Original Article

Efficient System for Criminal Face Detection Technique on Innovative Facial Features To Improve Accuracy Using LBPH In Comparison With CNN

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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 faster based on innovative facial features. Innovative Local Binary Pattern Histograms algorithm is used for the face recognition method. **Materials and Methods:** Face detection for identifying the criminals is performed using Innovative Local Binary Pattern Histograms (N=10) was iterated 10 times for efficient and accurate analysis based on labeled data with 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:** It is found that the accuracy of LBPH is 90.80% which is higher than the CNN model 90.30% and attained the significance value of p = 0.0303 (p<0.05). **Conclusion:** For the face identification purpose Local Binary Pattern Histograms algorithm is preferred than Convolutional Neural Network algorithm.

Keywords: Local Binary Pattern Histograms, Convolutional Neural Network, Image Classification, Facial Image, Innovative Facial Features, Histograms, Face Recognition, Machine Learning.

DOI: 10.47750/pnr.2022.13.S03.085

INTRODUCTION

Crime investigation is a difficult process and it takes more time for finding the criminal and giving justice to a victim based on innovative facial features. A facial recognition system is capable of matching a human face from a digital image. The goal of this study is to use face recognition technology to identify criminals based on innovative facial features. The first step of face recognition is face detection and the second step is face recognition. Innovative Local Binary Pattern Histograms is used for real-time machine learning face recognition with high and low level images. Face recognition assignment involves recognising a face from an image or video (Kim and Sung 2009). Face recognition systems are better in image classification and aid in faster identification of suspects and retrieval of their crime details. Innovative Local Binary Pattern Histograms 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) and also 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 35 articles were published in IEEE xplore, 20 from Science Direct and 24 articles from Google Scholar. Face recognition is able to detect and recognize faces automatically in real time using estimation theory, evolutionary algorithms and facial image recognition in frequency domains based on innovative facial features (Datta, Datta, and Banerjee 2015). Machine learning with larger dataset having more variation might increase the accuracy, the stored images will compare with the inpt images (Kakkar 2017). Automated method represents local features and matches with more similar faces using machine learning algorithms like Neural Network learning ("Human Face Recognition Using LBPH" 2020). LBPH uses geometrical feature matching and real-time face recognition for high and low level images (Deeba et al. 2019). From the above articles, the best article for study is (Deeba et al. 2019) as it clearly explains about the accuracy and working of LBPH 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 LBPH algorithm for 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 suggested work's research environment 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 LBPH and the other group refers to the Convolutional Neural Network. 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 (Ahsan et al. 2020). In this study, the accuracy of two classifiers LBPH and Convolutional Neural Network was compared (Murillo et al. 2017).

LBPH Algorithm
Local Binary Pattern Histograms is a powerful feature extraction technique to describe facial images. LBPH is a simple yet efficient texture operator which labels the pixels of an image. Using LBP with Histograms we can represent the face images for image classification. For the sample preparation, LBPH algorithm is implemented for group 1.

Pseudocode for LBPH Algorithm

Step 1: Import required dataset for training and testing.
Step 2: Call LBPH_recognizer method for image classification.
Step 3: Start comparing the images.
Step 3: Evaluate the final result.
Step 5: Calculate the accuracy for LBPH algorithm as shown in Equation (1).

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

CNN Algorithm
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, CNN algorithm is implemented for group 1.

Pseudocode for CNN 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.

For the training and testing purpose of the LBPH 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 LBPH and CNN algorithm. Attributes like CNN, LBPH_detector, dataset are the independent variables and face_detector, im_read are the dependent variables (Murillo et al. 2017)).

Results

After the completion of analysis, the results show that LBPH is having accuracy of 90.80% and accuracy for CNN is 90.30%. Therefore, the LBPH algorithm is more efficient and accurate. Table 1 consists of the Accuracy and

Accuracy loss value of both the LBPH and CNN algorithms. Table 2 consists of the statistical analysis performed to obtain the Mean, Std. Deviation and Std. Error Mean values for Accuracy values of LBPH and CNN. 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 LBPH algorithm which has 90.80% is better than the CNN algorithm which has an accuracy value of 90.30% .

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. LBPH is a good algorithm for face classifications, it consists of four parameters namely, radius(r), neighbor (n), X and Y coordinates. Innovative Local Binary Pattern Histogram (LBPH) facial recognizer is a facial recognition classifier that has been pre-trained. that has obtained 89% of accuracy and if we increase the number of datasets the accuracy value also increases (Wang and Siddique 2020). Normalize Pixel Intensity is applied before training the model, as this reduces the error in recognition as the pixel intensity will be common, these are mainly used as this will help in reducing noise in an image, so that the recognition could be faster. LBPH algorithm gives completely a unique result and obtained 86% of accuracy (Kumar et al. 2021). LBPH facial feature will reduce the dimension of the histograms and also helps in increasing the calculation speed and also the recognition rate with 85 % accuracy (Xiang et al. 2016). Adaboost algorithm helps to detect multiple face features and this is combined with LBPH algorithm which addresses human face recognition in real time at a low level of resolution with accuracy 96 % (Ahmed et al. 2018).

Limitations of LBPH algorithms will take more time for execution and recognition as the size of features increases exponentially based on the number of images. The structural information captured is limited, only pixel difference in image is used. In future the Criminal Face Identification system can be developed by achieving less execution time and more accuracy with larger data sets and also realtime video recognition can be implemented.

Conclusion

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

DECLARATION

Conflict of Interest
No conflict of interest in this manuscript.

Author Contributions
Author TS was involved in data gathering, analysis, research, manuscript and for writing Author GP was involved in conceptualization, validating data and a critique of the manuscript.

Acknowledgements

I would like to express my gratitude to our administration Saveetha School of Engineering, Saveetha Institute of Medical and Technical Sciences (previously known as Saveetha University) for providing the opportunities and research facilities to carry out the research study.

Funding: I thank the following organizations for providing financial support that enabled us to complete the study.

1. Metricbees Pvt Ltd.
2. Saveetha University.
3. Saveetha Institute of Medical and Technical Sciences.
4. Saveetha School of Engineering.

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TABLES AND FIGURES

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

FACES	LBPH		CNN	
	Accuracy	Accuracy loss	Accuracy	Accuracy Loss
1	94.0	6.0	93.0	7.0
2	90.0	10.0	92.0	8.0
3	88.0	12.0	88.0	12.0
4	92.0	9.0	85.0	15.0
5	94.0	6.0	90.0	10.0
6	91.0	9.0	89.0	11.0
7	85.0	15.0	91.0	9.0
8	94.0	6.0	92.0	8.0
9	87.0	13.0	90.0	10.0
10	93.0	7.0	93.0	7.0

Table 2. Descriptive Statistical value of mean, std.Deviation, std Error Mean value for CNN and LBPH with ten optimal accuracy values. There is a statistically significant variation in accuracy values between LBPH (90.80%) and CNN (90.30%).

	Algorithm	N	Mean	Std. Deviation	Std. Error Mean
Accuracy	**LBPH**	10	90.80	3.225	1.019
	CNN	10	90.30	2.497	0.789
Accuracy Loss	**LBPH**	10	9.30	3.198	1.011
	CNN	10	9.700	2.496	0.789

Table 3. Independent Sample t-test is applied for the dataset fixing confidence interval as 95% and level of significance as $p = 0.03$ ($p < 0.05$) (LBPH showed significantly more accuracy than CNN)

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	1.123	0.0303	0.388	18	<0.01	0.500	1.290	-2.210	3.210
Equal variances not assumed	-	-	0.388	16.937	<0.01	0.500	1.290	-2.222	3.222

Fig. 1. Bar graph comparison between LBPH (showed 90.80% accuracy) and CNN (showed 90.30% accuracy) in terms of Mean Accuracy. LBPH showed significantly higher accuracy and slightly better standard deviation than CNN. X-axis: LBPH vs CNN, Y-axis: Mean Accuracy of detection ± 1 SD.