An ANN based Technique for On-Road Vehicle Identification and Trail

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ABSTRACT
This paper introduces an artificial neural network(ANN) based machine learning technique for on-road vehicle recognition and tracking that falls under the machine learning community. The feature extraction technique employed in this recognition and tracking system is multilevel Haar Wavelet transform which mainly focuses in separating low frequency components from high frequency components present in the image. This highlighted feature of Haar transform enables to increase the transmission speed of images and considerably aids in reducing the noise level. The neural network is trained by the images from database which has been subjected to feature extraction. The robust on-road vehicle recognition system is then integrated with a Kalman filter, which is extended to multiple vehicle tracking system to build complete vehicle recognition and tracking system and it has been evaluated on public domain vehicle images. This study reveals that this system yields high recalling rate, appreciable precision, and better localization effects on the recognized and tracked images.

General Terms
Image recognition, Tracking, filtering

Keywords
Machine learning, feature extraction, ANN

1. INTRODUCTION
Automotive accidents that occur worldwide tends to injure atleast 20 to 50 million people annually. As a result of these accidents it is estimated that roughly 1.2 million people face their tragic ends each year which tends to be a major factor of concern. Moreover medical care, damage incurred to properties and other miscellaneous expenses associated with auto accidents accounts nearly 1% to 3% of worlds domestic product[9]. Owing to these problems faced economically and pains encountered physically there has been a tremendous interest in developing safety systems by vehicle manufacturers and academics.

Accuracy, reliability and efficiency in identifying hazardous conditions are the basic requirements of safety systems [3]. Generally interest is subjected in designing a safety system which, with much tactics helps in avoiding collisions by gracefully detecting lane departures [6] pedestrians [1] or other vehicles [5]. Computer vision is a critical technology that is recognized worldwide in the development of intelligent vehicles. An intuitive way of information delivery to human drivers is a peculiar potential showcased by this vision-based vehicle recognition technique [4]. This paper introduces an attractive framework for vehicle recognition and tracking. This vehicle recognition based learning system adopts two iterations, one employing training the neural network and the other points to the tracking phenomena which aids vehicle recognition. This adopted style of learning portrays acutely a much significant drop in false positives per frame and false-detection rates while at the same time care is being imposed in maintaining a high vehicle-recognition rate [11]. This recognition and tracking system is integrated precisely with a special type of filter say Kalman which extends its support in multiple vehicle tracking. The novelty and contributions of this paper encapsulates the following. A general learning framework for on-road vehicle recognition and tracking succeeds neural based learning. Correlation of tracked images with trained neural network is adopted to rightly recognize and track the vehicles on-road. Experimental results reveals that this effectively trained recognition and tracking system will yield an admirable precision and recalling rates and at the same time maintaining good localization effects.

2. NEURAL BASED LEARNING
Neural based learning falls under machine learning community. Machine learning is simply a twig of artificial intelligence, which is associated with the erection and study of systems that can learn from data. Machine learning adopts two fundamental terms namely representation and generalization. Representation refers in portraying data instances and evaluating functions on these instances.

Generalization is the property that the system will perform well on unobserved data occurrences. Neural network depicts a computing system made up of a number of simple, highly interconnected processing fundamentals, which routes information by their dynamic state response to external inputs [8].

Neural networks are generally organized in layers. Layers are composed of multiple interconnected nodes that include an activation function. Patterns are introduced to the network by means of an input layer, which corresponds to one or more hidden layers where the actual processing is done through a system of weighted connections, which ultimately links to an output layer [10]. The diagram of feed forward back propagation neural network is shown below in Fig.a.

Each of the circles in the Fig a is termed a unit alias neuron which contains an input-output transfer function. Feed forward back propagation neural network is employed in this paper which uses a variety of transfer functions. The extracted wavelet features of the loaded database images serves as the input in training the neural network. This trained neural network is then saved which completes the neural based learning in vehicle recognition and tracking framework.

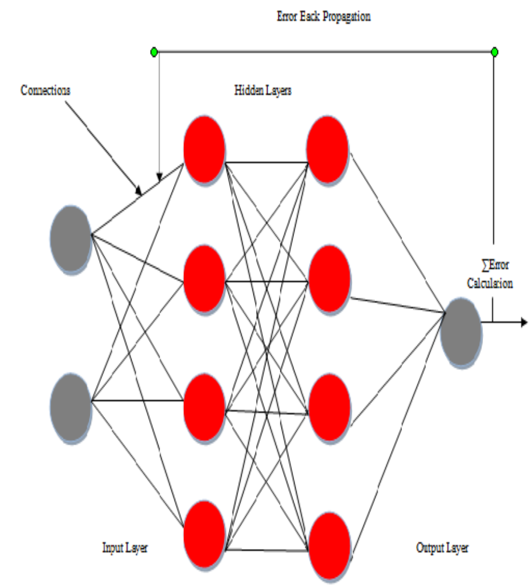

Fig.a. Feed forward neural network

3. VEHICLE RECOGNITION AND TRACKING

Vehicle recognition and tracking proceeds with the tracking process. The tracking process incorporates several steps for its completion. Receiving the inputs, foreground detection, filtering and cropping are the steps which forms the basis of tracking. The block diagram that depicts the complete functional description of vehicle recognition and tracking is shown in Fig.b.

3.1 Receiving the Inputs

Receiving the inputs forms the first step in the tracking process. A PC is employed in receiving the inputs that is the video images and converts them to frames. These converted frames of video images are then employed in foreground detection.

3.2 Foreground Detection

Inorder to check whether the individual pixels of a particular video frame belong to background or foreground, the foreground detector performs a comparison of color or grayscale of that particular video frame with a background model.

It then computes a foreground mask. Given a series of either grayscale or color video frames, the foreground detector computes the foreground mask using Gaussian Mixture Model(GMM). GMM is employed to detect the foreground which helps in the conversion of foreground mask to binary format.

Gaussian Mixture models are formed by combining multivariate normal density components. These are often used for data clustering. These binary images that are produced as output by foreground detector is subjected to filtering.

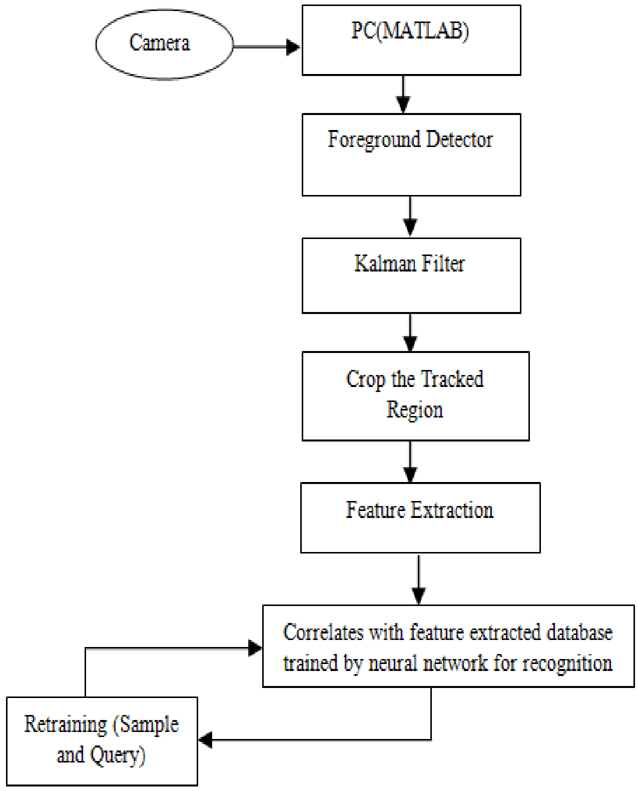

Fig.b. Functional description of vehicle recognition and tracking

3.3 Kalman Filter

One of the key features of Kalman filter is its ability to track multiple objects [7]. Here objects refer to vehicles. The Kalman filter has numerous technical applications. A common application is controlling of vehicles.

Kalman filter, alias linear quadratic estimation is an algorithm that utilizes a series of measurements surveyed over time, containing noise which are the unsystematic deviations and also includes other inaccuracies and produces estimates of nameless variables that tend to be more accurate than those based on a solitary measurement alone.

Kalman filter functions continuously on torrents of noisy input data from foreground detector to generate a statistically best possible estimate of the principal system state. The working of the filter is based on a two-step process. The Kalman filter generates estimates of the current state variables along with their uncertainties in the forecasting process.

Once the result of the subsequent measurement is scrutinized, these approximates are rationalized using a weighted average, with more weightage given to approximates with privileged certainty. In this way the filter helps in classifying the frames into assigned, unassigned, missed or predicted.

Thus Kalman filter aids in multi tracking of the vehicles, based on the frame classification. If certain frames in a particular track are not tracked for a specific amount of time, then those tracks will be deleted automatically. This completes the tracking process which is succeeded by cropping and feature extraction which opens the door for recognition phenomena.

3.4 Cropping and Feature Extraction

The tracked region by Kalman filter alone is cropped and taken separately. To this cropped tracked region, feature extraction technique is applied. Discreet Wavelet Transform is the feature extraction technique adopted in this paper.

Feature extraction technique is mainly used in this paper to separate the high frequency components such as noise present in the image from low frequency components of the image so that noise gets eliminated and helps in fast transmission of images from wavelet transform block to neural network for correlation and recognition process[2].

4. CORRELATION AND RECOGNITION

The feature extracted and cropped regions of the tracked images of Kalman filter is subjected to correlation. Correlation simply means comparing this tracked region of the filter with the feature extracted images loaded in the data base with the help of an acute learning and classification process say neural network which also has been well trained to aid in correlation of the tracked images.

During this correlation process if the correlation factor exceeds a specified factor say 0.9, then the image is said to be tracked and hence recognized. This forms the final step in tracking and recognition process. Thus starting with neural learning, succeeded by tracking and recognition completes the process of on-road vehicle recognition and tracking.

5. EXPERIMENTAL EVALUATION

The experimental evaluation reveals that there is considerable drop in false positives per frame and increase in true positive rates. True positive rate is defined as the ratio of detected vehicles to total number of vehicles. False positives are a factor that is employed in the estimation of false detection rates. False detection rate is defined as the ratio of false positives to the sum of detected vehicles and false positives.

These two parameters are thus involved in estimating the performance, efficiency and linearity of the tracked regions. Fig.c illustrates the improved performance and Fig.d illustrates the linearity and appreciable efficiency in tracking. Performance plot of Fig.c depicts that the tracking is achieved with less number of epochs or iteration. Fig.d shows the linearity and the peak efficiency in tracking.

This project is implemented using MATLAB version R2013a, which is a numerical computing environment and fourth generation programming language. This most recent version of MATLAB employs computer vision system toolbox. This toolbox offers tools and algorithms for the simulation and design of video processing systems and computer vision.

It also includes systematic procedures for detecting the motions, extracting the features, object detection and tracking, video processing and analysis, stereo vision etc. For swift prototyping and embedded system design, the system toolbox bears fixed point arithmetic and C-code generation unit.

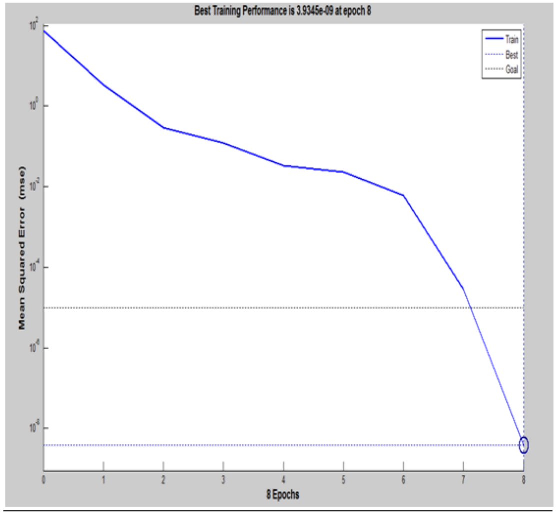

Fig.c. Performance plot

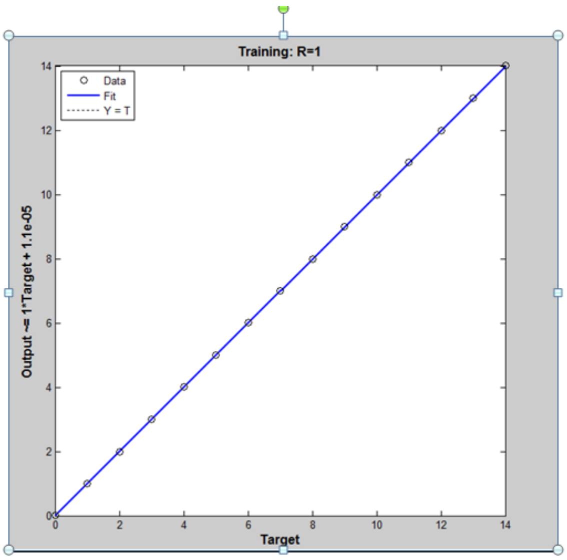

Fig.d. Linearity plot

6. CONCLUSION

The neural based framework for on-road vehicle recognition and tracking is introduced in this paper aided with multilevel Haar wavelet as feature extraction technique and feedforward backpropagation neural network as learning, classification method. This neural based framework helps in implementing complete vehicle recognition and tracking

system, coupled with a detailed quantitative analysis. The designed system has been evaluated on public domain vehicle images, which thereby yields a notable precision and recalling rates coupled with an appreciable localization and robustness effect.

The research efforts include the following areas:

- Pedestrian-protection systems
- Trajectory learning
- Integrated Active Safety Systems

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Mr. B. Karunamoorthy received B.E (EEE) from Madras University in 2001 and M.E in Power Electronics and Drives from Anna University in 2005. Presently he is working as Assistant Professor in Kumaraguru College of Technology. He has 4 years of industrial experience and 8 years of teaching experience.

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