# Automatic Car license plate Recognition system using Multiclass SVM and OCR

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***Abstract:*** *Automatic car license plate recognition system has always attracted researchers. It is a dynamic region of exploration in machine vision and its application. Over the years there have been many techniques where in car license plate recognition systems have been successfully proposed and developed. Broadly the car license plate recognition systems are classified as template matching based and extracting features based. Template matching based is simple and straight forward method but it is vulnerable to any font change, rotation and noise. Extracting feature based method is a fast method and more accurate but feature extraction is a challenge and any no robust feature decreases the recognition accuracy.*

*On the basis of my preliminary results I propose an integrated template and feature based method for automatic car license plate recognition system for INDIAN cars license system. I aim in developing an automatic car license recognition system based on still images. Image database set is collected for different categories of car license system adopted in INDIA. Template matching is done via implementation of optical character recognition system which shall help in recognizing characters of the license plate. But to enhance the speed and to increase the accuracy of the system the images are classified using a new variant of state vector machine known as Multiclass SVM.*

*The idea is to implement the proposed system using the computational intelligence concept, image processing concept and artificial intelligence concept. The proposed system is then evaluated via MATLAB's Computer Vision Toolbox and Artificial Intelligence toolbox.*

***Keywords:*** *computational intelligence, image processing and artificial intelligence.*

## 1. Introduction

Automatic car license plate recognition system is an integrated application of artificial intelligence and image processing. Many such systems have been proposed and implemented over the past few years. Car plate recognition systems are broadly categorized as template matching based systems and feature extraction based systems. In template matching the system is trained over certain templates which further help in recognition of the new inputs. But it is prone to error because different font sizes are used for car license numbers. In feature extraction system a database of images is formed through which certain unique features are selected and stored. Now the input image features are matched with the database image features and on the basis of the matching the outcome is displayed. This system is an efficient one if proper features of the images are selected. Thus, the challenge lies in the selection of these features.

In this paper I propose an integrated template and feature based method which shall be tailor made for Indian car license system. I make use of Multi class SVM system and OCR for pattern matching.

## 2. Background

### *A. SVM based Classification*

The Support Vector Machine is an application used to classify dataset. It is a binary classifier binary classifier which computes a hyper plane that acts like a decision function. SVM is trained and then tested. In the case of images it can be trained on image dataset which may be containing some particular object or feature, and then the SVM classifier can make decisions regarding the presence of an object or a feature in the tested image. Thus it can be used in identifying features like car license, in additional test images. [1]

**Binary Classification**: it is defined as follows

Given training data (xi, yen) for i = 1. . . N, within∈ Rd and yi∈ {−1, 1}, learn a classifier f(x) such that

$$f(\mathbf{x}_i) \begin{cases} \geq 0 & y_i = +1 \\ < 0 & y_i = -1 \end{cases}$$

i.e. f (xi) > 0 for a correct classification.

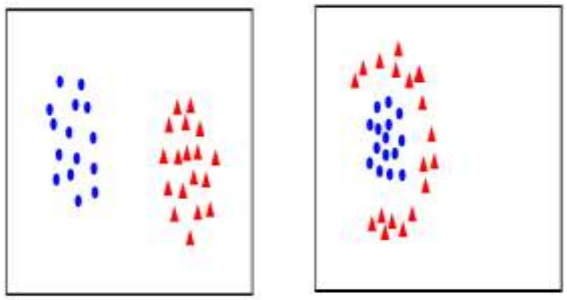

**Figure 1: showing binary classification**

**Linear classifiers**

A linear classifier has the form

$$f(\mathbf{x}) = \mathbf{w}^{\top}\mathbf{x} + b$$

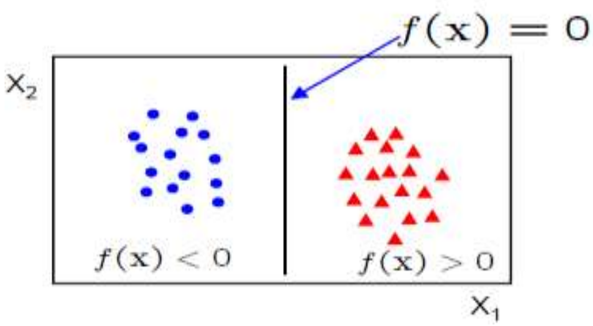


**Figure 2: showing linear classification.**

Given a set of training examples, each marked as belonging to one of two categories, an SVM training algorithm follows an approach where in it builds a model or classes that assign new examples into one category or the other, thus making it a non-probabilistic binary linear classifier.

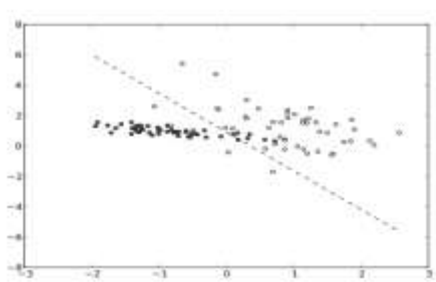

**Figure 3: SVM decision boundary showed by scattering spot.**

SVM (support Vector Machine) are connected with learning calculations that are valuable in breaking down the information and perceiving examples, which are utilized for order and relapse investigation.

Consider a given set of preparing samples; such that each of them is checked as to having a place with one of the two classes, a SVM preparing calculation should assemble a model or a class that appoints new illustrations or information into one classification or the other, making it a non-probabilistic twofold straight classifier.

A SVM model or class is a representation of the information as focuses in the given information space, mapped in a way so that the information of the different classifications are isolated by an acceptable characterized hole that is as wide as would be prudent. New samples of information are then mapped into that same information space and anticipated to have a place with any of the given class focused around which side of the crevice they should fall on. Aside from performing straight characterization, SVM can be utilized as a part of performing a non-direct order through what is referred to be as the piece trap, wherein certainly mapping their inputs into high-dimensional gimmick spaces is utilized.

A support vector machine creates a hyper plane or sets of hyper planes in an unbounded dimensional space, such that they can be utilized for order, relapse, or some other particular use. A good partition is obtained by a hyper plane which has the highest gap between the classes have bigger edge, as bigger the edge one might have the lower slip of the classifier.

The primary issue is the separation of bunches in a limited space, the greater part of the times the groups are not accessible on the same plane. This was the reason of overhauling the limited spaces to multi-dimensional spaces keeping in mind the end goal to give less demanding partition of these in those spaces. To keep the computational burden sensible, the mappings utilized by SVM plans are intended to guarantee that speck items may be figured effectively as far as the variables in the first space, by characterizing them as far as a piece capacity k(x,y) chose to suit the issue. The hyper planes in the higher-dimensional space are characterized as the situated of focuses whose dab item with a vector in that space is steady. Thusly, the total of parts above can be utilized to gauge the relative closeness of each one test point to the information focuses beginning in one or the other of the sets to be segregated. Note the way that the set of focuses x mapped into any hyper plane can be very convoluted therefore, permitting significantly more mind boggling segregation between sets which are not arched at all in the first space.

Information characterization is a typical errand in machine learning. Assume some given information guides each one have a place toward one of two classes, and the objective is to choose which class another information point will be in. in a help vector machine, the information point is accounted for as a p-dimensional vector (a rundown of p numbers), and what is to be found is whether these focuses can be separated with a (p − 1)-dimensional hyper plane. This is known as a direct classifier. There are numerous hyper planes that may order the information. One sensible decision as the best hyper plane is the particular case that speaks to the biggest partition, or edge, between the two classes. So we pick the hyper plane so the separation from it to the closest information point on each one side is boosted. Most extreme edge hyper plane is said to exist if such a result is accomplished and the straight classifier which gives such result is known as a greatest edge classified.

*B. Classification of images*

Once a data set is pre-processed it becomes necessary to classify the dataset into different action classes. Conventional grouping methodologies on picture arrangement errands are hard to actualize and don't give come about as indented, in light of the high dimensionality of the peculiarity space. Thus I utilize support vector machines (SVM's) which can sum up well on troublesome picture order issues. It is seen that SVM are suitable where the main gimmicks are high dimensional histograms. It is watched that a straightforward remapping of the data in SVM enhances the execution of direct SVM's to more prominent degree and subsequently it makes them, for this issue, a substantial option to RBF bits. In this model we utilize SVM with histogram based order of pictures at L1 Norm. [2]

This amazingly great execution in SVM is because of the prevalent speculation capacity of SVM's in high-dimensional spaces and that to the utilization of overwhelming tailed RBF's as portions regarding nonlinear changes connected to the histogram canister values.

The histograms considered are color histograms. Shade histograms are as a picture representation in light of the sensible execution that can be gotten notwithstanding their great straightforwardness..

The Support vector machine (SVM) methodology is thought to be the best in addition to different decisions in view of its high speculation execution and productivity in characterization without the need to include from the earlier learning, actually when the measurement of the information space is high. It gives less normal blunder. Think about given as a set of focuses which has a place with both of two classes, a direct SVM finds the hyper plane which helps in choice making leaving the biggest conceivable division of purposes of the same class on the same side, while boosting the separation of either class from the hyper plane. This hyper plane minimizes the danger of misclassifying illustrations of the test set. [3]

## 3. Methodology

**Algorithm 1: proposed methodology of ACL**

Step 1.Prepration of data set of car license plate system

Step 1.1 Make one set of dataset as training set

Step 1.2 makes another set as testing set use 70-30 ratio for training and testing.

Step 2: Read all the images from the prepared dataset.

Step 3: histograms are normalized for L1 norm.

Step 4: Multiclass SVM is trained for the obtained histogram and the classification process is carried out as one vs. all schemes using histogram intersection kernel.

Step 5: the training is carried out for one model for each action class in a 1-vs-all fashion. Positive training results in return of car license images of a particular category like personal car or commercial car and the negative training return other parts of images.

Step 8: Testing is performed with action detection at maximum similarity score is selected or it should be more than 50%. In some cases where rectangular boxes are absent the similarity score for entire image is taken.

Step 9: Display the result of matching performed over test images.

Step 10: Once the classes of images are formed OCR is called in for image template matching and finding the characters of the license plate.

**Classification of images using Multi-class SVM**

Usually SVM is applicable for classification between two classes. In this case it is needed to classify the images into six different action classes. To do so it is required to change the mathematical definition of SVM so that it can be used for multi-class classification.

The other approach is to uses SVM one class at a time, where the first class is classified against union of the rest of the classes, then takes the outcome of the classification and classifies it with second class and so on. This approach is linear in terms of the number of classes. It requires carrying out maximum class SVM based searching. This approach consumes lot of time. The time efficiency can be improved by using binary search where two unions of classes i.e. i to k as first union and k+1 to n are classified. The output of 1 to k classes is then further classified by taking classification through 1 to R and R+1 to k and so on. Each class will require ceiling (log2 (n)) of SVM runs, where n is the number of classes. This would improve up to only floor (n/ceiling (log2 (n))/2) distinct classes with respect to linear SVM.

So for performing multiple class classification it is suggested to extend the capabilities of SVM. In this method K is the number of classes, K decision functions are constructed for each class. Each decision functions are a linear combination of all the training data belonging to a class. A testing data set is then represented as the class with the maximum output value from its decision function.

$$f_k(x) = \sum_{i:y_i=k}^{l} \lambda_i K(x, x_i) + b_k$$

$$f(x) = \arg\max_k f_k(x)$$

Now the SVM is trained where in minimization is carried out and a kernel is obtained as:

$$w_m = \sum_{i:y_i=m}^{l} \lambda_i x_i$$

This approach minimizes the L1 norm of w rather than L2 norm.

$$L_1 \text{ norm} = \sum_i |(w)_i|$$

The selected SVM for the classification is a non-probabilistic binary linear classifier. The outcome of the SVM always depends on the choices of the kernels used. Any poor choice of kernel can result in inefficient classification. Thus proper research work is to be carried out for SVM kernel choices. In this case the kernel choices are the ones generally used for pattern recognition. The SVM used here classifies each dataset with car license in rectangular boxes into multiple classes. It is trained using the images of the database. Positive training results in detection of car license as one set and negative training results in return of other parts of the image apart from car license as another set. It is followed by testing where in maximum similarity score is selected for matching criteria. [5]

The given SVM kernel products between input vectors x and y are:

$$K_{poly}(\mathbf{x}, \mathbf{y}) = (\mathbf{x} \cdot \mathbf{y} + 1)^p$$

$$K_{Gaussian}(\mathbf{x}, \mathbf{y}) = e^{-\rho||\mathbf{x}-\mathbf{y}||_2^2}$$

In the case of Gaussian RBF based SVM machine, the number of centers, and the support vectors, the assigned weights (_i) and the set threshold (b) are all produced automatically during the SVM training process and thus give excellent results. Thus the positive results obtained by using Gaussian based SVM, the generalized forms of RBF kernels defined as the function given below as:

$$K_{d-RBF}(\mathbf{x}, \mathbf{y}) = e^{-\rho d(\mathbf{x}, \mathbf{y})}$$

d(x, y) can be chosen to be any distance in the input space.

In this research work histogram are normalized at L1 norm. The L1 distance, is predicted to behave like a

Laplacian RBF which is given by following equation. It is used for classification for the designed SVM. The choice is made as it has less average error rates.

**Algorithm 2: classification of dataset using SVM**

Given: SVM Classifier is set for one vs. all comparison using multi-class function.

Step 1: SVM designed in here is trained using the images from the databases using histogram intersection kernels.

Step 2: Histogram for the images are visual histogram and object histogram. These histograms are normalized at L1 norm.

Step 3: Multi class SVM is set to as the function given above.

Step 4: Training of SVM is carried out

Step 5: After training takes place successfully testing is carried out for the images.

Step 6: Similarity score is calculated for each image.

Step 7: Score greater than 50% similarity measure is selected.

Step 8: Images are classified into six action set as labeled.

Step 9: The result with test images mapped to car class labeled is returned.

## 4. Conclusion and Future work

The paper proposes an automatic car license recognition system where in the car license data base is first classified into various categories of license plates followed in India. This classification is done through multiclass SVM. Once the classification is done an integrated OCR and SVM based recognizer is used for character recognition of the license plate. The proposed method is built to enhance speed and accuracy.

The whole proposed system is to be validated using MATLAB with machine learning and image processing concepts.

## 5. References

[1]. Moshe Blank, Lena Gorelick, Eli Schechtman, Michal Irani, and Ronen Basri.Actions as space time-shapes. In IEEE International Conference on Computer Vi-sion, ICCV, 2, pp.1395–1402, Oct 2005.

[2]. J. Yamato, J. Ohya, K. Ishii, Recognizing human action in time-sequential images using hidden Markov model, Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition. 379 – 385, 1992.

[3]. S. Haykin, Neural Networks: A Comprehensive Foundation, Prentice Hall, 1998.

[4]. Standard MPEG1: ISO/IEC 11172, Coding of moving pictures and associated audio for digital storage media at up to about 1.5 Mbit/s, 1996.

[5]. T. Kohonen, The self-organizing map, Proceedings of the IEEE 78 (9):1464 – 1480. 1990.