Original Article

Realtime Criminal Face Recognition System based on Innovative Facial Classification to Improve Accuracy using Arcface over Deepface

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Abstract

Aim: The objective of this study is to use face recognition technology to identify the suspects through facial biometrics which helps in identification of criminals in a better way. LBPH algorithm is used for the face recognition method. **Materials and Methods:** Face detection for identifying the criminals is performed using Arcface (N=10) over Deepface model (N=10) with Gpower of 80% and alpha =0.05, split size of 70% and 30 % for training and testing model respectively. **Results:** It is found that the accuracy of Arcface is 92.50% which is higher than the Deepface model 91.90% and attained the significance value of p=0.0118 (p<0.05), showing that there is a significant difference between the groups.. **Conclusion:** For the face identification purpose Arcface algorithm is preferred than Deepface algorithm.

Keywords: Arcface, Deepface, Innovative Facial Classification, Facial Image, Face Recognition, Machine Learning.

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INTRODUCTION

Criminal investigation is a time-consuming process that takes longer to discover the criminal and bring justice to the victim. From a digital image, a facial recognition system can match a human face and it is analyzed by Innovative Facial classification. The purpose of this research is to identify criminals using face recognition technologies. The first step of face recognition is face detection and the second step is face recognition. Criminal identification with face recognition helps in completing criminal investigation faster (Gurav et al. 2015). Face recognition systems are better and aid in faster identification of suspects and retrieval of their crime details. Face recognition using machine learning is a robust method when compared to other algorithms (Ahsan et al. 2020). Criminal face recognition plays an important role in facial image recognition and is widely used in Forensics for identifying the victims (Valentine and Davis 2015). In criminal investigation for finding and retrieving information about the suspect (Abdullah et al. 2017).

Criminal face recognition is being developed by many organizations and more than 45 articles were published in IEEE xplore, 25 from Science Direct and 20 articles from Google Scholar. Automation technique in criminal face recognition helps in time management (Karve et al. 2020). Face recognition is an efficient method using Innovative facial classification for identifying the criminals (Gurav et al. 2015). Innovative Arcface consistently outperforms the state of art in face recognition techniques (Deng et al. 2021). Arcface uses machine learning which is better than the deep learning models in face recognition (Yang et al. 2021). From the above articles, the best article for study is (Deng et al. 2021) as it clearly explains about the accuracy and working of Arcface model.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)

Based on the literature survey, it can be concluded that the LBPH algorithm in the criminal face identification system supports faster face recognition and also uses histograms for comparison and it is more accurate, whereas the previous study yielded with less accuracy. The aim of this study is to achieve higher accuracy results for criminal face identification using the LBPH 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. In this research model, there are two groups one group refers to Arcface and the other group refers to Deepface. Sample size was calculated using clincalc 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 (Singh et al. 2021). In this study, the accuracy of two innovative facial classification algorithms Arcface and Deepface was compared (Murillo et al. 2017).

Arcface Algorithm
To acquire highly discriminative characteristics for facial image recognition, Additive Angular Margin Loss (ArcFace) is used. Due to the perfect correlation to the geodesic distance on the hypersphere, ArcFace has a clear geometric interpretation as it uses machine learning. For the sample preparation, an Innovative Arcface algorithm is implemented for group 1.

Pseudocode for LBPH Algorithm

Step 1: Import required dataset for training and testing.
Step 2: Find the encodings of the innovative facial classification to compare.
Step 3: Start comparing the facial images.
Step 3: Evaluate the final result.
Step 5: Calculate the accuracy for Arcface algorithm as shown in equation (1).

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

Deepface Algorithm
Deepface is the most lightweight facial recognition library used in python. Deepface uses machine learning and AI models for face recognition. Deepface extracts details like age, gender, emotion by extracting attributes from an image.

Pseudocode for Deepface Algorithm

Step 1: Import required dataset for training and testing.
Step 2: Read the facial image.
Step 3: Convert image into BGR format for face recognition.
Step 4: Evaluate the final result.

For the training and testing purpose of the Arcface 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 Deepface and Arcface algorithm. Attributes like cv2, face_recognition, dataset are the independent variables and matchfaces, draw_box are the dependent variables. (Murillo et al. 2017))

Results

After the completion of analysis, the results show that Arcface is having accuracy of 92.50% and accuracy for CNN is 91.90%. Therefore, the Arcface algorithm is more efficient and accurate. Table 1 consists of the Accuracy and Accuracy loss value of both the Arcface and Deepface algorithms. Table 2 consists of the statistical analysis performed to obtain the Mean, Std. Deviation and Std. Error Mean values for Accuracy values of Arcface and Deepface. 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 Arcface algorithm which has 92.50% is better than the Deepface algorithm which has an accuracy value of 91.90% . 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.

With Arcface algorithm the Innovative facial classification of images is more accurate as they differentiate the images with image boundaries (Lin et al. 2021). Arcface is an optimized algorithm for recognizing images as this algorithm introduces the Arc Loss function which optimizes the angular distance in an image (Baltanas, Ruiz-Sarmiento, and Gonzalez-Jimenez 2021). Face recognition with opencv helps in increasing the recognition rate with edge detection and Arcface utilizes face alignment in order to recognize more efficiently (Howse 2013). Machine learning helps in automating the face recognition process, the distance between faces in an image is calculated using the cosine distance, with this the similar measure is found (Abdullah et al. 2017).
Limitations of Arcface algorithm is, it consumes more memory for recognizing the facial images. The more identities for recognition results in more parameters. In future the Criminal Face Identification system can be developed by achieving less memory consumption with more accuracy.

Conclusion

After evaluating the data, it is discovered that the Arcface algorithm for criminal face identification is more accurate than the Deep face method, and this Arcface algorithm can be used for further research.

Declaration

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 WDP 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 Arcface and Deepface Algorithm for face detection and identification

FACES	ARCFACE		DEEPFACE	
	Accuracy	**Accuracy loss**	**Accuracy**	**Accuracy Loss**
1	95.0	5.0	95.0	5.0
2	91.0	9.0	91.0	9.0
3	92.0	8.0	89.0	11.0
4	93.0	7.0	93.0	7.0
5	92.0	8.0	92.0	8.0

6	90.0	10.0	88.0	12.0
7	93.0	11.0	92.0	8.0
8	93.0	7.0	95.0	5.0
9	94.0	8.0	94.0	6.0
10	92.0	10.0	90.0	10.0

Table 2. Descriptive Statistical value of mean, std.Deviation, std Error Mean value for Arcface and Deepface with ten optimal accuracy values. There is a statistically significant variation in accuracy values between Arcface (92.50%) and Deepface (91.90%).

	Algorithm	**N**	**Mean**	**Std. Deviation**	**Std. Error Mean**
Accuracy	**ARCFACE**	10	92.50	2.233	0.706
	DEEPFACE	10	91.90	2.915	0.921
Accuracy Loss	**ARCFACE**	10	8.9000	2.233	0.706
	DEEPFACE	10	10.900	2.806	0.887

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

Accuracy	**Levene'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 Difference**	**Std. Error Difference**	**Lower**	**Upper**
Equal variances assumed	2.697	0.118	0.674	18	<0.01	0.600	0.890	-1.27	2.47
Equal variances not assumed	-	-	0.674	14.609	<0.01	0.600	0.890	-1.30	2.50

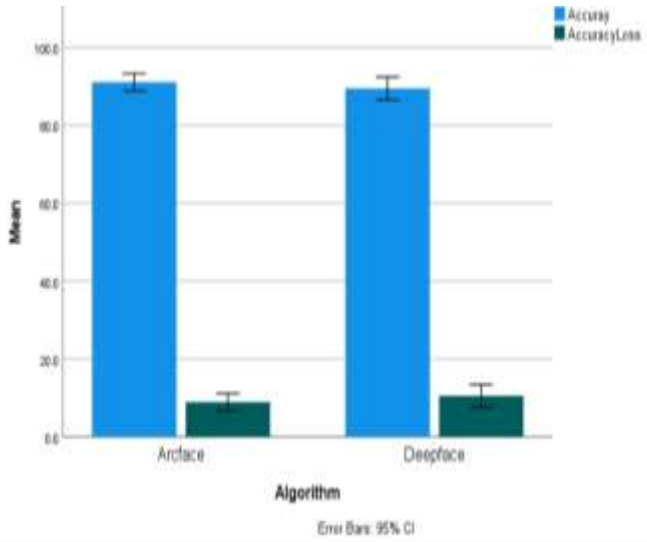

Fig. 1. Bar graph comparison between Arcface (showed 92.50% accuracy) and Deepface(showed 91.90% accuracy) in terms of Mean Accuracy. Deepface showed significantly higher accuracy and slightly better standard deviation than LBPH. X-axis: Arcface vs Deepface, Y-axis: Mean Accuracy of detection ± 1 SD.