

Automation of Speed in a High speed vehicle based on Roadside sign image recognition using Raspberry-Pi

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ABSTRACT: Digital signal processing is used in many fields such as space exploration, medicine, geology etc. The main objective of this paper is to demonstrate the ability of image processing algorithms on embedded computing platforms .It describes a road sign recognition system based on an embedded system that reads and recognizes speed signs and also controls the speed of the moving vehicle. The paper also describes how to deal with numbers using image processing techniques based on shape and dimension analysis. Colour analysis also plays an important role in road sign detection. Raspberry Pi is the main component for the implementation of this system, as it has built in capabilities. It is a computer vision based system for traffic sign detection, tracking, and recognition in real time. The signs on the road side are captured with the help of camera interfaced to the video port of raspberry pi. The captured image is then compared with pre-defined road signs. Dimension analysis is performed with the help of K nearest algorithm. Upon obtaining the best match, the corresponding speed limit in the detected image will be sent to raspberry pi and it generates a pulse width modulated signal in order to control the speed of vehicle accordingly.

I.INTRODUCTION

There are four types of traffic signs that are shown in the traffic code: a) warning; b) prohibition; c) obligation; and d) informative. Depending on the form and the color, the warning signs are equilateral triangles with one vertex upwards. They have a white background and are surrounded by a red border. Prohibition signs are circles with a white or blue background and a red border. Both warning signs and prohibition signs have a yellow background if they are located in an area where there are public works. To indicate obligation, the signs are circles with a blue background. Informative signs have the same colour. Finally, there are two exceptions: a) the yield sign, an inverted triangle; and the stop sign, a hexagon. To detect the position of the sign in the image, we must know the two properties i.e., colour and shape. Traffic sign recognition is used to maintain traffic signs, warn the distracted drivers, and prevent his/her actions that can lead an accident. A real-time automatic speed sign detection and recognition can help the driver, significantly increasing his/her safety. Traffic sign recognition also gets an immense interest lately by large scale companies driven by the market needs for intelligent applications such as autonomous driving, driver

assistance systems (ADAS), mobile mapping etc. Our worked focused on a low cost, off the shelf solution, specifically, a mini embedded computer Raspberry Pi, that is capable of doing everything you would expect a desktop computer to do, from word processing, image processing to playing games This project aimed to demonstrate use the of simple shape recognition algorithms and open source optical character recognition (Tesseract OCR) on Raspberry Pi Tesseract OCR is one of the top character recognition engines in terms of accuracy. Tesseract can detect letters in various forms of images, and it uses the open source C library Leptonica library. In this project we will be able to pass images to Tesseract OCR and read them. To improve accuracy we had to do pre-processing on images before pass them Tesseract OCR engine

II. EXISTING SYSTEM

The existing system has incorporated autonomous gear changing according to the speed. Fully autonomous driving in real urban settings has remained an important but elusive goal. Many notable attempts have been made, and several important milestones have been reached. Perhaps the most famous was the 2007 DARPA Urban Challenge, in which teams from across the world designed the hardware and software for autonomous vehicles that could handle dynamic obstacles, intersections, and merging. In the event, over 50 robotic and non-robotic vehicles drove simultaneously on a closed course for an entire day, and six robots successfully completed the race

International Journal of Multidisciplinary Research in Science, Engineering, Technology & Management (IJMRSETM)

(A Monthly, Peer Reviewed Online Journal)

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Volume 5, Issue 1, January 2018

III.PROPOSED SYSTEM

The identification of the speed signs is achieved by two main stages: detection and recognition. In the detection phase the image is pre-processed, enhanced, and segmented according to sign properties such as colour, shape, and dimension. The output of segmented image contains potential regions, which can be recognized as possible speed signs. The effectiveness and speed are the important factors throughout the whole process, because capturing images from the video port of Raspberry Pi and processing images as they come into to the pipe should be synchronized. In the recognition stage, each of the images is tested with K-Nearest algorithm according to their dimensions, which is an important factor to detect the speed signs, since we want to process images only once as they come, it also emphasizes the differences among the other rectangle shapes. The shape (rectangle) of the signs plays a central role in this stage. When a speed sign detected, it is passed into the optical character recognition engine to be converted and written out as a text file.

SYSTEM CONFIGURATION

RASPBERRY PI

- Raspberry pi is preferred nowadays over microcontrollers because of its cost effectiveness and faster performance.
- Microcontrollers cannot handle intensive calculations.
- Raspberry pi generates PWM which alternates the speed.
- Raspberry pi is Linux operating system.
- **Technical Specifications:**
- Broadcom BCM2837 Arm7 Quad Core Processor powered Single Board Computer running at 900MHz
- 1GB RAM
- 40pin extended GPIO
- 4 x USB 2 ports
- 4 pole Stereo output and Composite video port
- Full size HDMI
- CSI camera port for connecting the Raspberry Pi camera
- DSI display port for connecting the Raspberry Pi touch screen display
- Micro SD port for loading your operating system and storing data
- Micro USB power source

Switched-Mode Power Supply

A switched-mode power supply (switching-mode power supply, switch-mode power supply, switched power supply, SMPS, or switcher) is an electronic power supply that incorporates a switching regulator to convert electrical power efficiently. Like other power supplies, an SMPS transfers power from a DC or AC source (often mains power), to DC loads, such as a personal computer, while converting voltage and current characteristics.

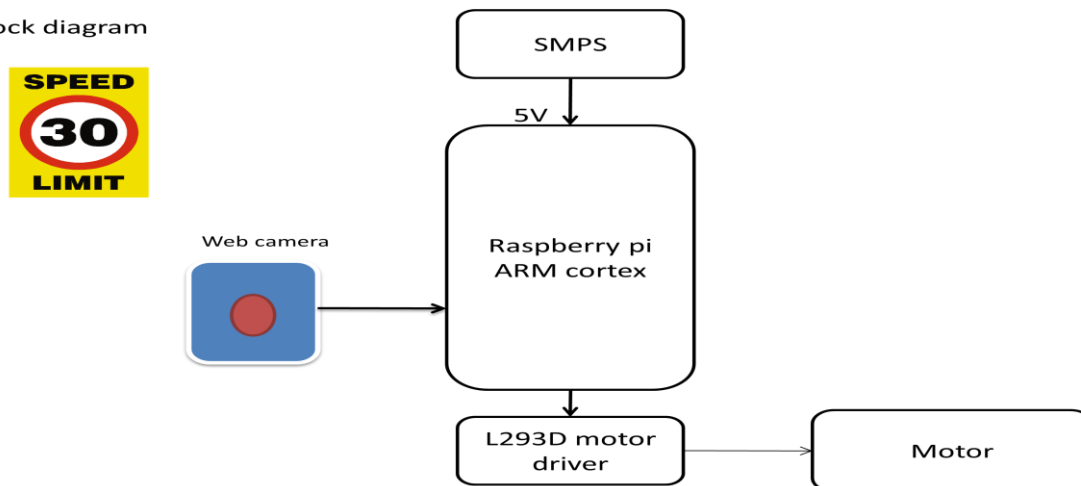
- Switching regulators are used as replacements for linear regulators when higher efficiency, smaller size or lighter weight are required. They are, however, more complicated; their switching currents can cause electrical noise problems if not carefully suppressed, and simple designs may have a poor power factor.

L293D MOTOR DRIVER

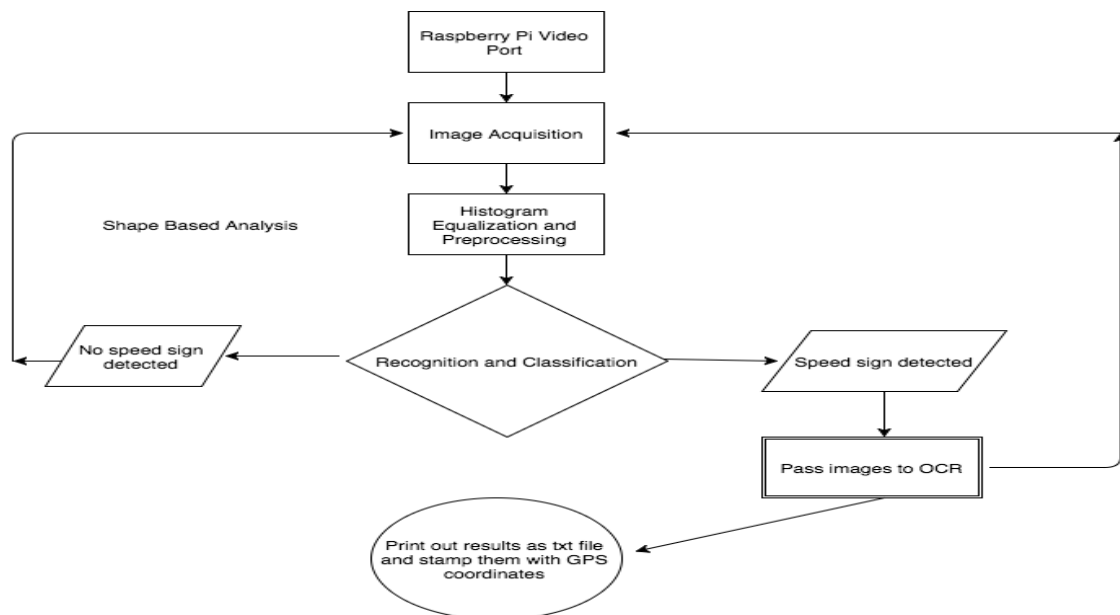
- L293D is a typical Motor driver or Motor Driver IC which allows DC motor to drive on either direction. L293D is a 16-pin IC which can control a set of two DC motors simultaneously in any direction. It means that you can control two DC motor with a single L293D IC. Dual H-bridge *Motor Driver integrated circuit (IC)*.
- The power supply from SMPS is 5v. the required voltage for a motor is 12v, L293D driver gives a step up voltage.

IV. BLOCK DIAGRAM

Block diagram



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CAPTURING IMAGES

A Raspberry Pi is capable of capturing a sequence of images rapidly by utilizing its video- capture port with JPEG encoder.

- Images may not be in a desired resolution/size all the time (distorted, rotated,blurred etc.).
- Denoising algorithms are to be applied.
- Capture sequence method is used in this project as that is the fastest way to get the road sign.
- Using the capture sequence method our Raspberry Pi camera is able to capture images in rate of 20fps at a 640×480 resolution.
- One of the major issues is the size, memory and bandwidth.

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Volume 5, Issue 1, January 2018

PREPROCESSING

- Pre-processing stage consists of three steps: Skew Correction, Binarization and Noise removal. The captured image is checked for skewing. There are possibilities of image getting skewed with either left or right orientation. Here the image is first brightened and binarized.
- The function for skew detection checks for an angle of orientation between ± 15 degrees and if detected then a simple image rotation is carried out till the lines match with the true horizontal axis, which produces a skew corrected image. The noise introduced during capturing or due to poor quality of the page has to be cleared before further processing.

Multithreading in Capturing and Processing Images

- Taking the IO bandwidth constraints into account structuring the multithread is important
- The sequence of images (VIDEO) is broken into pieces of information (INDIVIDUAL IMAGES).
- The broken frame of information (IMAGE) is being tested with the reference pre-stored image.
- A synchronization should be maintained between the image capturing and processing or else a stall would occur.

Feature Extraction

- Feature extraction is the individual image, glyph is considered and extracted for features.
- First a character glyph is defined by the following attributes: Height of the character; Width of the character; Numbers of horizontal lines present—short and long; Numbers of vertical lines present—short and long; Numbers of circles present; Numbers of horizontally oriented arcs; Numbers of vertically oriented arcs; Centroid of the image; Position of the various features; Pixels in the various regions.

DETECTING SIGNS

The shape detection is based on the OpenCV's Python implementation preceded by filtering and edge detection. To prevent the noise from being mistaken as edges, and produce wrong results, the noise must be reduced to certain level. Thus, the images are smoothed by applying Gaussian Filter. The purpose of the edge detection is to significantly reduce the amount of data in the image by converting the image into binary format. In our application it is important to find the rectangles in each of frames as these may potentially correspond to road speed signs. This shape detection must be done at least once in every 40 frames to ensure close to real processing.

CANNY DETECTION ALGORITHM

- Apply Gaussian filter to smooth the image in order to remove the noise
- Find the intensity gradients of the image
- Apply non-maximum suppression to get rid of spurious response to edge detection
- Apply double threshold to determine potential edges
- Track edge by *hysteresis*: Finalize the detection of edges by suppressing all the other edges that are weak and not connected to strong edges.

RECOGNISATION SPEED SIGNS

K-NEAREST ALGORITHM

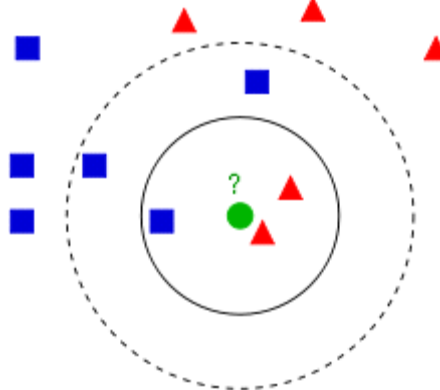
In pattern recognition, the k-nearest neighbors algorithm (k-NN) is a non-parametric method used for classification and regression.[1] In both cases, the input consists of the k closest training examples in the feature space. The output depends on whether k-NN is used for classification or regression:

- In k-NN classification, the output is a class membership. An object is classified by a majority vote of its neighbors, with the object being assigned to the class most common among its k nearest neighbors (k is a positive integer, typically small). If $k = 1$, then the object is simply assigned to the class of that single nearest neighbor.
- In k-NN regression, the output is the property value for the object. This value is the average of the values of its k nearest neighbors.

A commonly used distance metric for continuous variables is Euclidean distance. For discrete variables, such as for text classification, another metric can be used, such as the overlap metric (or Hamming distance). In the context of gene expression micro array data, for example, k-NN has also been employed with correlation coefficients such as Pearson and Spearman.[3] Often, the classification accuracy of k-NN can be improved significantly if the distance metric is

learned with specialized algorithms such as Large Margin Nearest Neighbor or Neighbourhood components analysis.

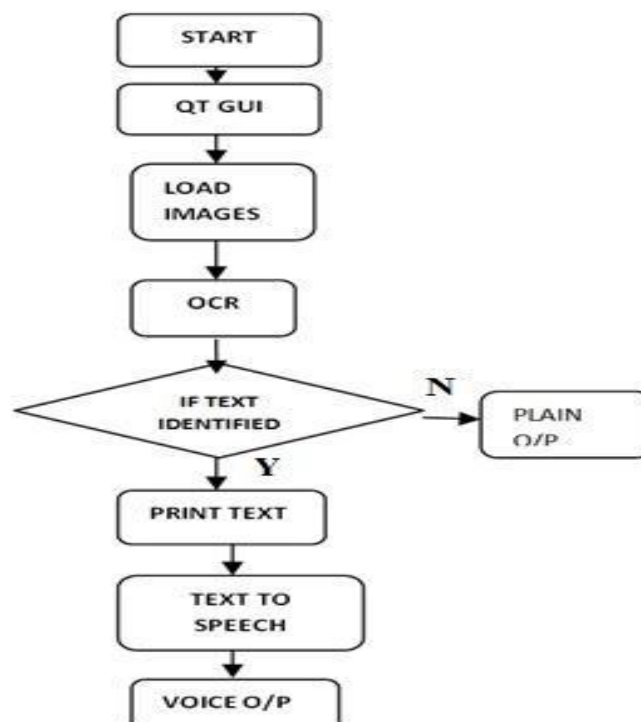
Both for classification and regression, it can be useful to assign weight to the contributions of the neighbors, so that the nearer neighbors contribute more to the average than the more distant ones. For example, a common weighting scheme consists in giving each neighbor a weight of $1/d$, where d is the distance to the neighbor.[2]



Example of k-NN classification.

The test sample (green circle) should be classified either to the first class of blue squares or to the second class of red triangles. If $k = 3$ (solid line circle) it is assigned to the second class because there are 2 triangles and only 1 square inside the inner circle. If $k = 5$ (dashed line circle) it is assigned to the first class (3 squares vs. 2 triangles inside the outer circle). The neighbours are taken from a set of objects for which the correct classification (or, in the case of regression, the value of the property) is known. This can be thought of as the training set for the algorithm, though no explicit training step is required. The k-nearest neighbor algorithm is sensitive to the local structure of the data.

Nearest neighbour rules in effect compute the decision boundary in an implicit manner. It is also possible to compute the decision boundary itself explicitly, and to do so in an efficient manner so that the computational complexity is a function of the boundary complexity



Most systems breakdown when input document images are highly degraded. OCR is a process which associates a symbolic meaning with objects (letters, symbols an number) with the image of a character. It is defined as the process

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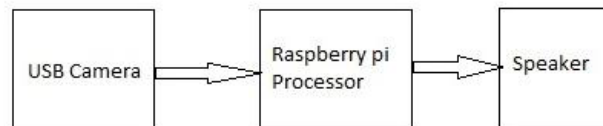
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Volume 5, Issue 1, January 2018

of converting scanned images of machine printed into a computer processable format. A methodology is implemented to recognize sequence of characters and the line of reading. As part of the software development [S. Yanadume,2004] the Open CV (Open source Computer Vision) libraries is utilized to do image capture of English text, to do the character recognition. Optical character recognition (OCR) is the translation of captured images of printed English text into machine-encoded text. It is widely used to convert books and documents into electronic files for use in storage and document analysis. OCR makes it possible to apply techniques such as machine translation, text-to-speech and text mining to the capture / scanned page.

The Hardware system is composed by following parts: an image capturing camera [2006], Raspberry Pi board to run image recognition programs on it and a Headphone to deliver the output speech. The system block diagram is shown in figure



V.CONCLUSION

The work described in this paper is split into two parts, as “detection” and “recognition”. For the detection part, shape-based algorithms were used because color-based segmentation is much less reliable than shape-based segmentation. In cases similar to speed sign detection, they were many different techniques used, such as genetic algorithms, Hough transforms, and artificial neural networks based algorithms. Complex techniques were not chosen because the computation power of raspberry power is limited despite their availability within the OpenCV libraries (such as Eigen faces, SURF-SIFT template matching, and Fuzzy matching). Other classifiers like k nearest neighbour, and Euclidian distance were chosen for this project in order to keep Raspberry pi running. Speed sign detection in different conditions like lighting, disorientation was not tested well. Detection, tracking and recognition are interwoven. But recognition reduces false positives and detection narrows the choices and increases accuracy of a system. Keeping the results is another important part; as the result needs to be improved as more databases are being developed by the time. This project’s implementation focused on real-time video processing, however, for future work (direction, trajectory, speed changes etc.) should be considered to improve the system’s robustness of the speed sign reading process. A comparison of the performance within an embedded system of this project will provide the baseline of the improvements. However, the lack of an open source evaluation framework for similar systems (datasets for speed signs, labelled data etc.) makes it hard to perform that comparison. Our work supports claims that the complexity of traffic sign recognition systems will continue to be reduced in the near future as embedded technology advances.

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