

Criminal Identification System to Improve Accuracy of Face Recognition using Innovative CNN in Comparison with HAAR Cascade

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Abstract

Aim: Criminal face identification system helps in identifying criminal or suspect and also retrieves information about the suspect. This saves us time for manual work. Innovative Convolutional Neural Network (CNN) are applied to discriminate between criminal and non-criminal facial images. **Materials and Methods:** Criminal face recognition is performed using CNN (N=10) over HAAR Cascade (N=10) was iterated 10 times for efficient and accurate analysis based on labeled data with 2 groups G power in 80% and threshold 0.05%, CI 95% mean and standard deviation. The split size of training and testing of 70% and 30% respectively. **Results:** After analyzing the results, the accuracy for HAAR is 84.50% and the accuracy for CNN is 90.30% and attained the significance value of $p=0.0309$ ($p<0.05$), showing that there is a significant difference between the groups. **Conclusion:** CNN is better than the HAAR Cascade algorithm for face recognition.

Keywords: Facial Image, Innovative Convolutional Neural Network, Image Classification, Machine Learning, HAAR Cascade Algorithm.

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INTRODUCTION

Face is the primary means of recognising a person. Face recognition systems use a computer's algorithm to detect a person's face. This criminal face detection helps in identifying the suspect faster (Lang and Gu 2009). The general task for the system is to validate or recognize faces from a set of facial images. It is a neural network application which helps us to investigate and distinguish between criminal and a non-criminal. Face recognition provides vast benefits when compared to other biometric identification like fingerprints (Valentine and Davis 2015). This system not only helps in face recognition but also in retrieving the previous crimes, if any, of the suspect. CNN has recently outperformed other neural network architectures and this works on image classification, the machine learning procedure helps in facial recognition (Osowski 2020). This criminal face identification system can be implemented in the forensics for identifying the victim, also used in criminal investigation purpose for identifying criminals (Abdullah et al. 2017).

Around 30 articles in IEEE Explore, 10 articles in Science Direct and 8 articles in Google Scholar were published in the last 5 years. Facial image recognition and Machine Learning is a rapidly transforming technology and there are more developers developing and implementing this technology. CNN model helps in face recognition systems and gives out more accurate results (Yu et al. 2018). HAAR Cascade could be used to effectively locate an optimal solution (Duffner 2009). The HAAR method simplifies layering the sampling and finally connected layer to optimize the model parameter (Wang et al. 2020). Clear and correct images may increase the accuracy of face recognition using machine learning algorithms (Rezq and El-Sayed 2008). Among these articles, the best article would be (Abdullah et al. 2017) as this is more relevant and useful for current research and it helps in memory management in machine learning algorithms. Our team has extensive knowledge and research experience that has translate into high quality publications (Bhansali et al. 2021; Jayanth et al. 2021; Sudhakar, Ravel, and Perumal 2021; Sathiyamoorthi et al. 2021; Deepanraj et al. 2021; Raju et al. 2021; Arun Prakash et al. 2020; Kamath et al. 2020; Shanmugam et al. 2021; Rajasekaran et al. 2020; Adhinarayanan et al. 2020; Rajesh et al. 2020; Aurtherson et al. 2021)

From this literature survey, it can be concluded that this machine learning system helps in identifying criminals which brings effective results as the previous results were giving less accuracy as it was detecting some false images. The aim of the study is to achieve a higher accuracy rate for identification of suspects using the CNN algorithm.

Materials And Methods

The study setting of the proposed work was conducted in Web Ontology Laboratory, Saveetha School of Engineering, Saveetha Institute of Medical and Technical Sciences, Saveetha University. In this research model, there are two groups one group refers to Innovative Convolutional Neural Network and the other group refers to HAAR. Sample size was calculated using clinical analysis, 10 sample sizes estimated per group, totally 20 samples with alpha and beta value 0.05 and 0.2, 95% confidence, pretest power 80% and enrolment ratio 1 (Li 2022). In this study, the accuracy of two classifiers Innovative Convolutional Neural Network and HAAR was compared (Murillo et al. 2017).

Cnn Algorithm

Innovative Convolutional Neural Network is a deep learning algorithm which can take in an input image, and is able to differentiate one image from another, it follows the image classification method. For the sample preparation, Innovative Convolutional Neural Network algorithm is implemented for group 1.

PseudocodeForCNN Algorithm

- Step 1: Import required dataset for training and testing.
- Step 2: Set the MTCnn detector to analyze the image.
- Step 3: Call CNN method for image classification to compare and recognize the person.
- Step 4: Evaluate the final result.
- Step 5: Calculate the accuracy for CNN algorithm as shown in Equation (1)

$$\text{Accuracy} = \frac{\text{Number of correct predictions}}{\text{Total Number of predictions}} \times 100\% \quad (1)$$

HAAR Cascade Algorithm

HAAR Cascade is an object detection algorithm which is used to identify facial images. For the sample preparation, the HAAR Cascade algorithm is implemented for group II.

Pseudocode for HAAR Cascade Algorithm

- Step 1: Import required dataset for training and testing.
- Step 2: Call the face_cascade method to detect the faces.
- Step 3: Analyze the image for recognition.
- Step 4: Evaluate the final result.
- Step 5: Calculate the accuracy for HAAR Cascade algorithm.

For the training and testing purpose of the CNN algorithm, a computer with AMD Ryzen 5 (3550H) 64 bit processor, 8GB RAM of memory and this model is developed using python language of version 3.8. The dataset has been collected in the image format from google which consists of different facial images and these same datasets were used for both the training and testing purpose.

Statistical Analysis

Statistical software used in the study is the IBM SPSS version 28. The independent sample t-test calculation for analyzing equal variance, standard error, and levene's test are evaluated. The SPSS was also used for evaluating the accuracy of the algorithms namely CNN and HAAR algorithm. Attributes like image, pixel resolution are the independent variables and face_detector, resized_faces and accuracy are the dependent variables.

Results

After the completion of analysis, the results show that HAAR Cascade is having accuracy of 84.50% and accuracy for CNN is 90.30%. Therefore, the CNN algorithm is more efficient and accurate. Table 1 consists of the Accuracy and Accuracy loss value of both the CNN and HAAR algorithms. Table 2 consists of the statistical analysis performed to obtain the Mean, Std. Deviation and Std. Error Mean values for Accuracy values of CNN and HAAR. Table 3 provides information for independent sample t-test was performed to obtain t-test Equality. Comparison of these two algorithms is presented using a bar plot with error rate included as shown in Fig. 1.

Discussion

From this research, it can be concluded that the CNN algorithm which has 90.30% is significantly better than the HAAR cascade algorithm which has accuracy value of 84.50%. For the testing purpose, the face detection model is used both for training and testing, each sample group gives us different results. For training the dataset, 80% of images having people's faces and also for testing 80% of images were used from the dataset.

Results show that the CNN model outperformed the existing algorithms as the algorithm reduces overall computation time (Khalil-Hani and Sung 2014; Ayat et al. 2019). MTCNN uses custom CNN for face detection and alignment in real time and using resized images helps in speeding up the detection (Chaves et al. 2020). CNN algorithm gives out better and optimal results and the accuracy value is increased. This can also be used in emotion detection (Riyantoko, Sugiarto, and Hindrayani 2021). CNN reduces the image without losing the data which are important to recognize an image. This extracts high level features from an image. CNN are a category of Neural Network areas that have proven effective results in image classification (Ge et al. 2021).

CNN algorithm executes effectively for images but considering the live videos, there are some limitations with respect to accuracy. In videos there are many frames per seconds so accuracy may vary. It does not encode the position and orientation of objects. In future the Criminal Face Identification system can be developed by real time face detection from videos and higher accuracy rate can be achieved by larger datasets.

Conclusion

After analyzing the results, CNN algorithm for Criminal face detection is better than the HAAR Cascade algorithm in terms of accuracy and this CNN algorithm can be implemented for further development.

Declarations

Conflict of Interest

No conflict of interest in this manuscript.

Author Contributions

Author TS was involved in data collection, data analysis, manuscript and for writing Author GP was involved in conceptualization, data validation and critical review of manuscript.

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Tables And Figures

Table 1. Accuracy and Accuracy loss values for CNN and HAAR Algorithm for face detection and identification.

FACES	CNN		HAAR	
	Accuracy	Accuracy loss	Accuracy	Accuracy Loss
1	93.0	7.0	86.0	14.0
2	92.0	8.0	83.0	17.0
3	88.0	12.0	85.0	15.0
4	85.0	15.0	82.0	18.0
5	90.0	10.0	84.0	16.0
6	89.0	11.0	83.0	17.0
7	91.0	9.0	85.0	15.0
8	92.0	8.0	85.0	15.0
9	90.0	10.0	84.0	16.0
10	93.0	7.0	88.0	12.0

Table 2. Descriptive Statistical value of mean, std.Deviation, std Error Mean value for CNN and HAAR with ten optimal accuracy values. There is a statistically significant variation in accuracy values between HAAR and CNN.

	Algorithm	N	Mean	Std. Deviation	Std. Error Mean
Accuracy	CNN	10	90.30	2.497	0.790
	HAAR	10	84.50	1.716	0.543
Accuracy Loss	CNN	10	9.7000	2.49666	0.78951
	HAAR	10	15.5000	1.71594	0.54263

Table 3. Independent Sample t-test is applied for the dataset fixing confidence interval as 95% and level of significance is $p=0.0309$ ($p < 0.05$) (CNN showed significantly more accuracy than HAAR)

Accuracy	Levene's Test for Equality of Variances		t-test for Equality of Means					
	F	Sig.	t	df	Sig. (2-	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference

					tailed)			Lower	Upper
Equal variances assumed	1.095	0.0309	6.054	18	0.01	5.800	0.958	3.787	7.813
Equal variances not assumed	-	-	6.054	15.952	0.01	5.800	0.958	3.769	7.831

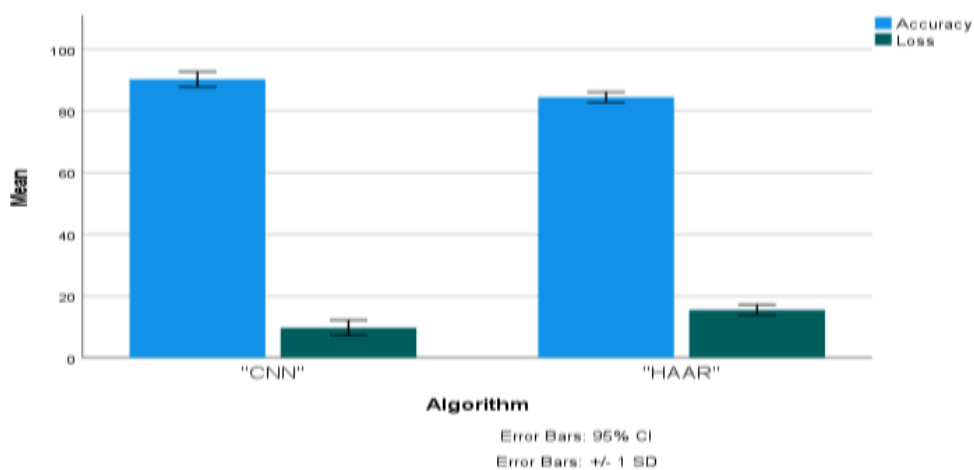


Fig. 1. Bar graph comparison between CNN (showed 90.30% accuracy) and HAAR (showed 84.50% accuracy) in terms of Mean Accuracy. CNN showed significantly higher accuracy and slightly better standard deviation than HAAR. X-axis: CNN vs HAAR, Y-axis: Mean Accuracy of detection \pm 1 SD.