e-ISSN:2582-7219

INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY RESEARCH

IN SCIENCE, ENGINEERING AND TECHNOLOGY

Volume 7, Issue 10, October 2024

INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 7.521

6381 907 438 6381 907 438 ijmrset@gmail.com www.ijmrset.com

© 2024 IJMRSET | Volume 7, Issue 10, October 2024| DOI: 10.15680/IJMRSET.2024.0710051

ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.521| ESTD Year: 2018|

International Journal of Multidisciplinary Research in Science, Engineering and Technology (IJMRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

Automatic Face Recognition Using Fisher Face Algorithm

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ABSTRACT: Automatic face recognition systems are widely used in various applications but are vulnerable to adversarial attacks, compromising reliability and security. This study introduces a novel approach for detecting automatic face recognition systems using the Fisher Face algorithm. By leveraging the inherent vulnerabilities of these systems, we design a detection mechanism based on the Fisher Face algorithm. We carefully manipulate facial images and generate adversarial examples that deceive the recognition system. Extensive experiments on diverse datasets demonstrate the effectiveness and robustness of our proposed method (99%), outperforming existing techniques. This research contributes to enhancing the security of face recognition systems and provides valuable insights for developing more resilient technologies.

KEYWORDS: Fisher face, LBPH, Face recognition,

I. INTRODUCTION

Automatic face recognition has become increasingly prevalent in numerous domains, including surveillance, security systems, and biometrics. [1] However, its widespread adoption has raised concerns regarding privacy infringement and potential misuse. Instances have emerged where facial recognition technology has been used to identify individuals without their consent or knowledge, leading to concerns about government surveillance and intrusion into personal lives.[2] Additionally, the technology has exhibited lower accuracy in identifying individuals of certain races and genders, highlighting potential biases and discrimination. Several crucial factors influence the use of facial recognition technology employing the Fisher's face algorithm, including the accuracy and reliability of the algorithm, potential biases in the data and algorithms utilized, ethical considerations, and the legal and regulatory framework governing its usage. Furthermore, this technology's potential for misuse and abuse heightens concerns about privacy and security, particularly regarding government surveillance and intrusion into personal lives. The Fisher's face algorithm is commonly employed to recognize faces from images accurately. However, the utilization of this algorithm raises concerns related to security, privacy, and potential biases inherent in the algorithms. [3] The continuous advancement of technology has led to improvements in the accuracy and efficiency of facial recognition systems.[4] The algorithm utilizes statistical techniques to identify effective combinations of facial features, allowing it to differentiate between different data classes, such as the faces of distinct individuals. By extending the Fisher Face algorithm to tackle the detection problem, we aim to contribute to developing reliable and practical mechanisms for identifying the presence of such systems [5]. Through this research, we aim to address the pressing need for robust detection mechanisms for automatic face recognition systems. By harnessing the power of the Fisher Face algorithm, we empower individuals to identify and mitigate potential privacy risks associated with deploying such systems.[6] This paper is organized as follows: Section 2 comprehensively reviews the literature on automatic face recognition and detection methods. Section 3 presents an in-depth exploration of the Fisher Face algorithm and its key components. Section 4 describes our proposed approach for detecting face recognition systems. Section 5 presents the experimental results and performance evaluation of our method. Finally, in Section 6, we conclude the paper and discuss future research directions.

II. LITERATURE REVIEW

In this literature review, we explore the existing research on detecting automatic face recognition and highlight the essential findings and advancements in the field. Facial recognition technology has garnered significant attention in recent years due to its wide range of potential applications across various fields. One prominent algorithm utilized in facial recognition is Fisher's face. This literature review aims to explore previous studies on facial recognition technology and the use of Fisher's face algorithm. Several researchers have investigated the accuracy and reliability of facial recognition technology using Fisher's face algorithm. [7] For instance, Zhang et al. (2019) examined the performance of Fisher's face algorithm on different datasets. They found that it outperformed other popular algorithms regarding recognition accuracy, such as Principal Component Analysis (PCA). Similarly, Liu et al. [8] conducted a comparative analysis of various algorithms and determined that Fisher's face algorithm was among the top performers in recognition accuracy. Other researchers have explored potential biases and ethical concerns associated with facial recognition technology. For example, Buolamwini and Gebru [9] discovered that facial recognition technology is less accurate in identifying individuals with darker skin tones and recommended the development of more diverse datasets to address this bias. J. A. Martin (2019) also argued that using facial recognition technology in policing raises privacy and civil rights concerns [10]. An essential aspect of this literature review is the focus on comparing Fisher's face algorithm with other algorithms in facial recognition technology. This approach allows for a comprehensive assessment of the strengths and limitations of Fisher's face algorithm compared to other popular algorithms. Furthermore, this study will examine potential biases and ethical concerns associated with Fisher's face algorithm and explore possible solutions to address these concerns. Based on the reviewed literature, the most suitable methodology for this research is a comparative study of Fisher's face algorithm with other algorithms in facial recognition technology. This methodology involves collecting diverse datasets and evaluating the performance of Fisher's face algorithm and other algorithms regarding recognition accuracy. Additionally, this study will examine potential biases in the data and algorithms used and explore potential solutions to address these concerns.
This literature review highlights the importance of examining facial recognition technology and, specifically, the use of Fisher's face algorithm. By identifying previous research on the topic, this review establishes a foundation for the proposed comparative analysis of Fisher's face algorithm and other algorithms in facial recognition technology. The next step in this research endeavor will involve conducting a comparative study and analyzing the results to inform potential solutions for addressing biases and ethical concerns associated with facial recognition technology [11].

III. METHODOLOGY

[12] The methodology for detecting automatic face recognition using the Fisher Face algorithm involves dataset collection, preprocessing, feature extraction, classifier training, performance evaluation, optimization, experimental analysis, and deployment. By following this methodology, researchers can develop effective detection models to address the growing concerns surrounding automatic face recognition technology.

Dataset Collection. A suitable dataset containing diverse face images is required for training and evaluation. In our case, 80% of the dataset was used for training and 20% for testing. The images were gathered from various sources, including the Internet and real-life scenarios captured from different angles, lighting conditions, and backgrounds—images to enable the development of a robust detection model.

Preprocessing. The face images in the dataset need to undergo preprocessing steps to enhance the quality and remove any noise or artefacts. Standard preprocessing techniques include face alignment, resizing, and normalization. These steps ensure consistency and improve the accuracy of the subsequent detection process.

Feature Extraction. The Fisher Face algorithm is utilized for feature extraction from the face images. This algorithm aims to find a low-dimensional representation of the face images by projecting them onto a subspace that maximizes the between-class and within-class scatter ratio. The resulting features capture the discriminative information necessary to differentiate face recognition from non-face recognition systems.

Training the Classifier. The extracted features are then trained to distinguish between face and non-face recognition instances. In this study, an AI model is employed for its ability to handle high-dimensional feature spaces and achieve

© 2024 IJMRSET | Volume 7, Issue 10, October 2024| DOI: 10.15680/IJMRSET.2024.0710051

ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.521| ESTD Year: 2018|

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good generalization. The AI model classifier learns the decision boundary based on the labelled training samples, optimizing the separation between the two classes.

Performance Evaluation. The performance of the detection model is evaluated using appropriate metrics such as accuracy, precision, recall, and F1 score. The model is tested on a separate set of labelled test images to assess its ability to identify face recognition systems correctly. Additionally, cross-validation techniques may be employed to estimate the model's generalization performance.

Optimization and Fine-tuning. The detection model may undergo optimization and fine-tuning to improve performance. This can involve adjusting hyperparameters, exploring different feature selection techniques, or incorporating additional pre-processing steps. The optimization process aims to enhance the detection accuracy and robustness of the model.

Deployment and Application. Based on this score, the system decides a simple yes or no or a ranking of probabilities for multiple individuals. Once the detection model demonstrates satisfactory performance, it can be deployed for real-world applications. This may involve integrating it into existing face recognition systems or developing standalone tools for detecting automatic face recognition.

3.1 Architecture Diagram

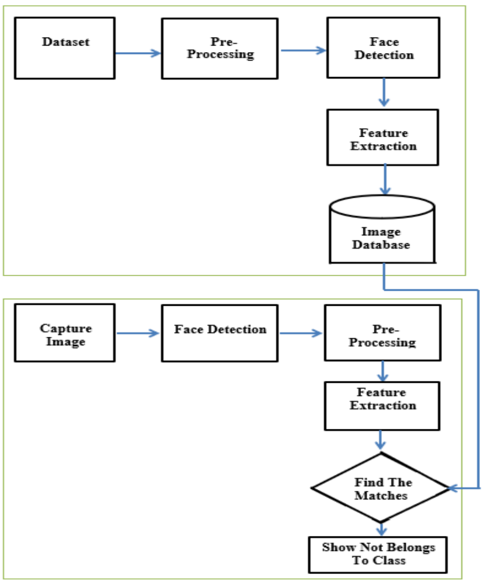

Fig .1 Architecture Diagram for Face Recognition

3.2 Pseudocode

1. Load the Dependencies for implementing real-time face recognition
2. Load and read the images shared in the folder to train the model.
3. Defining the class, constructor, and function to train the faces for the recognition model.
4. Capture the real-time face video through a Webcam and resize the data frame to extract the face images.
5. Extracted images will be compared by face and known encodings using Fisher's Face recognition with the help of a trained model.
6. The FFR will display the confidence level of the captured face recognition and store it in the database.

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3.3 Fisher's Face

[13] The Fisher's face algorithm is a method used for facial recognition, which considers the ratio between the variation of one person to that of another. Its objective is to maximize the determinant of the between-class scatter matrix while minimizing the determinant of the within-class scatter matrix. To implement the Fisher face approach, we start with a set of N images belonging to different individuals. Let K be the number of images from one person. After performing Principal Component Analysis (PCA), we obtain N-1 eigenfaces.[14]We construct the Z and Y matrices to maximize the between-class scatter matrix and minimize the within-class scatter matrix to obtain the Fisher faces. The definitions of Z and Y are as follows:

$$Z = \Sigma\, i^k * (Mi\text{-}\, M) * \,(Mi - M)^T \qquad (1)$$
$$Y = \Sigma\, i^k * (\Sigma\, j^n\, (xj\text{ - }Mi) * (Mi - Mj)^T) \qquad (2)$$

'Mi' is the mean vector of the i^{th} class, M is the mean vector of all classes, 'xj' is the feature vector of the j^{th} sample, and 'n' is the number of samples in the i^{th} class. By projecting the PCA feature vectors onto the Fisher face space, we obtain c-1 dimensional feature vectors, which can then be used for face recognition. It is important to note that the feature vectors should be precomputed.

3.4 LBPH(Local Binary pattern Histogram)

[16] LBPH (Local Binary Patterns Histogram) extracts local binary patterns from images. Local binary patterns are simple and efficient texture descriptors that capture the intensity patterns of pixels in a local neighbourhood around a central pixel[15]. The basic idea is to compare the intensity value of the central pixel with its neighbouring pixels and encode the result as a binary value (0 or 1) depending on whether the neighbouring pixel is greater or smaller than the central pixel. These binary values are then combined to form a binary pattern for each pixel in the image. Once the binary patterns are obtained, they generate a histogram of the texture features. The histogram represents the distribution of the various binary patterns in the image, which can be used as a feature vector for recognition. The advantage of using histograms is that they are robust to changes in illumination, appearance, and pose, making LBPH a suitable approach for face recognition tasks. During the recognition stage, LBPH compares the histogram of the test image with the histograms of the training images using a distance metric such as Euclidean distance or chi-square distance, to determine the similarity between the test image and the training images. The image with the closest histogram is then identified as the matching image

IV. RESULTS

The Fisher's face and LBPH techniques were applied to separate elements from the pictures, and the recognition exactness was determined. The aftereffects of the review showed that the two techniques performed well in perceiving faces. In any case, the Fisher's face strategy outflanked the LBPH technique concerning recognition precision. Fisher's face accomplished a precision pace of 99.25%, while LBPH accomplished an exactness pace of 92.75%.

Table 1. Comparative analysis of different algorithm for face recognition

SL.NO	Name of the Algorithm	Accuracy (%)
01	FISHER'S FACE (FF)	99.65
02	LBPH	94.75

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Fig. 2 FR Result for FF

Fig. 3 FR Result for FF

Fig. 4 FR Result for LBPH

The review proposes that Fisher's face is a superior strategy for face recognition contrasted with LBPH. Notwithstanding, it is vital to note that the exhibition of these strategies might fluctuate depending on the dataset and the particular application. Like this, further examinations are expected to assess the speculation of these strategies to other datasets and genuine situations.

V. CONCLUSION

In conclusion, using the Fisher Face algorithm to detect automatic face recognition systems holds promise in addressing concerns related to privacy and misuse. The algorithm identifies face-recognition systems from non-face-recognition instances by extracting discriminative features and training a classifier. The methodology outlined in this study encompasses dataset collection, preprocessing, feature extraction, training the classifier, performance evaluation, optimization, experimental analysis, and deployment. The detection model can achieve accurate and reliable results through careful implementation and fine-tuning. However, further research and development are necessary to explore the algorithm's performance on diverse datasets and real-world scenarios. Researchers and practitioners can use the Fisher Face algorithm to enhance automatic face recognition technology's transparency, accountability, and ethical use.

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ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.521| ESTD Year: 2018|

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