Pharmacy Impact for Distinguishing Normal Face from Abnormal Face Due to COVID- 19

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Original Research Article

ABSTRACT

In today's world face detection is the most important task. Due to the chromosomes disorder sometimes a human face suffers from different abnormalities. In the recent scenario, the entire globe is facing enormous health risks occurred due to Covid-19. To fight against this deadly disease, consumption of drugs is essential. Consumption of drugs may provide some abnormalities to human face. For example, one eye is bigger than the other, cliff face, different chin-length, variation of nose length, length or width of lips are different, etc. To assess these human face abnormalities, the application of computer vision is favoured in this study. This work analyses an input image of human's frontal face and performs a segregation method to separate the abnormal faces. In this research work, a method has been proposed that can detect normal or abnormal faces from a frontal input image due to COVID-19. This method has used Fast Fourier Transformation (FFT) and Discrete Cosine Transformation of frequency domain and spatial domain analysis to detect those faces.

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1. INTRODUCTION

A face is a key feature to identify a human. During the early stage of embryogenesis development genetic factors often play a key role to develop a face. Due to the chromosomal disorder, facial abnormalities can occur. The on-going health situation all over the world is becoming worse for the Covid-19 disease. To eradicate the disease, the application of some heavy drugs is coming into the picture. These drugs may eventually hamper the facial structure of human beings. This study made a survey on facial features during and after COVID-19 vaccine to be given to people. This study was done over 500 humans. It was found the changes due to the effect of drugs to be given in hospitals as well as camp for vaccination of COVID-19. In this modern era with advanced research technologies, it is possible to identify this facial disorder with help of various methods. Researchers develop various methods to identify a face. The target of the paper is to find out the changes. They also develop algorithms to detect different facial parts. The primary objective of this study is to detect whether a human face is normal or abnormal. To implement this process in this research first face and facial detection system are developed. The process is based on the length and the width of the face. Also facial areas are used for the detection process. This research is a real-world application with a high accuracy rate. The Fast Fourier transformation and Discrete Cosine transformation are used for the precise detection of normal and abnormal humans. The findings of this research suggested that this proposed methodology is useful in this research area and can lead more objective research in the future.

2. RELATED WORKS

Several researchers implemented algorithms for face detection with different classification algorithms. For this, they use either a single classification model or a combined models. To detect a face faked or not, researchers used Generative Adversarial Networks (GANs) used to detect automatically those fake faces [1]. Some researchers review in their papers about the Down syndrome (DS) disorder of the human, caused by chromosome abnormalities. They describe face detection, feature extraction and different classification techniques on it [2]. To detect a face researchers used haar cascade likes and Euclidean distance measurement in their experiment. They show that the recognition rate is 91.1% for the experiment [3]. Researchers proposed a generalized solution to detect visually observable symptoms on faces. For this purpose they used a semi-supervised learning technique with different classification technique algorithms [4]. Other researchers proposed in their research papers an improved technique in face recognition based on Principal Component Analysis and Fast Fourier transformation algorithm. They used the yale database and series of experiments to develop the model [5]. It is true that medical disease such as heart disease as well panic due to abrupt information in the social media create problems during COVID-19. These problems are solved by the Machine Learning [6-8].

3. HUMAN FACE STRUCTURE

Each human face has unique features aspects of every individual. In the human body, the face is the key body part for identifying a human. In anatomy human face [9]is divided into three main regions, 1) Upper Face, 2) Middle face and 3) Lower face.

3.1 Upper Face

The area started from just below the hairline to the under lower eye-lid is known as the upper face. This region is divided into two regions.

3.1.1 Forehead

It is the biggest and superior region of the upper face area. This area started from just below the hairline area. It contains two features, skull, and scalp.

3.1.2 Eyes

In the upper face region, the eyes are situated at the semi-circular orbital socket. It is the other superior area of the upper face region. It contains two eye-lids, upper and lower eyelids, and the eyebrows.

3.1.3 Middle Face

The middle face started from the lower eyelid region to just above the upperlip region. This is the central part of a face. It is divided into three parts 1) Nose, 2) Cheek, 3) Ear.

3.1.4 Nose

It is the middle line structure that extends to the face region. In this experiment the nose region divides into two parts, 1) Nose tip and 2) The region from the nose tip to just above the upper lip region.

3.1.5 Cheeks

This region is lateral to the nose. It contains skin and fat pads.

3.1.6 Ears

Humans' ears are used to hear the sound from the environment. This part is the lateral outline of the nose region.

3.2 Lower Face

The lower face region is started from the upper lip region to the ching region. This part contains four parts 1) Upper Lip region, 2) Lip region, 3) Chin region, and 4) Jawline region.

3.2.1 Upper Lip Region

This area started from the below nose region to just above the lip region.

3.2.2 Lip Region

This region is from just below the upper lip region to just above the chin region. This area is also known as the mouth.

3.2.3 Chin Region

This area started from the below lip region to the end of the face region. This is the expanded region of the cheeks.

3.2.4 Jaw Lines

This area is parallel to the nose tip point. The jawline region defines the lower structure of the human face.

All the regions' details described above are shown in Fig. 1. All the yellow points with red color encircled are the main 8 points of a face and others are used to define those areas more precisely.
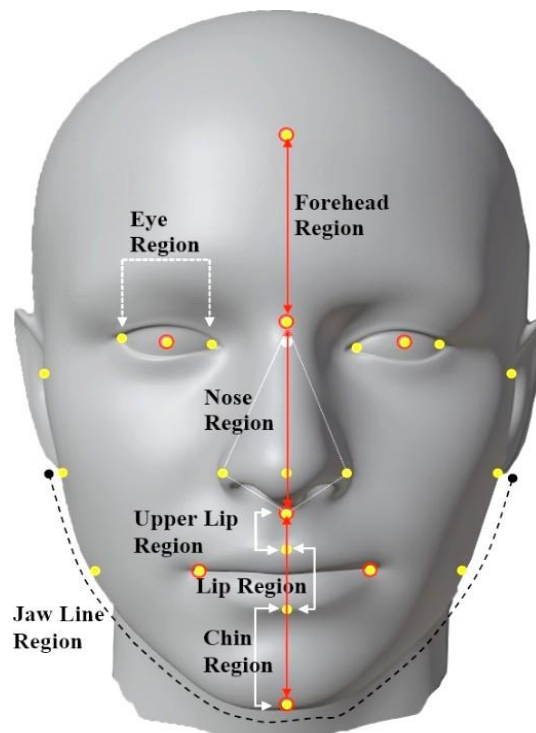

Fig. 1. Human face structure

4. PROPOSED METHODOLOGY

The proposed method includes six steps. These are 1) Pre-Processing, 2) Face Detection, 3) Facial Parts Detection, 4) Euclidean distance calculation, 5) Fast Fourier and Discrete Cosine Transformation, and 6) Classification analysis. The steps are shown in Fig. 2.

4.1 Image Pre-Processing

In this part, the below steps are followed [10-12].

Step 1: Resize the input image.
Step 2: Convert the RGB input color image into grayscale image.
Step 3: To remove any noise from the image apply a filter.
Step 4: To improve the contrast of the filtered image apply the histogram equalization technique.

Here removing remove the noise from the grayscale image, Gaussian filter is used.

4.2 Face Detection

Face detection is the key step for the proposed method. The pre-processing of the input image is the second step. Here Viola-Jones face detection algorithm [13] is used. This algorithm is very much useful to detect and categorize a human from non-human faces.

4.3 Facial Parts Detection

Next it is important to detect the different facial parts of that face [14]. In this step different facial features like forehead, nose, both eye regions, upper lip, lip, chin area, and jawline detection are detected. For detecting these facial parts the Viola-Jones algorithm is used.

4.4 Euclidean Distance Calculation

After successfully detecting the face and different facial parts, the fourth step is to calculate the length and width of those regions. To calculate the length and width of those extracted facial features the Euclidean Distance [15] is used.

$$Euclidean\ Distance, ED = \sqrt{(x_2{}^2 - x_1{}^2) - (y_2{}^2 - y_1{}^2)} \tag{1}$$

Where (x_1, y_1) and (x_2, y_2) are the two co-ordinates of two points.

4.5 Fast Fourier Transformation (FFT) and Discrete Cosine Transformation (DCT)

The fifth step is to calculate the fast Fourier transformation and Discrete Cosine transformation of the created matrices from step four.

4.6 Fast Fourier Transformation (FFT)

Fast Fourier transformation (FFT) is part of the Discrete Fourier transformation (DFT) algorithm. This algorithm is used to reduce the number of computations for N points. It reduces the computations of N points to $2n\lg N\ from\ 2N$. Where **lg** is the algorithm of base-2. FFT has two classes 1) decimation in time and 2) decimation in frequency. The basic idea behind FFT is to break the N points into two $\frac{N}{2}$ lengths. The equation of FFT is shown in equation 2. [16].

$$\sum_{n=0}^{N-1} a_n e^{-\frac{2\pi i n k}{N}} = \sum_{n=0}^{\frac{N}{2}-1} a_{2n} e^{-\frac{2\pi i (2n)k}{N}} + \sum_{n=0}^{\frac{N}{2}-1} a_{2n+1} e^{-\frac{2\pi i (2n+1)k}{N}}$$

$$= \sum_{n=0}^{\frac{N}{2}-1} a_n even_e{}^{-\frac{2\pi i n k}{\frac{N}{2}}} + e^{-2\pi i n k/N} \sum_{n=0}^{\frac{N}{2}-1} a_n odd_e{}^{-\frac{2\pi i n k}{\frac{N}{2}}} \tag{2}$$

4.7 Discrete Cosine Transformation (DCT)

The Discrete Cosine transformation technique [17] is used to convert a signal into its frequency components. In this experiment, this technique was used to convert the pixel values in the spatial domain to its frequency domain. The equation of DCT is shown in equation 3.

$$F(i, j) = \frac{1}{4} C_i C_j \sum_{x=0}^{7} \sum_{y=0}^{7} f(i, j) \cos \frac{(2x + 1)j\pi}{16} \cos \frac{(2y + 1)i\pi}{16} \tag{3}$$
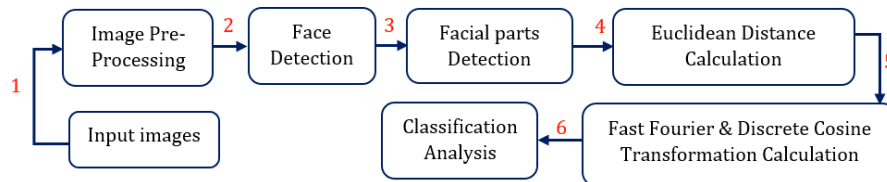

Fig. 2. Steps involved in the proposed method

4.8 Classification Analysis

The final step is to compare the calculated matrices of the training dataset with the test dataset. Based on the threshold value, a binary matrix is created. This matrices are used to determine the normal and abnormal humans from the input facial images. The required algorithms and data flow diagrams are shown in the algorithms and data flow diagram section.

5. ALGORITHMS AND DATA FLOW DIAGRAM

The algorithms that describe the proposed methodology are given below.

5.1 Detection_of_Normal_Abnormal_Humans (Image dataset) [Perform the Normal and Abnormal Human Detection]

Step1: Read the images from the dataset
Step2: Resize them
Step3: convert the images into grayscale images {i}
Step4: Perform histogram equalization for each image *HIS{i}*
Step5: Detect the 'Face' from each image
Step6: Detect features from the 'face' i.e. 'forehead', 'nose', 'eyes', 'chin', 'upperlip','nose', and 'lip'.
Step7: Extract the features 'forehead', 'nose', 'eyes', 'eyebrow', 'chin', 'upper lip', 'nose', 'lip' from stored images in *HIS{i}*
Step8: Calculate the Euclidean distance using equation 1 for the length of each extracted feature

Step:9 Create matrix 'A' that contains the calculated values
Step10: Perform FFT on matrix 'A' to form matrix 'B' that contains the coefficient values of the frequency domain
Step11: Perform DCT on matrix 'A' to form matrix 'C' that contains the coefficient values of the frequency domain
Step12: For each image calculates the threshold value (*Th*) by calling *FFT_Thresh(matrixB,I,col)*
Step13: Call function *Thresh_Compute(Th,matrixB,i,col)*to form the binary matrix
Step14: For each image calculate the threshold value (*Th*) by calling *DCT_Thresh(matrixC,i,col)*
Step15: Call function *Thresh_Compute(Th,matrixBC,i,col)*to form the binary matrix
Step16: Display the result by calling the function *Display_Prediction(Th)*

5.2 Thresh (D [] [], i,m)[Compute the Threshold Value for Coefficient of the Matrix]

Step1: sum = 0
Step2: *for* all j calculate, sum = sum + D[i][j]
Step3: Th = sum/m
Step4: return(Th)

5.3 Thresh_Compute (Th,D[][],i,m) [Compute the Threshold Value for Coefficient of the Matrix]

Step1: for all j check, if (D[i][j]>=Th)
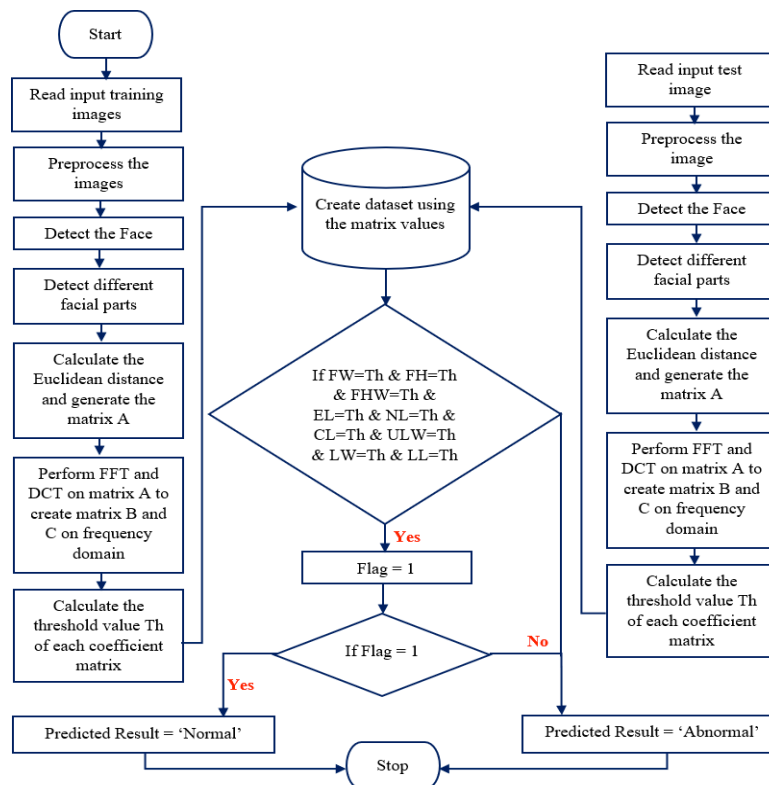Step2: if 'Yes', then assign E[i][j]=1

Fig. 3. Data Flow Diagram of Proposed Method

Step3: if 'No' then, E[i][j]=0
// 'E' is a binary matrix whose value '1' indicates normal, '0' abnormal

5.4 Display_Prediction(Th) [Display the Prediction Result]

Step1:If[Face_Height(FW)==Th
&&Face_Width(FW)==Th
&&forhead_width(FHW)==Th
&&Eye_length(EL)==Th&&Nose_length(NL)== Th&&Chin_length(CL)==Th&&upperlip_width(UL W)==Th&&Lip_Width(LW)==Th
&&Lip_Length(LL)==Th,then prediction_result == 'Normal'
Step2: Otherwise, predicted_result == 'Abnormal'

The dataflow diagram of the proposed methodology is shown in Fig. 3.

6. RESULTS AND DISCUSSION

In this experiment the input database contains more than 2000 images of male and female humans of different ages. This database made primarily created by us. The images are taken from the dataset: https://www.kaggle.com/ciplab/real-and-fake-face-detection. In addition in this experiment, the World Wide Web (WWW) repository is used for requires images to create the primary dataset.

In this image dataset, all the images are in the RGB version. The proposed algorithm was implemented with the help of MATLAB 2020a. From preprocessing to face and different facial features detection several functions in MATLAB are used. The general structure of a human face and its different facial parts with their distance measurements are described in Fig. 4.

In Fig. 4 the yellow dots with red circles are the main points of a human face structure. All other yellow points are used to define the complete face structure. The yellow points with the white circle defines the top tip point of the nose and the high point of a human face. The length d_0 to d_{10} defines the Euclidean distance length of different facial parts.

The preprocessing result of the human face is depicted in Fig 5. The different facial parts are depicted in Fig. 6.
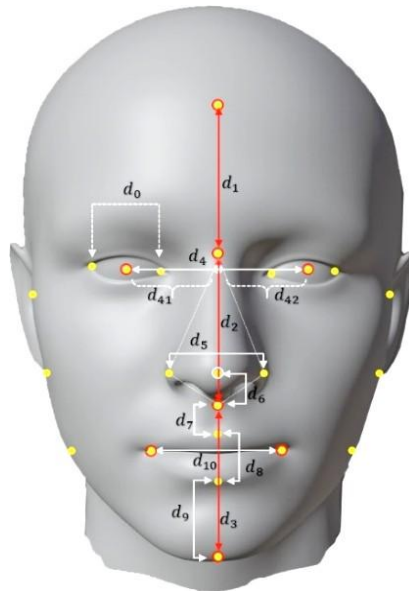
Fig. 4. The General Diagram of Human Face and Its Different Facial Parts

Table 1. Description (Euclidean Distance) of Several Points

| Points	Description (Euclidean Distance) [Based on Figure 1, 4]
d_0	Distance between two eye points (EL)
$d_1 + d_2 + d_3$	Face Length (FL)
d_2	Nose Length (NL)
$d_4(d_{41} + d_{42})$	Distance between the center point of the left eye to the right eye
d_5	Nose Width (NW)
d_6	Distance Between Nose tip point to the endpoint of the nose region
d_7	Width of Upper Lip (ULW)
d_8	Width of Lip Region (LW)
d_9	Width of Chin region (CL)
d_{10}	Length of Lip region (LL)
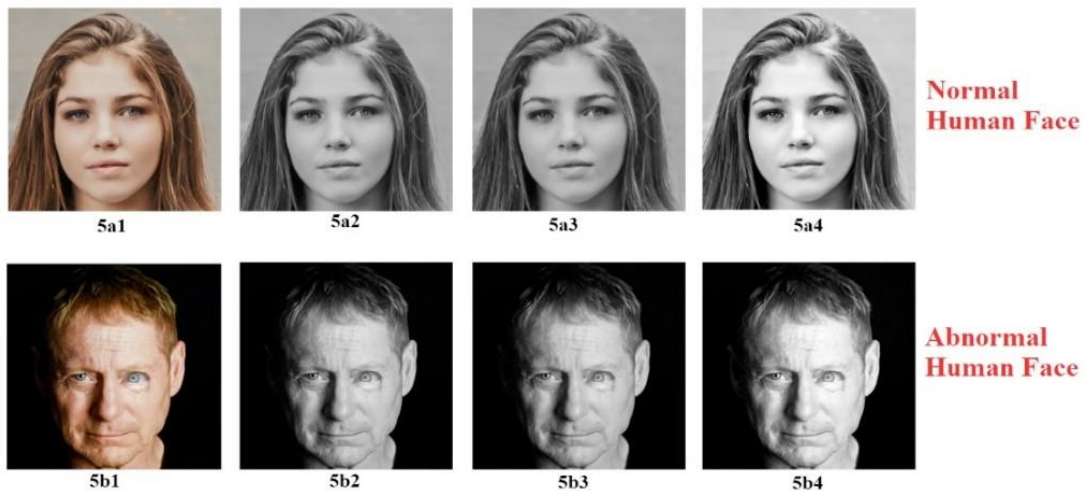
Fig. 5. The Preprocessing Result [(a1,b1) Original Image, (a2,b2) Grayscale Image, (a3,b3) noise removed using Gaussian Filter, (a4,b4) Histogram Equalized Image]
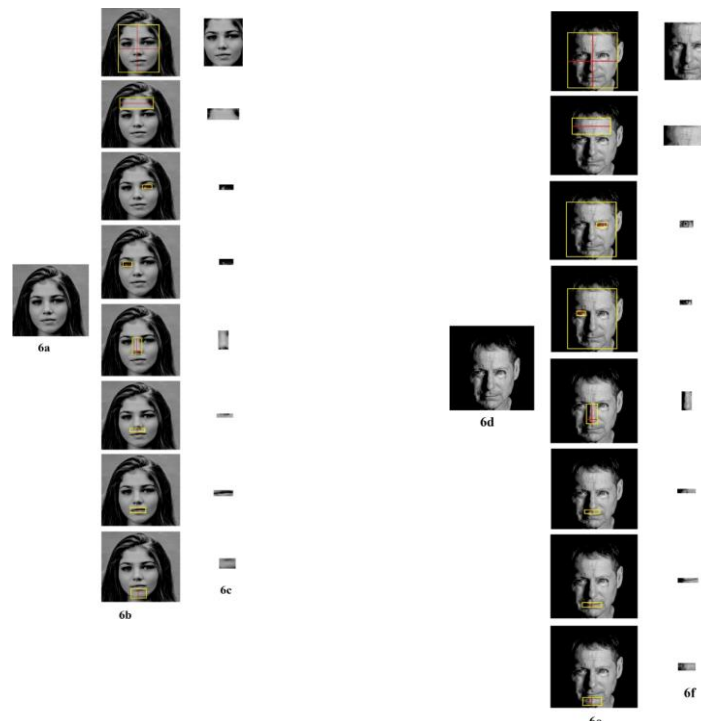
Fig. 6. Different Facial Part Detection and Their Euclidean Distance CalculationArea [(6a,6d) Original Preprocessed image, (6b,6e) Detected Facil Parts Region, (6c,6f) Different Facial Parts]

7. CONCLUSION

A thorough demonstration of abnormal human face identification has been conducted by this study. The changes in human face due to the vaccination of COVID-19 has been studied and proper identification is made after vaccination. Normal and Abnormal human detection is one of the secondary stages of human identification. In this experiment the proffered technique determines a human is normal or not based on their facial features. A two-stage method has been chosen to be implemented in this paper. At the first stage, this technique successfully detected the human face and their facial features from input images. Then in the second stage, it calculated the length and width of those facial features. Finally based on this length and width, this technique can determine whether the face is normal or abnormal.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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