Automatic Number plate recognition using Machine learning approach

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Abstract **-** Recognition is a task of machine learning and machine intelligence. Now in these days a number of places machine learning techniques are used for making decisions, recognizing patterns or predicting the trend. In this work an application of machine learning is demonstrated using the automatic number plate recognition technique. The number plate recognition involves the techniques of images processing and the machine learning to accurately identify the characters available in number plate. Additionally for making it more real model the video based number plate recognition is implemented in this work. The proposed technique involves two basic phases' first training with the different characters 0-9 and A-Z in different fonts. To find the exact identification of characters canny edge detection approach is used for extracting the edges from the training and testing images. After edge extraction the multiclass SVM (support vector machine) is used to train with the input samples. Finally the trained SVM model is used for classifying the target number plate characters. The implementation of the entire concept is performed using MATLAB technology. After implementation of the required technique the performance is computed in terms of time and space complexity. And to find the accurateness of model the accuracy and error rate is used. The results demonstrate the proposed technique is efficient as well as accurate for number plate recognition.

Index: License Plate Recognition, Classification, Support Vector Machine, Image Processing, Digital Image.

I. INTRODUCTION

Technology helps to improve different complex task in our daily life, even for decision making, market, monitoring and surveillance are now in these days becomes automated. In addition of that the machine learning and object recognition techniques are also provides help in different real world applications. The proposed work is focused on study of pattern matching and recognition techniques therefore an application of this domain is targeted for design and development. In this presented work the technique of image processing and character recognition is used for designing and developing the automatic number plate recognition. The proposed technique help to identify the number plate from the video and extract the accurate characters from the target number plate.

The proposed technique is first usages the concept of image processing for recovering edge feature from the given number plate images. This extracted image feature is further used with the multiclass classifier for
recognizing them. Therefore the proposed work is based on pattern recognition approach of machine learning and computer vision. The entire system works in two major modules first the training and seconds the testing. During the training of system the five different kinds of fonts are used for a single character. The set of characters are works here as the training set of images. In next the training set images are processed using the canny edge detection technique. The canny edge detection technique helps to identify the edge feature from the images. These features are used to learn and classify the similar appeared images. Here for training and testing of system a multi-class classifier is required which is derived using the SVM (support vector machine).

II. PROPOSED WORK

This chapter provides the detailed description of the proposed approach. Therefore first the formal details and requirements of the proposed model is explained and then the detailed methodology is discussed. In further the proposed methodology is formulated using the algorithm steps.

A. System Overview

The proposed work is an effort for making efficient and accurate model for the number plate recognition. In these context different techniques for accomplishing this task is studied and most effective method is demonstrated in this work. The proposed model includes the study of image processing concept as well as machine learning concept for recognizing the characters of number plate. During the design and implementation of the system the following key challenges are targeted to resolve in this work:

1. Grabbing the required image frames from the videos
2. Extraction of number plate from entire image
3. Learning with different fonts in number plate

To find the solution that considers the above given challenges a new system is introduced. That system works in two major phases. In first phase the system need to be learning on static characters and in next phase the learning is used to identify the characters. Therefore first a set of characters of different fonts are prepared (here only five types of fonts are considered in experiments the font selection and types of fonts can be included according to use of the system). These training dataset is used with the canny edge detection technique. That returns the edge features from the characters which are used with the SVM classifier. The SVM classifier learned with the character images and prepared for classification. In next phase the entire image or number plate is accepted as input. This section provides the basic understanding of the proposed system in further the detailed methodology and proposed algorithm is explained

B. Methodology

This section explain the working or functional aspect of the proposed system for recognizing the number plates more accurately. The entire model is developed in two modules first the training and then testing. Both the modules are described as:

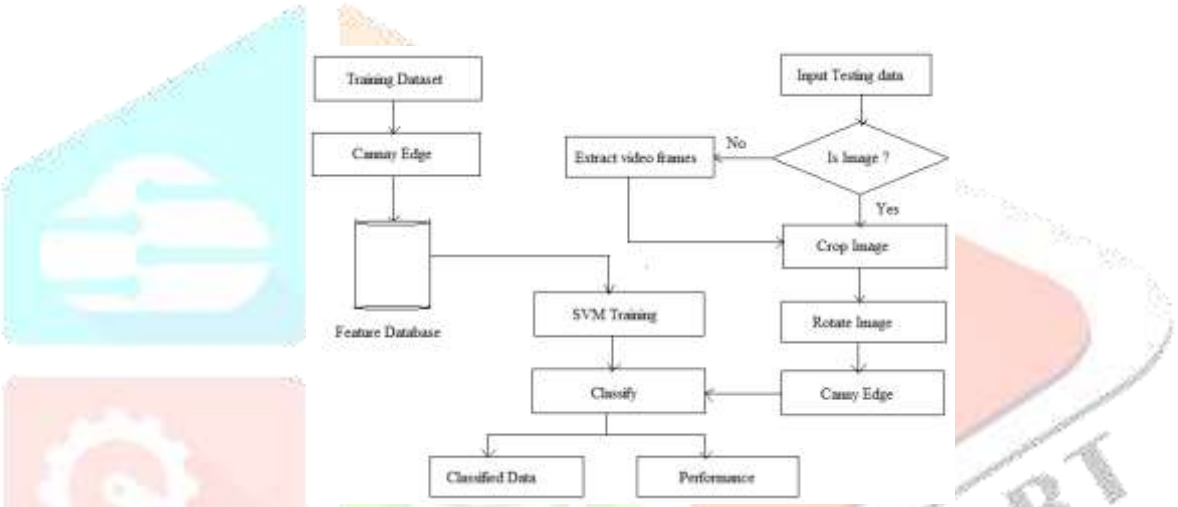

Figure 2.1 system architecture

Figure 2.1 contains both the modules for training and testing. The implemented components of the system are described as:

Training dataset: any machine learning system which are employed for pattern recognition need to perform training and then testing. During the training of data model a predefined set of samples are prepared. These samples are base line which is used to recognize after training. In this experiment the image based characters are need to be recognized. Therefore the set of characters from A-Z and the numbers 0-9 are created on images with five different fonts. These set of characters are further used for training of machine learning algorithm.

Input testing data: testing set can be a video or an image which contains the numbers to be recognize. Therefore the real world images and captured videos can also be used for testing of the system.
is image: the system check the data type is the input file is video or image. If the system find a video file as input then additional processes are need to perform otherwise the data is forwarded to the next phase for processing.

Extract video frame: if the data is found in video format then system extract the frames from the video. Additionally here user needs to select an appropriate frame for process with the system as number plate.

Crop image: if the selected frame of the video or the input image to recognize is in a predefined shape and size then nothing need to be perform on image otherwise the user input required to crop the image where the number plate shown in image.

Rotate image: sometimes the images taken from video or image captured are not in a regular angle therefore it is required to rotate the image to a specific angle. System implemented here a provision to change the angle of image according to the requirement of user.

Canny edge detection: canny edge detection is a technique to extract the edge features from the input images. These edge features are known as the low level descriptors of images. In this work for training images and testing images the canny edge detection approach is used. Before storing the input characters as the training set vector the images are processed with the canny edge detection technique additionally before performing classification of input number plate the canny detector is used to compute edges of the characters.

Feature database: the canny edge detection technique is used to process the input training set character images. The training data which involve the training set characters edge feature or edge descriptor and their classes are stored in a temp storage which is termed here feature database. Using this feature database the SVM classifier performs training.

SVM training: the feature database prepared using the canny edge detection and using the input characters are used here for training purpose.

Classify: after training of the SVM on different images Feature vectors the SVM is prepared for perform the

classification of similar pattern data. Here the test input based character's image and their edge feature is produced for recognizing their classes (i.e. classes are the characters).

Classified data: The individual images are classified using trained SVM classifier for recognizing the numbers of the images. This phase return the characters of the images as class label of classification.

Performance: after computing the classification labels of the input images the performance of the system is also measured in terms of time and space complexity with the accuracy of the system for image recognition.

C. Proposed Algorithm

This section explains how the training and testing of the proposed data model is performed. Table 2.1 contains the step process involved in the proposed algorithm for automatic number plate recognition.

Input: training dataset D, testing image I Output: number plate character C
Process: 1. 2. a 3. 4. 5. 6. a 7. 8. 9. 10. 11. a 12. 13. 14.

Table 2.1 proposed algorithm

III. RESULTS ANALYSIS

The given section includes the performance analysis of the implemented approach for the proposed Vehicle Number Plate Recognition. Therefore some essential performance parameters are obtained and listed with their evaluated performance.

A. Accuracy

The performance of the classification of Multiclass SVM to process algorithm in terms of accuracy is given in this section. The performance evaluation of proposed vehicle number plate recognition is evaluated using classifier. The accuracy of the number plate recognition can be evaluated using the following formula:

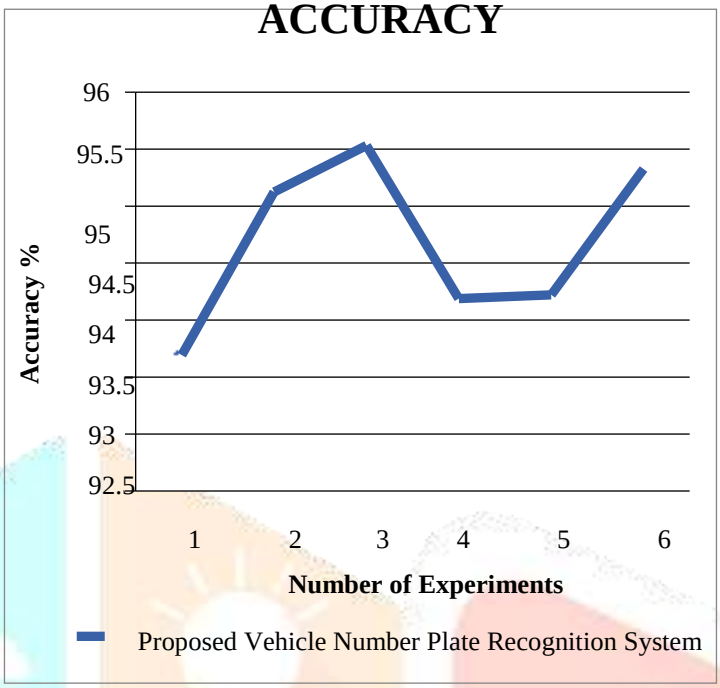

Figure 3.1 Accuracy

The accuracy of the implemented proposed algorithm of destination branding image is represented using table 3.1 and figure 3.1. The given graph figure 3.1 contains the accuracy of the implemented algorithms. The X axis of the diagram shows the different experiments and Y axis contains the obtained performance in terms of accuracy (%). To demonstrate the performance of the proposed technique is representing using blue line. This technique is evaluated on the basis of different input images. The input images contain the license number plate, the back of the corresponding car, and the surrounding areas outside the car. Therefore, we measured the accuracy of the system by the rate at which it correctly identified the license plate and its individual alphanumeric characters. According to the obtained results the performance of the proposed model provides more accurately recognized license number. Additionally the accuracy of the classification model is increases as the amount of instances for the learning of algorithm is increases.

Table 3.1 Tabular Values for Accuracy

Number of Experiments	Proposed Vehicle Number Plate Recognition (VNPR) System
1	93.6922
2	95.1245
3	95.5324
4	94.1879
5	94.2215
6	95.3261

B. Error Rate

The amount of data misclassified individual images or an image from video files during classification of algorithms is known as error rate of the system. This can also be computed using the following formula.

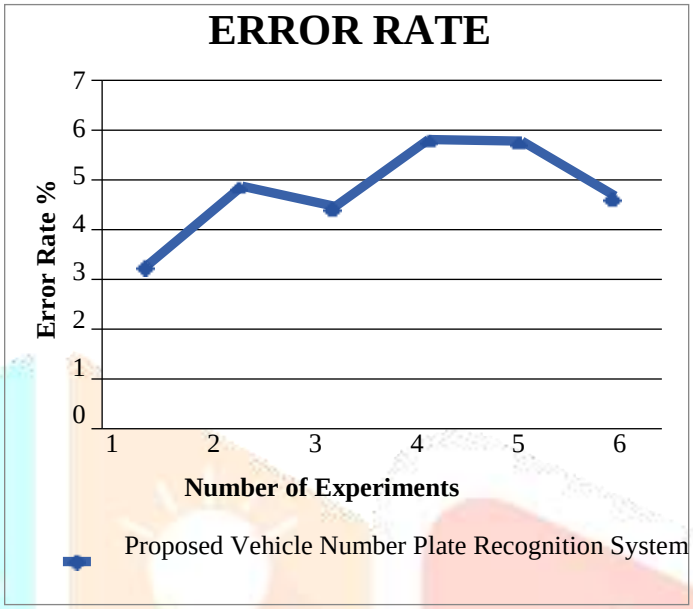

Figure 3.2 Error Rate

The figure 3.2 and table 3.2 shows the error rate of implemented proposed VNPR. In order to show the performance of the system the X axis contains the different experiments and the Y axis shows the performance in terms of error rate in percentage (%). The performance of the proposed VNPR technique is given using the blue line. The performance of the proposed image classification is effective and efficient during different execution and reducing with the amount of data increases. This overall system is very modular in that each functional block can be examined and analyzed independently of the others. This proves to be very Convenient for profiling and optimizing the overall system. Our analysis of the system is done on a per-image basis.

Table 3.2 Tabular Values for Error Rate

Number of Experiments	Proposed Vehicle Number Plate Recognition (VNPR) System
1	3.3078
2	4.8755
3	4.4676
4	5.8121
5	5.7785
6	4.6739

C. Memory Usage

Memory utilization of the framework additionally named as the space multifaceted nature regarding calculation execution. This can be assessed utilizing the accompanying equation:

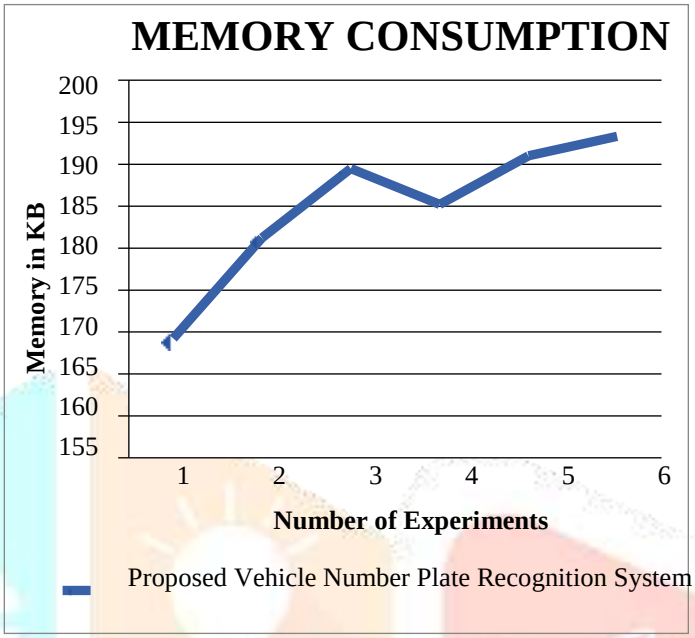

Figure 3.3 Memory Consumption

The amount of memory consumption depends on the amount of data reside in the main memory, therefore that affect the computational cost of an algorithm execution. The performance of the implemented web content mining approach of destination branding is given using figure 3.3 and data is numerically show by table 3.3. For clarification of the result, X axis of figure contains the different amount of code execution and the Y axis shows the respective memory consumption during execution in terms of kilobytes (KB). According to the obtained results the performance of algorithm demonstrates similar behavior with increasing size of images, but the amount of memory consumption is decreases/stable with different size of images. This consumed memory represents the required space by which algorithm of image classification of system is executed and produces efficient output.

Table 3.3 Tabular Values for Memory Consumption

Number of Experiments	Proposed Vehicle Number Plate Recognition (VNPR) System
1	169.235
2	181.223
3	189.485
4	185.203
5	191.001
6	193.325

D. Time Consumption

The possibility of converting the license plate recognition system into a commercial application depends heavily on the running time of the algorithm. Hence here we can define time complexity of the approach that the time requirement to execute entire algorithm to process train images. This can be computed by using following formula:

The time consumption of the proposed algorithm is given using figure 3.4 and table 3.4. In this diagram the X axis contains the program execution of the system and the Y axis contains time consumed which is measures in milliseconds. According to the evaluated performance of the proposed technique is process to identified correct and accurate license plate. For processing algorithm consume time which is illustrated in table 3.4 in numerically. But the amount of time is increases in similar manner as the amount of image for analysis is increases.

Number of Experiments	Proposed Vehicle Number Plate Recognition (VNPR) System
1	1.3265
2	1.4652
3	2.3631
4	2.7223
5	3.9013
6	4.0235

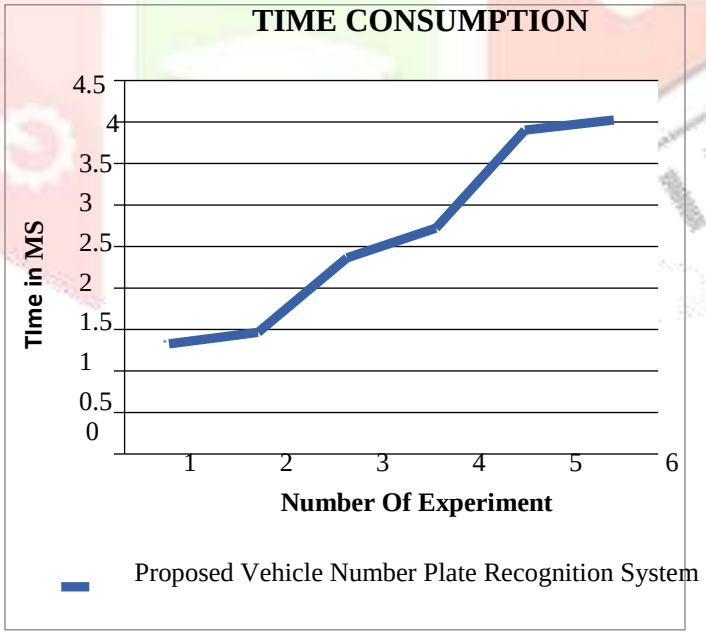

Figure 5.4 Time Consumption

IV. CONCLUSION & FUTURE WORK

The aim of the proposed work is to design an improved and accurate number plate recognition system. The implementation and the results analysis of the technique is explained in previous chapters. In this chapter the conclusion of the work as the research summary and future extension of the work is discussed.

A. Conclusion

Machine learning techniques are used in various different applications for providing ease in accuracy in different real world problems. The analysis of large amount of data, recognizing the faces from the crowed, building the decision making in banking and business domains are the key contribution of machine learning. In this presented work an application of machine learning is demonstrated which helps to recognizing the number plates. Basically there are a number of different techniques for number plate recognition exists but there are very few effective and accurate recognition techniques are exist. Therefore the proposed work is intended to design and investigate an effective and accurate method of number plate recognition.

The aim of the proposed work is to implement an efficient and accurate number plate recognition system. Therefore a new kind of plate recognition concept is proposed and implemented. The proposed model includes the concept of image processing and machine learning for accurate recovery of information from the digital image. The entire system works in two major modules first module is responsible for training with the characters. Therefore five different kinds of fonts are used for learning. The learning involves the edge recovery of characters and the learning with the SVM classifier. In next the testing module is developed which include the pre-processing of image or video, and classification of individual characters. The pre-processing of images and video involve the frame computation from input video, rotation of images and cropping of target. In next the feature extraction technique and classifier is implemented for recognition of number plates The implementation of the proposed technique is performed using MATLAB technology. After implementation of the proposed technique the performance of the technique is also measured in terms of accuracy and complexity. The table 4.1 provides the measured performance of the system as summary.

S. No.	Parameters	Remark
1	Accuracy	The accuracy of the number plate classification depends upon the image clearly and angle of image taken from but the process involved helps to recover the characters' accurately
2	Error rate	The error rate of the system is acceptable and decrease with the number of images and fonts available in database
3	Time complexity	Acceptable amount of time complexity is observed
4	Space complexity	Less memory resource required for performing the required recognition

Table 4.1 performance summary

According to the demonstrated results in table 4.1 the proposed technique shows the effective performance in terms of efficiency and the accurate outcomes of the classification of the characters. Therefore the proposed technique is acceptable for real world use with different applications.

B. Future Work

The aim of the proposed work is accomplished successfully. Additionally the performance of the work is also finding acceptable. In near future the following extension of the work is proposed work.

1. Improving the time and space complexity for recognizing the images and characters
2. Optimizing the edge detection technique for improving the classification accuracy of the system
3. Implementation of the system is real world traffic capturing and identification of number plates.

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