB camera does not have inbuilt memory to save the image so it just transfers the captured image to processing unit via USB communication. This cam draws input power from processing unit only via USB.

B) Gray scale conversion :

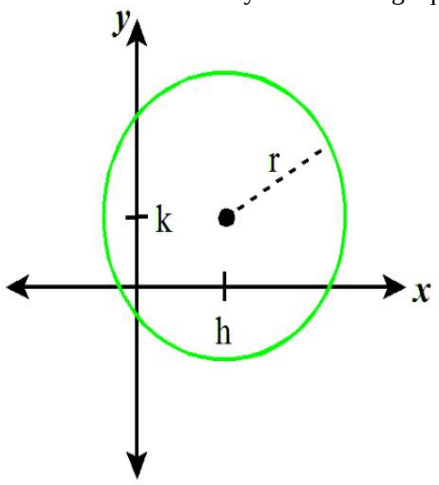
Image is made of pixels. A three channel colour image would have red, green and blue channlels. Each pixel is a combination of three intensity values which makes it complex during processing. Therefore image is initially converted to gray scale where it has only single channel with values ranging from 0 to 255 which makes it computationally easy and less memory occupying.

C) Image smoothening

Image is smoothened to reduce noise because image noise may lead in false edge detection. A non-linear Median filtering is used for image smoothening which is much better than the conventional linear Gaussian filter or an averaging filter.

D) Circle identification

In the traffic signs considered in these experiment each sign has a circle and a sign located inside the circle. Circle can be described by the following equation:



$$(x-h)^2+(y-k)^2=r^2$$

Fig 4.1: Hough circle depiction

A 3D matrix called **accumulator matrix** is used to store the potential values of coordinates X and Y.

Below are the steps to detect Hough circles :

- **Initialize the accumulator matrix** of dimensions rows*columns*max radius with zeros.
- **Pre processing the image** so that the circles appear as dark edges.
- **Looping through the points** by picking a point on the image using **"K-Means Clustering"** in OpenCV. Each time the code is run it picks a random point and converges upon their depending upon criteria.
- **Fixing r and looping through h and k** to find the value of r.
- **Voting** to pick the strongest points in the accumulator matrix which indicate the existence of circle with points h,k and r. This gives the hough space of circles.
- **Finding circles** by using the above circles as candidate circles. The maximum voted circle in the accumulator matrix gives the required circle.

E) Edge detection

After the circles are detected the next step is to identify the signal that is present in the circumference of the circle.

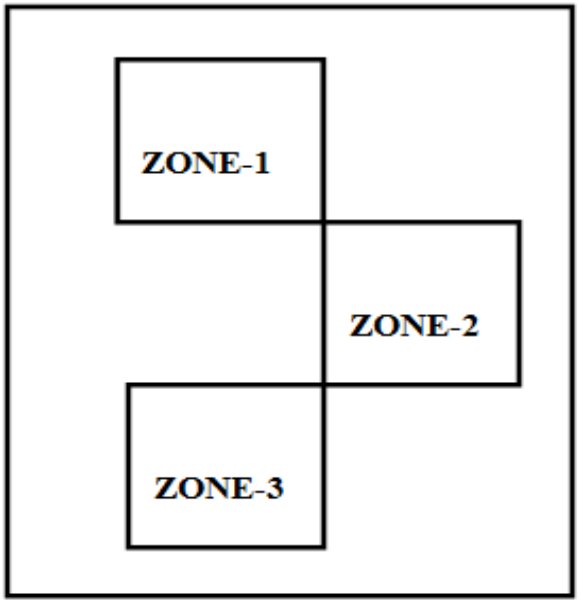


Fig 4.2: Zones for edge detection

Image space inside the circle is divided into three zones zone_0, zone_1 and zone_2. Zone_1 and Zone _2 are considered to detect the forward, turn right; turn left and u turn directions.

V. EXPERIMENTAL RESULT S

Fig5.1: Real time traffic sign detector

A prototype of self driving car is built as shown in the fig5.1. It is capable of detecting traffic signs, for demonstrating the actions only forward, right turn, left turn and U turn signs are used.

Results are as following:

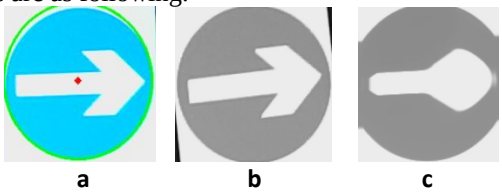


Fig5.2: Hough circle detection

Image captured via camera is as shown in fig 5.2 (a), (b) is the figure obtained by converting it into grayscale and (c) is the output of the median filtering which is able to preserve the edges to a maximum extent.

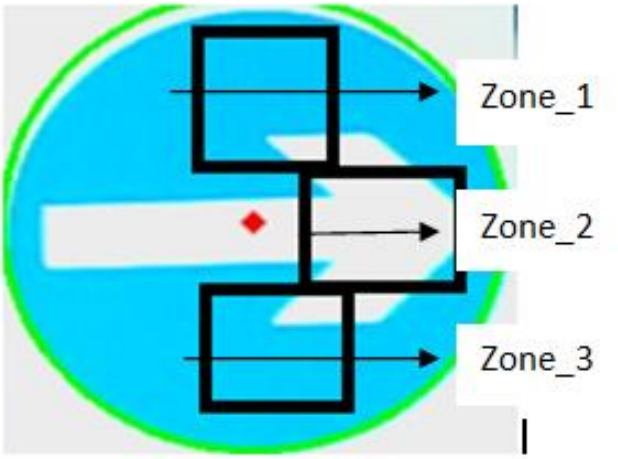


Fig 5.3: zones identifcation

The next step is to identify the traffic sign.This is done by first identifying the circle using k-means clustering and after that the circle is divided into zones as shown in fig 5.3. To identify the signs zone_1 and zone_2 are considered.

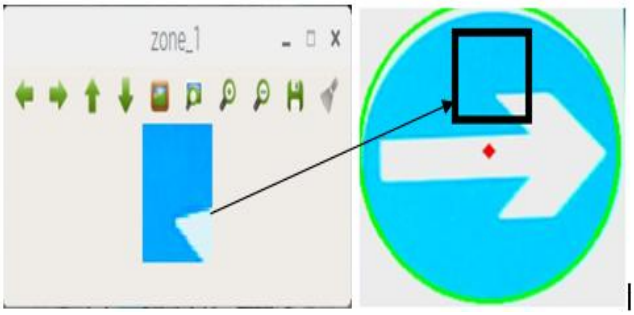


Fig 5.4: zone_1 identificaton for right turn sign

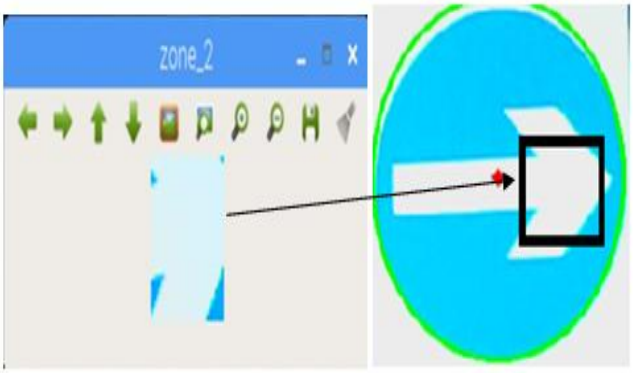


Fig 5.5: zone_2 identfication for right turn sign

Fig 5.4 and Fig 5.5 depicts the identification of zone_1 and zone_2. Algorithm matches the zones with the actual sign if it is true then the vehicleis moved in that particulr direction. Ultra sonic distance values are continuously displayed while running the prototype and whenever there is a obstacle detected the vehicle is slowed down and stopped.

VI. CONCLUSION AND FUTURE SCOPE

Traffic sign detection is one of the important factors in self driving cars. The prototype presented in this able to detect traffic signs and is intelligent enough to make decisions to stop the vehicle i.e if it is able to foresee a traffic sign and at the same instant if it is detects a obstacle it would slow down and stop instead of moving according to sign. Performance of the vehicle solely depends on the quality of the image captured. Since a camera with VGA sensor is used it is able to capture the images accurately. Hough circles and k means clustering is far better in detecting edges compared to conventional color based detection techniques.

This work can be further extended by embedding IoT technology and RFID technology to be able to detect the vehicles nearby. Networking algorithms can be used to find the vehicles and can be reported to traffic control sytem using GPS and IoT.

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