Scientific Journal of Informatics

http://journal.unnes.ac.id/nju/index.php/sji

Face Identification Based on K-Nearest Neighbor

Ni Kadek Ayu Wirdiani, Praba Hridayami, Ni Putu Ayu Widiari, Komang Diva Rismawan, Putu Bagus Candradinatha, I Putu Deva Jayantha

[1]Information Technology Department, Faculty of Engineering
Universitas Udayana, Indonesia
Email: [1]ayu_wirdi@yahoo.com, [2]phridayami@student.unud.ac.id, [3]widiariayyu@gmail.com, [4]divarismawan.20@gmail.com, [5]putubagus32@gmail.com, [6]devajayantha870@gmail.com

Abstract

Face identification has been widely applied this time, such as security on gadgets, smart home security, and others. Face dominates as a biometric which is most increase in the next few years. Face is used for biometric identification which is considered successful among several other types of biometrics and accurate results. Face recognition utilizes facial features for security purposes. The classification method in this paper is K-nearest Neighbor (KNN). The K-Nearest Neighbor algorithm uses neighborhood classification as the predictive value of a good instance value. K-NN includes an instance-based learning group. This paper developed face identification using Principal Component Analysis (PCA) or eigenface extraction methods. The stages of face identification research using the KNN method are pre-processing in the input image. Preprocessing used in this research are contrass stretching, grayscale, and segmentation used haar cascade. This research is registered 30 people, each person had 3 images used for training and 2 images used for testing. The results obtained from several trials of k values are as follows. Experiments with a value of k=1 get the best accuracy, namely 81%, k=2 get 53% accuracy, and k=3 get 45% accuracy.

Keywords: Convolutional Neural Network, K-Nearest Neighbor, Principal Component Analysis, haar cascade

1. INTRODUCTION

Along with the rapid development of technology, it needs to be balanced with appropriate security enhancements so that users are comfortable with the personal information stored on the technology. Face is one of the most popular types of biometrics this time. The face dominates as biometrics which is most increase in the next few years, which is 38%, followed by multimodal (22%), iris (11%), and fingerprint 9% [1].

Face identification has been widely applied this time, such as security on gadgets, smart home security, and others. Facial recognition also plays an important role in the field of biometric research and computer vision [2]. Facial biometrics is a personal identification system that is very different from one person to another. This difference makes face as a biometric that is widely applied because of the easy factor to be acquired.

Research related to face identification had previously been carried out by Changxing Ding, Chang Xu, and Dacheng Tao with his research entitled Multi-task Pose-Invariant Face Recognition. This paper of shooting faces in unrestricted environments usually contains significant variations in poses, which dramatically reduce the performance of algorithms designed to recognize the front face. This study developed a face verification algorithm for the problem of variations in significant facial poses. The best results were obtained using the High-dim LBP and Joint Bayessian methods with an accuracy of 93.18% [3].

The study entitled Real-Time Face Detection and Recognition in Complex Back-ground conducted research related to facial biometrics. This study developed an algorithm for real-time face detection and recognition with a complex background that is efficient and resilient. Ada Boost, cascade classifier, Local Binary Patent (LBP), Haar-like features, face image pre-processing and Principal Component Analysis (PCA) are a series of signal processing methods. The PCA algorithm is used to recognize faces efficiently. This rhythm reaches 99.2% for correct facial recognition and a true positive level of 98.8% for face detection [4].

There are three stages carried out in this study to identify faces, that is face detection, feature extraction and classification. Face detection is a step in face recognition to find the position of the face from an image that will be extracted later. Face detection displays the location of all faces in the input image given, usually in the form of a box divider. Face detectors must be strong for variations in poses, lighting, viewing angles, expressions, scales, skin color, multiple occlusions, disguises, make-up, etc. [5]. Feature extraction is a step to determine the natural characteristics of a face which will then be classified or recognized. Whereas, classification is the process of matching input with data in a database.

The face is one of the biometrics that is very easily acquired, namely using a camera. This paper develops face identification using the K-Nearest Neighbor classification method, using feature extraction Principal Component Analysis (PCA). The classification method used is K-nearest Neighbor (KNN). This paper will produce a program using the python programming language, which is used for the purpose of identifying faces.

2. RELATED WORK

The application of face identification using the PCA (Principal Component Analy-sis) method as feature extraction and KNN as a classification has been done before, so that it becomes a reference for making a system that can do more activities than the previous system.

One of the studies that has been conducted is stated in the journal entitled "Multi-Faces Recognition Process Using Haar Cascades and Eigenfaces Methods". The way the system works is to propose a solution for a faster face recognition process and accurate results. The proposed facial recognition process is carried out using the Haar Cascades and Eigenface method hybrid process, which can detect many faces (55 faces) in one detection process. The image pre-processing process consists of several stages, namely training data, grayscale conversion, and preprocessing with Haar Cascade. The feature extraction process

consists of two stages, namely the stages of training and testing, where the data being tested will be divided into two namely training data and testing data which will be processed using the PCA (Principal Component Analysis) method, better known as eigenfaces method. The face identification process uses the Euclidean Distance similarity method. This enhanced face recognition approach is able to recognize many faces with an accuracy rate of 91.67 [2].

Other research that has been done is stated in the journal entitled "Aplikasi Identifikasi Wajah Berbasis Android". The way the system works is the sample eigenface registration stage, registration of data and the user's face image, and the identification process of the user's face image. At the stage of image identification, a new image is taken to take the eigenface weight or image weight value. The new Eigenface weight image is compared with Eigenface weight images stored in the database. The result of the identification that appears is the user data that has the least amount of Eigenface weight difference. The success rate of face identification trials was 68% and the rate of misidentification was 32%, from a total of 25 identifications. Some important factors that influence the success rate of identification are facial position and light intensity when registering [6].

Other research examples are listed in the journal entitled "Handwriting Recognition using Eccentricity and Metric Feature Extraction based on K-Nearest Neighbors". This journal proposed a recognition process that consists of several stages such as thresholding, noise removal, and cropping before feature extraction and classification. The dataset will be divided into training data and testing data. Thresholding is the basis of transformation to produce binary images of color/ gray images depending on the threshold value. The noise removal method used on this paper is the median filter. The median filter is used to reduce the frequency of detail and sharpness of the edges of the image and also eliminate the noise of salt and pepper. The next preprocessing step is to crop the image by looking for the image area by considering the size of the object. After cropping the object is obtained, then separate the image on two different data, namely training data and testing data. The feature extraction method used is eccentricity and metrics. Eccentricity is obtained between the value determining between the small elliptical focal distance and the main focus of the ellipse of an object. While the metric is the ratio between the area and circumference of the object. For the classification used the KNN method is used to classify objects based on training data with the distance nearest to the object, where the formula for calculating the distance used in this paper is the Euclidean distance formula. Based on the results of the testing obtained accuracy of 85.38% for the Handwriting Recognition using Eccentricity and Metric Feature Extraction based on K-Nearest Neighbors [7].

Examples of other studies are listed in the title "Voice Recognition using K Nearest Neighbor and Double Distance Method". This journal developed a new method to improve the accuracy of using data outliers, namely double distance method. This doubled distance method will be combined with the KNN method with k=1 as the center of the voice recognition. Frame work consist two stages are training and testing process. The training process is feature extraction using Mel Frequency Cepstrum Coefficients (MFCC). While the testing process

through the introduction stage using the KNN method. Testing process is divided into two parts, the first part used the KNN method and the second used the doubled distance method. The input used is audio of 11 subjects where each subject produced the word "computer" in Bahasa which is stored in database to be used as training data and testing data. The MFCC method is to convert domain signals from the time domain to the frequency domain, while time domain signals are more difficult because of data complexity. The similarity between testing data and training data is calculated by the Euclidean distance formula. Based on the results of testing, the method of KNN with one data center is 84.85% and the accuracy of the doubled distance method is 96.97%. From the result, we know double distance method improve the accuracy of voice recognition [8].

3. METHODS

Face identification Using the K-Nearest Neighbor Method consists of two phases namely the training phase and the testing phase. The dataset used in the training phase are 790 images consisting of 158 classes with each class consisting of three training images and two for testing images. The following will explain the chart or scheme in stages from each phase on flowchart below.

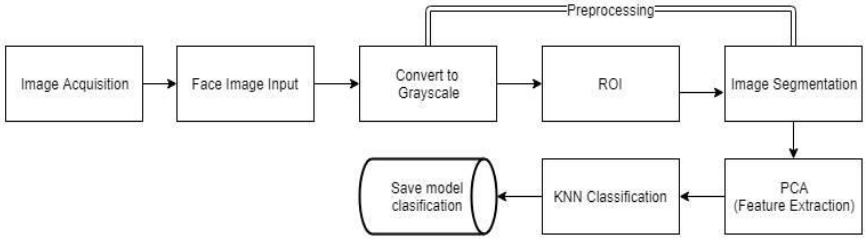

Figure 1. Phase Training Scheme Face identification

While the testing or testing phase involves a database of features that have been obtained from the results of training. The testing scheme is as follows.

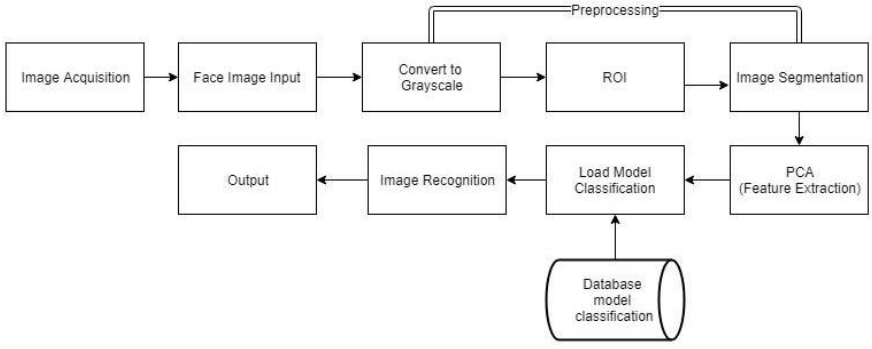

Figure 2. Testing Phase Scheme

3.1 Data Source

Data source used comes from manual shooting. This dataset research contains 790 faces from 158 people taken from several angles. The dataset has not gone through the segmentation process so that there is still a background that is quite significant outside the face object. The dataset has been separated into each folder containing the name of the individual owner of the face.

Figure 3. Example dataset model

3.2 Image Enhancement

Image Enhancement is an accentuation or sharpening of the elements of an image such as edge and boundaries or contrast levels that can make the graphic display of the image more useful for analysis and display [9]. Stages of image enhancement in the face identification system using the K-Nearest Neighbor (KNN) method consists of ROI (Region of Image), image conversion to grayscale color space and contrast stretching. An image enhancement technique that seeks to increase contrast in the image by stretching called Contrast stretching. The concept of contrast stretching is to maintain the range of values of intensity it contains to reach the desired range of values. This is used to enhance the information in the image and maintain other details [10]. The following is the image enhancement result of face identification research using the KNN method.

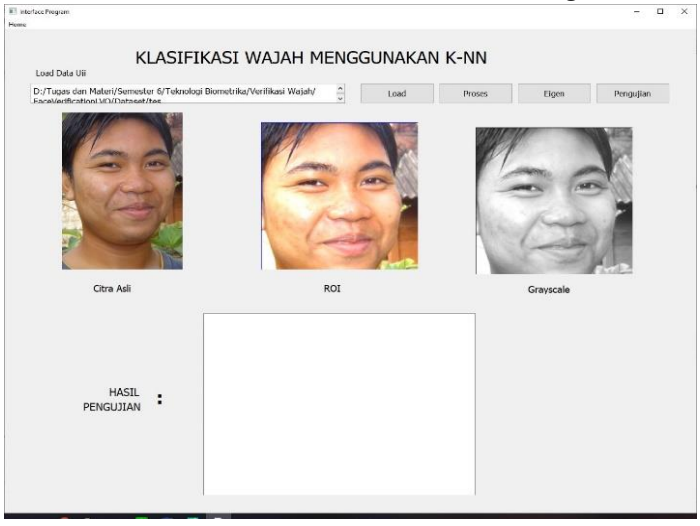

Figure 4. Image Enhancement

3.3 Feature Extraction

Feature extraction is a stage to find the characteristic features of an inputted image. Feature extraction is a process which is extracted features to encourage the classifier to make decisions when classifying.

The Principal Component Analysis feature extraction method used in this paper is one of the popular extraction methods [11]. The PCA method is one way to reduce the dimensions of data with the least amount of information loss [12]. This method is used in many fields, such as biometrics, feature extraction, image processing, data compression, etc. In the PCA method, faces are described as linear combinations of eigenvector weights called Eigenfaces. This eigenvector is a covariance matrix from the image database. the number of images in the database will be the same as the number of Eigenfaces received [13]. Furthermore, is an example of feature extraction using the face identification system using the Principal Component Analysis (PCA) method.

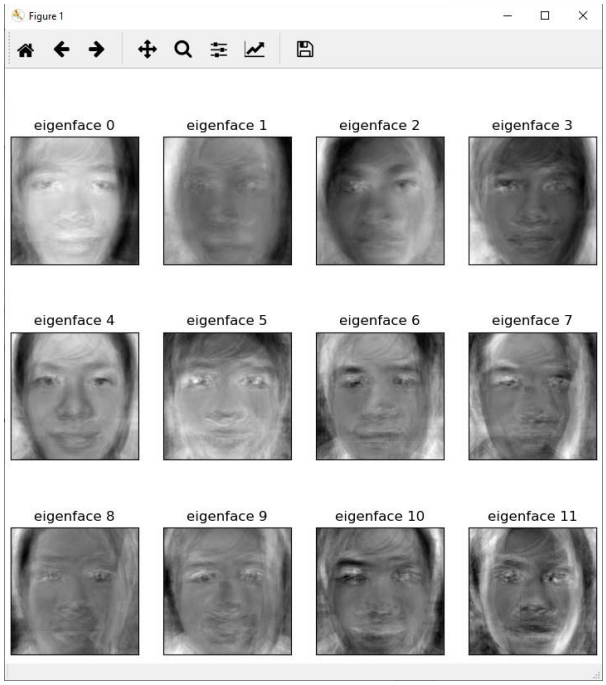

Figure 5. Feature Extraction using PCA

3.4 KNN Classification

Face classification is a stage for the process of matching testing data and training data from face datasets. KNN is one of the simple algorithms that can be used for classification. Regardless of its simplicity, this method is quite effective as a classification. This method was first proposed by T. M. Cover and P. E. Hart

in 1967 [14] but then modified to improve the performance of the KNN. The basic concept of KNN is to have several training samples and testing samples determined by members. If k=1, the testing sample is assigned to the nearest single neighbor class. However, finding the right k value for a particular problem is a problem that affects the performance of the KNN [15]. The classification stages in face identification systems use the K-Nearest Neighbor (KNN) method where the eigen image of the feature extraction process used as input is as follows.

Figure 6. The results of identification using KNN

4. RESULT AND DISCUSSION

Tests were carried out using face datasets manually with Citra, namely 790 face images from 158 people taken from several angles divided into 30 classes for research material. The following is a face identification system test using the K-Nearest Neighbor method with a change in parameter k which is the neighboring points of each class.

Table 1. Testing with k = 1

Nama	Precision	Recall	fi-score	Support
Adhi Pramudya	1.00	0.50	0.67	2
Agung Meidi	0.67	1.00	0.80	2
Agus Hendra	1.00	1.00	1.00	2
Agus Wiratha	0.67	1.00	0.80	2
Alit D	1.00	0.50	0.67	2
Alit Sudawiaya	0.67	1.00	0.80	2
Aniek Laksmidewi	1.00	1.00	1.00	2
Ariana	1.00	0.50	0.67	2
Arik	1.00	1.00	1.00	2
Aris Eko P	0.50	1.00	0.67	2
Arsa Suteja	1.00	1.00	1.00	2
Arsika	1.00	1.00	1.00	2
Artajaya	1.00	0.50	0.67	2
Arya D	1.00	1.00	1.00	2
Aryana	1.00	0.50	0.67	2
Aryawan	1.00	1.00	1.00	2
Ayu Puspa Dewi	1.00	0.50	0.67	2
Bawa Arnawa	1.00	0.50	0.67	2
Bawa P	1.00	0.50	0.67	2
Benediltus	1.00	1.00	1.00	2
Budiasa	0.50	0.50	0.50	2
Citra Aprilia	1.00	1.00	1.00	2
Deazy	1.00	1.00	1.00	2
Deny Satriawan	0.33	0.50	0.40	2
Eka Cahyadi	0.67	1.00	0.80	2
Gita Indrawan	1.00	1.00	1.00	2
Gusur	1.00	1.00	1.00	2
Ibu Budi	0.50	1.00	0.67	2
Iwan Tofani	1.00	1.00	1.00	2
Maya Ritasari	1.00	0.50	0.67	2
avg / total	**0.88**	**0.82**	**0.81**	**2**

Table 1 is a face identification system testing table with the K-Nearest Neighbor (KNN) method with parameters k=1 using face training data with 30 classes consisting of 2 testing data and 3 training data, which obtained an accuracy or fi-score of 81% .

Table 2. Testing with k = 2

Nama	Precision	Recall	fi-score	support
Adhi Pramudya	0.33	0.50	0.40	2
Agung Meidi	0.50	0.50	0.50	2
Agus Hendra	0.50	1.00	0.67	2
Agus Wiratha	0.33	0.50	0.40	2

Alit D	0.33	0.50	0.40	2
Alit Sudawiaya	0.50	1.00	0.67	2
Aniek Laksmidewi	1.00	1.00	1.00	2
Ariana	1.00	1.00	1.00	2
Arik	0.67	1.00	0.80	2
Aris Eko P	0.50	1.00	0.67	2
Arsa Suteja	0.67	1.00	0.80	2
Arsika	1.00	1.00	1.00	2
Artajaya	1.00	1.00	1.00	2
Arya D	1.00	1.00	1.00	2
Aryana	0.50	0.50	0.50	2
Aryawan	0.50	1.00	0.67	2
Ayu Puspa Dewi	0.00	0.00	0.00	2
Bawa Arnawa	0.00	0.00	0.00	2
Bawa P	0.00	0.00	0.00	2
Benediltus	0.25	0.50	0.33	2
Budiasa	1.00	0.50	0.67	2
Citra Aprilia	1.00	0.50	0.67	2
Deazy	1.00	0.50	0.67	2
Deny Satriawan	0.50	1.00	0.67	2
Eka Cahyadi	0.67	1.00	0.80	2
Gita Indrawan	0.00	0.00	0.00	2
Gusur	0.00	0.00	0.00	2
Ibu Budi	0.00	0.00	0.00	2
Iwan Tofani	1.00	0.50	0.67	2
Maya Ritasari	0.00	0.00	0.00	2
avg / total	**0.52**	**0.60**	**0.53**	**60**

Table 2 is a face identification system testing table with the K-Nearest Neighbor (KNN) method with parameters k=2 using face training data with 30 classes, which obtained accuracy or fi-score of 53%.

Table 3. Testing with k = 3

Nama	Precision	Recall	Fi-score	Support
Adhi Pramudya	0.67	1.00	0.80	2
Agung Meidi	1.00	1.00	1.00	2
Agus Hendra	0.50	1.00	0.67	2
Agus Wiratha	0.00	0.00	0.00	2
Alit D	0.33	0.50	0.40	2
Alit Sudawiaya	0.33	1.00	0.50	2
Aniek Laksmidewi	1.00	0.50	0.67	2
Ariana	1.00	0.50	0.67	2
Arik	0.50	1.00	0.67	2
Aris Eko P	0.25	0.50	0.33	2
Arsa Suteja	1.00	0.50	0.67	2
Arsika	0.33	0.50	0.40	2

Artajaya	0.50	0.50	0.50	2
Arya D	1.00	1.00	1.00	2
Aryana	1.00	0.50	0.67	2
Aryawan	1.00	0.50	0.67	2
Ayu Puspa Dewi	0.00	0.00	0.00	2
Bawa Arnawa	0.00	0.00	0.00	2
Bawa P	0.00	0.00	0.00	2
Benediltus	0.33	0.50	0.40	2
Budiasa	1.00	0.50	0.67	2
Citra Aprilia	1.00	0.50	0.67	2
Deazy	1.00	1.00	1.00	2
Deny Satriawan	0.33	0.50	0.40	2
Eka Cahyadi	0.33	0.50	0.40	2
Gita Indrawan	0.00	0.00	0.00	2
Gusur	0.00	0.00	0.00	2
Ibu Budi	0.50	0.50	0.50	2
Iwan Tofani	0.50	0.50	0.50	2
Maya Ritasari	0.00	0.00	0.00	2
avg / total	**0.51**	**0.50**	**0.47**	**60**

Table 3 is a face identification system testing table with the K-Nearest Neighbor (KNN) method with parameters k=3, using face training data with 30 classes where accuracy or fi-score is 47%.

From the results of research conducted by applying the facial identification system using K-Nearest Neighbor (KNN) or eigenface divided into two parts, namely the training process and testing process. In the research process using changes in parameters k = 1, k = 2, k = 3. Testing k = 1 gets the accuracy of 81%, testing k = 2 gets the results of accuracy of 53%, testing k = 3 gets the results of accuracy of 47%. From the results of the study, the value of k greatly affects the level of accuracy of the system. The parameter value k and accuracy are inversely proportional, namely the greater the value of k, the smaller the accuracy of the identification system

5. CONCLUSION

In this paper we conducted an experiment for face identification using the KNN method. KNN is one of the simplest algorithms that can be used for classification. The source of data used comes from manual shooting. This dataset contains 790 face images from 158 people taken from several angles divided into 30 classes for research material. The face identification stage using the KNN method consists of two stages, namely the training stage and the testing phase. In the training stage, the inputted image will experience an en-displacement image, feature extraction and classification using the KNN method. The step of image displacement in the image is taking ROI from the image, changing the image to the Grayscale color space, and contrast stretching. The feature extraction stage is to find the characteristic features of an image inputted using PCA. The

classification stage on face identification uses the KNN method, a method that uses the concept of neighbor distance where the distance from trained samples is measured depending on the value of K and the test data is determined by the member.

In the testing phase, the inputted image will also undergo a process like in the training phase, but the image used is an image that has never been tested for training to measure the accuracy of the similarities between training images and testing images. Based on the results of experiments with changes in parameters obtained results are different for each parameter. Testing k=1 gets the accuracy of 81%, testing k=2 gets the results of accuracy of 53%, testing k=3 gets the results of accuracy of 47%. From the results of the trial it can be concluded that the value of k greatly affects the level of accuracy of the system. The parameter value k and accuracy are inversely proportional, namely the greater the value of k then the smaller the accuracy of the identification system.

6. REFERENCES

[1] Kairos, "Face Recognition Goes Mainstream," (online: https://1drv.ms/w/s!AomKrU6kgs8WiltEnZ4SUzWDZLbE).

[2] T. Mantoro, M. A. Ayu and Suhendi, "Multi-Faces Recognition Process Using Haar Cascades and Eigenface Methods," *2018 6th International Conference on Multimedia Computing and Systems (ICMCS)*, pp. 1-5, 2018.

[3] C. Ding, C. Xu and D. Tao, "Multi-task Pose-Invariant Face Recognition," *IEEE TRANSACTIONS ON IMAGE PROCESSING*, vol. VOL. 24, no. NO.3, pp. 980-993, 2015.

[4] X. Zhang, T. Gonnot and J. Saniie, "Real-Time Face Detection and Recognition in Complex Background," *Journal of Signal and Information Processing*, vol. 8, pp. 99-112 , 2017.

[5] A. B. J. Z. H. X. J. G. B. L. A. N.-C. C. C. D. C. R. C. Rajeev Ranjan, "A Fast and Accurate System for Face Detection,Identification, and Verification," JOURNAL OF LATEX CLASS FILES, VOL. 14, NO. 8,, AUGUST 2015.

[6] I. K. S. Widiakumara, I. K. G. D. Putra and K. S. Wibawa, "Aplikasi Identifikasi Wajah Berbasis Android," *LONTAR KOMPUTER*, vol. VOL. 8, no. NO. 3, pp. 200-207, 2017.

[7] E. H. Rachmawanto, G. R. Anarqi, D. R. I. M. Setiadi and C. A. Sari, "Handwriting Recognition using Eccentricity and Metric Feature Extraction based on K-Nearest Neighbors," International Seminar on Application for Technology of Information and Communication (iSemantic), 2018.

[8] Ranny, "Voice Recognition using k Nearest Neighbor and Double Distance Method," IEEE, 2016.

[9] I. M. O. W. N. W. I. B. P. A. I Made Dwi Putra Asana, "Metode Contrast Stretching untuk Perbaikan Kualitas Citra pada Proses Segmentasi Video," Jurnal Teknologi Elektro Vol. 16, No. 02, 2017.

[10] D. B. K. N. Mohanapriya, "Image Enhancement Using Multilevel Contrast Stretching and Noise Smoothening Technique for CT Images," International Journal of Scientific & Engineering Research, Volume 5, Issue 5, 2014.

[11] M. T. K. S. T. Z. S. A. M. A. a. B. F. Mahmud, "Face recognition using Principle Component Analysis and Linear Discriminant Analysis," 2015 International Conference on Electrical Engineering and Information Communication Technology (ICEEICT), 2015.

[12] L. C. P. a. A. A. Sumam, "Recognition Using Principal Component Analysis Method," International Journal of Advanced Research in Computer Engineering & Technology (IJARCET) ISSN: 2278 – 1323, Volume 1, Issue 9, November 2012.

[13] E. R. Y. L. A. M. S. Wai Yan Min, "Application of Statistical Data Processing for Solving the Problem of Face Recognition by Using Principal Components Analysis Method," IEEE, 2018.

[14] T. M. C. a. P. E. Hart, "Nearest Neighbor Pattern Classification," IEEE Transactions on Information Theory, Vol. 13, No. 1, pp. 21-27, January,1967.

[15] B. I. A. H. P. B. G. Firoz Mahmud, "Facial Region Segmentation Based Emotion Recognition Using K-Nearest Neighbors," International Conference on Innovation in Engineering and Technology (ICIET), 27-29 December, 2018.