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REAL-TIME FACE RECOGNITION FOR ATTENDANCE MONITORING SYSTEM

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ABSTRACT

Authentication is a momentous issue in controlling system in computer based globally. Human face recognition has been widely used to be an important branch of biometrics verifications in many applications such as door control, video monitoring system, networks security and also human computer interactions. This paper presented an automated attendance monitoring system with face recognition in a real-time background world for with a database of student's information by using Personal Component Analysis (PCA) algorithm. This task is very difficult as the real-time background subtraction in an image is still a challenge. Addition to that, managing a database with multiple of student information's is also an extra challenge to this system. The proposed biometric system is a real time attendance system based on the human face recognition with simple and fast algorithms and most important is gaining a high accuracy rate.
Keywords: *Automatic Attendance, Face Recognition, Authentication, Biometric, Principal Component Analysis (PCA).*

1. INTRODUCTION

Face recognition has been the motivation for research around the globe. The interest and time frame of studies in this field is indicative of its value and complexity, and has become an increasingly important form of biometric authentication. With the vast advancements in face recognition, more research should be done to improve the efficiency, practically and accuracy of the many method produced.

A genetic algorithm is chosen to be applied into face recognition for this project. Genetic algorithms are categorized as universal search heuristics. Genetic algorithm is used in computing as a technique for researches to find the true or estimated solutions to enhance and explore problems. It uses techniques inspired by evolutionary biology such as mutation, inheritance, crossover and selection. Facial Recognition satisfies the following characteristics, which qualify it for biometric authentication (Jain, Ross, & Prabhkar, 2004). Universality (have characteristic)

1. Distinctiveness (have different characteristic)
2. Permanence (characteristic is will not be change in periods)
3. Collectability (Threat measuring)

Face recognition started at after the machine became more intelligent and had the advance to improve the abilities and sense of human (Hossein Sahoolizadeh, 2008). Reasons for attention on facial recognition technology: Applicability in various applications including in content-based video processing system, law enforcement system and in security systems. The system is contactless so it does not require any user input. A contributing factors that strongly appearance of face recognition technology includes maturity of the digital camera technology with competitive price.

Biometrics is mainly used for authentication purposes and also refers to automatic recognition of an individual, "providing a right person with the right privileges, and the right access at the right time". Examples of particular applications include accessing to constructions, workstation systems, computer and cellular phones.

By that, securities could authorize an individual's identity depending on "who she is", and not "what she has" and "what she could remember". Depending on application framework, biometrics

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system is operates under two modes, verification and identification mode (Laha, 2008).

This research mainly encompassed of implementation of real-time face recognition for attendance monitoring system. As more propel advancements are received by institutions or universities, they are as yet confronting the issue of monitoring student attendance.

Most of the universities including MMU is so far grasping the ordinary procedures for passing the attendance sheet around the class for participation recording. To overcome that issue, this research exhibited a system in which participation administration can be made mechanised by face recognition. Automated face recognition attendance monitoring is extremely useful in sparing profitable time of the students and lecturers.

2. BACKGROUND OF THE RESEARCH

The first attempts to use face recognition began in the 1960's with a semi-automated system. Marks were made on photographs to locate the major features; it used features such as eyes, ears, noses, and mouths. Then distances and ratios were computed from these marks to a common reference point and compared to reference data.In the early 1970's Goldstein, Harmon and Lesk (A.J Goldstein, L.D Harmon, and A.B Lesk, May 1971) created a system of 21 subjective markers such as hair colour and lip thickness. This proved even harder to automate due to the subjective nature of many of the measurements still made completely by hand.

Fisher and Elschlagerb (M.A Fischler and R.A Elschlager, 1973) approaches to measure different pieces of the face and mapped them all onto a global template, which was found that these features do not contain enough unique data to represent an adult face. Another approach is the Connectionist approach (Abibi, 2000), which seeks to classify the human face using a combination of both range of gestures and a set of identifying markers. This is usually implemented using 2-dimensional pattern recognition and neural net principles. Most of the time this approach requires a huge number of training faces to achieve decent accuracy; for that reason it has yet to be implemented on a large scale. The first fully automated system (Y. Cui, 1992) to be developed utilized very general pattern recognition. It compared faces to a generic face model of expected features and created a series of patters for an image relative to this model. This approach is mainly statistical and relies on histograms and the gray scale value.

More elaborately, biometrics is "any automatically measurable, robust and distinctive physical characteristic or personal trait that can be used to identify an individual or verify the claimed identity of an individual" (Jain, Ross, & Prabhkar, 2004). Facial recognition is a type of biometrics. Iris scan, retinal scan, voice and fingerprint recognition are other methods of biometric recognition. Two main classes can be found in biometrics:

Physiological – It is associated with the body shape, includes all physical traits, iris, palm print, facial features etc. Fingerprints are the oldest biometrics which is used in ages of years before.

Behavioural – Related to the behavioural characteristics of a person. A characteristic widely used till today is signatures. Modern methods of behavioural studies are emerging such as keystroke dynamics and voice analysis.

2.1 Fingerprint

The accuracy of matching for fingerprints has proven for its effectiveness, and is considered to be the fastest method for biometric identification (Jain, Ross, & Prabhkar, 2004). Fingerprints are secure, unique and are not interchangeable. Systems that use fingerprint recognition are known to be cheap, easy to use and achieve acceptable levels of accuracy. Forensic applications uses fingerprint recognition broadly. Fingerprint-based has proven the biometrics most and it widely shares in the market. Not only is it faster than other techniques but also requires less energy to operate. Ridges and valleys which appeared on the surface of the fingertip formed the fingerprint pattern. A minutia is formed by the endpoints and the crossing points of ridge. Minutiae pattern of each person is unique and it remains the same for one's life.

2.2 Voice

Physiological and behavioural biometrics is combined to formed voice biometrics. Different shape and sizes of the appendages such as mouth, lips and nasal cavities give an individual voice to human. Individual's physiological characteristic of human voice remain the same for life. However, behavioural aspects of the speech of a person change due to age. For huge database identification for voice recognition, it is not reliable and also not applicable. Based on the repetition of an encoded phrase, text-dependent voice recognition system is formed (Jain, Ross, & Prabhkar, 2004). This system does recognize independent speaker speech. A difficulty level to form a text-independent system is higher depending to design a text-dependent system but it provides more security against scam.

2.3 Signatures

The characteristic of an individual's signature is defined in the way the name is signed. Signatures is a biometrics that is accepted as a method of

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verification by government and commercial transactions although it is require to be contact with writing instrument. A professional imitator can easily replicate signatures to login any system. Signatures are affected by behaviour that change over a period of time and are influenced by physical and emotional conditions of the signatories. Signature biometrics has some of the advantages, such as imitator could easily forge a signature, but it is very challenging to imitate an exact behaviour of signing (Jain, Ross, & Prabhkar, 2004). Moreover, it has a Low False Acceptance Rates (FAR).

2.4 Keystroke

Keystroke patterns are believed to vary from individuals. Keystroke do offers necessary discriminatory information to permit identity verifications. When a user is keying in the information, keystrokes of the user will be monitored unobtrusively. Two characteristics of keystroke dynamics were tested in recent experiments, (Boechat, Ferreira, & Carvalho, 2006)which are keystroke duration and keystroke latency. The best result was found when combined those two characteristics together.

2.5 Odour

Every human carries an order that is an individual of its biological composition. Altered odour is used to differentiate between several people. An aroma of surrounding of a person that flew over an array of biological sensors could detect an individual. The element odour produced by a person or a creature's body is a characteristic of an individual. Various biological compositions of the surrounding and the deodorant smells of an individual could affect the results of odour biometrics.

2.6 Facial, hand, vein infrared thermo gram

Every human body has an individual pattern of heat radiate. An infrared camera can function much likely a regular photograph that can sense the heat of individuals. A them gram-based system is contactless and is non-invasive. When heats are presented nearby the body, image acquisition became a challenge (Jain, Ross, & Prabhkar, 2004). A technology with near infrared imaging is used to scan the back of clenched to determine the hand vein structure. The value of the infrared sensors has inhibits the global use of thermo grams.

2.7 Palm Print

Humans palm are much likely the fingerprints which contain the pattern of valleys and ridges. The palm has a larger area than a finger. In consequence, palm prints are more distinctive than the fingerprints. Palm print scanner is slightly larger and expensive than a fingerprint sensor since it is needed to capture a larger area. A lower resolution scanner will not be able to scan the additional characters such as wrinkles so it would be cheaper. However when a high-resolution palm print scanner is used, to construct an accurate biometric data template, features including ridge and valley, hand geometry, and wrinkles could be combine (Goh, Connie, & Teoh, 2010b).

2.8 Hand and Finger Geometry

Hand geometry recognition systems used the measurements of the human hands, including the width, length, thickness and curvature of the fingers and palm. This system uses a digital camera and light to measures hand and finger geometry. The technique is simple, relatively user friendly and inexpensive. This system is installed globally, for example, Disney theme park use finger geometry readers to grant ticket holder admittance. Different environmental factor such as dry skins will not affect the accuracy of verification in this system. Hand geometry recognition system has a negative review for verifications identity of a large population. Furthermore, personal jewelleries may lead to be the challenge of extracting accurate hand geometry information. Hand geometry system may not be installed in devices such as laptop, as the physical size the system is huge. In recent studies, a new verification system is implemented. The system measures only a few fingers but not the entire palm and the size of the devices is smaller comparing with hand geometry devices.

Although, there are various types of biometric recognition are available, but in case of student attendance monitoring system, we have chosen the face recognition. Because face recognition has several advantages over other biometric technologies; it is natural, non – intrusive and easy to use. Furthermore, it is well-accepted and easily understood by people, and it is easy for a human operator to arbitrate machine decisions. Because of its prevalence as an institutionalized and accepted guarantor of identity since the advent of photography, there are large legacy systems based on face images — such as police records, passports and driving licenses — that are currently being automated. It has the advantage of ubiquity and of being universal over other major biometrics, in that everyone has a face and everyone readily displays the face.

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2.9 Face Recognition for Student Attendance Monitoring System:

Facial recognition system is widely used for identifying and verifying an individual by using digital camera or a video camera from a video source (Bhattacharyya, R, Alisherov, & Choi, 2009). Reasons of implementing face recognition biometrics in attendance monitoring system, includes it use legacy database, integrating with surveillance system and capture images of people in a public area.

The facial recognition applications range from a motionless, "mug-shot" verification into the uncontrolled face identification in a disorder environment such as airport (Jain, Ross, & Prabhkar, 2004). Face recognition is characterized as a system that functions accurately under stabilize condition. Famous approaches for face recognition including: The formations of the face attributes such as the ears, eyebrows, eye, lips, nose and chin, and their three-dimensional relationships. Analysis of facial images that can represent a face as a weighted combination of a number of recognised faces.

Recognizing a face mages captured of two images under a different environment such as with or without sunlight, is the difficulties of face recognition system. It is a doubt; when an insufficient basis together with some unrelated information is obtain to recognize an individual from a group of people with a high level of confidence. For a perfectly practice facial recognition system, it should automatically:

- Detect the presents of a face in the image
- Automatic in locating the face
- Face could be recognize in any view point
- Capture good quality images under any environment.

Nevertheless, the most attractive feature of face recognition system is the systems could still operate with or without the knowledge of the subject. Face recognition system can typically use with combinations of tasks includes verification, identification and watch list. Each of that represents distinctive challenges to the implementation of face recognition as well as other biometrics.

3. PROPOSED METHODOLOGY

By implementing the real-time face recognition attendance monitoring system, the attendance can be recorded more efficiently. The proposed system updates the attendance automatically once the student face is match with the template database.

The proposed system is able to identify the user and reject the student if they try to enter the wrong class or not in the correct time. Face recognition for attendance monitoring system is developed by extraction image from the webcam.

Implementing real-time face recognition for monitoring student attendance involving three phases, which include face region detection, template extraction and face recognition using genetic algorithms. In the first phase, face region detection itself is divided into four sub-phases, including image acquisition, face detection, straightening of face and cropping of face.

This system is using Principle Component Analysis approach to recognize face characteristic. PCA is used because of its simplicity. The system generates eigenface and does matching process by comparing the eigenface from the captured image with the image from the template database.

3.1 PCA (Principal Component Analysis

PCA method has been widely used in applications such as face recognition and image compression. PCA is a common technique for finding patterns in data, and expressing the data as eigenvector to highlight the similarities and differences between different data (Liu, 2000). The following steps summarize the PCA process.

1. Let {D1,D2,…DM} be the training data set.

   The average Avg is defined by:

   $$\mathbf{Avg} = \frac{1}{M}\sum_{i=1}^{M} Di$$

2. Each element in the training data set differs from Avg by the vector Yi=Di-Avg. The covariance matrix Cov is obtained as:

   $$\mathbf{Cov} = \frac{1}{M}\sum_{i=1}^{M} Yi.Yi^{T}$$

3. Choose M' significant eigenvectors of Cov as EK's, and compute the weight vectors Wik for each element in the training data set, where k varies from 1 to M'.

   $$W_{ik} = E_k^T.(D_i - Avg), \forall i,k$$

3.2 Image Acquisition

Face recognition for student attendance monitoring system obtained images by interfacing a web camera where image is capture with an automated light sensor. Thus it is efficient enough to use a webcam for face recognition system. Webcam is connected with MATLAB build-in function "Video input" during image acquisition.

Pre-processing

After of capturing the images, the proposed system proceed to the image pre-processing phase.

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The detected face is then pre-processed by removing undesirable noise and contrast is enhanced. The middle pixel of the mask will then replace by median filter with the median value of all other pixels in the mask because median filter is an effective neighbourhood averaging method.

Besides, the median filter is also an effective method that can suppress isolated noise with sharp edges (Brunelli, 1993). Precisely, all pixels in the neighbourhood are replaced by a pixel with the median filter.

To enhance the contrast, method Contrast Limited Adaptive Histogram Equalization (CLAHE) is needed. CLAHE is ordinary histogram equalization and a generalization of robust histogram equalization (Shivram, 2010). Operating of a small areas in the image, named tiles and not the whole images is main the reason CLAHE was chosen as the contrast enhancement technique.

The contrast of every tile's is improved separately and the neighbouring tiles are jointed using bilinear interpolation to abolish artificially induced boundaries. Contrast is controlled to prevent amplifying noises that represents in the image, especially the homogenous areas (Aswini kumar mohanty, 2011). Face image will then be cropped by the system and do histogram equalization.

3.3 Feature Extraction

For feature extraction phases, the proposed system used the Principal Component Analysis (PCA). The image matrix have to be set as a starting point for the PCA analysis.

After the image matrixes are set, the mean of each data dimensions is subtracted. The subtracted mean are the average from each dimensions. Formula below shows how mean is calculated.

$$\bar{x} = \frac{1}{n}\sum_{i=1}^{n} X_i$$

Calculating the covariance will be the next step. The Covariance formula is:

$$cov(x,y) = \frac{\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})}{(n-1)}$$

After calculating the covariance, system will calculate the eigenvectors of the covariance matrix. Then choose the eigenvector of the components and form a feature vector. Finally, a result from the product of row featuring vector and row data adjust is be the final data.

$$FinalData = RowFeatureVector \times RowDataAdjust$$

Row feature vector from the formula is the matrix with the eigenvectors in the columns transposed and Row data adjust will be the adjust data transpose. Final data be the final data set, which include the data items in columns and dimensions in rows.

3.4 Matching Process

In this process, the extracted image is compared with the image in the template database. This process uses Euclidian Distance to calculate the distance between 2 vectors of n elements.

$$d(p,q) = \sqrt{\sum_{i=1}^{n}(q_i - p_i)^2}$$

A matching score is produced after the matching process. Matching score would be concluded depending on the threshold score that have been set before.

3.5 Decision

After the overall process, the proposed system shows a result either accepted or rejected based on the threshold. Student's attendance is recorded if the result is matched during the matching notifications. The system shows the matching notification and record the student attendance if the result is matched. Otherwise, the system rejects the student by showing the error message.

4. EXPERIMENTS AND RESULTS

Table 1: Euclidian Distance From System Testing Based On Different Environments

Time / Environments	Lights On	Lights Off	Average Successful Rate
Day	1.25 to 3.17	1.67 to 3.64	2.43
Night	1.48 to 3.27	1.50 to 6.00	2.81

Several tests are conducted to check the performance of the real-time face recognition for attendance monitoring system. The testing results have been tested and taken from few different environment backgrounds. Basically is during the day and night time with lights either on or off. A testing table 1 is created below to collect all the testing results. There are several student photos tested in the table.

By generating this table, the researchers set the threshold for the proposed system based on the different type of environments.

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Based on the table 1, the researchers choose the lowest and the highest threshold score from all the different tested photos. Table 2 below shows the range of the threshold tested and an average successful rate is concluded.

Table 2: Environments Testing Threshold (Euclidian Distance)

Student Tested Photos	Day Light On	Day Light Off	Night Light On	Night Light Off	Lowest & Highest Rate
	1.25	1.28	1.49	1.50	1.25 & 1.50
	1.77	2.10	1.48	1.65	1.48 & 2.10
	2.02	1.87	2.15	2.39	1.87 & 2.39
	3.16	3.30	2.85	2.95	2.85 & 3.30
	2.40	2.45	3.27	3.58	2.40 & 3.58
	1.26	1.46	1.66	1.52	1.26 & 1.66

The researchers set the threshold for the proposed face recognition system based on the output threshold of the results obtained. Since the highest threshold in this system tested is 4.9968, the threshold in this system is set not to be more than 6.00. The system only accepts the user below the threshold set and stated the user as an imposter when the threshold is more than the threshold set.

Update the students' attendances: During the decision making, a threshold known as the minimum value is set. The user is acknowledged as an authorized person when the matching score is same or less than the threshold. On the other side, when the matching score is more than the threshold, the user will be acknowledged as an unauthorized person.

After that, the system checks whether the person is belongs to that selected subject or not right after the system recognized the face. If the selected subject is correct, the system automatically updates the student's attendance to the database

5. CONCLUSION

This research mainly comprised of implementation of real-time face recognition for attendance monitoring system. As more and more advanced technologies are adopted by institutions or universities, they are still facing the problem of monitoring student attendance. Most of the universities including MMU are still adopting the traditional methods of passing the attendance sheet around the class for attendance recording. To overcome that problem, this research presented a framework which attendance management can be made automated by face recognition. Automated face recognition attendance monitoring is very helpful in saving valuable time of the student and lecturers, paper and generating report at required time.

Implementing this real-time face recognition system basically involving three main phases, which include face region detection, template extraction, and face recognition. By the way, this system is proposed to be implemented with the low attendance rate mobile alert, which sends an SMS to particular parents when the attendance rate of students is below the enforced rate.

Up to this point, Principal Common Analysis is used in this system as a method of extracting the feature of images. PCA is used because of simplicity and its high accuracy. Moreover, the matching rate of face recognition using PCA is good based on the past research. Before the feature extraction process, all input images are extracted and converted from RGB into grayscale images. Then, the system starts the histogram equalization in order to enhance the image and the picture is resized so that all images will have the same size.

In the proposed system, students have to proceed to the enrolment process in order for the system to monitor their attendance. During the enrolment process, students have to input their information and also provide three face images as a template. After that, the system is able to recognize the student and differentiate the student with legitimate user or an imposter results. System will make the decisions depending on the threshold value set before.

During the recognition process, test images is compared with the image stored with student information from the database. Euclidian distance is used to calculate the distance between the two

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images. If the student achieved the minimum matching score of the threshold value, the student is recognized as a legitimate user. The system automatically updates the attendance into the database when a legitimate user is assured.

Moreover, the attendance rate of the student is monitored and analyse after the time period of attendance taking is over. If the student's attendance rate falls below eighty percent, a reminder message is generated by the system to warn the students. An Short Message Services (SMS) is also be sent to students' phone as an extra point of reminding to the students.

6. REFERENCES

[1] Andrea F. Abate, M. N. (2007). 2D and 3D face recognition.

[2] Aswini kumar mohanty, S. k. (2011). IJCSI International Journal of Computer Science Issues, Vol. 8, Issue 5, No 3,.

[3] Bauer, J. O. (2006). The Basics of MATLAB. Bhattacharyya, D., R, R., Alisherov, F., & Choi, M. (2009). Biometric Authentication: A Review. International Journal of u- and e-Service, Science and Technology.

[4] Boechat, G. S., Ferreira, J. C., & Carvalho, E. (2006). Using the Keystroke Dynamic for System of Personal Security. World Academy of Science, Engineering and Technology.

[5] Brunelli, R. (1993). Face recognition: features versus templates. Pattern Analysis and Machine Intelligence, IEEE Transactions on, 1042-1052.

[6] Cheng, J.-M. (2004). A method of estimating the equal error rate for automatic speaker verification.

[7] Diane Teng, S. L. (2009). Automated Students Attendance System. EngD thesis, Universiti Teknologi PETRONAS.

[8] Goh, M., Connie, T., & Teoh, A. (2010b). Locating Geometrical Descriptors for Hand Biometrics in a Contactless Environment. International Symposium on Information Technology. Kuala Lumpur, Malaysia.

[9] Hossein Sahoolizadeh, M. R. (2008). Face Recognition Using Morphological. World Academy of Science, Engineering and Technology.

[10] Hsuan Wang, C., Chuan Wei, C., & Hao Li, C. (2010). ICCCI'10 Proceedings of the Second international conference on Computational collective intelligence: technologies and applications - Volume Part II. 232-238.

[11] Jain, A. K., Ross, A., & Prabhkar, S. (2004). An Introduction to Biometric Recognition. Appeared in IEEE Transactions on Circuits and Systems for Video Technology, Special Issue on Image- and Video-Based Biometrics, Vol 14, No.1.

[12] Laha, J. (2008). Biometric Techniques - Enhancing Security Standards In High Performance Enterprise. Retrieved from ezinearticles: http://ezinearticles.com/?Biometric-Techniques---Enhancing-Security-Standards-In-High-Performance-Enterprise&id=1224599

[13] Shivram, J. (2010). Computer and Automation Engineering (ICCAE). The 2nd International Conference, (pp. 220-224). Bangalore, India.