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Enhancing Image Recognition of Damaged Number Plate in the Running Vehicle using Novel Genetic Algorithm Compared with Morphological Erosion Algorithm

Y.Harshavardhan
Project Scholar, Department of Computer Science and Engineering, Saveetha School of Engineering, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai, Tamilnadu. India. Pincode: 602105.

T.P.Anithaashri
Project Guide, Corresponding Author, Associate Professor, Department of Computer Science and Engineering , Saveetha School of Engineering, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai, Tamilnadu. India. Pincode: 602105.

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Abstract

Aim: Automatic detection of damaged number plates of the vehicle using image processing algorithms and improving the accuracy rate of readability in recognition of the number plates. **Materials and methods:** Two sample groups using 10 images from the sample dataset, which is tested at 80% for G power with t-test analysis. To improve the accuracy of recognition, the novel genetic algorithm is proposed and compared with the morphological erosion algorithm. **Results**: Test results prove that the novel genetic algorithm has an accuracy of 93.5 %, which seems to be better than the morphological erosion algorithms accuracy of 91.5%. Since the significance is around 0.46, there is a statistically significant difference among the study group with ($p < 0.05$). **Conclusion:** For distorted and damaged images, the detection and recognition of number plates using the genetic method seems to appear better than the morphological erosion algorithm. Detection of violations using road side cameras can perform better with our proposed work.

INTRODUCTION

The aim of this is to detect the damaged number plates using machine learning algorithms and image processing techniques (John et al. 2017) damaged number plates detection is used to detect,deter and disrupt criminality at local forces and tracking the criminals (Jain et al. 2016). The applications of number plate detection using morphological erosion algorithms are visual inspection and maintenance of variable playback speed (Aung, Nwe, and Yoshitaka 2019). The main application of number plate Object recognition detection is traffic monitoring systems (Vaishnav and Mandot 2018).
The existing system has 43 conference papers published in google scholar and 21 ieee journal papers are published. In earlier times most of the pattern Object recognition was applied in machine learning and image processing (Dhar et al. 2018). It is applied in genetic algorithm and morphological erosion algorithm which are getting the improved results.In this they implemented Bangladeshi license plates by using edge detection and morphological dilation algorithm (94.56%) (Jagtap, Jayash, and Sushil Holambe. 2018.). In this paper they proposed a blended algorithm for number plate Object recognition and

character segmentation and used improved ocr technique with an accuracy (89%) and this paper is mostly cited by 33 articles (Kakani, Gandhi, and Jani 2017). In this paper they implemented a multi style license plate recognition system by using artificial neural networks algorithms which contain character segmentation and number plate localization methods with an accuracy (89.5%) (Jagtap and Holambe 2018). The sober filter algorithm and Support Vector Machine technique by using vehicle number plates identifying the vehicles with an accuracy (85%) (Bagi et al. 2019) .
Previously our team has a rich experience in working on various research projects across multiple disciplines (Venu and Appavu 2021; Gudipaneni et al. 2020; Sivasamy, Venugopal, and Espinoza-González 2020; Sathish et al. 2020; Reddy et al. 2020; Sathish and Karthick 2020; Benin et al. 2020; Nalini, Selvaraj, and Kumar 2020). The research gap of existing systems of number plates are detected automatically in MATLAB which leads to decrease in accuracy (Bagi et al. 2019).The aim of this proposed work is to detect damaged number plates with the accuracy rate of readability using the genetic algorithm compared with morphological erosion algorithm (Jagtap, Jayash, and Sushil Holambe. 2018).

MATERIALS AND METHODS

The study setting of the proposed work is done in our Compiler Design Lab, Saveetha School of Engineering, Saveetha Institute of Medical and Technical Sciences, Chennai. The number of groups identified for the study is 2. Group 1 is a novel genetic algorithm and Group 2 is the morphological erosion algorithm. The sample dataset taken for each group is 237 and the total dataset is divided and iterated for 5 times.
Novel Genetic algorithm is a natural processing algorithm, it is an optimization technique used in number plate detection systems. It enhances the input image with traits and recognizes each character one by one. The morphological erosion algorithm is proposed for detecting the image pixels of the vehicle number plate. It contains a binary image and structuring element for underlying the image pixels in shrinking the size of the image by removing the irrelevant things present in it. A sample of the dataset with various attributes that are presented in Table 1. There are totally 10 images that are considered as sample training data set images useful for the proposed genetic algorithm in detecting the damaged number plates.
Software tool used for detecting the accuracy rate of damaged number plates using python programming language. Hardware configuration was Intel core i5 (2.70 GHZ) processor with 8 GB RAM and 64bit OS, x64-based processor system. The Software configuration was the Windows 10 operating system. The data was pre-processed after importing the dataset by removing noises. The dataset was splitted into two parts as training labels and testing records. The genetic algorithm and morphological erosion algorithms were evaluated with respect to training labels and testing records, the required parameter accuracy percentage was calculated.

Testing Procedure for Number Plate Detection using Genetic Algorithm

Genetic algorithm is a natural processing algorithm, it is an optimization technique used in number plate detection systems. It enhances the input image with traits and recognizes each character one by one.
Step 1 To start with testing first import the dataset consisting of images. Assign train labels to the data and get test tables for testing the images.
Step 2 The input image is preprocessed which is enhanced using the gaussian filter.
Step 3 In cleaning the number plate the binarized image is converted into gray scale images by removing the noise which is shown in Fig. 2.
Step 4 By using these contours the image of the car's number plate should be shown by applying ratio and the rotations.
Step 5 Character segmentation is an operation that divides the image into subimages by dividing each and every character in the number plate.

Step 6 In Character recognition the characters are recognized by aspect ratio in the number plate.
Step 7 After finding the characters one by one it is used to check whether they have the same number plate or not which is presented in Fig. 2.

Pseudocode For Genetic Algorithm

Pseudocode For Genetic Algorithm

Let t = 0;
Create an initial population p(t);{calculat
Evaluate population p(t);{calculate the fitness function for each individual }
while not termination do
p(t) = variation[p(t)];
Evaluate population [p(t)];
p(t+1)=apply genetic operations;{Next generation.}
t = t +1;
end while

Morphological erosion Algorithm
Testing Procedure for Number Plate Detection using Morphological erosion algorithm
The morphological erosion algorithm is proposed for detecting the image pixels. of the vehicle number plate. It contains a binary image and structuring element for underlying the image pixels in shrinking the size of the image by removing the irrelevant things present in it.
Step 1 import the image from the dataset downloaded from the kaggle website.
Step 2 it takes input as two pieces one as data and the other as a structuring element.
Step 3 input image is converted into binary image which represents the two dimensional integer.
Step 4 Removing the noise by using the morphological filters. Bounding box technique is used for segmentation of the characters based on the connected components.
Step 5 Extracting the number plates character morphological erosion algorithms which resized the image and then localization of the vehicle number plate as the output.

Pseudocode For morphological erosion Algorithm

Pseudocode For morphological erosion Algorithm
Define pvol_dilate(image,selem) dilated=convolve_nd(image,selem) dilated=elementwise_minmum(1dilated) Return dilated Define pvl_erode(image,selem) Erode =1-convolve_nd(1-image,selem) eroded=element wise-maximum(0,eroded) Return eroded

Statistical Analysis

This innovative damaged number plate detection system was tested on 237 car images. Each image is different in its length and also the environment conditions. Cars number plates used for detecting damaged number plates collected from kaggle website and the dataset is splitted as 80% is used as training and 20% is used for testing the images. The dependent variables are pixel width, resolution, and height and width of the number plate. The independent variables are date of image, size of the image, and location information.

RESULTS

In this innovative number plate detection research it is proved that the genetic algorithm appears to have better accuracy than the morphological erosion algorithm. Statistical analysis is done for comparing both genetic algorithm and morphological erosion algorithm using IBM SPSS tool. By taking accuracy,statistical analysis is performed in the SPSS tool. Parameters taken for comparison of both algorithms are accurate. Finally descriptive statistics applied for the dataset in SPSS.

From group statistics mentioned in Table 1, the mean, standard deviation and standard error mean are compared for our experimental algorithm genetic algorithm and morphological erosion algorithm. The genetic algorithm got a better mean accuracy value of (92.8%) in comparison with the morphological erosion algorithm.

In Table 2, the independent sample t-test results are shown with equal variance assumed as one category and without equal variance as another category. It's found that the level of significance is marginally better.

Fig. 1, shows the comparison of time taken for object recognition between genetic algorithms over morphological erosion algorithms. X axis gives the time taken in milliseconds and Y axis gives the time taken for object detection in seconds.

Fig. 2, represents the mean accuracy between the two algorithms. Genetic algorithms appear to produce consistent results with minimal standard deviation. There is a significant difference between genetic algorithms and the morphological erosion algorithm. The analysis observed that the genetic algorithm seems to be better than the morphological erosion algorithm in detection of damaged number plates.

DISCUSSION

There are similar papers on the detection of vehicle number plates using machine learning algorithms. In this paper they proposed an automatic license plate object recognition technology and morphological algorithms for complex images of the vehicles in MATLAB with an accuracy(98.4%) (Dhar et al. 2018). The deep neural networks algorithms and image binarization technique for finding the vehicles on the way with an accuracy (95.4%) (Rabbani et al. 2018). They proposed back propagation and neural network algorithms for detecting and monitoring the vehicle number plate recognition on various illuminated conditions with an accuracy (90%) (Alhaj Mustafa, Hassanin, and Al-Yaman 2018).

As per the above findings it is proved that the genetic algorithm has got better results and performance. The limitation of this study is that a huge color database was to be created manually extracting colors from number plates. The future work is Currently Have proposed the morphological erosion algorithms for our ANPR system. In the future this system runs on the OpenCV library with a machine learning algorithm and would also do the performance check of the system design.

CONCLUSION

It is inferred that the genetic algorithm seems to appear with better accuracy percentage (93.5%) in detecting the damaged number plates than the morphological erosion algorithm with the accuracy of (91.5%).

DECLARATIONS

Conflict of Interests
No conflict of interest in this manuscript.

Author Contribution
Author YHV was involved in data collection, data analysis, manuscript writing. Author TPA was involved in conceptualization, guidance and critical review of manuscript.

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Tables and Figures

Table. 1. Sample data sets with 10 images depicting the number plates of various cars. It consists of attributes like resolution, height and width of the image. Also damaged car license plates are included in the dataset which is taken from the kaggle dataset.

File name	Width	height	class	xmin	ymin	xmax	ymax
	149	43	License plate	283	177	432	220
	1374	294	License plate	121	43	1495	337
	459	239	License plate	26	15	485	254
	148	54	License plate	48	291	196	345
	113	58	License plate	61	131	174	189

Table. 2. Group statistics results (Mean of genetic algorithm (93.5%) appears to be more compared with morphological erosion algorithm (91.5%) and Standard Error Mean for genetic algorithm is 1.029 and morphological erosion algorithm is 1.013)

	Groups	N	Mean	Std.Deviation	Std.Error Mean
Accuracy	Genetic Algorithm	10	93.5000	2.30217	1.0295
	Morphological erosion algorithm	10	91.5000	3.95218	1.0137

Table. 3. Independent Sample T- test Result is applied for dataset fixing confidence interval as 95% and level of significance as 0.03 (genetic appears to perform significantly better than morphological erosion algorithm)

	Lavene's test for equality of variances		T-test for Equality of Means					95% confidence interval of the difference	
	F	Sig	t	df	sig(2 tailed)	Mean diff	Std.error	Lower	Upper

Accuracy	**Equal Variances assumed**	0.73	0.03	1.236	8	0.251	1.800	1.45602	-1.5579	5.15759
	Equal Variances not assumed			1.236	8	0.251	1.800	1.45602	-2.37623	6.46521

Fig. 1. Comparison of time taken for object recognition between genetic algorithms over morphological erosion algorithm. X axis gives the time taken in milliseconds and Y axis gives the time taken for object detection in seconds.

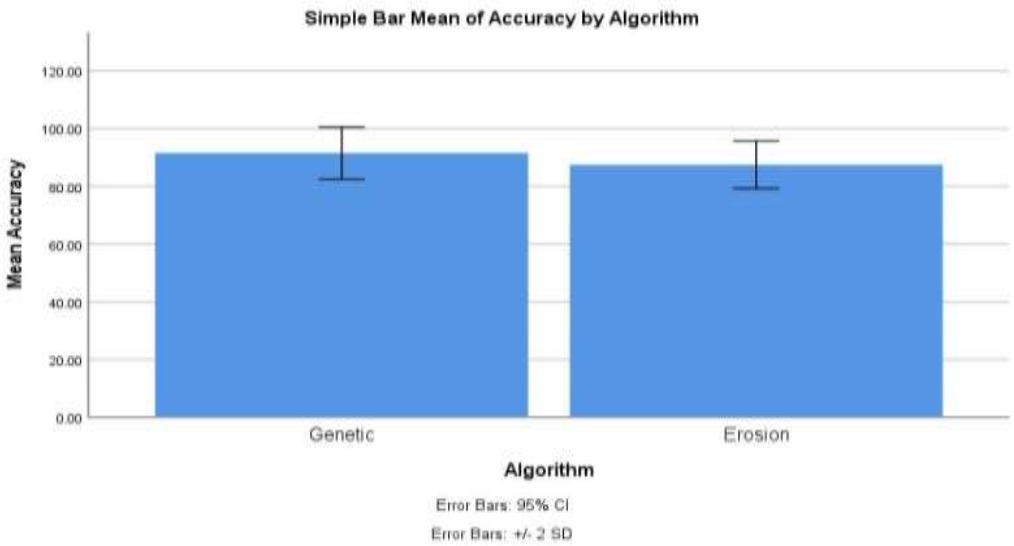

Fig. 2. Comparison of mean accuracy between genetic algorithm over morphological erosion algorithm, where the former is better than the later with 2.0% increase. X axis :Gives the algorithms and Y Axis: Mean accuracy of detection ± 1 SD.