LabVIEW based Intelligent Frontal & Non- Frontal Face Recognition System

Muralindran Mariappan, Manimehala Nadarajan, and Karthigayan Muthukaruppan

***Abstract*—** Face identification and tracking has taken a significant role in this modern technology. It had been widely used in security systems, intelligent robotics, mug shot and crowd surveillance. Face identification is a difficult task to be achieved as the position and orientation of the face will greatly impact the recognition and detection. In addition to that, changes in a person's appearance can lead to difficulties in identifying who the person is. To circumvent this problem, a system is designed to identify and track a person in a pre-defined range for frontal and non-frontal image. In this paper, the focus is laid on the face recognition to identify a person using Neural Network using LabVIEW as the whole system software. The designed system in LABVIEW has been tested real- time which gives a high accuracy for recognition. Network has been trained based on the available database and LABVIEW software is responsible for the whole architecture.

***Keywords*—** Face recognition and detection, Frontal and non-frontal**,** LABVIEW, Neural Network
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I. Introduction

Face recognition is one of the challenging and interesting research. Currently, available software which does such task has a major concern on the accuracy. Generally, biometric methods that are applied can be classified into physiological characteristics and behavioral patterns. Physiological characters like fingerprint, iris, face and DNA are often non-alterable except due to severe injuries. This makes it to be much stable than behavioral pattern like voice and keystroke that may fluctuate due to fatigue or illness [1].

In principle, face detection and recognition is more difficult to be achieved compared to fingerprint. This is due to the reason that there is a very high chance for the person's face to be positioned in different way as he or she walks. The frontal and non- frontal image must be considered for a real–time video processing. This is contributed by the position of the camera which is not at the same level as the person's face. This orientation problem provides room for this research.

In order to accomplish face detection stage, a presence of a person must be detected in a frame before extracting out the face region. There are many image processing methods that can be used to extract out the face region. Background subtraction is suitable for real- time processing as it can be updated for every frame. From this, any moving object can be extracted out.

There are various methods that are used for face recognition. Principal Component Analysis (PCA) and Linear Discriminant Analysis (LDA) which can only be used for frontal image recognition [3]. Template matching is done by comparing the captured image with the database created. This can be done for 3D images for real- time processing. The model is rotated to get the corresponding face projections. However, this method need to be modified to suit for non-frontal image [4]. A non- frontal face recognition was done using Elastic Bunch Graphing Matching (EBGM) by extracting the facial features. This method can tolerate a ±10º variation with 30º pan- angle. EBGM fails when a face is in 90º pan- angle where the features cannot be located for recognition [5].

The advancement of Artificial Intelligence (AI) has added value where Neural Network is used as major processing for face recognition. A typical neural network is made up of neurons built in various layers which are input, hidden and output layer. One hidden layer is sufficient enough to solve any complex problem [6]. Backpropagation neural network method is commonly used in various pattern matching schemes [2]. It has solved many real time problems.

The neural network training a number of times will result in a stronger weight of neurons but should not exceed the limit. This can cause the network to memorize instead of learning [7]. The network is trained on both ideal and noisy images [8].

In this paper, face recognition is proposed because no physical contact is required to run the system compared to fingerprint where the person need to tap their finger onto the scanner. The person can still be identified even if the position changes. This has been achieved by Neural Network in the LABVIEW architecture. The objective of the paper is to use Neural Network for face recognition and obtain a high accuracy of testing result.

The paper is organized as follows; Section II briefly describes the design and architecture of the system. The application of neural network in this research is explained in

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Section III which includes the method used in designing the architecture of neural network. The results and discussion are presented in Section IV and finally conclusion in Section V.

II. Design Methodology

In this section, the system architecture is described in detail. It has four processing stage as seen in Fig. 1. The system is initialized when a signal received from sensor, followed with face detection, recognition and finally tracking. The system operates on a video processing. This is due to the reason that video processing is found to be more suitable for a real- time system. LABVIEW is used as a design platform for the system. The flow of the system is illustrated in flowchart in Fig. 2.

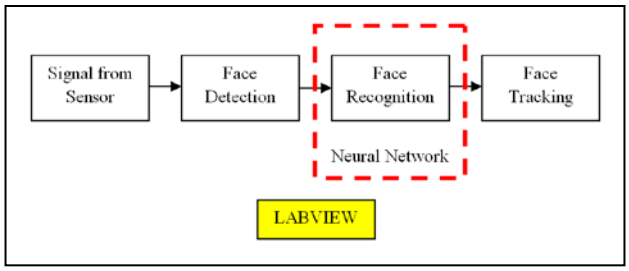

Fig. 1 System Architecture

The designed system begins with input signals received from the sensor. The sensor data is manipulated in LABVIEW and further processed if a motion is detected. The sensor implementation to the system has reduced the processing task vastly. The processing of captured frames includes face detection and recognition. Algorithms were developed for face detection where it incorporates background subtraction and masking as major processing.

This paper focuses on application of Neural Network for face recognition which is the third stage of the designed system. The extracted face region is sent to Neural Network for recognition. A database was created to accomplish face recognition stage comprising face images used for experimental purpose. The database is pre- trained and tested using offline training method. The trained database from MATLAB is integrated with LABVIEW for real- time testing as in Fig. 3. Finally, the system switches into tracking mode when detection and recognition gives the desired output. The application of Neural Network for face recognition is discussed in detail in the following section.

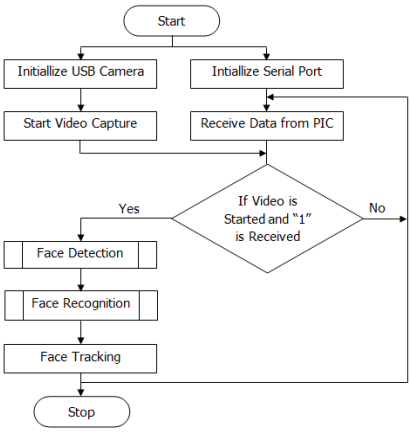

Fig. 2 Process Flow of the System

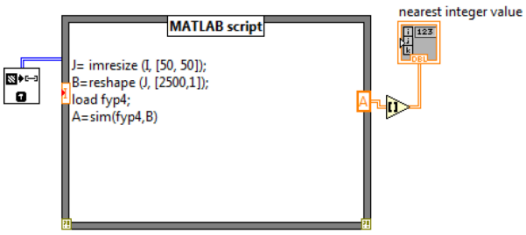

Fig. 3 Neural Network in LabVIEW

III. Application Of Neural Network

A. Neural Network Architecture

Feedforward backpropagation neural network is applied as it is the most common algorithm used for pattern recognition which is also one of the algorithms for supervised learning. A basic neural network has three layers consisting input layer, hidden layer and output layer which has respective training function. One hidden layer is sufficient enough to solve any complex problem.

In this research, the input for the neural network is the face region detected while the output is the target set for people in database. A simple architecture of neural network employed in this research is represented in Fig. 4 with one hidden layer.

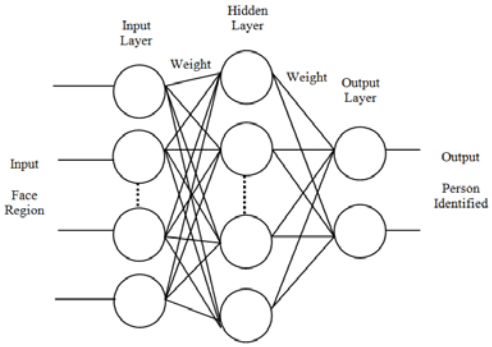

Fig. 4 Neural Network Architecture

The input to the network is the image converted to grayscale which enhance a faster processing. This image is resized and reshaped into 2500 rows. There are 160 columns where only 128 data has been considered for training while all of it has been used for testing. The output is the target set for 4 people which can be seen in Table I. The final layer that is set for a network is the hidden layer with selected number of neurons. Rule of thumb is manipulated to set the suitable number of hidden neurons [9].

Number of hidden neurons=

$$< \sqrt{\text{input neurons} \times 4} \quad (1)$$

TABLE I
Target Set For People in Database

Person 1	Person 2	Person 3	Person 4
0	0	0	1
0	0	1	0
0	1	0	0
1	0	0	0

B. Database

In this research, a database was created with face region of four people captured at different distance and angle. This is done so that the sample image is sufficient enough for training and testing. Besides, capturing images from different angle will ensure that at least one image can be processed as the person walks. This will eventually increase the recognition rate and improve the tracking mode. In addition to that, this system is designed for frontal and non- frontal face recognition. Hence, images in database should be trained in different angle. A sample of database is an in Fig. 5.

Fig. 5 Sample of Database

C. Training and Testing

There are about 160 face images in the database of four people. 80% of the data which is 128 images were used for training and all the 160 images were used for testing. The database was randomized during the testing stage. This is done to make sure that the network learns instead of memorizing. Insufficient training may lead to incorrect recognition. Thus, training must be done until 100% training accuracy is achieved. Fig. 6 shows the flowchart for training and testing the database. The results obtained are discussed in the following section.

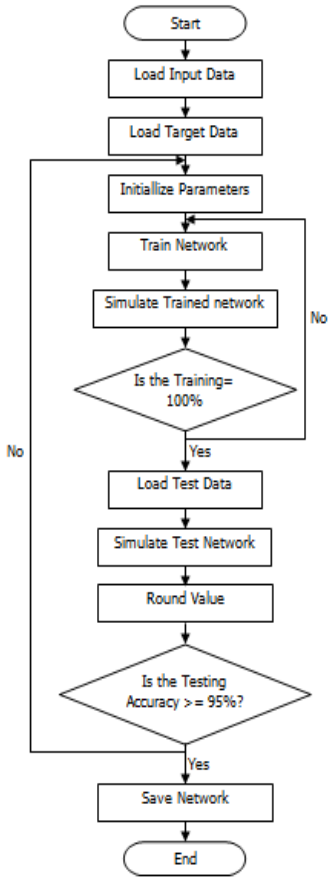

Fig. 6 Flowchart of Training and Testing

IV. Results and Discussion

This section elaborates the parameter setting for the network architecture. In addition to that, the training, testing and real- time recognition results are also discussed in here.

A. Parameters Setting

After few trials, it was found that the following parameters yield 100% training accuracy. Table II shows the best parameters with the training results.

TABLE II
Details of Training and Testing for Face Recognition

Feedforward Backpropagation Algorithm		
Defined Paramaters		
Transfer function	:	Tansig, Tansig
Hidden Neurons	:	150
Performance Goal	:	1e-4
Momentum Factor	:	0.9
Learning Rate	:	0.01
Training and Testing		
Training Epoch	:	133/500
Training Time	:	0:00:13
Training Accuracy	:	100%
Testing Accuracy	:	96.8%

From the training of database that has been conducted, tansig has been chosen as transfer function for both the layers as it converges. Besides, the number of hidden neurons has been to set to 150 neurons. This is done based on the rule of thumb as mentioned in Section III. Learning rate and performance goal is set to a lower value so that the network learns completely. This will increase the recognition rate and thus improving the accuracy of the whole system. A momentum factor of 0.9 is added in so that the network can recover back for training even if it falls into local minimum.

B. Training Results

In Fig. 7, tansig is used for both the layers, where 100% training accuracy met with 133 iterations. Fig. 7 shows the neural network toolbox illustrating the transfer function, iterations and performance goal that is achieved during training. 128 images from 160 images which are 80% of the database were successfully trained as seen in performance and confusion plot in Fig. 8 and Fig. 9 respectively with 100% training accuracy. Regression plot in Fig. 10 shows that all the data almost fit the line when the training is complete.

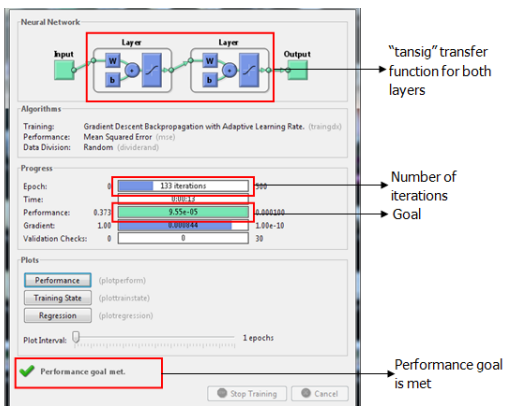

Fig. 7 Neural Network Toolbox

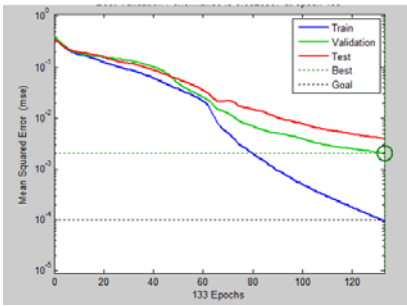

Fig. 8 Performance Plot

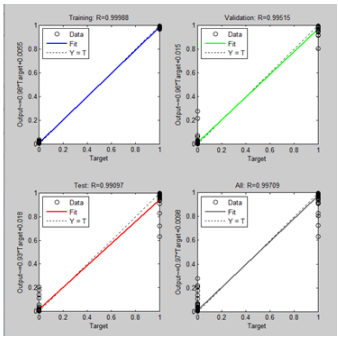

Fig. 9 Regression Plot

Fig. 10 Confusion Plot

C. Testing Results

All the images in the database which is 160 face images were used for testing purpose. The data was randomized before testing so that the system has an accurate performance for face recognition. The testing accuracy that has been achieved is 96.8% for 160 images of four people. However, there were five images that could not be recognized by the system. From this result, it can be shown that; in order to achieve a higher recognition rate, the face pixel should cover the most area in the extracted region.

D. Real- Time Testing

Real- time testing has been done for the complete system where a few frames were selected for comparison. The trained network was integrated in LABVIEW. A GUI panel was designed in LABVIEW indicating the recognition for people in database as set in Table I. Random numbers is generated if the face was found not to be in database. It can be concluded that the recognition gives a good accuracy when the person can be recognized at different distance. This can be seen from Fig. 11. A non- frontal and frontal face recognition system was designed in LABVIEW for a real- time application with a high accuracy. This is shown in Fig. 11 and Fig. 12 respectively.

Fig. 11 Face Recognition at Different Distance and Non –Frontal Image

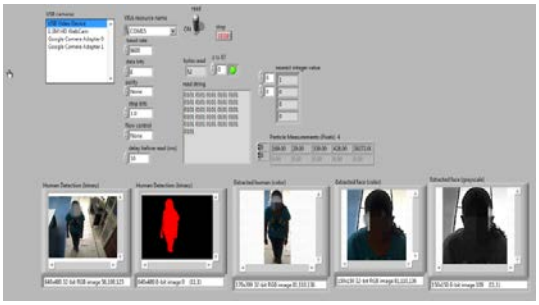

Fig. 12 Face Recognition for Frontal Image

V. CONCLUSION

This paper gives a general view of a face recognition system for frontal and non- frontal image for a real- time application. A system was designed in LABVIEW integrating a part of Neural Network from MATLAB. A 96.8% of accuracy for face recognition was achieved.

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