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RESEARCH ARTICLE

Smart Face Detection and Recognition in Low Resolution Images Using Alexnet CNN Compare Accuracy with SVM

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ABSTRACT

Aim: Machine learning algorithm plays a vital role in various biometric applications due to its admirable result in detection, recognition and classification. The main objective of this work is to perform comparative analysis on two different machine learning algorithms to recognize the person from low resolution images with high accuracy. **Materials & Methods:** AlexNet Convolutional Neural Network (ACNN) and Support Vector Machine (SVM) classifiers are implemented to recognize the face in a low resolution image dataset with 20 samples each. **Results:** Simulation result shows that ACNN achieves a significant recognition rate with 98% accuracy over SVM (89%). Attained significant accuracy ratio (p=0.002) in SPSS statistical analysis as well. **Conclusion:** For the considered low resolution images ACNN classifier provides better accuracy than SVM Classifier.

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Introduction

Face Recognition has become an important research field for over a couple of decades and several face recognition systems have been developed (Wójcik, Gromaszek, and Junisbekov 2016). Though fingerprint identification is an unique method, it is not feasible for classifying humans with respect to gender, color creed etc., for further analysis (Ramkumar and Logashanmugam 2018). Hence Human faces are used for biometric purposes. It is mainly used for personnel identification (Ramkumar and Logashanmugam 2016). It has many applications in our day to day life like surveillance cameras installation for monitoring person in workplaces, temples, buildings, border security, marketing, smart gadgets, biometric systems etc (Wójcik, Gromaszek, and Junisbekov 2016; Rai et al. 2019).

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Recently many researches have worked on face recognition. In IEEE from 2016-2021, 148 journals published on face recognition whereas 17,400 journal and conference papers in google scholar. SVM-based algorithm is compared with a principal component analysis using ferret dataset. In this method SVM achieved 77-78% identification performance whereas 54% for PCA. (Wójcik, Gromaszek, and Junisbekov 2016; Rai et al. 2019; Hides and Stanton 2017).SVM has a 7 percent equal error rate for authentication, while PCA has a 13 percent equal error rate. For face detection, feature extraction, and classification, the Viola Jones, Gabor filter, and Support Vector Machine (SVM) are used, respectively. (AHE) is used to improve recognition accuracy during the preprocessing stage. The accuracy has improved from 82.85 percent to 97.14 percent since the introduction of AHE. (Sino, Indrabayu, and Areni 2019). In Active shape model and Active Appearance Models algorithm, ASM is faster and more precise than AAM at extracting both the shape and texture of a given

object at the same time and measuring their accuracy on a single dataset of faces.(Iqtait, Mohamad, and Mamat 2018)

There are many difficulties in recognising the face due to pose variant, illumination invariant, noise, occluded and low resolution face images (Chang, Bowyer, and Flynn 2006). Although many methods are proposed on above mentioned problems there are still shortcomings in the recognition of low-resolution faces (Yang and Wen 2017) with high accuracy. Unconventional framework using ACNN has been implemented to overcome the factors affecting the recognition and improve the accuracy in person identification.

Materials and Methods

Data Preparation

This work is done in an electronics and communication lab, Saveetha School of Engineering. Sample low resolution images were collected from different people and created our own dataset. Sample size was calculated using clincalc analysis, 20 sample sizes estimated per group, totally 40 samples with alpha error, threshold 0.05, 95% confidence, pretest power 80% and enrolment ratio 1. In this study, we compare the accuracy of two classifier ACNN and SVM (Sharma and Sachdeva 2015)

Sample Preparation using ACNN

Two processes were done for group 1 sample preparation. 20 samples were taken from the image dataset. Initially, the input image is rescaled. Feature extraction and classification were carried out by training the samples using ACNN (Almabdy and Elrefaei 2019). In alexnet image datastore is used to store the data and label the images based on the folder name and divide the data into training and validation. Each label is used to split datastore into two new datastores and need to load the pretrained alexnet neural network. In order to visualize the network, analyze network is used. In alexnet there are totally 8 layers in that the first layer accepts the input image of size 227 x 227 by 3 where 3 is the number of color channels. The last three layers of alexnet are fine tuned for new classification problems. Learn factor values of fully connected layers are increased to learn faster in new layers.If the images in the dataset are of different size overfitting problem occurs to overcome this issue, data augmentation is done. Training options are specified to slow down learning in the transferred layers, set the initial rate to small and increase learning rate factors for fully connected layers to speed up learning in new final layers. And need to specify mini batch size and validation data. Finally train the network that consists of transferred and new layers. The estimated sample values are exported in MS Excel for further statistical analysis.

Sample Preparation using SVM

Image from the low resolution face image dataset is rescaled into 256 x 256 pixels. Feature extraction and classification is carried out by SVM (Thome 2012). Surf technique is used to extract facial features and returns feature vectors and these feature vectors are classified using SVM. SVM is trained with features of all the images instead of individual images and while testing rather than predicted label of testing image as a whole labels of obtained features are predicted. If the label of majority of features is matching with that of expected label then its a successful recognition.

Testing Setup & Testing Procedure

All the experiment setup was done in windows platform CRT monitor with resolution of 1024*768 pixels with configuration of 9th gen,intel i5, 4GB RAM, 500GB HDD and MATLAB software 2018 version with add ons required for complete training and testing purposes. Proposed work flow is shown in Fig 1. Low resolution images sample given as an input for testing procedure. In the pre-processing stage, scaling is done. Alexnet CNN detects the face and then features extraction to be done. For feature extraction, Fc8 layer is selected to extract image features. This layer's output contains more feature information and has a 1000 dimension, allowing for better retrieval performance. Finally the recognition of the face is done. The estimated sample values are exported in MS Excel for further statistical analysis. For statistical analysis SPSS IBM software is used. Noisy and blurred images are the independent variables and accuracy is the dependent variable. Independent sample T test is performed for sample analysis. Accuracy value estimated using the given formula

$$Accuracy = TP + TN/TP + TN + FP + FN$$

TP - True Positive
TN - True Negative
FP - False Positive
FN - False Negative

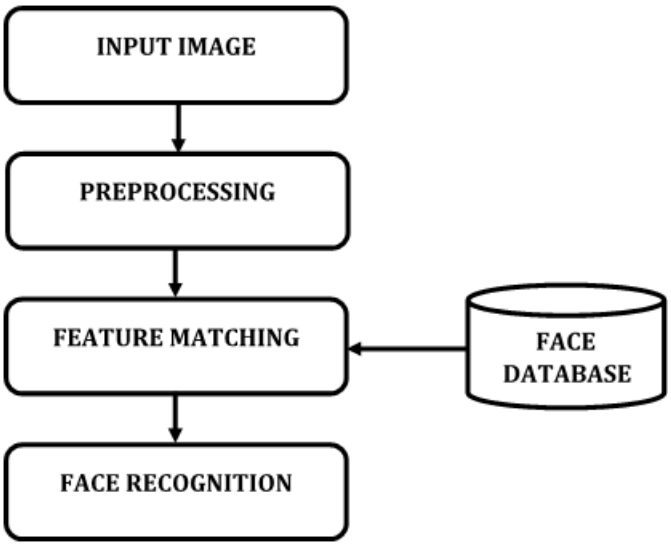

Fig. 1. Block diagram of proposed work shows several processing stages like preprocessing, feature matching for the given input images to recognise the face

Results

Novel technique for smart face detection and recognition accuracy is obtained in the low resolution face images on the performance pretrained Alexnet convolutional neural network and Support Vector Machine. For each sample, accuracy and loss were measured shown in Table 1.

Table 1. Accuracy of Face recognition in sample images using ACNN and SVM Classification. (ACNN mean Accuracy = 95.2% ; Loss =4.8% & SVM mean Accuracy = 83.94% ; Loss =16.06%)

Group 1 Sample Images	ACNN		Group 2 Sample Images	SVM	
	Accuracy	Loss		Accuracy	Loss
1	96.2	3.8	1	76.77	23.23
2	97	3	2	77.08	22.92
3	98	2	3	77.55	22.45
4	93	7	4	78.57	21.43
5	92	8	5	78.97	21.03
6	91	9	6	80.61	19.39
7	95	5	7	81.32	18.68
8	94.2	5.8	8	83.87	16.13
9	95.4	4.6	9	84.21	15.79
10	96.1	3.9	10	84.95	15.05
11	97.5	2.5	11	85.11	14.89
12	98.2	1.8	12	85.87	14.13
13	91	9	13	86.02	13.98
14	93.5	6.5	14	86.81	13.19
15	97	3	15	87.29	12.71
16	95	5	16	87.77	12.23
17	98	2	17	88.26	11.74
18	95	5	18	88.76	11.24
19	94.6	5.4	19	89.27	10.73
20	94	6	20	89.77	10.23

From Fig 2, it was observed that recognising different persons accurately using Alexnet Convolutional Neural Network from a low resolution dataset. Fig 3 shows the validation accuracy achieved 100% with 12 iterations. Based on the accuracy obtained from the simulation result from MATLAB, graphical representation shown in Fig 4.

Fig. 2. Recognition results for different persons obtained using ACNN from the low resolution image database, recognise the person accurately under low light conditions dataset.

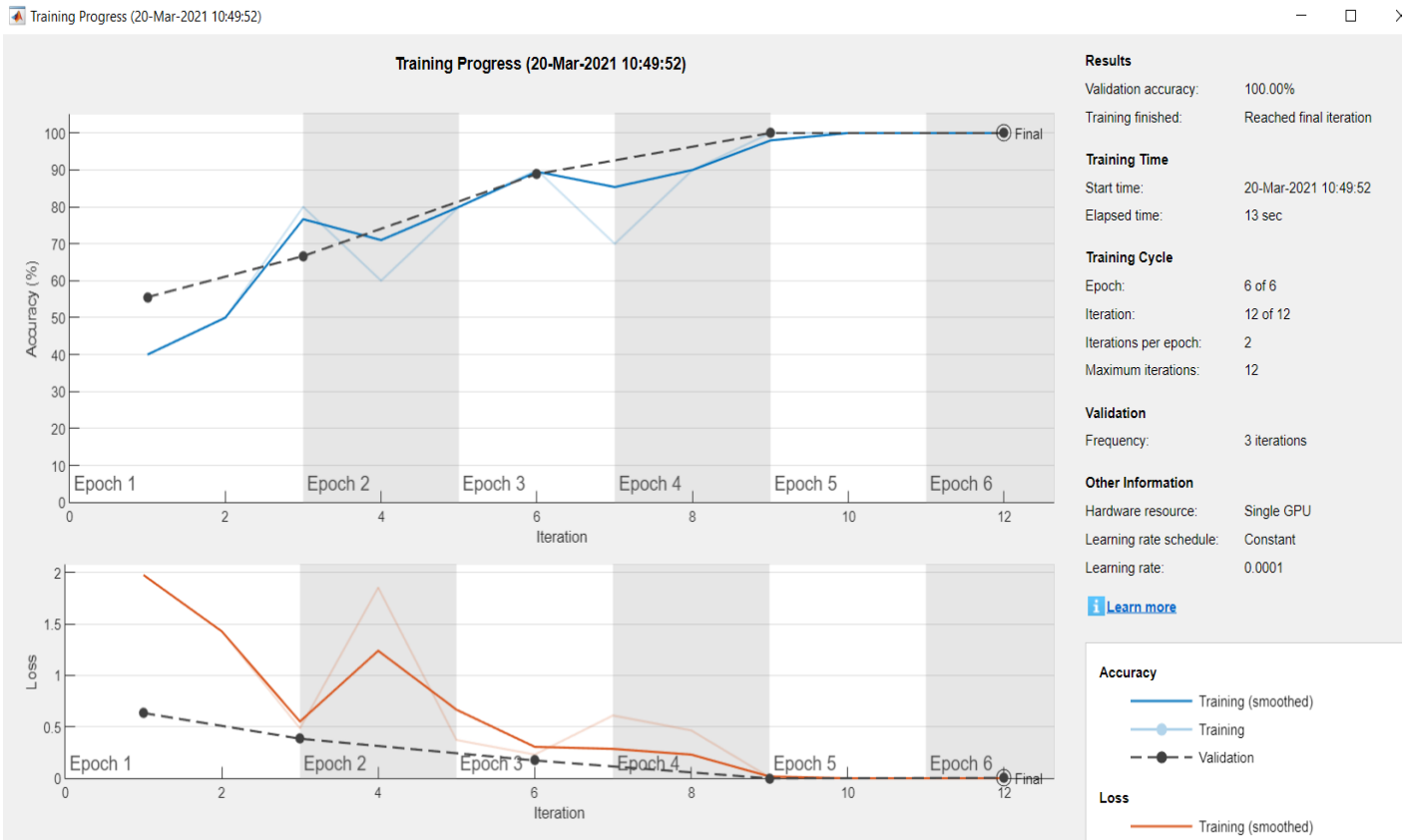

Fig. 3. Validation accuracy obtained after training the dataset using ACNN with 12 iterations and 2 iterations per epoch provides the validation accuracy 100% using MATLAB software

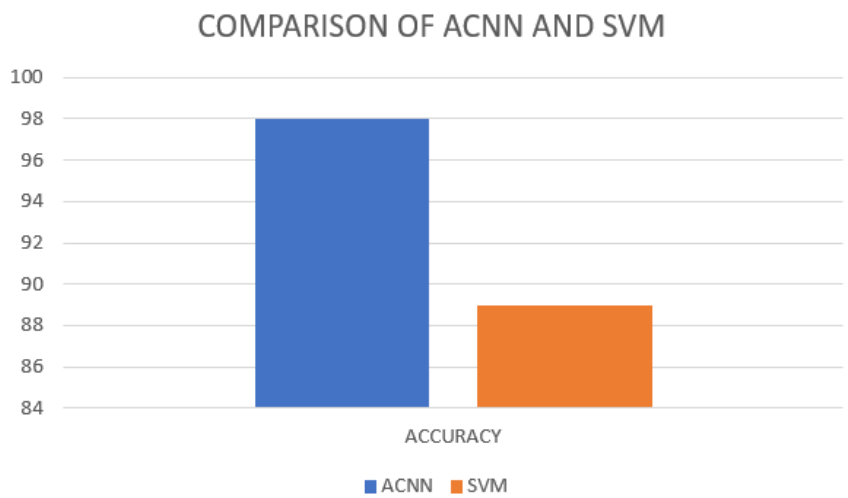

Fig. 4. Comparison graph for recognition accuracy of ACNN (98%) and SVM (89%) showing proposed method has better accuracy compared to existing method based on the MATLAB simulation results

Using SPSS Statistical analysis, ACNN obtained 2.22 standard deviation with 0.497 standard error while SVM obtained 4.35 standard deviation with 0.97 standard error shown in Table 2. Independent sample test performed for the obtained samples, attained statistically significant ($p<0.002$) shown in Table 3. Graphical representation for mean accuracy with 95% error bar shows the performance comparison of ACNN and SVM (Fig 5).

Table 2. Statistical analysis of ACNN and SVM. Mean accuracy value, Standard deviation and Standard Error Mean for ACNN and SVM algorithms are obtained for 20 iterations. It is observed that the ACNN algorithm performed better than the SVM algorithm.

Group statistics					
	group	N	Mean	Std Deviation	Std Error Mean
Accuracy	ACNN	20	95.0850	2.22670	.49790
	SVM	20	83.8900	4.35152	.97303

Table 3. Represents the independent sample T test using SPSS tool for ACCN and SVM in prediction of accuracy for low resolution image samples shows its statistical significance with p-value (0.002), Mean diff (11.19500) and Std error diff (1.09302)

Independent sample T test									
			T-test for Equality of Means					**95% Confidence interval of the difference**	
	Equal Variances	**Sig.**	**t**	**df**	**Sig. (2-tailed)**	**Mean diff**	**Std Error Diff**	**Lower**	**Upper**
Accuracy	Assumed	0.002	10.242	38	.000	11.19500	1.09302	8.98230	13.40770
	Not Assumed		10.242	28.312	.000	11.19500	1.09302	8.95716	13.43284

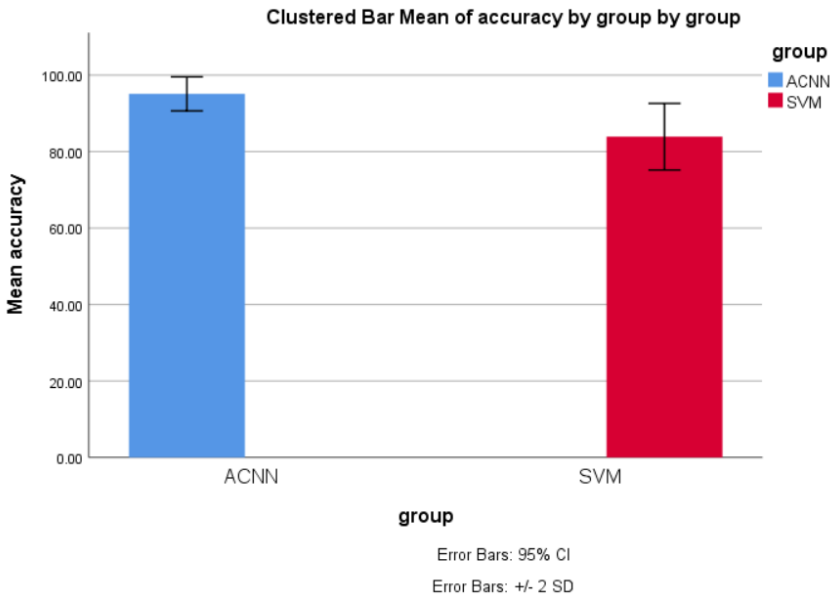

Fig 5: Comparison analysis of mean accuracy for two groups using ACNN and SVM. The mean accuracy of ACNN shows better accuracy results compared to SVM with error bar 95%. Parameter shows statistically significant (p-value 0.002) and it shows the effective prediction. X Axis: ACNN vs SVM Y Axis: Mean accuracy of detection ± 2 SD.

Discussions

In this study, it seems ACNN has achieved significantly better accuracy than SVM classifier in recognizing the face from low resolution images with accuracy of 98% ($P<0.05$). In this work performance of ACNN and SVM analyzed in recognising faces from the dataset created with low resolution face images. Proposed works proves that ACCN performs better recognition compared to SVM Classification.

Based on the previous research, some similar findings shows that CNN is performing better than other classifiers like SVM (Déniz, Castrillón, and Hernández 2003; Dino and Abdulrazzaq 2019; Islam, Raj, and Al-Murad 2017). In plant species extraction CNN performs better than SVM and other conventional methods (Hasan et al. 2019). For classification of images in a small dataset, CNN significantly achieves better accuracy than SVM (Chaganti et al. 2020). Some opposite findings also noted in the previous research, it shows that SVM combined with CNN results in high accuracy compared to CNN(Guo, Chen, and Li 2016).In some studies CNN as a feature extractor and SVM as classifier produce better results compared to CNN as feature extractor and classifier(Matsugu, Mori, and Suzuki 2004). CNN is having better accuracy and efficiency in feature extraction and classification compared to existing classifiers. Even though many CNN algorithms have proposed face recognition, dealing with low resolution images is a major task. Alexnet CNN is proposed to overcome this problem. Training time is the factor to be considered in the proposed work, training the sample consumes more time in ACNN. To overcome the limitation, future study should examine the minimum number of features required for recognising the face to reduce the training time with more accuracy.

Conclusion

Face recognition plays a vital role in real time applications. In the proposed work, Alexnet convolutional neural network classifiers recognising the low resolution face images significantly better than Support Vector Machine with high accuracy.

Declarations

Conflict of Interests

No conflict of interest in this manuscript.

Author Contribution

S. Mahesh - Methodology, Formal analysis, Writing original manuscript, Dr. G. Ramkumar - Review and editing, Supervision and Validation.

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