SELF-DRIVING CAR USING NEURAL NETWORK WITH RASPBERRY Pi

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Abstract

The paper aims in implementing an autonomous vehicle that can detect 43 distinct types of street signs and detect lanes using deep learning and a convolutional neural network on a Raspberry Pi. A neural network model is used to train the traffic sign characteristics, and then image classification is conducted utilizing live video input from the Raspberry Pi webcam camera. Automatic sign and lane detection that is fast, reliable, and real-time can help the driver and improve driving safety dramatically. The model is produced with the specified dataset after each frame of the video input is transformed to grey scale. To train the system for the desired outcomes, used the "Tensor Flow", "Keras", "sklearn", and "matplotlib" libraries to do numerical and logical computing. The Raspberry-Pi will be used as a processing power in a monocular vision autonomous car prototype. The Raspberry Pi module's webcam works in tandem with an ultrasonic sensor to get the data from the real time to the car, which then passes it on to the Raspberry Pi, allowing the car to arrive at its destination safely and smartly, decreasing the risk of driver error by responding to real-time traffic and obstacles. Many existing algorithms are combined to provide the necessary control to the car, which will benefit the automobile industry by reducing the amount of concentration required and the strain placed on the brain while driving, as well as lowering the risk of accidents caused by careless or inattentive drivers. The model has a 98.75% training data accuracy and a 98.79% testing data accuracy.

Keywords: Convolutional Neural Networks (CNN), Traffic Sign Detection, Traffic Signs Recognition, Raspberry Pi, Neural Network.

Introduction

Today's traffic forums involve drivers' constant attention to multiple sources, at the same time. In such cases it is easy for the driver to miss certain traffic-related information. Automatic traffic detection and real-time monitoring can support the driver and greatly increase driving safety. The main function of the TLD is to prevent accidents and save lives by alerting the presence of ared or green traffic light to the driver in a non- disruptive manner. Using the convolutional neural network, live video inputs are converted into individual frames to further integrate, and separate inputs made from the model we have produced. Therefore, assisting the driver with sound output based on live traffic light can avoid potentially harmful consequences that include both physical and human damage.

With the growing demand for ease of use, technology is now trying to seek automation in all possible aspects. Also, with the increase in the number of accidents in recent years due to the increase in the number of vehicles and the negligence of drivers, it now seems necessary for cars. So, in order to reap the benefits mentioned above, we are introducing a self-driving car that can eliminate human intervention in the driving sector. The car traveling on its own from one place to another will have integrated features such as route sightings, roadblocks and road signs. This feature will help the car to drive to the specified location in a straightforward manner, with greater impact, providing live front-view streaming with the help of a camera mounted on the vehicle and detect road signs and compliance properly to avoid accidents caused by traffic violations. This will ensure safer, easier, more advanced and more convenient travel, which is why it provides a transformation step in the field of automation and mobility.

The TSDR System is a computer vision system that uses artificial intelligence to identify, detect, extract, and recognize road traffic signs froma distance in order to provide crucial information tothe driver about what actions to take. The TSDR system captures an image from a moving vehicle to uniquely identify a traffic sign byremoving all superfluous data from the image and concentrating on extracting the traffic sign. The inability to recognize a traffic sign from a specific distance and act accordingly is one of the major problems and obstacles that leads to needless accidents. The driver's task is to detect the faded, obscured, and many signs at the same time. This is made worse by the fact that the signs are either destroyed or invisible to the driving force in bad weather and at night. To overcome the obstacles of traffic sign identification, the TSDR system plays a critical role, detecting and recognizing traffic signs and issuing a voice alert to the driver with up-to-date information on the traffic sign. This paper provides a view for several traffic sign detection and recognition methods for identifying road traffic signs based on color, form, and texture. This research also provides a brief review of TDR system topologies and the various traffic indicators accessible. Detection and recognition are the two stages of road sign identification. The picture is pre- processed, improved, and segmented depending on sign attributes such as color or shape during the detection stage. As a consequence, a segmented picture with potential traffic sign places is produced. Detection efficiency and speed are crucial components in the overall process since it lowers thesearch space and only reveals viable places. During the recognition stage, each candidate is assessed against a set of criteria to determine if it fits in the category of road signs, and then sorted into separate groups depending on these criteria. These features were chosen to highlight the differences between the classes. At this step, the shape of the sign is significant, and signs are classified as triangles, circles, or octagons. A second level of classification is possible with pictogram analysis. The precise class of a sign can be easily determined by examining pictogram shapes in conjunction with thetext on the sign's inside.

Review of Literature

[1] "Traffic Light Detection: A Learning Algorithm and Evaluations on Challenging Dataset" was proposed. It takes a successful ACF detector and applies it to the TL detection problem. There is no system in place to limit the number of false positives and negatives. There is no way to offer 3Ddata that could be used to improve trackingprecision.

[2] “Prototyping a Traffic Light Recognition Device with Expert Knowledge” was proposed. It uses Artificial Neural Networks (NN), Saliency Map (SM), and Blob Detection (BD) techniques to distinguish traffic lights. The prototype is viable, according to the results. It shows how to use the Galaxy S8+ and iPhone 6 as TLR devices.

[3] “Traffic light and sign detection for autonomous land vehicle using raspberry pi” was proposed. It locates lanes in road photographs by using low-level information such as painted lines or lane margins. Lane detection is approached as a calculation of model parameters, assuming that lane formations can be represented by a straight line or a parabolic curve. This technology tells the car when it has to take detours and when it needs to start/stop at traffic signals. It helps you save time and get better outcomes. This method has significant problems with light intensity fluctuations and shadows cast byobjects.

[4] “Intelligent Traffic Light Control using Image Processing” was proposed. The device effectively maintains a smooth traffic flow while also recording the license plate of any vehicle breaking traffic laws. It provides for speed monitoring at night. With the assistance of the local traffic agency, the strategy can be successfully implemented. All of the data collected by autos is stored on hard drives, however cloud storage can beused to increase data security.

[5], “The Traffic Light Detection Method” was proposed. To capture traffic signal data, wireless communication technology is used. Green, red, and yellow traffic light color can be fetched by subtracting two color components. A shoestring budget was used to implement the image classification technique. It's also possible to detect things in the environment. It has slow speed monitoring in poor light. It can't be trusted because it was only evaluated with a short dataset.

[6], “Traffic light detection on mobile devices”was proposed. Region-based approaches, histogram thresholding, neural networks, fuzzy algorithms, edge detection, and other techniques are used

to segment color pictures. Color image segmentation based on thresholding, computational restrictions For smart mobile devices, a rapid traffic light detecting technique is provided. The approach is optimized for mobile devices' processing capabilities and yields satisfactory detection rates. By employing a tracking strategy to validate/fine thedetection findings, improvements can be made.

[7], Masako Omachi and Shinichiro Omachi proposed "Traffic light detection with color andedge information" was proposed. To begin, change the colors space from RGB to normalized RGB. Then, by keeping the pixels with the colors of traffic lights, certain potential traffic light locations are discovered. Edge detection is done using the remaining pixels. Color information is employed to detect candidate traffic signal parts, resulting in more accurate results. A large-scale experiment witha big number of images is necessary to evaluate the proposed method, which will be the focus of future work.

Statement of the Problem

Today's traffic situations need drivers to pay continual attention to various information sources atthe same time. In such circumstances, it is simple for a motorist to overlook important traffic information. Automatic traffic sign identification and recognition that is fast, reliable, and real-time can assist the driver and considerably improve driving safety. TLD's major purpose is to save lives by non- intrusively notifying vehicles to the presence of a different traffic signal which it may encounter in thereal environment.

Research Methodology

The below flowchart as shown inn figure 1 gives entire explanation of proposed work. First the entire dataset is imported, and the pre-processing is done. First the input imageis sent to the Open CV library function to convert the coloured image into grey scale and then equalized such that it standardizes the lighting in an image with the shape segmentation. Shape is detected with the further feature extraction from the video frame. Then further modification is done on the parameter zoom, shear and rotation of the images.

The model generated is further added the filters like pooling, dense and dropout. Class of the traffic sign is detected with the threshold in consideration. The final output is action on the raspberry pi-controlled step motors with the motor driver on the basis of the class detected by the Tensor Flow model

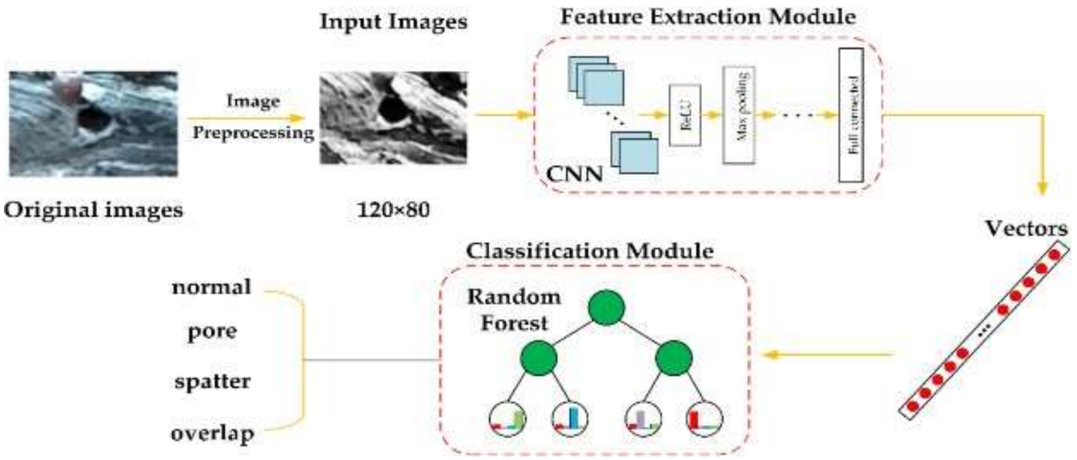

Figure 1: Signs Detection and Recognition Methodology

IMPLEMENTATION

A large dataset of the traffic signals was released for the general public at different conferences and experiments. This model uses a collective dataset from different datasets on the web.The data is further manipulated for the better accuracy.

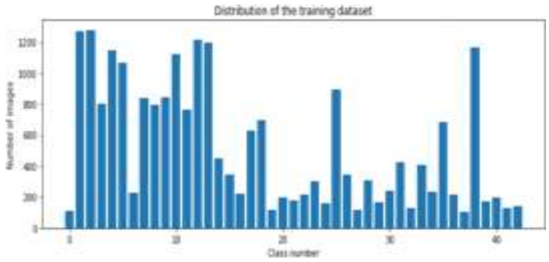

Fig.2 Dataset representation of images count oneach class

This modal has been implemented with Python 3.9.7, Tensor Flow 2.80, Open CV 3.4.17.63, Mat plot lib 3.5.2 and other dependencies packages. On the hardware, used Raspberry Pi 3B+, L298n Motor driver, camera and other components. With Convolutional Neural Network, a Tensor Flow model was created from the training dataset. Different layers of CNN were applied on the image frame for the better training of the data. The accuracy precision is used to evaluate the suggestedmodel in this study.

Because each image in the collection only hasone traffic sign. As a result, we ignore recall and focus solely on accuracy. For each picture, detectorsare only permitted to anticipate one bounding box.

- Detection: For each image, the detector only generates one bounding box. It is considered accurate if the box's IoU in relation to theobject ground truth box is more than 70% (IoU > 0.7). We also compute AP on the test set.
- Recognition: If and only if the photos are correctly categorised, a traffic sign identification is correct.

Results and Discussion

The camera module on the raspberry pi was used to capture video and based on that image frame; the trained model takes decisions automatically. It is able to detect the objects, so that the collision can be avoided which would be helpful in real world for preventing accidents. It is trained with more than 200 samples of images in different lighting conditions which helped in getting better accuracy and significantly fast detection. It can perform an action on the step motor of the vehicle based on the traffic sign detected by the webcam.

Fig.3 Detection of "right turn" and "No way"signs by the modal

Fig.4 Detection of "30 km/hr limit" and "Other"signs by the modal

Conclusion

The purpose of this research is to create thecomplete autonomous vehicle with all the basic components for the visualization, analyzing and processing. For the first part of the project, it will classify the live video input of the traffic lights intoaudio using the web cam of the laptop and traffic lights to be displayed on the mobile application. For the second part of the project, it will be implemented on the hardware device (Vehicle) using raspberry pi, pi camera, python on the computation and mobile application for the visualization of the traffic lights.

Future Work:

The work could be improved by including machine learning into the algorithm. The operations are performed on all frames by the current algorithm. It is accurate, but it might be much more efficient if it began learning on its own and avoided superfluous computations of places that are already known or recognized. Though the concept of an autonomous car began it all, many semi-autonomous features will emerge, reducing different traffic related issues and boosting safe drive by allowing for quicker reactions and fewer accidents. The following considerations will be made in our future efforts.

- Better performance with higher video frame rate
- Height and the width of an obstacle with object recognition
- Dynamic Image Processing
- Training with bigger dataset
- A camera of better resolution as the scenes keeps changing rapidly in the real world

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