© 2018 IJSRSET | Volume 4 | Issue 10 | Print ISSN: 2395-1990 | Online ISSN : 2394-4099
Themed Section : Engineering and Technology

A Comparison between Neural Network and Support Vector Machine in Classifying Static and Real-Time Images

Ahmed Abdal Shafi Rasel, Aiasha Siddika, Md. Towhidul Islam Robin
Department of Computer Science and Engineering, Stamford University Bangladesh

ABSTRACT

The objective of this paper is to make an overall comparison between Neural Network (NN) and Support Vector Machine (SVM) in classifying static and real-time images. The dataset is composed of images from which the feature vector is extracted and given as training data for the classifiers. In this work, we are using Histogram of Oriented Gradients (HOG) as our feature vector. The experimental result shows SVM to be slightly overperforming Multi-Layer Perceptron (MLP) in detecting humans from static and real-time images.
Keywords : Artificial Neural Network, Support Vector Machine, Image Classification

I. INTRODUCTION

In the field of computer vision, identifying or classifying different categories of images is of primary concern. Among various classification techniques, Artificial Neural Network and Support Vector Machine are among the mostly used techniques. In this work, we have extracted features from a set of images of different classes and provided them with training data for both the multi-class SVM and Neural Network. After that, we have analyzed their performance in classifying the test data provided. The system model proposed in this paper can be applied in many practical applications which require image recognition as part of their framework.

The rest of the paper is organized in sequence. Section II describes the literature review, section III demonstrates the methodology whereby we analyzed the performance of ANN and SVM. Section IV shows the experimental results & discussion and conclusions of our work is in Section V.

II. LITERATURE REVIEW

Many studies and practical works have been done on Support Vector Machine [1][2] and Artificial Neural Network [3][4]. Both techniques have evolved into more sophisticated classification technique over the years and resulted into having multiple variations.

,Different classification methods are there other than Neural Network and SVM. Fuzzy c-means clustering [5], Kalman Filtering [6] and Hidden Markov Model (HMM) [7] are among them. In this paper, we will be focusing only on Neural Network and SVM (Support Vector Machine). To use classifiers we need to extract relevant features from image data before feeding it into the neural network or SVM. There are various feature extraction methods. Principal Component Analysis (PCA) [8] [9] and Independent Component Analysis (ICA) [10] [11] have been used in many applications. Also, Histogram of Oriented Gradients (HOG) [12] [13] [14], Scale-invariant feature transform (SIFT) [15] [16] and Speeded Up Robust Features (SURF) [17] are quite popular in computer vision applications. In this work, we will be using the

HOG feature for both SVM and neural network to analyze their efficiency over the same data.

III. METHODOLOGY

The proposed method consists of identifying humans from different types of static images and real-time videos using both SVM and ANN and then comparing their results to identify which one works better.

A. Classification using Support Vector Machine

The SVM binary classification algorithm searches for an optimal hyperplane that separates the data into two classes. The optimal hyperplane for an SVM means the one with the largest margin between the two classes. Margin means the maximal width of the slab parallel to the hyperplane that has no interior data points. The support vectors are the data points that are closest to the separating hyperplane; these points are on the boundary of the slab. Figure 1. demonstrates the classification of SVM with the Maximum-margin hyperplane.

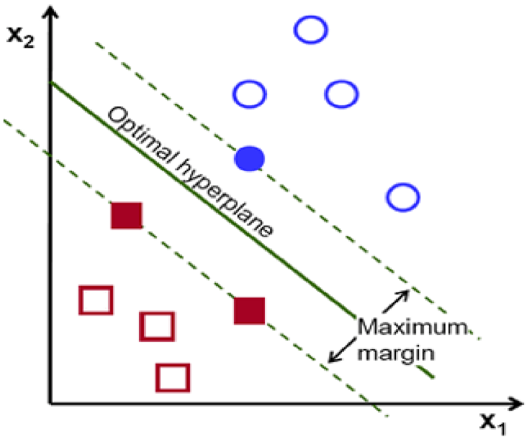

Figure 1. Classification of SVM with Maximum margin hyperplane

Since most practical application involves multiclass classification, a number of methods to generate multiclass SVMs from binary SVMs have been proposed by researchers. One vs. one, one vs. rest, Directed Acyclic Graph (DAG), and Error Corrected Output Coding (ECOC) based multiclass approaches create many binary classifiers and combine their results to determine the class label of a test pixel. We will be using ECOC based multiclass SVM classifier for our work.

B. Classification Using Artificial Neural Network

A neural network is a computing model whose layered structure resembles the networked structure of neurons in the brain, with layers of connected nodes. A neural network can learn from data—so it can be trained to recognize patterns, classify data, and forecast future events.

A neural network breaks down input into layers of abstraction. It can be trained over many examples to recognize patterns in speech or images, for example, just as the human brain does. Its behavior is defined by the way its individual elements are connected and by the strength, or weights, of those connections. These weights are automatically adjusted during training according to a specified learning rule until the neural network performs the desired task correctly.

Feed-forward artificial neural networks or, more particularly, multi-layer perceptrons (MLP) are the most commonly used type of neural networks. MLP consists of the input layer, output layer, and one or more hidden layers. Each layer of MLP includes one or more neurons directionally linked with the neurons from the previous and the next layer. The example below represents a 3-layer perceptron with three inputs, two outputs, and the hidden layer including five neurons.

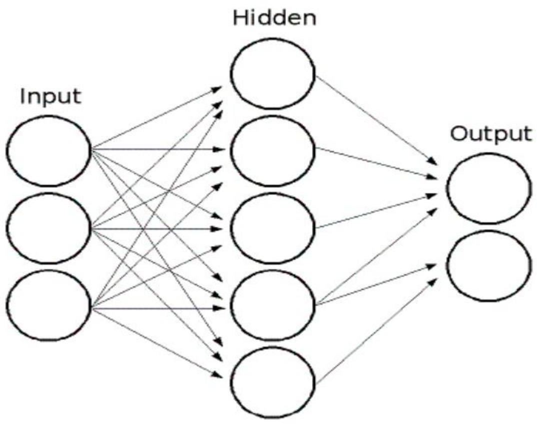

Figure 2. Multi-Layer Perceptrons

In our work, we will be using Multi-Layer Perceptrons for recognizing Humans from static and real-time images.

C. HOG as the Feature Vector

HOG is a feature descriptor which was introduced by Navneet Dalal and Bill Triggs in 2005. HOG is similar to that of edge orientation histograms, scale-invariant feature transform descriptors, and shape contexts, but differs in that it is computed on a dense grid of uniformly spaced cells and uses overlapping local contrast normalization for improved accuracy.

Computation of the HOG descriptor requires the following basic steps.

1. Global image normalization
2. Computing the gradient image
3. Computing gradient histograms
4. Normalizing across blocks
5. Flattening into a feature vector

We will be using HOG feature descriptor with both SVM and Neural Networks in the classification part.

IV. RESULTS AND DISCUSSION

In this section, we discuss the experimental result of using HOG feature descriptor with both Artificial Neural Network and Support Vector.

Firstly, we train the SVM classifier using HOG features. The dataset that we used for this purpose is INRIA Person Dataset. Every 1000 samples of human and non-human are prepared, and their size is 128×64. HOG features of every sample image should be extracted. Each 1000 test images of human and background from INRIA Person training sets are prepared. Table I shows the right rates and error rates of test image samples. For instance, there are 98% human samples are classified as human, while 5% Non-human samples are recognized as human, so the right rate of the Non-human sample is 95%, the error rate is 2%. Figure 3 shows the classification result on a static image.

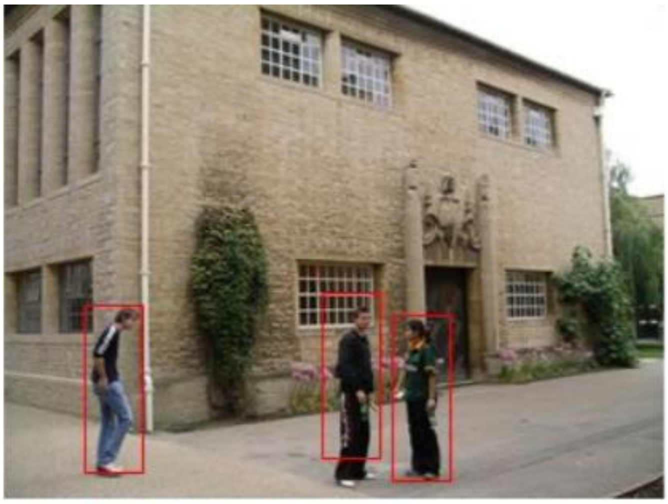

Figure 3. Detection Results on Static Image

Table 1. SVM Classification Results for Static Image

Result / Test Data	Human(%)	Non-Human(%)
Human	98	2
Non-Human	5	95

To compare the performance of classifiers, neural network method is used to show its classification ability. The same with SVM, every 1000 samples of human and non-human are prepared, the HOG features are the input vector of the neural network, and the teacher signal is defined as 1 and 0. New data is prepared to test the classification result after training. Table 2 shows the result.

Table 2. Neural Network Classification Results for Static Image

Result / Test Data	Human(%)	Non-Human(%)
Human	87	13
Non-Human	23	77

By comparisons, SVM is preferable to human classification. Our classification method can be used for the real-time video when the resolution of the scene is 320×240, the frame rate is 20fps, Figure 4 and table 3 show the classification results.

Table 3. Classification Results for Real-Time Videos

Video Stream				
	1	2	3	Total
Total People	300	550	420	1270
Detected People	271	498	377	1146
False Positives	27	48	41	116

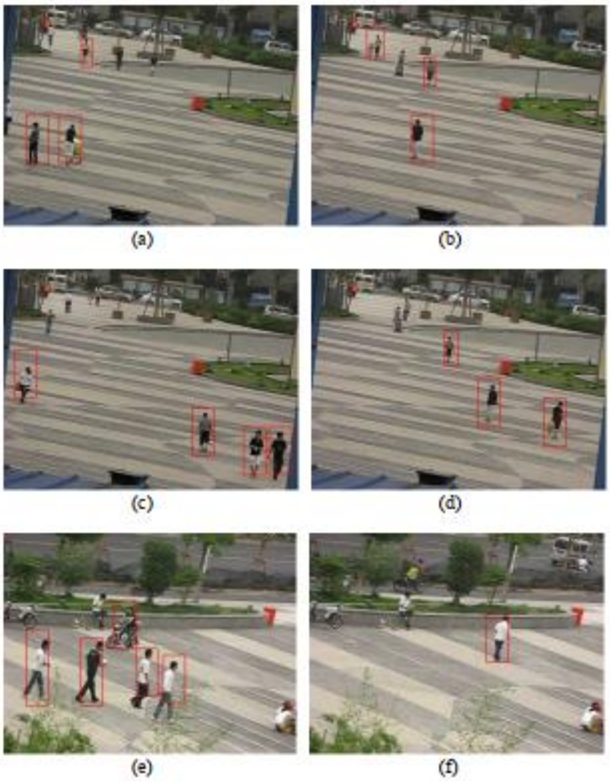

Figure 4. Human Detection from Real-Time Image

The experiments results prove the validity and effectiveness. The recognition accuracy was acquired under a laboratory setting, so it had some limits. In future work, this classification method will be used in intelligent surveillance field.

V. CONCLUSION

This paper outlines a comparison between Neural Network and Support Vector Machine in classifying static and real-time images. In our case, SVM works with better accuracy than Multi-Layer Perceptron in detecting Humans from a range of images. Hopefully, the findings of this paper will provide to be useful in practical applications of relevant fields.

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