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Journal of Applied Informatics and Technology, 3(1), 14-21

Research Article

The Application of a Face Recognition System for a Personal face Database

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Received:
1 December 2020
Revised:
4 July 2021
Accepted:
5 July 2021

Keywords:

Face Recognition, Face detection, Principal Component Analysis, Eigenface

Abstract: This study aimed to apply face recognition of the personal face detection, which this system implemented Eigenface to analyze face details in facial comparison database. Eigenface is an approach in the theory of principal component analysis (PCA). It was accepted that facial images could be synthesized based on data from the model and can store a person's face parameters in a small set of numbers, which is accurate and reliable. The data used in the assessment of efficiency and developed software, including 30 images. It was divided into three groups, and each group contained ten images. The experimental results were shown as follows ; the first dataset contained ten images with an image resolution of 100x100 pixels. We achieved a precision of 90%. The second data*set al*so contained ten images with an image resolution of 150x150 pixels. The result showed that we achieved a precision of 80%. The third dataset included ten images with a resolution of 200x200 pixels. We achieved a precision of only 70%. Our proposed system achieved a mean precision of 80% and was considered as good efficiency. It can be applied for application in criminal face detection.

1. Introduction

Over the past few years, information security systems have been developed to protect confidential information, limit the tendency of security violation by individuals automatically. Face recognition is one of biometrics with high precision and has a low risk of invasion of computer systems. This method indicates and confirms an image of a person from a digital photograph or video frames from video sources (Lin, 2000; Rathi, 2012; Hamid, 2010). Face detection is one of the most important stages of the face recognition system ; moreover, it can be categorized depending on unchangeable template matching and appearance method (Yang, 2002). As a result, a face recognition system has been applied in numerous businesses and industries. Face recognition identifies the relation of distinguish features of a face. The positions and main features are the foundation of face accuracy (Yang *et al*., 1994). The system considers symmetry of the eyes, the position of the nose, vertical and horizontal angles of the lips (Kotropoulos, 1997). It concludes the change components of an image, such as light and shadow. Another popular technique used is principal component analysis (PCA), which is the study of Mathematic equations using geometry principles to analyze facial features in equations (Karaduman, 2008). The Eigenface method is face analysis using various statistical methods (Atalay *et al*., 1996). The benefits of the system lead to the development of face recognition for criminal detection. Nowadays, more and more automatic access systems are based on various biometric techniques (Davis *et al*., 2010; Marciniak *et al*., 2011). The researcher is aware of the necessity of the field mentioned earlier, so the researcher studied, designed, and developed the system in concordance with national strategy and innovation movement, applied technology in business sectors, and improved the organizations' competence.

Face authentication and face identification are challenging problems. There have been more and more commercial, military and institutional applications in the recent past, making face recognition systems a popular subject.

In a face recognition system, the database consists of the images of the individuals that the system has to recognize. If possible, several images of the same individual should be included in the database. Suppose the images are selected so that they account for varying facial expressions and lighting conditions. In that case, the problem's solution can be found more efficiently than when only a single image of each individual is stored in the database. (Çarıkçı & Özen, 2012).

This study aims to develop a face recognition system that included face detection and face recognition.

2. Materials and Related work

2.1 Analyzing the problem and Reasons to choose the Eigenface method.

At present, service and management businesses play a key role in both government organizations and private sectors. Applying an IT security system helps reduce the cost of time and speed up the work. In addition, it elevates the efficiency in a large area of services, and the face recognition technology is used for security purposes.

We chose the Eigenface method in our study in order to obtain an efficient method and fast computation. (Çarıkçı & Özen, 2012). Pearson proposed the principal component analysis (PCA) to reduce the dimension of the data. It is a famous method that applies to face encoding, called Eigenface.

2.2 Research Equipments

A webcam is a video camera that captures an image in real-time or through the computer (see Figure 1). The computer can stream the video by recording or transferring via the internet. The webcam is connecting a computer with a USB port. Low-cost production with high flexibility makes video calling at a low price. Many quality web camera products can use in streaming. So, the mid-range webcams have a pixel resolution of 640x480 pixels and high-end webcams have a pixel resolution of 1280×720 or 1920×1080 pixels (Henry, 2015).

2.3 Development framework

Our proposed framework was divided into two parts.

1) Database storage: We use the AT&T face database (see Figure 2) to examine our framework. We also added our face images into the database to test the real-time face detection and recognition processes.

2) System function: First, the system captured the image sent from the web camera. The face detection algorithm then detected the face from the image. Second, we extracted the Eiganface feature from the face image and used it as the feature vector. Finally, we compared the Eiganface feature with the Eiganface features of the persons from the database. The system can be alert when it found the most similarity from the face database, as shown in Figure 3.

Figure 1. Webcam

Figure 2. Example of AT&T face database

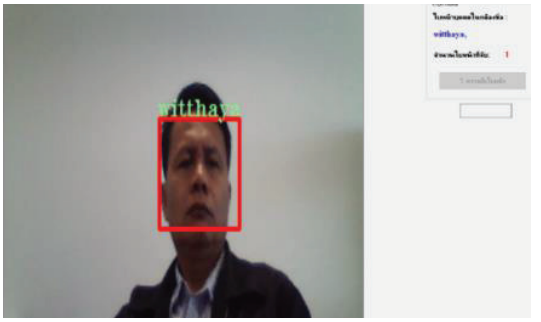

Figure 3. Capturing system from webcam

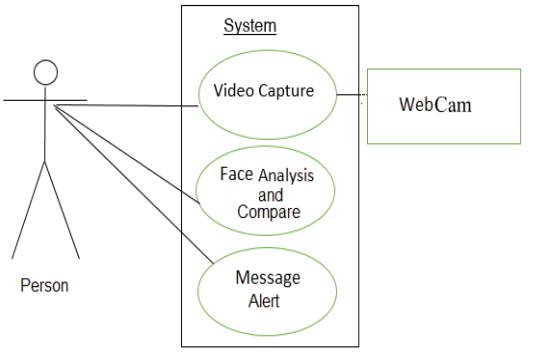

Figure 4. Use-Case Diagram of System

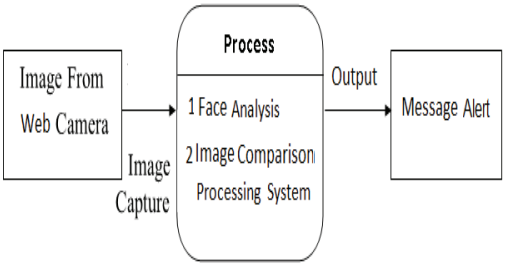

Figure 5. Overview of System Context Diagram

Figure 6. System Components

Table 1 IPO chart process

1. Input	2. Process	3. Output
1.1 Video Load	2.1 Face Analysis	3.1 Message Alert
1.2 Video Capture	2.2 Face Comparison	

2.4 System design

1) Designing system function process

The system function was designed using unified modeling langage (UML). The UML of our system is shown in Figure 4.

2) Function design of IPO chart system process

The system obtained an image from the webcam, which was stored as a gray image. Next, the system processed the face analysis (detection and encoding) and compared the Eigenface feature of the person that capture from the web camera and face database. Finally, the proposed system was notified the administrator by voice message to arrest the suspect.

2) Context diagram of the proposed system is shown in Figure 5.

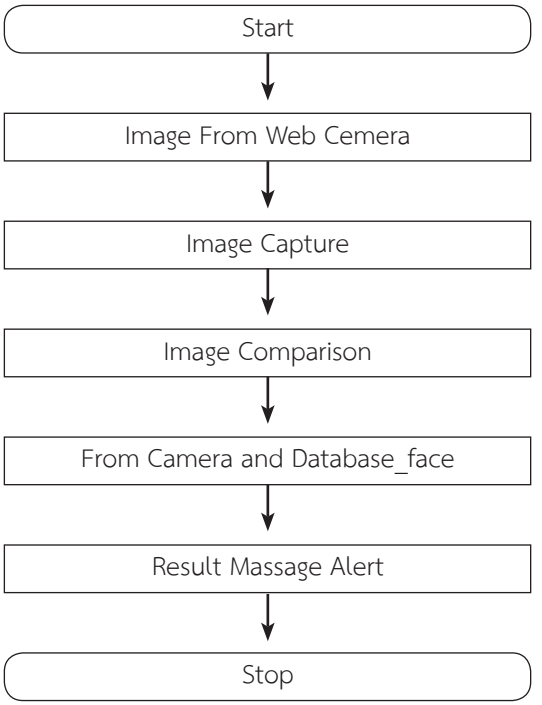

Figure 7. System Process

2.5 System component (see Figure 6)

2.6 System process (see Figure 7)

2.6.1 The processes of the proposed system are as follows:

1) Input an image via webcam.

2) Crop an image and process the data

3) Analyze an image and encode the face image using Eigenface method.

4) Compare Eigenface features.

5) When the system finished comparing and processing, it would alert the officer with voice message.

2.6.2 Algorithm of Eigenface

1) Input images and find image average

2) Distinguishing image: Select unique feature of an image by finding the differences of input image of each person and image averaging of a facial image.

3) Covariance Matrix Calculation: Create vector image as 1 dot wide by multiple 1 with an image's width and height (1 x (w x h)). Next, finding correlation of the difference by creating covariance metrix.

4) Eigen vector calcaulation after having covariance matrix and find Eigen vector applying linear equation covariance matrix and Eigen value.

5) Vector of weights calculation: When an image was adapted to Eigen space to represent a facial image of a person, Eigen vector was applied to find vector of weights (Turk & Pentland, 1991; Tolba, 2005; Çarıkçı & Özen, 2012).

2.7 System design and development: This study aims to develope system model for face Recogniton to automatically alert the officer from webcam using Visual C# as a tool of system design. In addition, face recognition was used in the development while user interface and webcam acted as image input devices for system processing.

Figure 8. Main Screen Interface

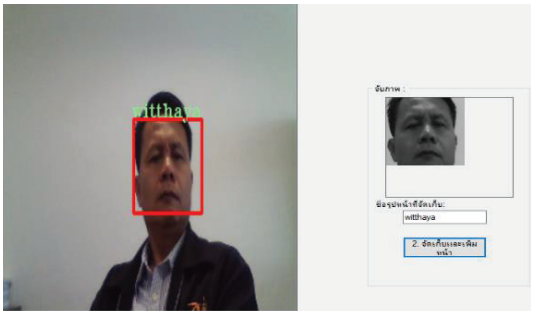

Figure 9. Facial Image Storage Screen

3. Results

3.1 System Design

3.1.1 Graphic User Interface

1) Main screen interface (see Figure 8)

2) Facial Image Storage Screen (see Figur 9)

3.2 Data testing for system efficiency

We evaluated the proposed system with the precision value. We performed the proposed system on the AT&T face database. First, we divided the face database into three groups and each group had ten images. We tested the precision of the system with different image resolutions ; 100x100, 150x150, and 200x200 pixels. The three groups of face images are shown in Figure 10.

(A)

(B)

(C)

Figure 10. The three group of face images used in the experiments ; (a) set 1 ; 100x100 pixels (b) set 2 ; 150x150 pixels, and (C) set 3 ; 200x200 pixels.

Table 2 A Comparison of the proposed system on the AT&T face database.

Dataset	Number of face	Relative error	Precision
Set 1: 100x100 pixels	10	0.1	90
Set 2: 150x150 pixels	10	0.2	80
Set 3: 200x200 pixels	10	0.3	70
Overall	**30**	**0.2**	**80**

Table 2 shows the efficiency evaluation using the PCA method to create the Eigenface feature. The overall results show that the proposed method obtained a precision value of 90%. The recommendation for system precision of the software was that the distance between a web camera and people should be less than 2 meters.

4. Conclusion

We proposed a face recognition system for a personal face database. The proposed system included two main processes ; face detection and face encoding. We proposed to use the principal component analysis (PCA) to extract the Eigenface from the face image. Then, we compared the Eigenface of the query face with faces from the database. For the experiments, we divided the AT&T face database into three groups and each group had ten images. Our proposed system achieved an average precision of 80%.

5. Acknowledgements

The researcher would like to express the gratitude to Faculty of Management and Information Technology for the support covering of place, equipment, time, and budget for this research.

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