RESEARCH ARTICLE OPEN ACCESS

FPGA Implementation of Human Behavior Analysis Using Facial Image

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ABSTRACT
The objective is to identify the status of the human behavior based on their facial expressions. A new idea for detecting human face as an input imagery and recognizing their facial expression using feature extraction parameters such as Angular second moment, Contrast and Homogeneity and behavior was achieved using Minimum distance classifier. A Facial Expression Recognition system needs to solve the following problems such as facial feature extraction and facial expression classification. The universally accepted seven principal emotions to be realized are Angry, Happy, Sad, Disgust, Fear and Surprise along neutral. The proposed method was evaluated on the JAFFE database images and Offline images using three of the facial expressions such as Happy, Sad and Neutral. The proposed system describes a real time automatic facial expression recognition system as an input. The digital hardware is designed for emotion recognition system using Verilog and implemented on Xilinx Spartan 3E kit. Thus the experimental result shows that the recognition rate gets to 93.33% by using offline images and 95.33% by using JAFFE dataset is obtained.
Keywords:- Facial Expression Recognition, JAFFE dataset, Offline images, FPGA.

I. INTRODUCTION

The turf of image processing is very interesting to recognize the human gesture. Emotion is a response to a particular situation. It is an integral part of our existence. Automatic emotion recognition is considered as one of the important task in computer vision, security, education, psychiatry and telecommunication. Facial expression recognition has been the fast developing areas because of its application areas such as image retrieval, biometrics and emotion analysis. A lot of exploration has been done in Facial expression recognition by solving the problems occurring in recognition of the facial expressions under different illuminations, gestures and other variations. The objective of this research work is to propose an efficient method of feature extraction technique for facial expression recognition. Emotions are the feeling or response to particular situation or an environment. It is because we understand other emotions and react based on that expression only improves the communications. Computers are "sensitively faced". They neither recognize other emotions nor possess its own emotions [1].

In emotive classification there are two basic emotions are there, Love-fear. Based on this we classify the emotion into positive and negative emotions. The six basic emotions are angry, happy, fear, disgust, sad, surprise. One more expression is neutral. The representation methods usually start with a dimensionality reduction procedure since the high dimensionality of the original visual space makes the statistical estimation very difficult & time consuming [2]. The extracted feature vector of the input face is matched against those of enrolled faces in the database, outputting the identity of the face when a match is found with a sufficient confidence or as an unknown face otherwise [3].

II. METHODOLOGY

Data preparation is an important phase since the prepared dataset becomes input to the Verilog training and testing. Once the image has been acquired and extracted using the image processing techniques are needed for image processing. First of all image filtering is performed in preprocessing of an image, and then the gray scale transformation is performed. Threshold technique is used to convert an intensity image to a text image. All these phases are completed using MATLAB toolbox. The block diagram of the facial expression recognition system is shown in Fig.3.1

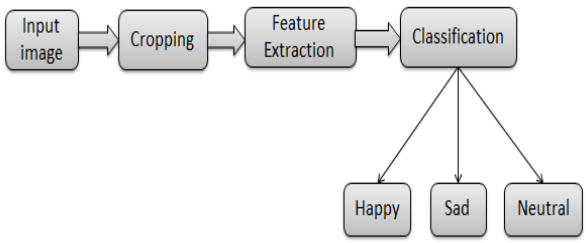

Fig.3.1 Block diagram of the facial expression recognition system

a. Proposed Outline

(i) Facial expressions such as Happy, Sad and Neutral are taken from the JAFFE images and also from Offline images.

(ii) Pre-process the image.

(iii) Convert the image into 3*3 pixel values and extract the feature values by comparing the center value of the pixel with the remaining pixels (i.e.,>=center value of pixel)

(iv) A binary format of 0's and 1's are obtained for the execution of the features.

(v) Feature parameters are extracted using Verilog code.

(vi) Finally it is implemented using FPGA kit.

b. Feature Extraction

In order to recognize facial expressions from frontal images, a set of key parameters that best describe the particular set of facial expression needs to be extracted from the image such that the parameters can be used to discriminate between expressions. This definite value was measured in number of pixels. The binary measures gave either a present (1) or an absent (0) value. The three parameters such as Contrast, Angular Second Moment, and Homogeneity were extracted and analyzed to decide their effectiveness in identifying a certain facial expression. The feature parameters can be analyzed using the following expressions.

1. Angular second moment

Energy is a measure of textural uniformity of an image, and hence it is often called as Uniformity or Angular Second Moment. Energy obtained is always highest when the grey level distribution is a constant.

ASM=b1^2+b2^2+b3^2+b4^2+b5^2 +b6^2+b7^2+b8^2

2. Contrast

Contrast measures the variance of a gray level and is the main diagonal near the moment of inertia. When Contrast is larger texture is deeper and is larger for varying intensity images.

Contrast=8^2*(b1+b2+b3+b4+b5+b6 +b7+b8)

3. Homogeneity

The quality of being uniform throughout in composition or structure of an image. Different moment gives expression to the homogeneity and the local change of image texture. Higher different moment value means fewer varieties in different section of image texture.

Homogeneity=(1-mean) ^2*(b1+b2+b3+b4+b5+b6+b7+b8)

Where,

Mean =b1+b2+b3+b4+b5+b6+b7+b8/8

III. EXPERIMENTAL ANALYSIS

Facial expression experiments are performed on grayscale image databases. Images from Offline facial images and JAFFE database are used for experiments. JAFFE database consists of grayscale images that have 7 expressions of 10 people including neutral. The images for expressions: 'neutral', 'happy', 'sad' is taken. The database is organized in the same sequence given above for each person. This database was used to test the accuracy of the facial expression recognition algorithm.

The Offline images of happy, sad, and neutral are also taken for experimental analysis. Each grayscale image sequence in the database depicted one of the expression classes (happy, sad and neutral against reference image). The first image in the sequence was a neutral image. Confidence level of each expression was calculated for each of the subsequent images against the reference image. The calculated vector of confidence levels was added to give total confidence for each of the expressions with the help of Minimum distance classifier to recognize the status of the human behavior.

a. Testing and Results

To test the proposed solution, three different sets of gestures of persons are prepared. These images are totally different from the learning subset of images in the sense that each face image was taken at different time with different instance of gesture. Even certain gesture is closed or has different orientation. Further, when only a single face had been exposed to the network and it was able to recognize the gesture with relatively high percentage of matching. The system was trained using the three different gesture images. The category used for the training is Happy, Sad and Neutral stages of face expressions. The setup is tested with 16 Offline images of 3 gestures and some of those were shown in Table.3.1

Serial no	Image	Result				Expression
		Happy	Sad	Neutral	Test	
1		46	16	9	11	Neutral
2		46	16	9	46	Happy
3		46	16	9	20	Sad
4		46	16	9	17	Sad
5		46	16	9	23	Sad(Fail)
6		46	16	9	10	Neutral
7		46	16	9	23	Sad
8		46	16	9	47	Happy
9		46	16	9	12	Neutral
10		46	16	9	15	Neutral

Table 3.1 Results of a sample of 10 tested images

The following Table.3.2 shows the statistical summary results of Offline images.

No. of input images	Types of gesture	Recognized images	Result (%)
5	Happy	4	80%
6	Neutral	6	100%
5	Sad	5	100%

Table.3.2 Statistical summary results of Offline images

The following Table.3.3 shows the statistical summary results of JAFFE images.

No. of input images (JAFFE images)	Types of gesture	Recognized images	Result (%)
31	Happy	28	90%
31	Sad	31	100%
30	Neutral	29	96%

Table.3.3 Statistical summary results of JAFFE images

Thus the recognition rate shows of about 80% for happy and about 100% for the expressions of sad and neutral, whereas for JAFFE images it shows 90% for Happy, 96% for Neutral and 100% for Sad.

b. Simulation Analysis

MATLAB software is used for preparing the database. The image is being read in MATLAB from which the pixels are generated into 256*256 then these pixels are used as inputs to the Verilog on which power method algorithm is applied. The values which are generated can have a slight difference and are based on the processor. Pixels are transferred to (UART) universal asynchronous receiver transmitter serial communication which is used for communication between software and hardware (FPGA). Xilinx ISE 13.4 has been used as a Verilog simulation and synthesis tool to test the design.

The simulation result for the facial expression Sad displaying 1 is shown in the Figure 3.2

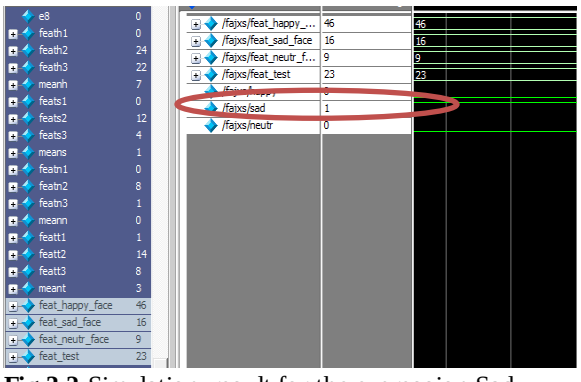

Fig.3.2 Simulation result for the expression Sad

The simulation result for the facial expression Neutral displaying 1 is shown in the Figure 3.3

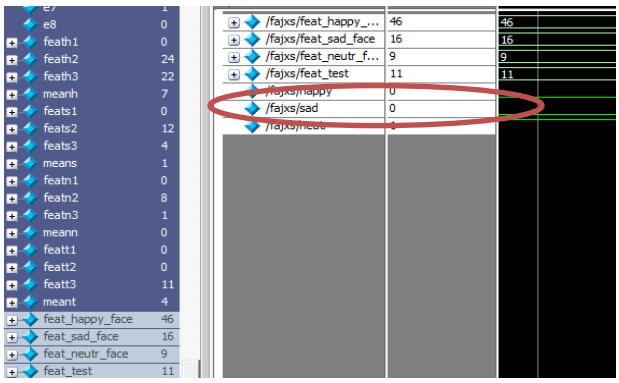

Fig.3.3 Simulation result for the expression Neutral

The simulation result for the facial expression Happy displaying 1 is shown in the Figure 3.4

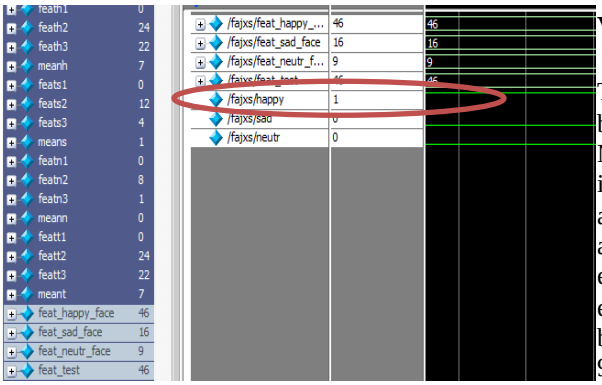

Fig.3.4 Simulation result for the expression Happy

c. Efficacy Analysis

The efficacy analysis of the facial expressions for Happy, Sad and Neutral of both JAFFE and Offline images are calculated and their results are shown in Fig.3.5

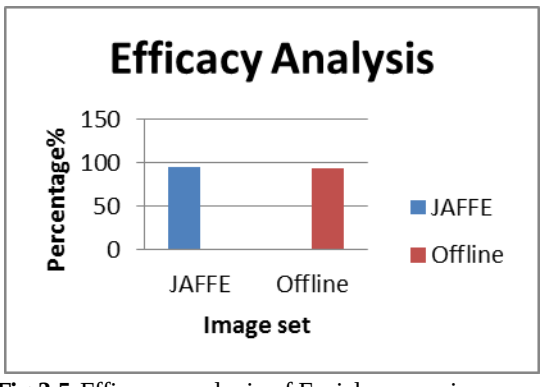

Fig.3.5 Efficacy analysis of Facial expression.

IV. HARDWARE DESCRIPTION

The algorithm is implemented on FPGA kit. The board used is Nexys2 circuit board which is based on Xilinx Spartan 3E FPGA. It's on board high speed USB (Universal serial bus) 2 port, 16Mbytes of RAM and ROM and several input-output devices and ports make it an ideal platform for digital systems of all kinds. The FPGA on the Nexys2 board must be configured. During configuration a bit file is transferred into memory cells within the FPGA. The FPGA can be programmed in two ways: directly from a PC using the on board platform flash ROM or through the USB port. A jumper on the Nexys2 board determines which source the FPGA will use to load its configuration. The FPGA will automatically load a configuration from the platform flash ROM. Eight LED (Light emitting diode) are provided for circuit output.

V. CONCLUSION

Thus the main objective of the present work is based on the classification of emotions using Minimum distance classifier on Xilinx which is implemented on Spartan 3E kit. The proposed algorithm is implemented on JAFFE database and also with Offline facial images. Each image is enhanced, localized and its distinct features are extracted and have found the status of the human behavior. An overall excellent classification rate of 93.33% results for principal emotions like Happy, Sad along with Neutral on Offline images is obtained and for JAFFE classification rate of 95.33% is attained. The Experimental results show that algorithm can be effectively distinguishing different expressions by identifying features. Therefore in future an attempt can be made to develop hybrid approach for facial feature extraction and recognition accuracy can be further improved using same NN (Neural Network) approach.

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