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Smart Road Sign Detection for Driver Assistance System

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Abstract: **The aim of the project is to detect and recognize traffic signs in video sequences recorded by an onboard vehicle camera. Traffic Sign Recognition (TSR) is used to regulate traffic signs, warn a driver and command or prohibit certain actions. A fast real-time and robust automatic traffic sign detection and recognition can support and disburden the driver and significantly increase driving safety and comfort. Automatic recognition of traffic signs is also important for automated intelligent driving vehicle or driver assistance systems. This paper presents a study to recognize traffic sign patterns using openCV technique. The main objective of this paper is to demonstrate the ability of image processing algorithms on a small computing platform. Specifically we created a road sign recognition system based on an embedded system that reads and recognizes Traffic signs, requirements and also describes difficulties behind implementing a real time base system with embedded system and how to deal with diff colors using image processing techniques based on shape and dimension analysis. The paper also shows the techniques used for classification and recognition of images of traffic signs. Here color analysis plays a specifically important role in many other different applications for Traffic sign detection. Raspberry Pi is the main target for the implementation as it provides an interface between sensors, database and image processing results while also performing functions to manipulate peripherals units.**

***Index Terms*—Raspberry Pi, Arduinomega2560, data analytics, HC05, Cascades**

I. INTRODUCTION

Safety is an important issue nowadays. Supervised learning systems are powerful tools for monitoring, managing and creating a safe and precautionary environment by implying artificial intelligence. Efforts are being made to design intelligent detection systems that are capable to recognize the objects. Background modelling method should be able to adapt the gradual variations in the scene due to the lighting condition e.g. raining or sudden change from daylight to lights in the evening, shadow regions, etc. Due to dynamic changes in the background, motion detection becomes difficult. After detection, tracking is done. The main purpose of tracking is to carry out real time tracking on the detected target and to calculate the tracking target in the exact location. The feature extraction technique must be invariant to rotation, change in illumination, etc. The classifier must consume less time for training and also there must be lesser number of input parameters that need to be provided for classifier. Supervised learning system has got more research area in computer vision applications. Video surveillance system is a powerful tool used for detecting the object and performing an automatic action accordingly. There is a need for effective Monitoring of places due to global safety concerns. The main objective of supervised learning is not only to put artificial intelligence in place of human brain but it should be capable to recognize the object automatically. The goal is to detect and track an object and perform an automatic action. The ongoing research on object tracking in video sequences has attracted many researchers. Detecting the objects in the video and tracking its motion to identify its characteristics has been emerging as a demanding research area in the domain of Image processing and computer vision. This is to give a review on the state of the art tracking methods, categorize them into different categories, and then identify useful tracking methods. Most of the methods include object segmentation using background subtraction. The tracking strategies use different methodologies like Mean-shift, Kalman filter, Particle filter etc. The performance of the tracking methods vary with respect to background information. Road and traffic signs have been designed to be principally distinguishable from the natural and/or man-made backgrounds. They are characterized by many features make them recognizable with respect to the environment. Road signs are designed, manufactured and installed according to tight regulations. They are designed in fixed 2-D shapes like triangles, circles, octagons, or rectangles. The colors of the signs are chosen to be far away from the environment, which make them easily recognizable by the drivers. The information on the sign has one colour and the rest of the sign has another colour. The tint of the paint that covers the sign should correspond to a specific wavelength in the visible spectrum. The signs are located in well-defined locations with respect to the road, so that the driver can, more or less, expect the location of these signs. They may contain a pictogram, a string of characters or both. The road signs are characterized by using fixed text fonts, and character heights. They can appear in different conditions, including partly occulted, distorted, damaged and clustered in a group of more than one sign.

A controller board based on the ATmega2560 was deployed for the prototype design. diagram consists of a microprocessor i.e. Raspberry Pi which handles all the image processing action in the project. When the camera captures the video sequence, if the particular image's match is found from

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the database the processor sends signal to microcontroller i.e. Arduino atmega 2560 based on the image particular action is taken to control the motor. As a precautionary step ultrasonic sensor is placed to detect obstacles and stops the vehicle. The LCD displays the action taken in form of picture and text. Furthermore we have a Bluetooth module to manually control the vehicle which ceases its action in case the microcontroller takes any action.

II.LITERATURE SURVEY

From the collected training sets, they built LBP histograms, then used these histograms as inputs to the learning application and trained the face classifier, detection result was quite good. Finally, they implement a face detector which uses trained face classifier as a S60 Symbian application. On VGA input, a face detection which use LBP-based classifier took 3.2 second to process whole image while Haar-like feature based classifier took 6.3 seconds to process image.

Later they introduced and implemented a face detection algorithm, based on LBP features. Motivated by the fact that computing Haar-like features are too computationally heavy to work on mobile product, they utilized another feature which was computationally simpler than Haar-like feature. Although LBP feature is simpler, their implementation shows that it is enough to discriminate faces and non faces faster. Later they introduced and implemented a face detection algorithm, based on LBP features. Motivated by the fact that computing Haar-like features are too computationally heavy to work on mobile product, they utilized another feature which was computationally simpler than Haar-like feature. Although LBP feature is simpler, their implementation shows that it is enough to discriminate faces and non faces faster.

They presented the properties of two types of neural networks: radial basis function networks and feed-forward network. The advantages and disadvantages of the two types of neural network architectures were shown based on examples. The examples indicated approaches to be taken relative to the network model selection for applications. Artificial neural networks (ANN) are distributed systems composed of several processing units called artificial neurons that calculate with certain mathematical functions. The design of ANNs was motivated by the structure of a real brain. Artificial neurons are the smallest unit in the neural network. These units are arranged in one or more layers and interconnected by a large number of connections. An artificial neural network (ANN) has the ability to learn from experiences, improving its performance and adapting to the changes in the environment. ANN approach is convenient when an analytical model is difficult to obtain.

Considering the potential of this approach, paper established the comparison between Multilayer FeedForward network (FFN) and a Radial Basis Function Network (RBF) for object tracking. The RBF and FFN networks are usually used in the same kind of applications (nonlinear mapping approximation and pattern recognition), however their internal calculation structures are different. Traditional neural networks need to be well trained before it is applied for applications. Training data can be directly applied as network inputs, and the networks parameters, called "weights", are adjusted iteratively according with the differences between desired network behaviors and actual network behaviors.

III. RELATED WORK

There are many researches in the literature deal with Road Sign Recognition (RSR) problem. In this section, we will explore some of those approaches.

3.1 Fast grey scale road sign model Matching and recognition

Mobile Mapping is a standard technique for compiling cartographic information from a mobile vehicle. [1] author paper proposes a novel method for modeling the recognition in a Mobile Mapping process that consists in fitting a model to recover the sign distortion and applying recognition techniques on weak classifiers cascade results. High variance of sign appearance has made the detection and recognition of road signs a computer vision problem over which many studies have lately been performed. There are two main approaches in this field, the color-based and the grayscale based sign recognition. Color-based approach allows reducing International Journal of Computer Applications (0975 – 8887) Volume 120 – No.24, June 2015. 11 false positives results in the recognition process whereas grayscale methods concentrate on the geometry of the model to recognize it. The color-based studies are based on segmentation by thresholding in color space [2][3][4]. Ghica [5] study focused exclusively on neural networks that are used for image filtering and sign recognition, while other approaches are based on genetic algorithms [6]. The studies on gray-scale images use geometric reasoning [7] and most of them on the Hough transforms, and usually color is used as a complementary

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technique to eliminate false positive results of the classification method.

3.2 Detection by Adaboost

The Adaboost algorithm presents a general framework to combine classifiers in order to solve the supervised pattern recognition problem . This approach consists of a) choosing a (weak) classifier, b) modifying example weights in order to give priority to examples where the previous classifiers fail, and c) combining classifiers in a multiple classifier. As a result, each state of the boosting process, which selects a new weak classifier, can be viewed as a feature selection process where features correspond to the image pixels values . The input images of our recognition procedure are provided by the weak classifiers cascade detection process .

3.3 Road Traffic Sign Detection

Author suggest for road vehicles can have three main roles: a) road detection; b) obstacle detection; and c) sign recognition. The first two have been studied for many years and with many good results, but traffic sign recognition is a less-studied field. Traffic signs provide drivers with very valuable information about the road, in order to make driving safer and easier. They think that traffic signs must play the same role for autonomous vehicles. They are designed to be easily recognized by human drivers mainly because their color and shapes are very different from natural environments. The algorithm described in this paper takes advantage of these features. It has two main parts. The first one, for the detection, uses color thresholding to segment the image and shape analysis to detect the signs. The second one, for the classification, uses a neural network. Some results from natural scenes are shown. On the other hand, the algorithm is valid to detect other kinds of marks that would tell the mobile robot to perform some task at that place.

3.4 Traffic sign detection

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 format of 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 color. Finally, there are two exceptions: a) the yield sign, an inverted triangle; and b) the stop sign, a hexagon. They were not studied here. To detect the position of the sign in the image, we must know the two properties we talked about before, i.e., color and shape.

IV. SYSTEM ANALYSIS

4.1. Existing System

Active contour model is used for finding object outline from an image. In the contour-based tracking algorithm, the objects are tracked by considering their outlines as boundary contours. Thereafter these contours are updated dynamically in successive frames. Active contour model is used for finding object outline from an image. In the contour-based tracking algorithm, the objects are tracked by considering their outlines as boundary contours. Thereafter these contours are updated dynamically in successive frames.

4.2. Proposed System

When the camera captures the video sequence, if the particular image's match is found from the database the processor sends signal to microcontroller i.e. Arduino atmega 2560 based on the image particular action is taken to control the motor. As a precautionary step ultrasonic sensor is placed to detect obstacles and stops the vehicle. The LCD displays the action taken in form of picture and text. Furthermore we have a Bluetooth module to manually control the vehicle which ceases its action in case the microcontroller takes any action.

4.3. System Design

Tracking objects in video sequences of surveillance camera is nowadays a demanding application. Tracking objects is much more challenging in video sequences to improve recognition and tracking performances. There are many existing methods of object tracking but all has some drawbacks. Some of the existing models for object tracking are contour-based models, region-based models and feature point-based models. When the camera captures the video sequence, if the particular image's match is found from the database the processor sends signal to microcontroller i.e. Arduino atmega 2560 based on the image particular action is taken to control the motor. As a precautionary step ultrasonic sensor is placed to detect obstacles and stops the vehicle. The LCD displays the action taken in form of picture and text. Furthermore we have a Bluetooth module to manually control

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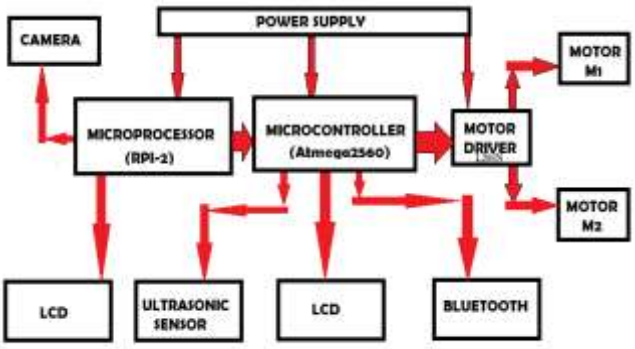

Fig1:Block Diagram of SRSD

In this project, Arduino UNO with an on board ATMEGA2560 Microcontroller and Raspberry Pi is used. The Atmega2560 on the Arduino Mega comes pre burned with a bootloader that allows you to upload new code to it without the use of an external hardware programmer. It communicates using the original STK500 protocol (reference, C header files). When a traffic sign is encountered a signal is sent from GPIO pins of the Raspberry Pi to the Arduino to take specific action such as STOP, SPEED LIMIT etc. The system implementation of the proposed design is illustrated in Figure below:

V. SOFTWARE ARCHITECTURE

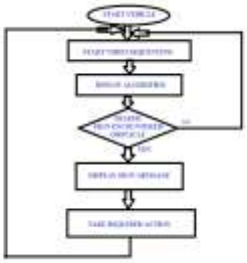

Fig3:Flow Chart

As the vehicle starts the camera starts its video sequencing, based on the algorithms deployed the vehicle moves further and carries all its processing actions. When an obstacles/traffic sign is detected the action is displayed on the LCD and the necessary action for the speed control of motor is taken.

6. Expeimental Workdone

The experimental work is based on traffic sign database. It is a standard information database which contains different signs of on road traffic rules. There are 3 traffic signs STOP and SPEED LIMIT (30) and a red traffic street light that we have used to train and store in database. Each sign has its own activity which is performed accordingly what the signs signifies.

Figure 5: Signs used

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Results of Sign Detection/Tracking There are different action classes and we have done our experiments on different signs. Colour Based Thresholding is done to detect the red portion around the traffic signs. In our experimental work, we are taking 3 different signs and they signify their own particular action.Results of Sign Detection After all the signs were analysed. Results of traffic sign detection are obtained by using colour based thresholding. The output will be a gray scale image. We use median filter to filter out the noise component. Then the resulting image is converted into binary image. If the neighbourhood pixels of the resulting image is less than 300 pixels is removed so that the small traces of noise in the image can be easily removed.

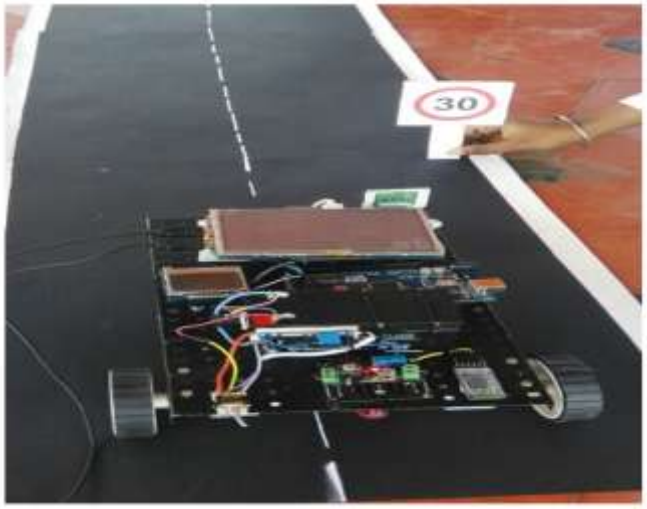

Fig4:Project Vehicle

VII. CONCLUSION AND FUTURE ENHANCEMENT

Object Detection and Tracking is very important for any intelligent system for applications in Robotics & Intelligent Systems. Recognizing traffic signs poses various challenges as it is tedious to continuously monitor the screen; it leads to human boredom and fatigue. Hence, there is the need of an intelligent surveillance system that can automatically recognize various traffic signs and accordingly take precautionary steps that may avoid collisions or accidents to happen. In this project work, object detection and tracking (specifically the traffic signs) has been done to automate the driving system. The various stages for Object Detection and Tracking are: Colour Based Thresholding, Training the system using Haar and LBP cascading, Crop the resulting image, feature extraction, classification & evaluation. Object detection has been done using colour based thresholding, , feature extraction has been done based on HOG (Histograms of Oriented Gradients). Classification has been done using Multi-SVM and Adaboost. The signals which are sent by the processor help the controller to take the required action.

Implementing the same algorithm as defined in our project work on digital signal processors can reduce the volume and cost, and can increase speed and reliability. The system can be given an additional feature using GPS by helping the vehicle to operate at times of dull illumination, as a high definition and costly camera is required for night detection. Moreover, different training algorithms can be cascaded together for better feature extraction for large number of signal detection. Further the same algorithm can be implemented on automatic vehicles to reduce road accidents leading to safety of human beings and the vehicle in our project can only detect and say which traffic sign is encountered but this is incomplete unless and until it is implemented in an intelligent system may be artificial intelligence or any other intelligent system in order to make it fully automated.

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