

A Novel Approach Object Recognition Using Efficient Support Vector Machine Classifier

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Abstract: In this paper Object Recognition technique is proposed, that produce the best idea to recognize the object from the given input image and it is implemented in MATLAB tool. The past few years, SVM has been applied and estimated only as pixel-based image classifiers. Recently pixel based process moving towards object recognition technique. In an analysis, the SVMs performances are compared with some other classifiers such that BPN classifier and KNN classifier. This technique is obtained by extracting the energies from wave atom transform. The extracted features are given to the SVM classifier as an input and recognize the corresponding image in an object. Finally the experimental results are shown for COIL-100 database. The result of our proposed method is evaluated to increasing the rate of recognition accuracy and correct recognition rate.

Key words: Object Recognition, Wave Atom Transform, SVM Classifier, Classification Rate, Feature Extraction.

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I. Introduction

The Object recognition task is finding and identifying objects in a given image or sequences of videos and it is a basic problem in computer vision. So recognizing two dimensional objects from known images. Generally, most of the researchers consider the feature for recognizing the objects. This method is a very simple task for a human observer. Different approaches have been proposed in this literature. The approach of object recognition has been applied in various applications like manufacturing, which means for defecting the cracks, surveillance system, character recognition of optical and face recognition, etc. It plays a valuable role in pattern recognition and pattern classification. Human beings generally recognizing the objects through vision with great accuracy sometimes objects will be unclear, we consider how this performance was obtained by the researchers. If expand a theoretical problem, they can improve the computer model to recognize an object such as how to model or to recognize the object. In our paper, the proposed method is designed as image obtaining, preprocessing method, extraction process and classification technique.

Our research paper explained the pattern recognition process to the object recognition or classification problem with suitable results using the proposed SVM classifier. It proposes the SVM classifier is the best method for classification of object recognition. SVM is an automatic classifier is an easy to build and implementation method. This approach is very useful for the quality control and inspection task in the industry purposes and that is very successful in a controlled environment. Various methods have been proposed to recognize the objects in real time applications.

Shailedra Kumar Shrivastava, et.al [1] appropriates the Support Vector Machine Recognition for Handwritten Devanagari Numeral Recognition script. Moment invariant techniques are used for extraction process and it is achieved by 18 features are extracted which is used in SVM for recognition process. The kernel mutual subspace method [2] presented the preferable technique for implementing the robust object recognition performed by PCA component testing on multiple input images. This method is a very efficient process for large scale recognition problems. In [3], described the problems of concern in image processing. In an analysis, Artificial Neural Network (ANN) and SVM applied to image classification model has been improved the recognition rate.

In [4], expressed to find the details of the object, the canny edge detection method is occupied. K-Nearest Neighbor is applied to the feature extraction method to recognize the image by compared by available image. The KNN classifier performance was better to compare Fuzzy K-Nearest Neighbor classifier. In [5], involved the Principle Component Analysis (PCA) can be applied to mathematical procedures and it is changed correlated variables into uncorrelated variables have been analyzed. This system is able to determine the front and rear views of pedestrians and also detect the side views of pedestrians in images. In

[6] represents the multiple objects within the images using features as range and color and this approach is reduced saturation noise due to the reflection properties but does not work on the transparent images.

II. Support Vector Machine (Svm) In Image Processing

Recently, some attention has been worked to support vector machines for remote sensing image applications. SVMs only appear to particularly advantageous in the presence of heterogeneous classes and few training samples. SVM is one of the core machine learning technology and SVM have been applied to function such as handwritten digit recognition, object recognition and text classification. The aim of this paper is to demonstrate the SVM potential for a computer vision problem, they recognize the some objects from single images [7]. Recently, the recognition approach has received increasing the some attention from computer vision and psychophysical communities. Generally, to find the SVMs for classification tasks, (i) Feature extraction or data reduction are does not require. (ii) SVM classifier can be applied to the corresponding images directly. The SVM method has been tested on the given images. In the input images, half of the images are training images and remaining half of the images are test images. Then the color information can be discarded and Classifier tested on the remaining images are corrupted and generated noise, bias and occlusions. The recognition rate is achieved by using SVM and it is well suitable for an object recognition technique. Various performance indicators are used to support our experimental results, such as classification accuracy, computational time complexity of the architecture adaptation process and stability of parameter setting. The Support Vector machine classifiers are based on the hyperplanes that can be separate the margin between the two classes are maximized [8]. It is suitable for applying in many real applications including handwritten digital recognition, object recognition, speaker identification, posture recognition in home based health care and tremor cancellation in microsurgery.

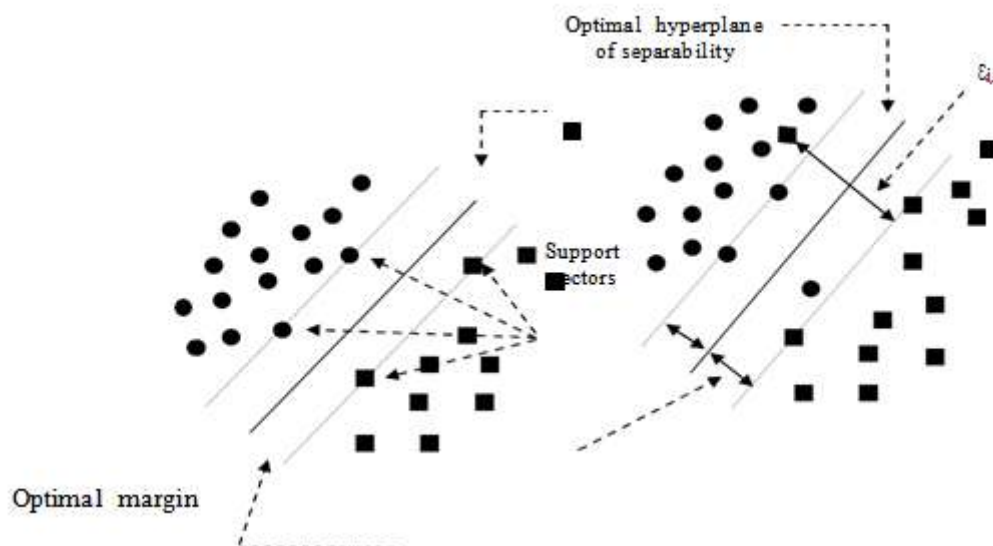


Figure 1 Linear separable classes are considered the left side. Non-linear separable classes considered right side. Estimate the error of the hyperplane fitting.

Let us consider the formulation of a binary classification problem. If the training images are represented by $\{x_i, y_i\}$, where $i = 1, 2, \dots, N$, and $y_i \in \{-1, +1\}$, Where N is the training images, we consider the $y_i = +1$ for class ω_1 and class ω_2 consider the $y_i = -1$. It means possible to calculate the one hyperplane is defined by a vector is consider w with a bias w_0 is separate the classes without error.

$$f(x) = w \cdot x + w_0 = 0 \quad (1)$$

To find a hyperplane, w and w_0 should be calculated in away that $y_i(w \cdot x_i + w_0) \geq +1$ for $Y_i = +1$ (class ω_1) and $y_i(w \cdot x_i + w_0) \leq -1$ for $Y_i = -1$ (class ω_2). These two can be combined and expressed by,

$$y_i(w \cdot x_i + w_0) - 1 \geq 0 \quad (2)$$

Linear and non linear separable classes are supplied for many hyperplanes [9], but there is only one optimal hyperplane is expected to derive better than other hyperplanes are leaving the maximum margin between the classes. If the support vectors must be defined, easy to find the optimal hyperplane. The support vectors lie between two hyperplanes and it is parallel to the optimal plane and estimated by,

$$w \cdot x_i + w_0 = \pm 1 \quad (3)$$

The hyperplane parameters w and w_0 take place, the margin can be given as $\frac{1}{\|w\|}$. Below equation can be used to find an optimal hyperplane by following expressions:

$$\text{Minimize } \frac{1}{2} \|w\|^2 \tag{4}$$

$$\text{Subject to } y_i(w \cdot x_i + w_0) - 1 \geq 0, i = 0, 1, \dots, N$$

The above equation can be translated by using a Lagrangian formulation.

$$\text{Maximize } \sum_{i=1}^N h_i - \frac{1}{2} \sum_{i,j=1}^N h_i h_j v_i \cdot v_j (x_i \cdot x_j)$$

$$\text{Subject to } \sum_{i=1}^N h_i v_i = 0 \text{ and } h_i \geq 0, i = 1, 2, \dots, N$$

Where λ_i are the Lagrange multipliers. The optimal hyperplane discriminant function becomes:

$$f(x) = \sum_{i \in S} h_i v_i(x) + w_0$$

Where S is a subset of training sample images are correspond to the non-zero Lagrange multipliers. These types of training images are called support vectors.

Generally the classes are not linearly separable. So above equation 2 cannot be satisfied. This function can be formulated to combine the maximization of margin and minimization of slack variables ξ is defined by,

$$\text{Minimize } J(w, w_0, \xi) = \frac{1}{2} \|w\|^2 + C \sum_{i=1}^N \xi_i \tag{7}$$

$$\text{Subject to } y_i(w \cdot x + w_0) \geq 1 - \xi_i \tag{8}$$

In the non-linear discriminant functions, the SVM plots high-dimensional feature space into the input vector X and to design the optimal separating hyperplane in that space. Consider the mapping function, the feature vectors is the inner product is to mapping space can be derived as a function of particular vector in the original imagespace.

The inner product operation has been derived as,

$$\Phi(x) \Phi(z) = K(x, z) \tag{9}$$

Where $K(x, z)$ is a kernel function. The kernel function K is used for finding the training images without knowing the explicit form of Φ . The dual optimization problem is followed as,

$$\text{Maximize } \sum_{i=1}^N h_i - \frac{1}{2} \sum_{i,j=1}^N h_i h_j v_i \cdot v_j K(x_i, x_j) \tag{10}$$

$$\text{Subject to } \sum_{i=1}^N h_i v_i = 0 \text{ and } h_i \geq 0, i = 1, 2, \dots, N$$

The classifier result is given below

$$f(x) = \sum_{i \in S} h_i v_i(x) + w_0 \tag{11}$$

Finally, the above equation (11) can be mentioned, the Support Vector Machine was constructed and to be applied only for two class problems. If we use the SVM approach, the binary problems can be reduced.

III. Proposed method

(i). Wave Atom Transform

Wave atom transform suggests a better representation of images constructed by oscillatory patterns. Wave atom transform is the case of fingerprint images and it presents the both the multiscale and the multidirectional properties. The wave atom transforms is able to adapt the arbitrary local directions of a pattern. We consider two scheme analysis were proposed in A Novel Approach Object Recognition Using Efficient Support Vector Machine Classifier

[10] [11] where two indexes are proposed. These names are α and β where α denotes the whether the decomposition is multiscale (i.e. $\alpha=1$ or $\alpha=0$) and β elements are placed and poorly directional ($\beta=1$) or the lengthened the full directions ($\beta=0$). Adaptive transform consists decomposed image in a database and functions are defined by the corresponding space by the localization with width is $2^{-\alpha j}$ and length is denoted by $2^{\beta j}$ and its defined by frequency domain by using paving expressed by coordinates $2^{\alpha j}$ and $2^{\beta j}$. This classification permits to categorize the wavelets to $\alpha = \beta = 1$. Ridgelet transform will correspond to $\alpha = 1$ and $\beta = 0$. Gabor transform will consider $\alpha = \beta = 0$. Curvelet transform will correspond to $\alpha = 1, \beta = 1/2$. Wave atoms are defined in $\alpha = \beta = 1/2$.

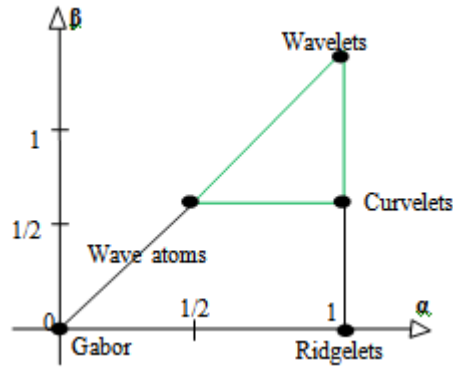


Figure 2 α, β Diagram

In this paper, wave atom transform provides a better image representation and it is including the textures. A Wave atom is noted $0_\mu(x)$, Where μ is the parameter of a scale, rotation and translation, so we consider the integer value $\mu = (j, m, n) = (j, m_1, m_2, n_1, n_2)$ combined with a point (x_μ, y_μ) in the phase is expressed by,

$$C_1 2^j \leq \max_{i=1,2} |m_i| \leq C_2 2^j \quad (12)$$

Where C_1 and C_2 are two positive constants. The index parameter j is the scale parameter and m is the angle of oscillation. If the square size is doubled, the scale j increases by 1. At a scale value j is given, the squares are indexed by (m_1, m_2) are near to the starting axis.

(ii). Feature Extraction Energy

In our work, feature extraction is the preprocessing step to recognize the objects and machine learning problems. Feature extraction is the key process of object recognition or pattern recognition techniques. It means transforming the input data into set of features is called feature extraction. The features are extracted that the relevant information from the input data is performing the desired function is used to reduced representation of full size input. The extraction process is an important role in object recognition techniques since the input data related to an object are contained within the extracted features [12]. It is a special form of size reduction, which is consider to simplifying the number of resources, required to describe a large set of data accurately. Generally, the original image is decomposed using WAT. For the classification process, all the coefficients are considered as features. This method is applied to training images and feature vectors are stored in the database called as Object – Base. [11]. Estimate the energy of the sub-band of the image I is expressed by,

$$C_1 2^j \leq \max_{i=1,2} |m_i| \leq C_2 2^j \quad (12)$$

Where R, C is the width and height of the sub-band image and $I_c(i, j)$ is the pixel value of e^{th} sub-band of the image respectively.

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(iii). Classification stage

In our work, object recognition method used in the paper can be summarized as shown in Figure 1. We propose a general object recognition framework based on SVM classifiers. The performance of recognition process was improved by using the SVM classifier. Our proposed SVM is a binary classifier and it is convenient for classification and recognition in a high dimensional space. This classifier is a best suitable method for image classification and object recognition and this methodology is applied for Object-Based Image analysis. Classification stage was needed to perform a segmentation of the image.

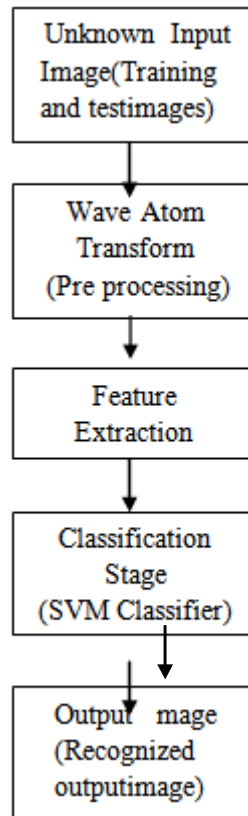


Figure 3 Image classification process

Figure. 3 shows the block diagram of our proposed method. In the proposed method, the given unknown image is to extract the edges of the object by using pre-processed steps. Once the edges are extracted, then the corresponding seven moment invariants are estimated and the feature vector is designed. The wave atom transform is the pre-processing step of feature extraction process. Traditionally, most of the research scholars used KNN classifier is used to find neighbor image data with all the possible images. If a label is found in the image, the KNN algorithm can quits. So SVM classifier is applied to the object. Our proposed algorithm is used to recognize the objects and the results are compared to those found with single BPN [13] and KNN [14] classifiers. The SVM classifier gives better performance compared to the traditional method.

IV. Experimental results

The proposed method was implemented in MATLAB Tool. The experiment is operated to calculate the recognition accuracy and verify the robustness of the proposed method. In our paper, COIL-100 database is used in 3D object recognition is shown in Figure. 4. This type of database consists of 100 different object images. Each object is rotated with 5 degree angle interval on the vertical axis. Every object having 72 images, which is totally consider up to 7200 images for the whole database. During the experimental time the first phase is to color image converted into the gray image and perform some pre-processing stage (Consider the WAT) to remove the image noise. The whole COIL-100 database is split into two sets, namely training set and test set. The training sets are designed for three various sampling angles (10, 30, and 50 degrees). The proposed system is experimented using test and training images. To calculate the recognition accuracy of the proposed method compared other techniques and estimate the correct recognition percentages were determined. The result values of training images can be increased. From the results it is proved that the proposed method gives the best performance in terms of CRPs compare the other techniques. The CRP is calculated as,

$$CRP = \frac{N_p}{T}$$

Where, the N_p is the number of positive recognition and T is the total number of conducted test images. The CRP values and recognition accuracy can be tabulated shown in below Table.1 and Table.2.

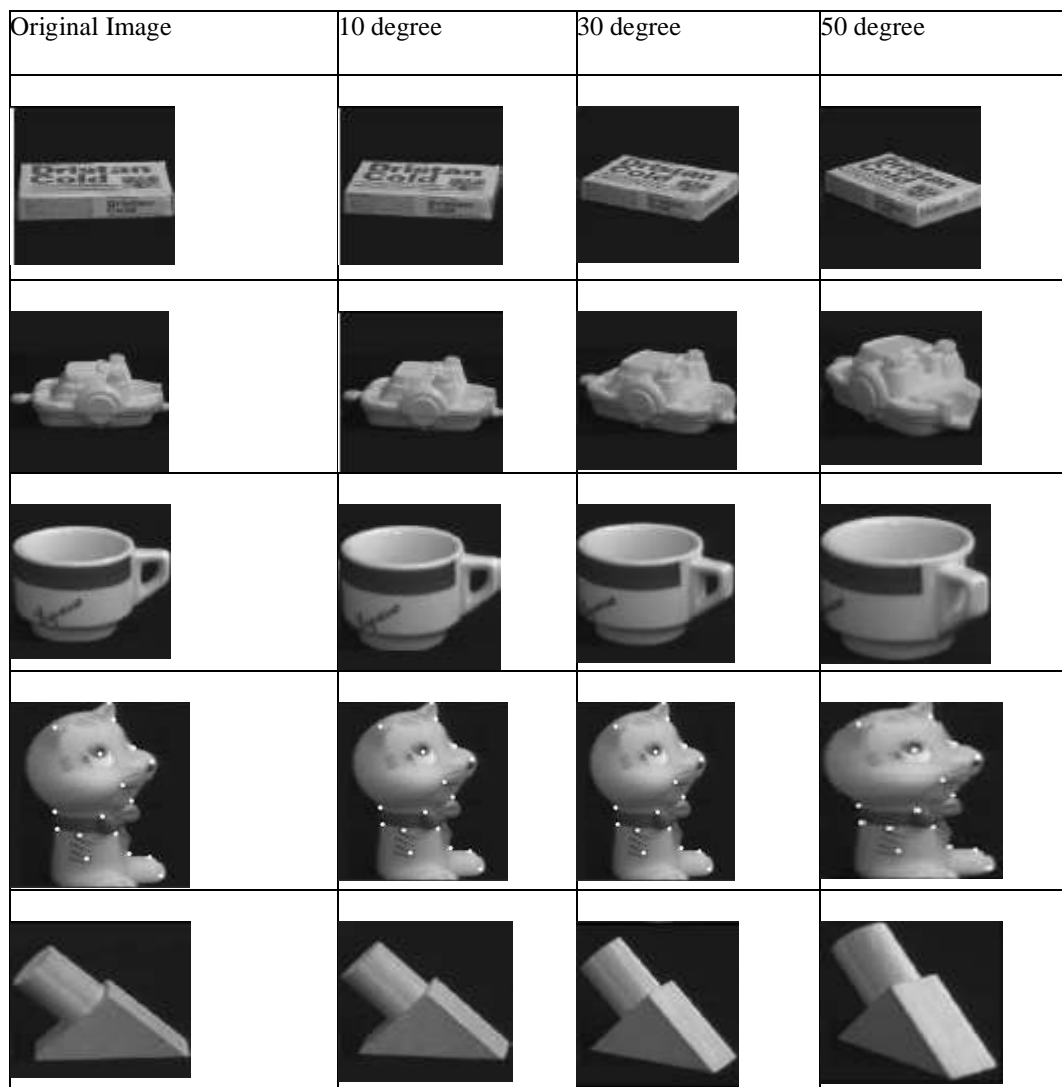


Figure 4 sample images from COIL-100 Database

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Table 1 Recognition accuracy in terms of CRPs of the proposed method, KNN and BPN classifier methods

Classifying methods	Percentage of recognition accuracy rate			
	10	30	50	Average (10,30,50)
KNN	75.52%	81.33%	84.28%	80.37%
BPN	76.5%	73.44%	77.87%	75.93%
SVM (Proposed)	80.43%	82.19%	85.24%	82.62%

Table 2 CRP for different number of samples using proposed method, KNN and BPN classifier

Number of samples	Correct recognition rate (CRP%)		
	KNN	BPN	SVM
25	80	75.01	85.42
50	83.51	76.42	88.93
75	84.92	78.41	90.45
100	85.44	78.77	93.82
125	88.70	79.43	97.88

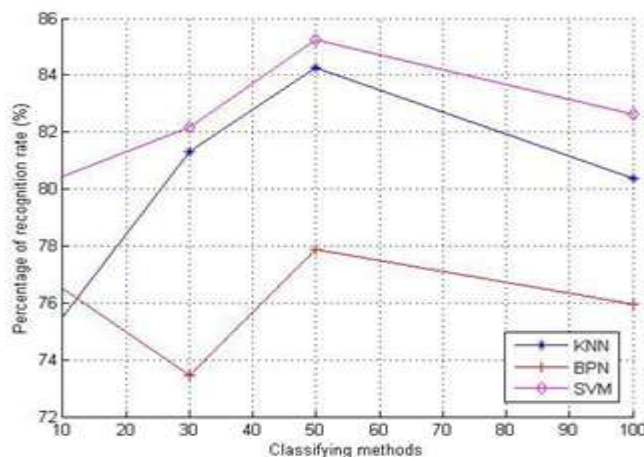


Figure 5 Recognition performances for the different Classifiers

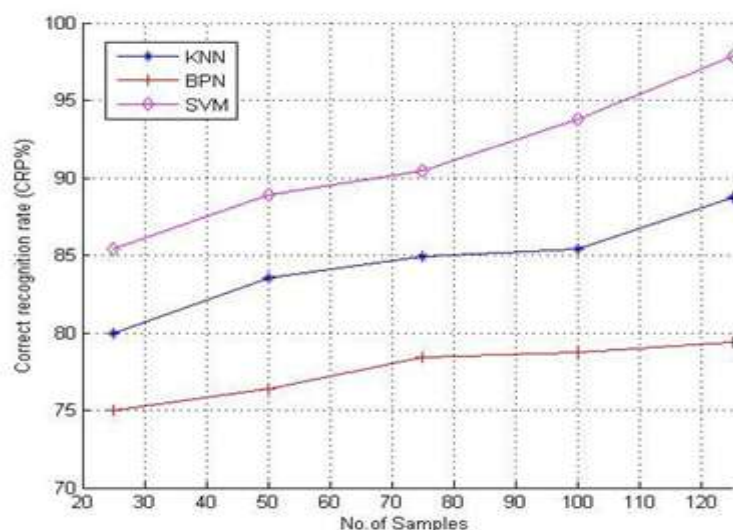


Figure 6 CRP values for number of samples

V. Conclusion

In this paper, we have presented SVM based object recognition using Moment invariant features. Our paper presented how the SVM recognizes the object using WAT. Our extension method is implemented in MATLAB with training and testing images applicable in the COIL- 100 database. The proposed technique of SVM classifier method performs well and provides high recognition accuracy compared with existing methods and it is applied to different applications like computer vision for the blind, surveillance systems, fish species, Content- Based Image Retrieval (CBIR), robotics, medical imaging process, automated visual inspection and human computer interaction. The recognition accuracy can be achieved by 82.62% compared other techniques. The advantage of SVM classifier is reducing the dimensional space and recognition performance was good.

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