ISSN 2278-3091
Volume 8, No.4, July – August 2019
International Journal of Advanced Trends in Computer Science and Engineering
Available Online at http://www.warse.org/IJATCSE/static/pdf/file/ijatcse17842019.pdf
https://doi.org/10.30534/ijatcse/2019/17842019

Face Recognition Using MATLAB

Aaron Don M. Africa, Ara Jyllian A. Abello, Zendrel G. Gacuya, Isaiah Kyle A. Naco, Victor Antonio R. Valdes

Department of Electronics and Communications Engineering
De La Salle University, Manila
2401 Taft Ave., Malate, Manila 1004,
Philippines, aaron.africa@dlsu.edu.ph

ABSTRACT

This project dives into the topic of facial recognition and facial detection in a digital communications system. Face recognition is a technology that is widely used today which brings various benefits to society. Facial recognition differs from facial detection in the aspect that facial detection only finds and detects the present face/s in an image whereas, in facial recognition, the computer finds the face/s present in a subject and is able to distinguish the face from a sample of different faces. This research focuses on the implementation of both a facial recognition system and a facial detection system in MATLAB. This research would use the different imaging toolboxes available in the program and would be judged on its ability to accurately detect and recognize a sample in a given database. Additionally, this system should be able to create and to read a database of different faces.

Key words: Facial recognition, MATLAB, spatial imaging, database monitoring, Rough Set Theory.

1. INTRODUCTION

According to MathWorks, face recognition is the identification process of a person in images or videos through analyzation and comparison of patterns [1]. Face recognition algorithms usually extract the facial features of a person and thoroughly compares them to the facial features in the database and locates the best match. It has become an essential part of biometric, security, surveillance systems, and image and video indexing systems.

A face recognition system is an intricate image-processing problem in real-world applications containing complex effects of illumination, occlusion, and imaging condition on the live images [2,3]. A face recognition system contains of face detection and recognition methods in image analysis. The process of detection is utilized to locate the position of the faces in an image. While the recognition algorithm is utilized to classify a certain image with structured properties that are used in most computer vision applications. Face recognition applications utilizes standard images and videos, and the detection algorithm finds the faces in a given frame and extracts a face image which includes eyes, nose, eyebrows, and lips which makes the algorithm more complex than a single detection or recognition algorithm.

In Figure 1, the flow of face recognition system application can be seen. The first step for a face recognition system is to get an image through an external device like a camera. The next step is face detection from the acquired image. The system then goes to the face recognition part wherein it the acquired image undergoes matching with faces in the face database and then it goes to the final step which is where the identity of the person is found.

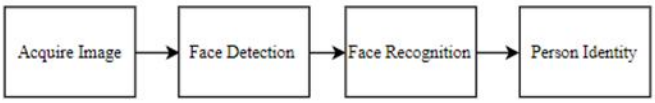

Figure 1: Block Diagram of a Face Recognition System

2. BACKGROUND OF THE STUDY

In the present day, almost all available technology like computers and utilizes digital communications. One of the most common gadgets is smartphones. The hardware and software designs of smartphones are being improved for better user experience. One of the improvements is better security wherein phones use biometric information like the facial pattern. In addition, this feature is also more efficient for most users because there are no buttons required.

On another light, face recognition has become an interest of researchers in recent years. This comes from the increasing demands in security, commercial and law enforcement application wherein there is a need for automatic recognition, facial recognition visual system and design of an interface to be used. Facial recognition encompasses different disciplines like computer vision, image processing, machine learning and many more.

The maintenance of the security of information for physical and intellectual properties is gaining importance and is becoming more difficult. Various crimes related to the theft of property such as credit card fraud hacked accounts and even breach in data owned by the government.

3. STATEMENT OF THE PROBLEM

Today, the security of data and information is important. Different ways to access these data are being used such as PINs and RFID technology. Although the mentioned ways give safety to the stored information, there are times that passwords are forgotten, cards are lost or corrupted. Facial recognition may be used for securing personal data and avoid theft.

Another problem is the identification of a person for law enforcement. Identity of a criminal may also be recorded for easier access to data in the future. Face recognition aids an accurate and efficient recognition of a person in an image to match stored information in the database.

4. SIGNIFICANCE OF THE STUDY

Being able to accurately identify faces is a very important part of a facial recognition system since there are many parameters to consider like illumination, camera angles, and facial expressions. Many methods of accurately detecting a face and matching it to a database have been created with various levels of accuracy and effectiveness. These methods are continually being refined to better improve facial recognition technology.

An immediate application of facial recognition is security [4]. One can use facial recognition to identify criminals when in view of a camera. This can apply to a camera spotting an escaped or known criminal or a camera storing a person's face after seeing said person commit a crime. A good system would also be able to identify who works inside a building and who is trespassing. Having a very accurate system will greatly increase security in many places, especially airports, banks, and prisons.

Facial recognition is also capable of preventing fraud [5]. Fraud mostly happens because anyone can pretend to be you as long as they have your information. A way to prevent this is to include a way of checking the person's face before any decision or transaction can be made. If facial recognition software and technology were to be improved further to the point that even the smallest detail of one's face is identifiable, then fraud cases will decrease significantly.

Facial recognition also makes services and work more convenient. Logging in to your social media accounts or clocking into work can be simplified by having a facial recognition system set up to monitor your or the employees' comings and goings.

5. LITERATURE REVIEW

In Shamla Mantri and Kalpana Bapat's paper [6,7] on a neural network-based facial recognition using MATLAB, they propose using a self-organizing map (SOM) to measure image similarity. A SOM is a type of artificial neural network (ANN) that uses unsupervised learning to create a "map", which is a very small approximation of the input space of the training samples, to train itself. According to them, using a SOM in facial identification provides very promising results when considering variations in illumination and changes in facial poses and expressions. Its success in facial detection is due to its special property of creating "internal representations" of the input signals and their abstractions. According to their results, the face recognition rate from using SOM is 92.40% for 40 persons.

In the paper titled "Attendance Monitoring Using Real-Time Face Recognition in MATLAB" by authors Ramya. C N, Anusha, B E, Lakshmi. V, Lalitha. S, Abhilasha. A S [8], their facial recognition technology also has the ability to send an SMS to any person not present in class using GSM technology. According to the authors, the system is very efficient and does not need as much maintenance compared to the other methods of facial recognition. The authors used Principal Component Analysis (PCA) for facial recognition due to its efficiency in relation to this project. PCA reduces the dimensionality of large data sets and retains most of the original information. Their proposed model has a digital camera that takes photos of students or employees. These pictures are then sent to an enrollment module, then the pictures undergo the facial recognition process, then the database is checked, and attendance is marked.

Authors Kavita Singh, Mukesh Zaveri, and Mukesh Raghuwanshi wrote a paper on using a modified Gabor algorithm and rough set theory concepts to deal with the posed problem in facial recognition. Entitled "Rough Set Based Pose Invariant Face Recognition with Mug Shot Images," their proposed system consists of a face detection module, a pose classification module, a feature extraction module, and recognition module. Their objective was to deal with the issues when it comes to identifying people from mug shots. Their use of Rough Set Theory is due to it being an excellent mathematical tool in handling uncertain parts in any given data, which is a great help when dealing with different poses and angles in facial recognition.

Another paper deals with using SOM in facial recognition. A paper entitled "A MATLAB based Face Recognition System using Image Processing and Neural Networks" by Jawad Nagi, Syed Khaleel Ahmed, and Farrukh Nagi presents another technique for facial recognition, this time using two-dimensional discrete cosine transform (2D-DCT) to compress images [9]. Through this technique, redundant data is removed, and features based on skin color are extracted from faces. According to the authors, research revealed that since skin color varies per individual, the main distinguishing characteristic is intensity rather than chrominance. This technique uses SOM to classify the intensity values of grayscale pixels compressed by 2D-DCT into separate groups. This will then allow the system to check if the subject of the image is present or absent from the database.

A paper titled "Face Recognition Methods & Applications" by authors Divyarajsinh N. Parmar and Brijesh B. Mehta lists and explains the various ways of facial recognition and also their different applications. Such methods of facial recognition are Holistic Matching methods, Feature-based methods, and Hybrid methods. The Holistic Matching method takes into account the complete facial region as input data in the system. Methods like the Eigenfaces, Linear Discriminant Analysis, and Principal Component Analysis are included in this category. Feature-based methods consider facial features like eyes, nose, and mouth and extract their locations and geometric statistics and feed them to a structural classifier [10,11]. Hybrid methods combine Holistic Matching and Feature-based. Another paper by Navreet Kapur titled "Review of Face Recognition System Using MATLAB" goes into more detail with methods like PCA algorithm [12, 13], Support Vector Machines (SVM), Independent Component Analysis (ICA), and Linear Discriminant Analysis (LDA). According to Navreet Kapur, newer methods such as ANN, SOM, and SVM will yield better results when dealing with enhanced facial recognition. These papers helped the group gain a better understanding of the concepts involved in facial recognition.

6. THEORETICAL CONSIDERATION

When writing this paper, the group had to gather enough information on facial recognition in order to understand it first then implement it into MATLAB. The group operated under the assumption that facial recognition required some form of spatial imaging. The group considered this because in order for a system to recognize a face, it has to be able to somehow identify the features of a face like the eyes, nose, and cheeks [14]. Another thing the group considered was the use of some kind of decision-making program that can decide whether or not the face detected is really a face, and to match the face to another face that should be stored in a database of some kind.

There are two theories that were considered for this paper. These theories are not exclusively technological. They are two of the known psychological theories explaining the process behind how a human can recognize another human's face. The group chose to consider these theories in order to work out how to program the system to recognize faces. One theory is called the feature analysis theory. This theory states that humans first look at the features of the face, like the eyes and lips [15]. This theory is also known as the bottom-up theory because it looks at the small details first before looking at the whole picture. The other theory was the Holistic form. The second theory states that humans look at the face is looked at as a whole. This theory is also known as the top-down theory because the whole picture is looked at first.

7. DESIGN CONSIDERATIONS

The digital communications system of the facial recognition program starts with the hardware. The hardware to be used in this system is built in web-camera of a laptop whose purpose is to take a photo of the subject to be examined. Once the photo is taken, it is then converted digitally to the computer. The digital copy of the photos taken would be stored in the database to be used later. The program created is designed to take a photo and to determine focus, and crop around the face of the subject. Once the database is updated with the photos of the face of a subject, the photos are then converted into vectors by the program in order for it to be easily recognizable by the computer. The computer then follows the program and converts all of the photos in the database into 2D vectors. Once the computer has a database of 2D vectors, it is now ready to receive an input of a face that is to be examined. The input in the computer will a photo of a face and the computer will then convert the input face into 2D vectors. After this is done, the computer would have the duty of finding the 2D vector in the database that has the closest similarity with the 2D vector of the input. The one with the most similarities with the input would now be recognized as the similar face and the photos would be displayed in their 3D image form for the user to inspect.

8. METHODOLOGY

Facial recognition using MATLAB has two parts: the face detection and facial recognition from the database [16, 17, 18, 19, 20,21]. The flowchart of the entire process is seen in Figure 2. For a face recognition system, there should be a database of facial images of people to be recognized. Then, the feature extraction step is done [22, 23 24]. In this step, discriminative information about each face is stored in a compact feature vector [25]. After, there is a learning or modeling step wherein a machine learning algorithm is used to fit a model of the appearance of the faces in the gallery. This is where the discrimination of faces in the gallery happens and the output of this step is a classifier. A classifier is a model wherein input images are recognized and compared to an input query image. A face detection algorithm is used to find the location of the face in the input query image [26,27]. When found, the face is cropped, resized and normalized to match the size and pose of the images used in the face database and then it undergoes the process of feature extraction. When there is a match between the input query image and the database, the classifier then indicates on which person from the database the face belongs to.

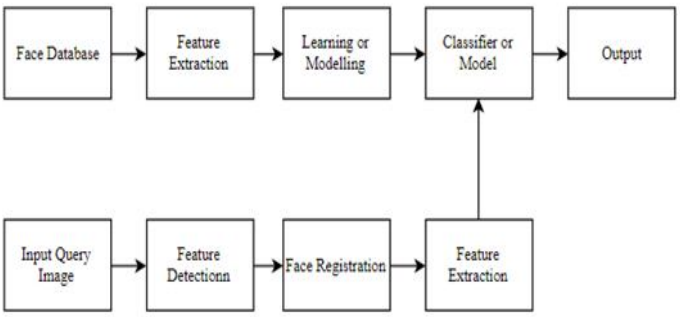

Figure 2: Block Diagram of Facial Recognition using MATLAB

9. RESULTS AND DISCUSSION

9.1. Face Detection

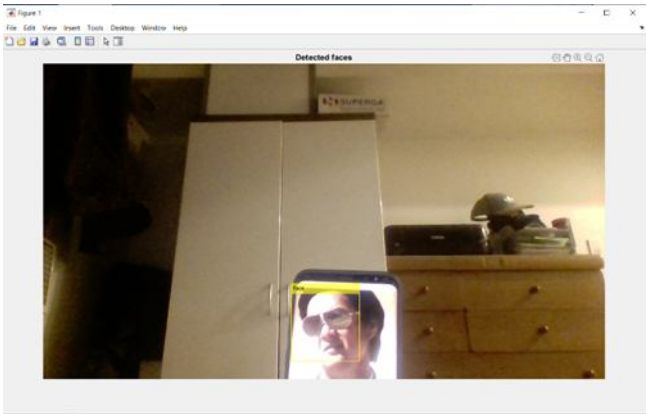

Figure 3: Input query image

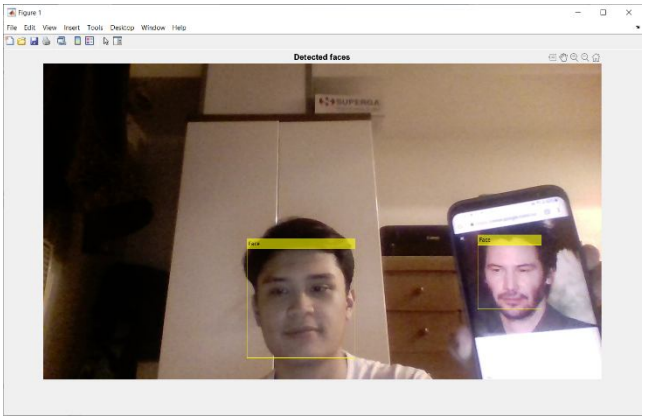

Figure 4: Input query image

Figure 5: Cropped and resized detected face

9.2. Recognition from a Database

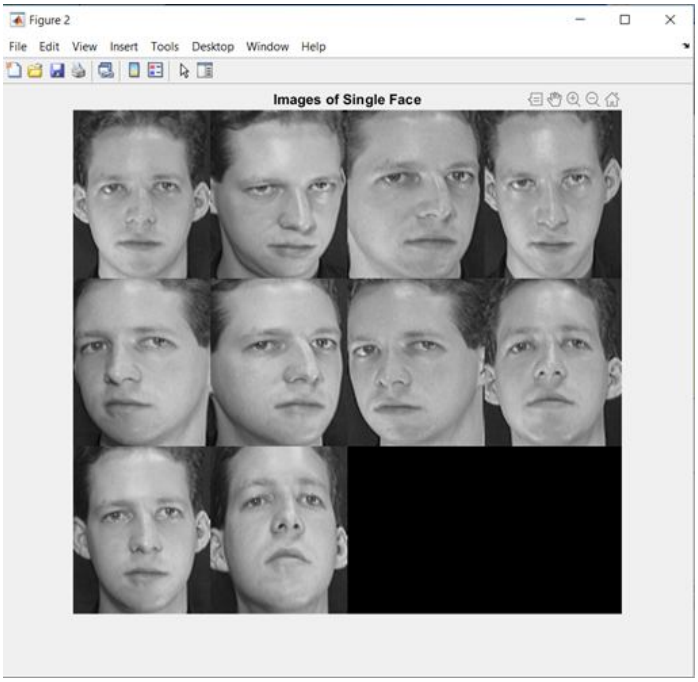

Figure 6: Face database

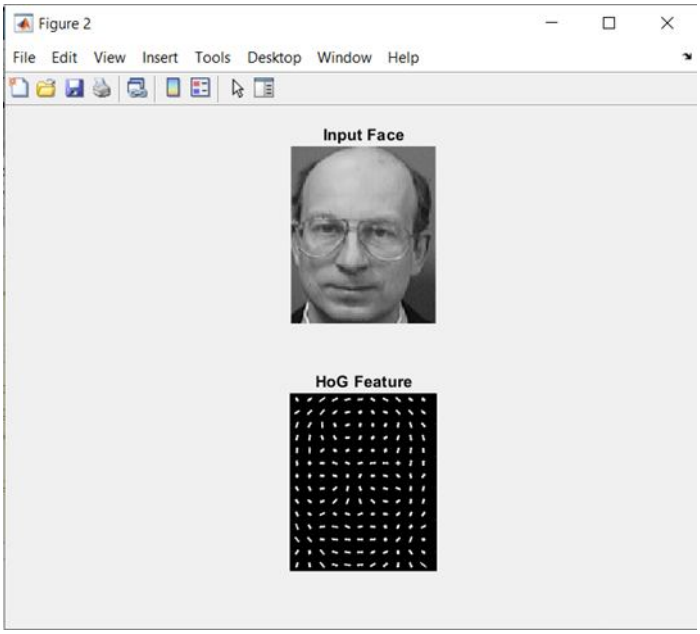

Figure 7: Feature extraction

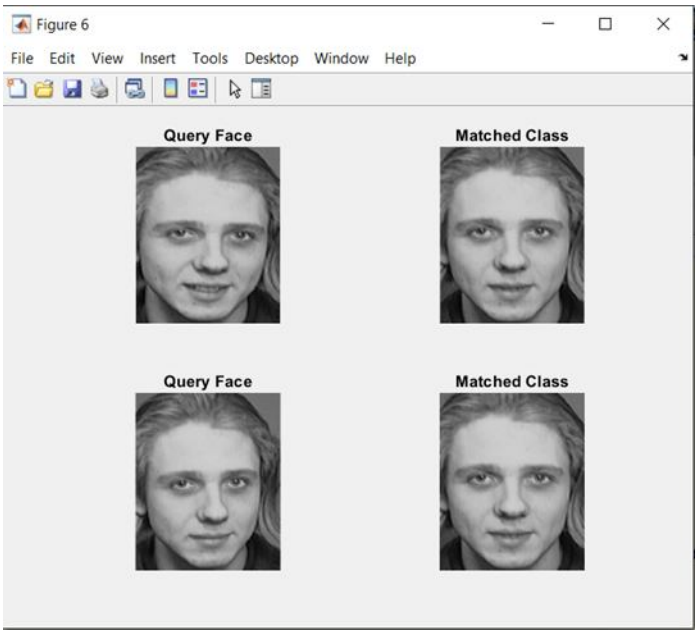

Figure 8: Facial recognition output

For the group's chosen topic, the group decided to divide the simulations into two different works. The first simulation is for face detection. Face detection refers to the act of finding and distinguishing a face in a photo. The group accomplished this through a simulation in MATLAB. The program is made to activate the webcam and to scan the environment. The environment is scanned for objects that have the characteristics of a face; namely the eyes, nose, and mouth. Once this is found, the program then captures a still of the webcam and highlights the noted objects which are similar to a face with a yellow rectangle which labels the object as 'Face'. The program has the capability to detect more than one face at a time but since the program looks for patterns which are similar to a face, there are some instances where the program would detect a face even when it is not there. This may be due to some pattern of dirt, print, or lighting that the program finds similar to the characteristics of a face. After the program finds a face, it allows the user to save the image of a face into a database with a name that the user desires.

For the results of the first simulation, as can be seen in Figure 3.0, the program can detect a face that is flashed on a cell phone. The program could see the outlines of a face which it highlights and labels as a face. After this, the user will be given the option to save the highlighted face into a jpeg file which can be seen in Figure 3.2. The program was successful in distinguishing a face in the environment even if the face was shown in a cell phone screen. For Figure 3.1 it can be seen that the program was successful in highlighting two faces at the same time. The first face was an actual face and the second was an image shown through a phone screen. This proves the versatility and usability of the program.

For the second simulation, the program uses a pre-shot database from AT&T. The database includes a set of ten photos of 40 different people and the purpose of the program is to get a random photo and recognize to which person or which photo set the random photo belongs to. In Figure 4.0, a sample of the ten photos of a person in the database can be seen. The purpose of this figure is to show the user what the database looks like. The next figure, Figure 4.1, shows how the program converts the photo into a series of vectors which enables the program to distinguish one photo from another more easily. Finally, for figure 4.2, the program is seen to recognize the two different query photo, or the photos in question, and match them into their respective sets of 10 photos which is represented by a single photo from the set. This proves that the program could recognize the photos from the database.

10. CONCLUSION

The topic chosen by the group was a digital system on facial detection and facial recognition. At the start of the project, the group's objectives were to represent a digital system in a simple yet effective way, to successfully simulate a facial detection and recognition program, to learn more about the functions that MATLAB has to offer, and to increase their knowledge on the various applications that digital communication has. The eyes of the group were opened to the various possible topics that they could tackle and the effects that each topic has in the world that we live in today. The research of the group led to the realization about how the modernization of technology brings even more possibilities and ideas for the future of digital communications.

The group chose the topic of facial recognition and detection because it is a technology that is already available today. Upon the research of the group, not only did they find out about the different uses of facial recognition in the world today, but also about the importance and the convenience that it brings in a person's daily life. Facial recognition can bring

security, convenience, and even accuracy to society. It can bring security by being a safety feature in securing a person's prized items or personal information. Since facial recognition is useful in society, it is important to know how it works and how to implement it; which is why the researchers made two separate programs for the detection, and the recognition of a face. At the end of their research and implementation, the results that the researchers received were successful and reached the objectives that they have set. This allows the researchers to find more ways on how to improve the facial recognition technology that we have today. The research of the group would prove to be important for further research about the implementation of the topic in digital communications.

11. RECOMMENDATIONS

While the group was successful in simulating a facial detection and recognition system, the system still detected "faces" where there were none. As stated above, the system most likely detected "faces" there due to some pattern of dirt, print, or illumination that the program finds similar to the characteristics of a face. This is problematic, especially in places where there is a lot going on in the environment. Reflections can also prove detrimental to the system's facial recognition abilities. To improve this system, the system should be able to accurately distinguish a human face from patterns of dirt, print, or illumination that resemble a human face [28]. To accomplish this, a better method of facial recognition should be employed. Another reason why the system detected a face that does not exist is because of the quality of the camera. The group, while writing this paper, used a webcam to gather the input for the system. A camera of higher quality will surely produce better results. The database should also be considered [29,30].

A feature that could be added is the capability to record facial patterns for future reference. Another would be to accurately distinguish multiple faces in a crowd of people while also avoiding errors [30,31]. This will prove to be useful when a camera is monitoring a pathway that sees a lot of foot traffic.

REFERENCES

[1] Face Recognition. https://www.mathworks.com/discovery/face-recognition .html .2019

[2] S.D.F. Hilado, E.P. Dadios, and R.C. Gustilo, "Face detection using neural networks with skin segmentation," IEEE 5th International Conference on Cybernetics and Intelligent Systems. pp. 261-265, 2011. https://doi.org/10.1109/ICCIS.2011.6070338

[3] J.A.C. Jose, M.K. Cabatuan, E.P. Dadios, and L.A. Gan Lim, "Depth estimation in monocular Breast Self-Examination image sequence using optical flow," International Conference on Humanoid, Nanotechnology, Information Technology, Communication and Control, Environment and Management, HNICEM. 2014. https://doi.org/10.1109/HNICEM.2014.7016220

[4] JS. Suhas, A. Kurhe and Dr.P. Khanale, "Face Recognition Using Principal Component Analysis and Linear Discriminant Analysis on Holistic Approach in Facial Images Database." IOSR Journal of Engineering. Vol. 2, No. 12, pp. 15-231999, 2012. https://doi.org/10.9790/3021-021241523

[5] S. Mantri and K. Bapat, "Neural Network Based Face Recognition Using Matlab." IJCSET. Vol 5, No. 1, pp. 6-9, 2011.

[6] C. N. Ramya, V. Lakshmi, B. Anusha, and A. S. Abhilasha, "Attendance Monitoring Using Real Time Face Recognition In Matlab." International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE). Vol. 5, No. 5, pp. 1308-1312, 2016.

[7] K. Singh, M. Zaveri and M. M. Raghuwanshi, "Rough set based pose invariant face recognition with mug shot images" Journal of Intelligent & Fuzzy Systems: Applications in Engineering and Technology. Vol. 26, pp. 523-539, 2014.

[8] J. Nagi, S. Ahmed, and F. Nagi, "A MATLAB based Face Recognition System using Image Processing and Neural Networks." 4th International Colloquium on Signal Processing and Its Applications. 2008.

[9] M. Tayyab and M. F. Zafar, "Face Detection Using 2D-Discrete Cosine Transform And Back Propagation Neural Network", Proc. 2009 International Conference on Emerging Technologies. pp. 35-39, 2009. https://doi.org/10.1109/ICET.2009.5353205

[10] D. N. Parmar and B. B. Mehta, "Face Recognition Methods & Applications." Int. J. Computer Technology & Applications. Vol. 4, No. 1, pp. 84-86, 2013.

[11] N. Kaur, "Review of Face Recognition System Using MATLAB." International Journal of Computer Science Trends and Technology (IJCST). Vol. 4, No. 3, pp. 30-36, 2016. https://doi.org/10.14445/22312803/IJCTT-V36P127

[12] S. Asadi, Dr. D. V. Subba R. V. Saikrishna, "A Comparative study of Face Recognition with PCA and Cross-Correlation Technique", IJCA. Vol. 10, No. 8, pp. 0975-8887, 2010. https://doi.org/10.5120/1502-2019

[13] Y. Zhang, C. McCullough, J.R. Sullins, "Hand-Drawn Face Sketch Recognition by Humans and a PCA-Based Algorithm," IEEE Transactions On Systems, Man and Cybernatics Systems and Humans. Vol. 40, No. 3, 2010. https://doi.org/10.1109/TSMCA.2010.2041654

[14] A. Elmahmudi, and H. Ugail, "Deep face recognition using imperfect facial data. Future Generation Computer Systems. Vol. 99, pp. 213-225, 2019. https://doi.org/10.1016/j.future.2019.04.025

[15] H. Boughrara, L. Chen, C. Ben Ama18r, and M. Chtourou, "Facial expression recognition based on perceived facial images and local feature matching." Image Analysis and Processing. Vol. 8157, 2013. https://doi.org/10.1109/ICITeS.2012.6216663

[16] S. Kherchaoui and A. Houacine, "Face Detection Based On A Model Of The Skin Color With Constraints And Template Matching," Proc. 2010 International

Conference on Machine and Web Intelligence. pp. 469-472, 2010.
https://doi.org/10.1109/ICMWI.2010.5648043

[17] M. Roomi, and M.P. Beham, "A Review Of Face Recognition Methods," International Journal of Pattern Recognition and Artificial Intelligence. Vol. 27, No. 4, 2013.
https://doi.org/10.1142/S0218001413560053

[18] N. Soni, G. Mathur and M. Kumar, "A Matlab Based High Speed Face Recognition System Using Som Neural Networks," International Journal of Engineering Research and Applications (IJERA), Vol. 3, No. 4, pp. 785-790, 2014.

[19] S. Singh, A. Tripathi, A. Mahajan, and S. Prabhakaran, "Analysis of Face Recognition in MATLAB," International Journal of Scientific & Engineering Research. Volume 3, No. 2, 2012.

[20] Y. Le, "The review and results of different methods for facial recognition," Paper presented at the IOP Conference Series: Materials Science and Engineering. Vol. 231, No. 1. 2017.
https://doi.org/10.1088/1757-899X/231/1/012021

[21] R.A.A. Masilang, M.K. Cabatuan, and E.P. Dadios, "Hand initialization and tracking using a modified KLT tracker for a computer vision-based breast self-examination system," International Conference on Humanoid, Nanotechnology, Information Technology, Communication and Control, Environment and Management, HNICEM. 2014.
https://doi.org/10.1109/HNICEM.2014.7016244

[22] X. Wang, Q. Ruan, and Y. Ming, "3D Face Recognition Using Corresponding Point Direction Measure and Depth Local Features," Proc. ICSP 2010. pp.86-89, 2010.
https://doi.org/10.1109/ICOSP.2010.5656654

[23] K. W. Bowyer, K. Chang, P. J. Flynn, and X. Chen, "Face recognition using 2-D, 3-D and infrared: Is multimodal better than multisampling?" Proc. IEEE. Vol. 94, No. 11, pp. 2012.
https://doi.org/10.1109/JPROC.2006.885134

[24] Q. Shi, Y. Cheung, Q. Zhao, and H. Lu, "Feature extraction for incomplete data via low-rank tensor decomposition with feature regularization," IEEE Transactions on Neural Networks and Learning Systems. Vol. 30, No. 6, pp. 1803-1817, 2019.
https://doi.org/10.1109/TNNLS.2018.2873655

[25] S. A. Khan, H. S. Ahmed Qasim, and I. Azam, "Feature extraction trends for intelligent facial expression recognition: A survey," Informatica. Vol. 42, No. 4, pp. 507-514, 2018.
https://doi.org/10.31449/inf.v42i4.2037

[26] M.K. Cabatuan, E.P. Dadios, R.N.G. Naguib, and A. Oikonomou, "Computer vision-based breast self-examination stroke position and palpation pressure level classification using artificial neural networks and wavelet transforms," Annual International Conference of the IEEE Engineering in Medicine and Biology Society. pp. 6259-6262, 2012.
https://doi.org/10.1109/EMBC.2012.6347425

[27] E. Mohammadi, E.P. Dadios, L.A. Gan Lim, M.K. Cabatuan, R.N.G. Naguib, J.M.C. Avila, and A. Oikonomou, "Real-time evaluation of breast self-examination using computer vision," International Journal of Biomedical Imaging. Vol. 2014, 2014.
https://doi.org/10.1155/2014/924759

[28] S. Shankar and V.R. Udupi, "Recognition of Faces – An Optimized Algorithmic Chain," Procedia Computer Science. Vol. 89, pp. 597-606, 2014.
https://doi.org/10.1016/j.procs.2016.06.020

[29] D. Ahamad, M. Akhtar, and S. Hameed, "A Review and Analysis of Big Data and MapReduce." International Journal of Advanced Trends in Computer Science and Engineering (IJATCSE). Vol. 8, No. 1, pp. 1-3, 2019.
https://doi.org/10.30534/ijatcse/2019/01812019

[30] S. Rao, M. Devi, and P. Kumar, "Wireless sensor Network based Industrial Automation using Internet of Things (IoT)." International Journal of Advanced Trends in Computer Science and Engineering (IJATCSE). Vol.7, No. 6, pp. 82-86, 2018.
https://doi.org/10.30534/ijatcse/2018/01762018

[31] L. Torrizo, and A. Africa, "Next-Hour Electrical Load Forecasting using Artificial Neural Network: Applicability in the Philippines." International Journal of Advanced Trends in Computer Science and Engineering (IJATCSE). Vol. 8, No. 3, pp. 831-835, 2019.