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HANDWRITTEN DIGIT RECOGNITION USING SVM ALGORITHM IN MACHINE LEARNING

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ABSTRACT

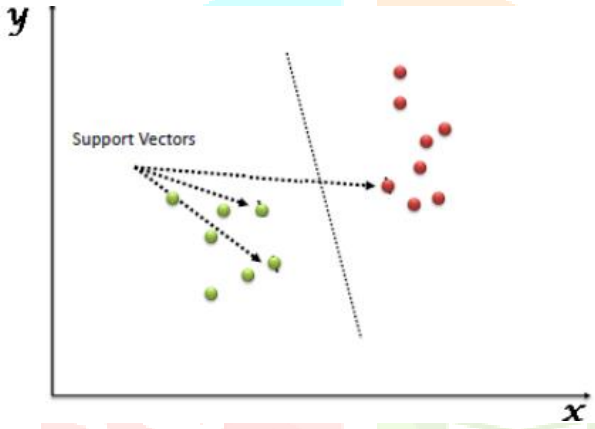
Meanwhile Neural Networks based algorithms have intimated steadfast potential on various visual tasks including the recognition of Digits. This paper presents Support Vector Machine (SVM) based Real Time Hand-Written Digit Recognition System. The system involves two main sections i.e. training and recognition section. SVM classifier is used as the training algorithm and then tested it on MNIST dataset. We achieved a training accuracy of 98.05% and a test accuracy of 97.83% demonstrating that the proposed method can achieve significant and promising performance in digit recognition. Then we implemented our model to recognize user given handwritten digits in real time.

INTRODUCTION

Digit recognition is the widely studied part of character recognition which is most enthralling part of Computer Vision and Robotics. The most common application of digit recognition are license plate recognition, in banks for credit card number recognition, street number recognition, in post offices for sorting the mail, phone number recognition etc. As posit, handwritten digit, printed digit and typewritten digit are three classification of digit found in application. Among them for any digit recognition system, printed and typewritten digit are more predictable. They can be recognized in a more precise manner deeming to the fact representing the combination of a finite number of different characters. Variations of digits depending on the font change are simpler for recognition. Every font preserves basic structure of then digit. So, any digit can be found in various different forms. While handwritten digit may have infinite number of forms depending on the handwriting of the person. Hand-written digit recognition is much more difficult compared to printed and typewritten digit. In this paper we proposed Support Vector Machine (SVM) as the Neural network-based classification techniques have been widely used in recent time for character recognition.

Support Vector Machine:

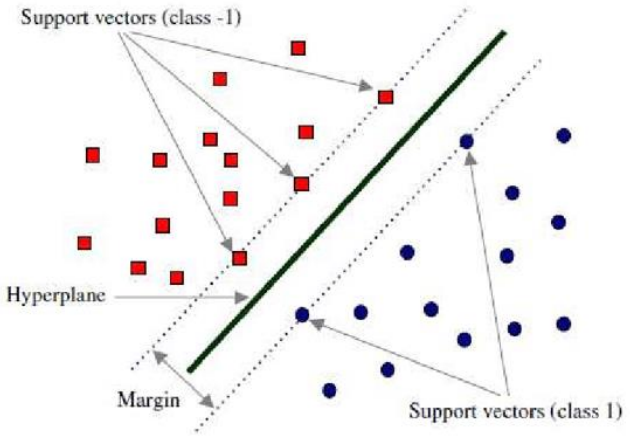
"Support Vector Machine" (SVM) is a supervised ML algorithm that can be used for both classification or regression challenges. However, it is mostly used in classification problems. In the SVM algorithm, we plot each data item as a point in n-dimensional space (where n is a number of features you have) with the value of each feature being the value of a particular coordinate. Then, we perform classification by finding the hyper-plane that differentiates the two classes very well (look at the below snapshot).



Support Vectors are simply the coordinates of individual observation. The SVM classifier is a frontier that best segregates the two classes (hyper-plane/ line).

Support-Vectors:

The data points closest to the hyper-plane are called support vectors, and they influence the hyper-position plane's and orientation. We must choose a hyperplane with the greatest margin, i.e. the distance between the support vectors and the hyperplane. The hyper-plane can be changed by even minor interference in the position of these support vectors.



2.Methodology

This portion deals with acquisition, some pre-processing, thresholding and feature extraction process of input image consist of user's hand-written digit. This steps are specified as follows:

2.1 Image Acquisition

Acquisition task is considered as the first step of user provided hand written digit recognition. Image acquisition process is mainly concern with obtaining text image from a scanner or a prestored image file where the format of the image may be PNG, BMP, JPEG, etc. A digital camera, scanner, webcam or any input devices is used to capture the input image. To make the image as readable format some pre-processing and thresholding task is performed on that image.

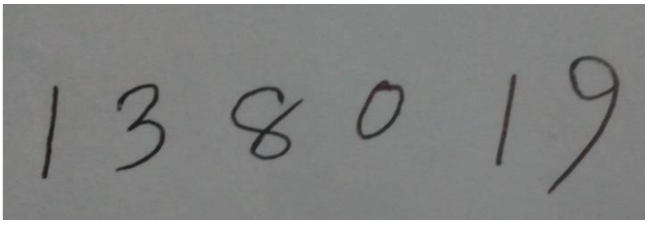


Fig. Input Image

2.2 Pre-Processing

The acquired input image is subjected to a number of prefatory processing steps to make it functional to the descriptive stages of recognition process.

The intention of Pre-processing is to produce data that are readable for the recognition systems to operate precisely. Pre-processing steps are as follows:

2.2.1 Gray Image Conversion

Grayscale images consist of many shades of gray. It is a result of calculating individual pixel intensity of the acquired image where range of lower pixel value represents the black pixel intensity and higher value represents white pixel intensity. For achieving accuracy of input document a RGB image is transformed into gray image which consist of pixel value from 0 to 255. The transformation [1] process from RGB to gray is followed by the equation.

$$Y(i, j) = 0.299 \times R(i, j) + 0.587 \times G(i, j) + 0.114 \times B(i, j)$$

Where R(i; j), G(i; j) & B(i; j) represents the corresponding Red, Green and Blue color element of the image and Y (i; j) is the gray image.

2.2.2 Binarization & Thresholding

At the former step the image is converted RGB into gray image which is required to convert into a binary image for further processes of analysis and recognition. Binarization process involves in separating the pixel values of the gray scale image into two sessions 0 and 255 according to the threshold value. Thresholding process involves the setting of the contextual values for pixels beneath a threshold value and assigning an expected dissimilar value for the pixels. To get the featured object as white image and the background as black image we need to perform the inverse thresholding process followed by the equation:

$$Y(i, j) = \begin{cases} 0 & if\ Y(i, j) > T \\ 255 & Otherwise \end{cases}$$

Here T represents the threshold number.

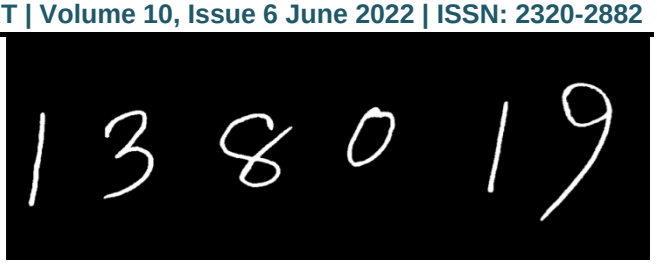


Fig: Input image after performing inverse thresholding operation

2.3 Feature Extraction

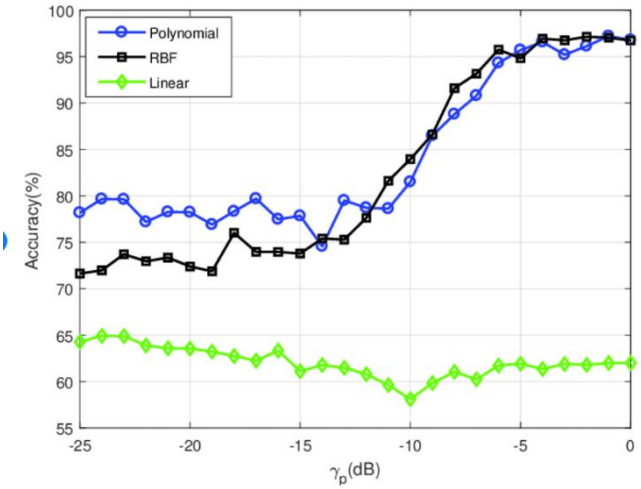
Feature extraction process involves of extracting a set of features and differentiating the object features from raw background. This process provides the featured information about an object or a group of objects in order to assist classification task. After performing the feature extraction task, the features are represented as a feature vector. n order to avoid the additional complexity and to improve the accuracy of the classifier, an additional compressed and distinctive representation is obligatory. The digit which has to be recognized should be white having the pixel value 255 and the background should be black having the pixel value 0. Binary Inverse Thresholding was used to threshold the image to find the needed pixel value. Contour [6] search technique was used for feature extraction where contour can be defined simply as a curve joining all the continuous points having same color or intensity. In many applications such as shape analysis, object detection and recognition contour can be used as an useful means.

2.4 Training Algorithm

The main decision-making task of recognizing a digit is performed by the classifier model. Using the extracted features followed by previous stages identify the digits. In this work SVM a machine learning algorithm is proposed as a classifier model.

Support Vector Machine (SVM) a binary classifier creates a hyper plane or group of hyper planes in a

high or infinite dimensional space for separating



data from different classes. A set of labeled training pattern (y1 , x1).…….(yM , xM) where, yi ∈ {-1,1} is said to be linearly separable if there exists a vector w and a scalar b such that the inequalities.

w. xi+b ≥ 1 if yi = 1

w. xi+b ≤ 1 if yi = -1

are valid for all elements of the training set. Thus the optimal hyperplane is

w0 x+b0 =0

the unique one which separates the training data with a maximal margin. Hyperplane should be as far as possible from instances of both classes. The distance that should be maximized is ρ0 = 2 ‖w‖ . As real time data is noise contaminated thus, we can't separate training data without error. In this case the training set has to be separated with a minimal number of errors. So soft margin was proposed to solve this problem. A slack variable is introduced to allow some instances to be misclassified. The definition is as follows:

$yi\ (w.\ xi + b) \geq 1 - \epsilon i\ ;\ \epsilon i \geq 0\ ,\ 1 \leq i \leq n$

A kernel function is used instead of dot product to make SVM suitable for nonlinearly separable data. In practice Gaussian Radial Basis Function (RBF), Polynomial function and Sigmoid function are used as kernel function. In this proposed work Polynomial function is used as the kernel function which is only dependable on the number of support vectors not on the degree of polynomial.

Conclusion

Figure shows the comparison of the accuracy of the support vector machine (SVM)-based classifiers trained with linear, radial-basis function (RBF), and polynomial kernel functions.

We describe an application of automatic handwritten digit recognition based on the best classifier algorithm Support Vector Machine in this proposed work. When real-time input data (picture) is required, the procedure always begins with noise reduction and some preprocessing tasks. If the input picture is not properly processed, the classifier may miss some important information from feature vectors, causing the digit to be incorrectly classified. During the training phase, an SVM classifier was developed using the dataset, and the performance of the classifier was tested, yielding a satisfactory result. The trained model was then applied to the captured image in order to accomplish the digit recognition challenge.

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