Road Sign Recognition System For The Smart Car Using Machine Learning

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Abstract- *Road sign recognition is one of the important tasks of intelligent transportation systems (ITS). The research aims at implementation of road sign detection and control of an autonomous vehicle using K-Means Clustering algorithm. In this proposed work, the system automatically detects the road signs, controls the vehicle and command certain actions. The system consists of Raspberry Pi 3 Model B+ and Pi camera which automatically captures the video data and converts them into number of frames which are processed by the proposed algorithm in OpenCV to detect the road sign and control the vehicle. Based on the detected sign, the vehicle is controlled by two DC motors interfaced with Raspberry Pi 3.*

Keywords- Raspberry Pi, K-Means Clustering, Open CV

I. INTRODUCTION

In the modern time, the vehicles are engrossed to be automated to give human driver hassle-free driving. With the rapid development of technology and economy in the modern society, various aspects have been considered in the field of automobile which demands automated vehicle as automobiles have become a necessary means of transportation in the daily travel of people. Autonomous technology can support, or even hail self-driving which is of remarkable importance to free the human body and considerably reduce the number of crashes on our roads. Road sign detection and recognition are vital in the development of smart vehicles, which directly affects the implementation of driving behaviors. It improves safety by informing the drivers about the current state of Road signs on the road.

Intelligent transportation systems (ITS) have great potential to save time, to save money, to save lives, and to improve our environment. It has considerable Potential to be a future commercial success. The proper interpretation of road signs therefore plays a vital role and impacts on the process. Road sign detection (RSD) is the most important procedure in RSR (Road sign recognition) which is a process of recognizing and locating signs. These recognized signs are taken as inputs for the system.

II. LITERATURE REVIEW

Amol Jayant and Mahajan [1] have proposed a methodology for street sign acknowledgment framework in which the traffic sign image is obtained from the moving vehicle. Sorting of road sign image is done by using ANN to obtain the correct classification percentage.

Ayoub Ellahyani, Mohamed El Ansari [2] they have a strategy for street sign discovery and acknowledgment. In this work they have divided it into three stages: first, a color segmentation method is used to extract regions of interest (ROIs). Then polygonal approximation technique to detect triangular, rectangular, and circular shapes. The last stage aims at identifying the detected signs using a new designed feature and SVM classifier.

Chiung Yao Fang [3] describes an approach for detecting and tracking road signs from a sequence of video images with chaotic backgrounds and under various weather conditions.

The shape and color features were extracted using two-layer neural network. In the tracking phase, Kalman filter was used to locate traffic signs in the previous phase through image sequences.

Amal Bouti, Jamal Riffi [4] implemented and tested a system of detection of road sign. The approach taken in this work consists of using convolutional neural network where this network is supposed to differentiate between different classes of signs. M. Prabu, Pooja, Mallika, Nidhi Ranjan [5] Proposed a Traffic sign recognition is based on Advanced Driving Assistance System (ADAS) which is used by vehicles to identify various traffic signs ahead. For the process of visual imagery, ANN (Artificial Neural Network) or CNN (Convolution Neural Networks) are used.

III. PROPOSED TRAFFIC SIGN DETECTION AND RECOGNITION METHOD

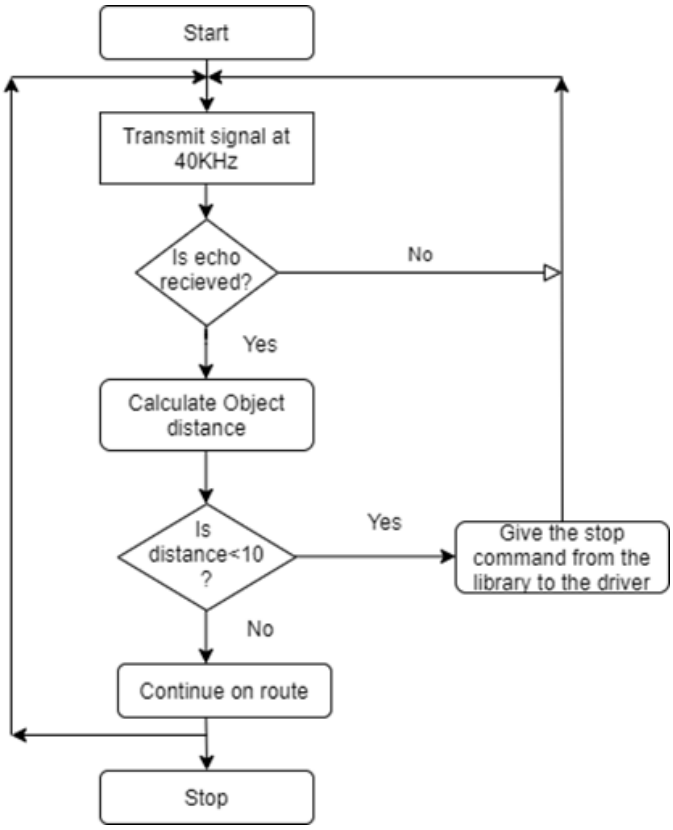

Figure 1: Flow Diagram of Obstacle detection

Figure 1 shows the flow diagram of obstacle detection system. Initially the Ultrasonic sensor is transmitting a sound signal at 40KHz. The sound waves hitting the objects in its path will result in an echo signal. The distance of an object from the ultra-sonic sensor is calculated as:

Distance L = 1/2 × T × C

Figure 2 shows the flow diagram of various steps involved in Image processing. It is important to detect the Road sign from the image. And check their position in the form of pixel co-ordinates for the decision of Move. Here in this algorithm Road Sign detection is done as described below. During the image analysis, raspberry pi generates the command as described above in the flow diagram. These generated commands are forwarded to raspberry Pi board through GPIO pin. For forwarding this command following table is referred.

Table 1: Generation of commands

Command	M11	M12	M21	M22
Stop	Low	Low	Low	Low
Forward	High	Low	High	Low
Left	Low	High	High	Low
Right	High	Low	Low	High

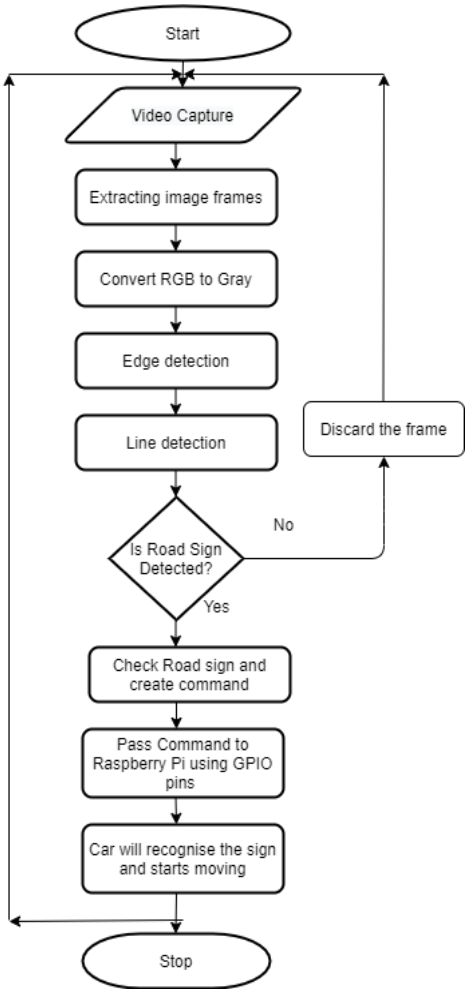

Figure 2: Flow Diagram of Image Processing Algorithm

IV. BLOCK DIAGRAM

Block diagram describes the prototype of autonomous car and command flow between the various sub-systems. As shown in figure, there are two sub-system. They are Image processing sub-system and obstacle detection sub-system. Camera attached to image processing sub-system which captures the image and provides it to the system. System extracts the data from the image and generates the command to move the car. Mainly image processing is used here to detect the road lane. The commands generated are forwarded to obstacle detection subsystem. Obstacle detection

sub-system is detecting the obstacle in front of car and also calculate the distance between the obstacle and the car. And if sufficient distance is available to move car forward the command from Raspberry pi is forwarded to motor driver else this command is rejected.

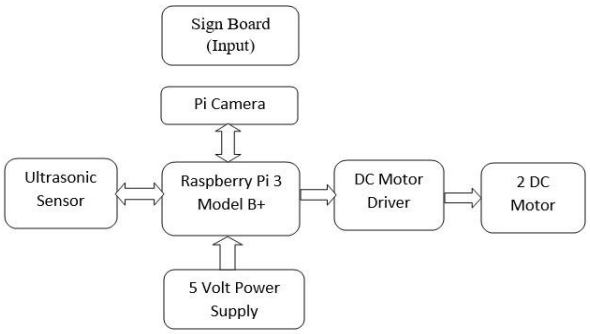

Figure 3: Block diagram of the proposed system

Methodology:

1. In this research, Raspberry Pi 3 model B+ is the core controlling unit.
2. Installation of software on Raspberry Pi 3 model B+.
3. Interfacing of Pi camera with Raspberry Pi 3 model B+.
4. Collection of road sign images are done and stored in the database.
5. Coding for image capturing and sign detection are done on the Raspbian OS using Open CV and Python.
6. In image acquisition step the road sign images are taken in Pi camera with 5 megapixels, so that there will be a good distribution of images taken under different lighting conditions and at different angles.
7. The images are preprocessed using K-Means Clustering algorithm, Gray scaling algorithm, Median Blur algorithm, Circle Hough Transform (CHT).
8. The system consists of two modules detection stage and classification stage.
9. The main work of the detection module is to segment the captured input image and extracted out the areas in which it contains road sign pattern and then given to the classification stage.
10. The proposed algorithm uses K-Means Clustering algorithm for the road sign image in order determines the best value for K center points or centroids by an iterative process.
11. Assigns each data point to its closest K-center. Those data points which are near to the particular K-center, create a cluster.
12. The main aim of classification stage is to classify the extracted regions to its input to the road sign database.
13. The final reduced and normalized regions of road sign image is detected.
14. A proto type car is made in that all the components are mounted.
15. When the camera senses the road sign and it compares with stored image. If both the sign images are matching then the desired result is obtained to move the car.
16. The images are processed with K-Means Clustering algorithm for sign detection and classification. Based on the detected sign, the vehicle is controlled by DC motor interfaced with Raspberry Pi 3 model B+.

V. ALGORITHMS

A. K-Means Clustering

It is an algorithm to detect clusters in a given set of points. It does this without any supervision or correcting the results. It works with any number of dimensions as well (that is, it works on a plane, 3D space, 4D space and any other finite dimensional spaces).

Working:

1. The k-means clustering algorithm attempts to split a given data set containing no information as to class identity into a fixed number (k) of clusters. Initially k number of so called centroids are chosen.
2. A centroid is a data point (imaginary or real) at the center of a cluster. In each centroid is an existing data point in the given input data set, picked at random.
3. Each centroid is thereafter set to the arithmetic mean of the cluster it defines. The process of classification and centroid adjustment is repeated until the values of the centroids stabilize.

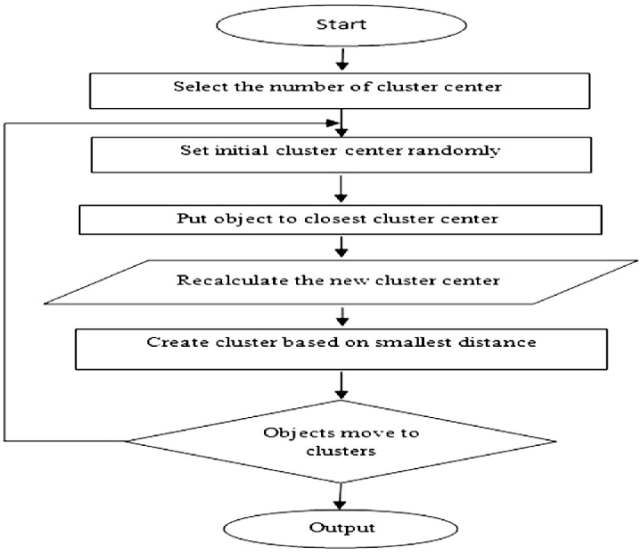

Figure 4: Flow Diagram of K-means Clustering Algorithm

B. Grayscaling

It is the process of converting an image from other color spaces e.g RGB, CMYK, HSV, etc. to shades of gray. It varies between complete black and complete white.

Importance of gray scaling –

1. Dimension reduction: For e.g. In RGB images there are three color channels and has three dimensions while grayscale images are single dimensional.
2. Reduces model complexity: neural network will need only 100 input node for grayscale images.

C. **Median Blur Algorithm**

The median filter is a non-linear digital filtering technique, often used to remove noise from an image or signal.

D. **Circle Hough Transform (CHT)**

1. It is a basic feature extraction technique used in digital image processing for detecting circles in imperfect images.
2. cv2. HoughCircles(image, method, dp, minDist) Where Image is the image file converted to grey scale Method is the algorithm used to detct the circles.

VI. EXPERIMENTAL RESULTS

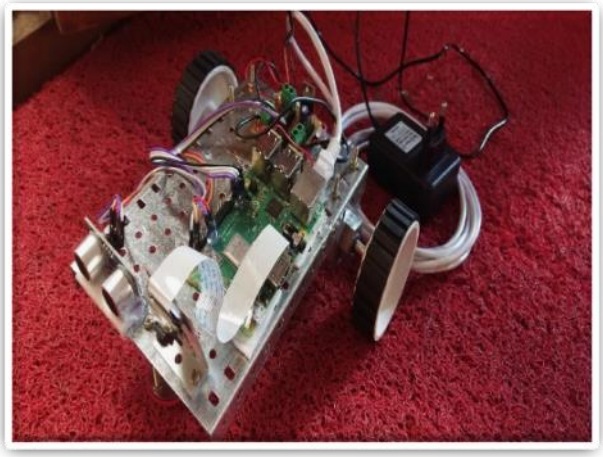

Figure 5: Cross View of the Car

A. Experimental Setup

Fig 5 shows the Experimental setup. Raspberry Pi 3 Model B+ processor is the main controlling unit in the system. Pi Camera is interfaced with the Raspberry Pi 3 model B+ which continuously captures the video frames of the road sign during motion of vehicle. According to the code in the Raspbian OS the captured frames are processed and are displayed in the monitor. The images are processed with Various algorithm like K-means Clustering, Gray Scaling etc for sign detection and classification. Based on the detected sign, the vehicle is controlled by DC motor interfaced with Raspberry Pi.

The motor can be driven using L298 motor driver. The power to the system is given by 12V battery**.** The results are been taken in Open CV, which is installed in Raspberry Pi 3 kit. The below shown figures are Raspberry Pi results having Image Identification with message display when vehicle detects the road sign. Based on the sign detection, the vehicle is controlled by DC motor interfaced with Raspberry Pi 3 model B+. Here we have taken several image database of road signs and it is well trained using K means clustering algorithm. The algorithm has an ability to detect a road sign in multiple angles of different size. It is more robust to illumination changes than the color histogram.

B. Result Analysis

These are the Road Sign images used in our work. These images are taken as inputs. When these images are placed in front of the Pi camera, it captures the image, recognizes the road sign and then it will give actions according to the road sign image.

Fig 6: Stop Image Identification with message display "stop"

The figure 6 shows the Stop sign Image Identification with message display as "stop" when vehicle detects the road sign and it is displayed in monitor. STOP Sign will stop the moving car.

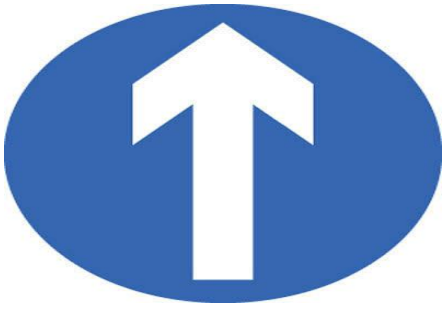

Fig 7: Forward Image Identification with message display "forward"

The figure 7 shows the forward sign image identification with message display as "forward" when vehicle detects the road sign and it is displayed in the monitor. FORWARD sign will make the car to move in straight direction.

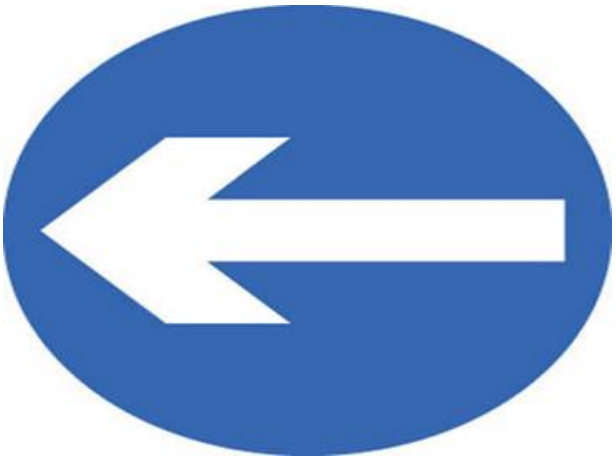

Fig 8: Turn Left Image Identification with message display "left"

The figure 8 shows the turn left road sign Image Identification with message display as "motor left" when vehicle detects the road sign and it is displayed in monitor. LEFT sign will make the car to move in a left direction.

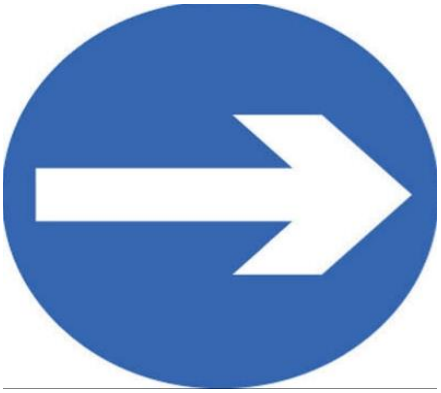

Fig 9: Turn Right Image Identification with message display "right"

The figure 9 shows the turn right road sign Image Identification with message display as "right" when vehicle detects the road sign and it is displayed in monitor. RIGHT sign will make the car to move in a right direction

VIII. CONCLUSION

1. The design and implementation of a Road Sign Recognition system for Autonomous vehicle using Raspberry pi is proposed in this paper. This method is used to convey information about the vehicle which needs to take left/right and forward/stop according to road signs. Rather than road signs anything which comes in front of the camera then it will be treated as obstacle which is sensed by the ultrasonic sensor.
2. The implementation and comparison of K-Means Clustering is an algorithm, grayscaling, Median Blur Algorithm, Circle Hough Transorm (CHT) are made for around 4 datasets of different road sign image using OpenCv in Python. The overall implementation done using Raspberry Pi 3 model B+ processor utilizing OpenCV platform produces lesser execution time with higher detection rate when compared to MATLAB processing time.
3. The algorithm has an ability to detect a road sign in multiple angles of different size.
4. It is more robust to illumination changes than the color histogram

IX. FUTURE SCOPE

The system is trained to detect only few image datasets due to less memory capacity of SD card in Raspberry pi processor. For training more datasets, the GPU like processor can be used because they are capable of performing

parallel processing and it provides high-end computation with less processing time. It can be trained and store huge datasets efficiently.

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