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A Facial Emotion Identification (FEI) System by using MATLAB - Arduino Communication based Technique to show Human Coding Skills

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Abstract:
In this paper the Facial Emotion Identification (FEI) System that defines the different aspects of the human behavior and also the mental frame of mind. The MATLAB - Arduino based Communication Technique is used to accumulate, observe and examine the human facial emotions in immediate physical surrounding environment. FEI system can recognize expressions from a person's face. It helps in several platforms like health care, advertising, criminal identification, access and security payment data and social robotic interaction. The facial Emotion Identification system algorithm is developed on MATLAB. The proposed technique can detect facial emotion and track it by using MATLAB - Arduino communication. There are various methods of FEI exist. Face detection algorithm on MATLAB platform proposed by Viola and Jones algorithms with LBP and SVMs for training sample. The given technique will recognize a countenance that compared with different facial expressions and processing the image to predict the human emotions as evidently shown.

Keywords: *Facial Emotion Identification (FEI), image tracking, Local Binary Pattern (LBP), Support Vector Machines (SVMs) Arduino, MATLAB.*

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I. Introduction

Emotion Identification process helps in identifying the human emotion, generally by facial expressions. This is something that human do automatically, determined by using computational methodelogoly.23 Facial Emotion Identification (FEI) have high potential and important topic in the field of digital image processing and AI. In MATLAB toolbox image processing is built in function. An Image Processing Toolbox gives a complete set of reference-standard algorithms and work table for image processing to accumulate, observe and examine. For this algorithm have to be development in MATLAB and interfacing with the other main components such as web camera and ARDUINO board is also a quit simple as compared to other methodology. The main objective of the paper is to descry human facial emotion by using web camera. There are different image processing methods; aim to descry different human facial expression. Human expressions image detection representation in toolbox is called integral Image, can process a proper image from the different sudden change in human expressions and pick up proper image easily and at a faster rate [10]. In this methodelogoly we detect facial expressions and trace them rapidly, this all can be done by using MATLAB software accompanied by feeding the image processing algorithms [5]. After capturing the image's expressions, deviation on vertical and horizontal axis of the captured image is then ready for Arduino board along with the serial communication that steer the control signals and commensurate by axis values such that it detect human face which is in range of web camera. Then the remaining image processing process takes place for the selection of emotions [7]. The use of video and audio surveillance increased rapidly due to several security concerns. This technique is very efficient, fast detection and tracking algorithm that can helps in identification of terrorist, access & security payment data and social robotic interaction as well as its compatibility and accuracy [3].

In this technique, Arduino board is used because of its compatibility and easy integration with hardware and software components, also there are several ways to programmed the board. IDE software is used for programming, it is an open-source Arduino Software (IDE) makes easy to write code and upload it to the board or can also be programmed by MATLAB with the help of special function consist of analog and digital input /output pins.

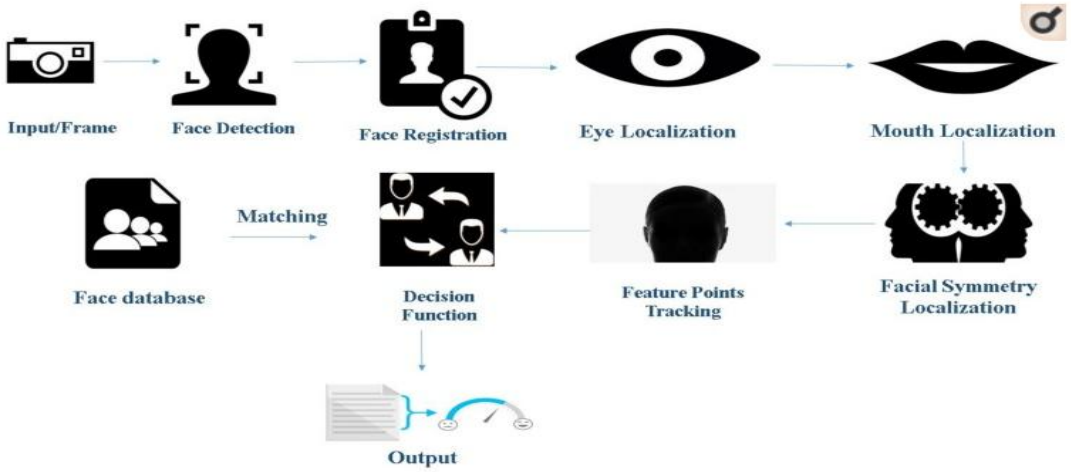

Figure 1: Face detection and emotion recognition using geometric feature-based process.

II. Basic Structure of FEI

The Cohn-Kanade AU-Coded Facial Expression dataset is very helpful for the facial image examination. Image dataset consist of several expressions of image sequences from few defined subjects. Along with meta-data include monitoring of FACS action units and emotion specified expressions. Then this images are examine by proffer algorithm, preprocessing is performed after first stage of datasets for facial expression recognition system. In this stage preprocessing of images is proffer for face recognition in uncontrolled and low lighting conditions. Face detection uses pre processing datasets for recognizing facial features by extracting features or landmarks from the image of the face. Extract facial features, like the shape and size of the face, the size of Jaw of Jaw, and position of eyes. The Viola-Jones algorithms have four stages, and sections are selecting Haar-like features, creating an integral image, Running AdaBoost training and creating classifier cascades. Then LBP technique is used for typical facial feature information. The LBP operator transforms an image into an array or image of integer labels represent look of image. SVM train model using Bayesian optimization to generate the Points and Classifier. It create some base points from the dataset for every class then this data is putting in one of the matrix, and makes vector graph that labels the class of each point, after that it is given to cross validation to recheck the data of the given functions like happy, sad, scared, surprised, angry, confused and optimize the fit with the integration of MATLAB-Arduino serial communication system, By two ways setup one is using command window or by using MATLAB GUI. The Arduino code for both techniques is same. The dataset from MATLAB to the Arduino serially using command window and then Arduino read the incoming serial data. Then this serially transmitted data can be used to control train of samples by webcam connected to it. LCD is used with Arduino that shows facial expressions functions results serially received data by the Arduino.

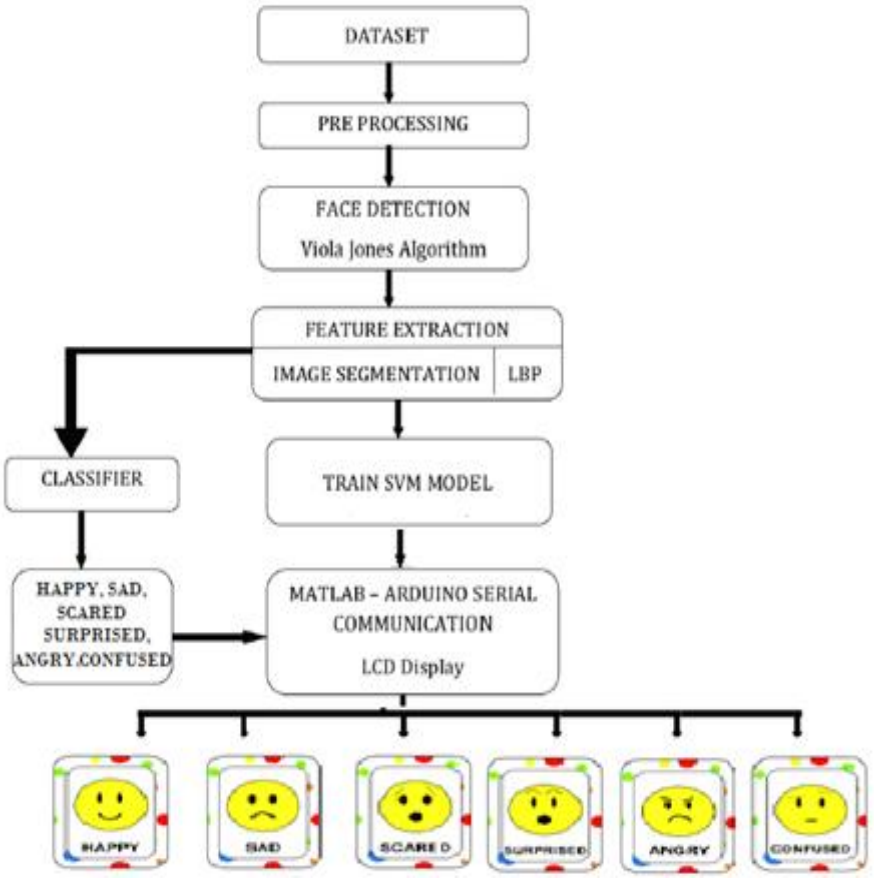

Figure 2: Block diagram of facial expressions recognition.

III. Algorithms used for Image Processing

1. Viola and Jones Face Detector

A Viola Jones face detection is widely used method for real-time face detection framework and other important function is that it only used for face detection recognition process. Its training is slow, but detection is very fast and robust. The human can detect the facial expression easily, but in computers it required precise instructions and constrains practice, so to achieve the face detection it require full view frontal upright image of the objects. Therefore to get successful face detection, object should be on camera.

2. Local Binary Pattern (LBP)

Local binary pattern is the visual descriptor used in the classification in computer vision and as well as one of the most powerful features for visual classification. Visual driver labels pixels of image by approaching the neighborhood of every and each pixel and examine the result as binary number. The pixels should be in circle or clockwise in direction. If the centers value is greater to neighbors value will written as 0 or write 1, it generates the binary number. Then compute the histogram over the cell over the cell, of the frequency of each number occurring. It is also possible to analyze images in typical real-time settings.

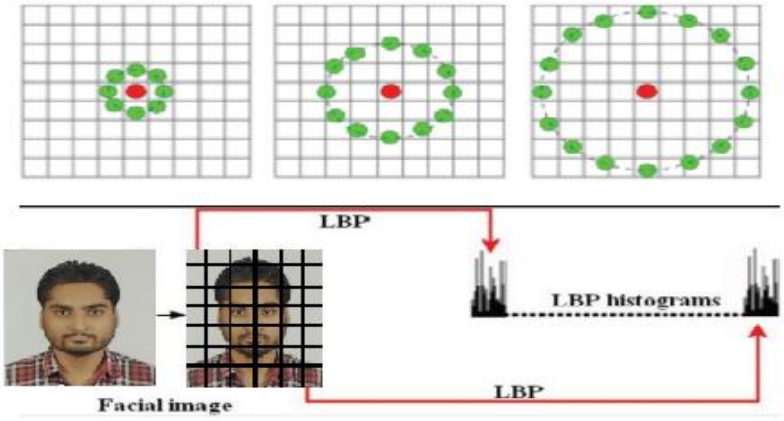

Figure 3: Description of facial expressions with local binary patterns.

3. Integral Image

In Viola-Jones face detection algorithm first is image representation known as Integral Image that allows the characters used in detector is computed very fast, so that the input images are converted into integral image or also called summed area table. Let an integral image at location x, y contains the sum of the pixels above and to the left of x, y, inclusive, This can quickly be computed in one pass through the image.

$$ii\,(x+y) = \sum_{x' \le x, y' \le y} i\,(x', y')$$

Let A,B,C,D be the values of the integral image at the corners of a rectangle. Then the sum of original image values within the rectangle can be computed as shown in figure 3.

$$sum = A - B - C + D$$

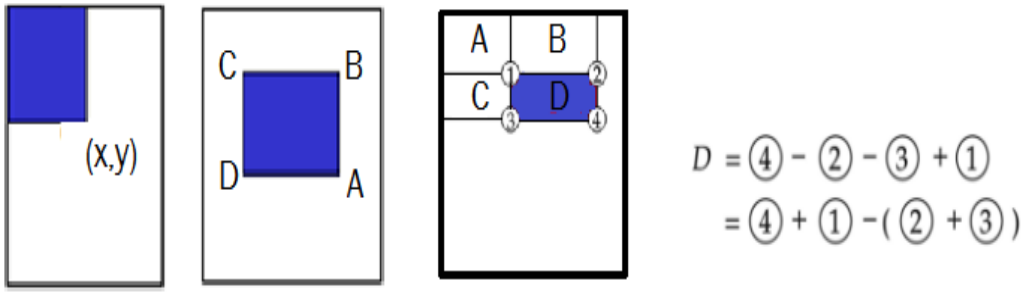

Figure 4: Conversion of original image to integral image and how to calculate a rectangular region using an integral image

4. Haar Feature

Haar feature are basically used to detect edge. Faces of human being have some similar features, like eye region is darker than upper check region; nose region is brighter than eye region. By this match haar features are able to detect, their location and size to detect face.

Figure 5: Haar-like features

Haar feature can analysis is there is a face or not. For that in Haar features defines two region, that are black represent by +1 and white represent by -1 . Each feature is a single value obtained by subtracting sum of pixels under white rectangle from sum of pixels under black rectangle. Four rectangle features computes the difference between the sum of the diagonal pairs of rectangle. Similarly, a three-rectangle feature computes the difference between the sum of the edges of the rectangle to the middle one, as shown. Last rectangle feature is the difference between the pixels within rectangular regions which may horizontal or vertically adjacent to each other and are of same shape and size. The Haar features are shown in figure 4.

5. AdaBoost

Adaboost removes the redundant feature of Haar feature. Only few numbers of these features can be combined to form successful classifier. It is hard to find these features, so AdaBoost is used which selects features and also train classifier. Next the feature can also detect the nose bridge, as we know that mainly the upper lips have more constant feature. Therefore it can be eliminated. AdaBoost determine relevant features out of 160000 or more feature. By Identification of features, a weighted value is added to it that is used to check a given window is a face or not.

$$F(x) = \mathrm{a1f1(x)} + \mathrm{a2f2(x)} + \mathrm{a3f3(x)} + \mathrm{a4f4(x)} + \mathrm{a5f5(x)} + \ldots.$$

Where, F(x) is considered as a strong classifier and f(x) weak. The weak classifier gives 0 and 1 binary value. There will be only two conditions when the feature is present the value is 1, or else 0 when it is not present. For strong classifiers we can use 2500 classifier. Here selected features are said to be okay if it perform better than the random guessing i.e. it has to detect more than half of cases Adaboost develops the classifier that self learns and adapts the threshold value for selecting the features from the overall features to build a strong classifier.

6. Cascade Classifier

In this state algorithm have two kinds of images called positive and negative image. When there is a positive image, it consists of images of faces and similarly if there are negative images it has images without faces. All this images are used to train classifier. Need of extract features is done by using, Haar features. Simpler classifier output is used as an input for the classifier, it means that the system may either reject the window or pass it on is called strong classifiers. To achieve the desired output this process is repeated again and again. Generally, for sub-band coding of images we filter each row of the image, so the detected output of sub band have to proceed all the crucial point of the picture in classifiers , if not then sub band window is rejected. AdaBoost is used as a tool to construct the different stages and also, for the training of classifiers cascade. It designed in as a way that the thresholds value have minimum false or negatives image. The accuracy of the classifier is depends on the computation time Therefore there is a tradeoff between accuracy and speed i.e. computation time. So to reduce such types of errors one another classifier is constructed by using two features called first stage classifier. In first stage classifier 100 percent faces are detected, so that we get 30 percent from the total faces called false positive rate. Then the output of first stage is given as input to second classifier stage which goes off. This all will reduce the errors of facial expression detection and increase the efficiency of detection.

7. SVM classifier

Classifying the data plays an important role in the facial expression recognitions. The support vector machine (SVM) is basically to from hyper plane in between data sets to indicate which class it belongs to. The input from the feature extraction and LBP is given to train the SVM model, but it is difficult to train it. Because if we train the model, it should understand the structure of given data and perform the right class label mapping, to achieve the exact results hyper plane has the largest distance to the nearest training data points of standard testing set. The results is been analyzes the performance limitation of our implementation and introduces an experimental solution by with SVM classifier.

IV. MATLAB - Aurduino Interfacing

Serial communication is the process of sending one bit of data at a time, continuously over a communication channel. MATLAB- Aurdunio interfacing for facial expression recognition the camera is placed to default state, camera with servomotor. The uses of servomotor in camera enhance the detection of facial expression of the image in horizontal and vertical co-ordinates. In this research we are using two servomotors to present a PAN and TILT movement. The output of the camera accord to MATLAB to detect facial expression based on viola jones algorithm. Firstly it starts to detect face and their expressions by using each and every frame of streamed video, after this bounding box is introduced with the given images. Then the mean position of the entire points in given images frame, which characterized and locate the expressions as discussed in integral image and haar features bounding box calculation, is done. Then the result from the bounding box is feed to Arduino Micro controller by using a string, it is basically a Arduino IDE Serial Monitor window to show text on

an LCD shows; sad, scared, angry, happy, confused, surprised. The MATLAB- Aurduino interfacing is done by using serial cable, it connects computer and Arduino Micro controller board. The Arduino micro controller board controls the camera in PAN and TITLT position. So that the first, PAN servomotor can detect the face horizontally and TILT servomotor vertically. The frame is split up in four segments called right, left, top & bottom or in equal parts. Arduino Micro controller board examine the location of mean points comes in right half or left half in the frame. When mean point dives on right half so the camera is panned to left and if it falls into the left half of the frame then the camera is panned to right. Similarly, the camera is tilted using the bottom and top halves of the frame. Lastly the position of the camera is moved to the center.

Figure 7: General Scheme

V. Results

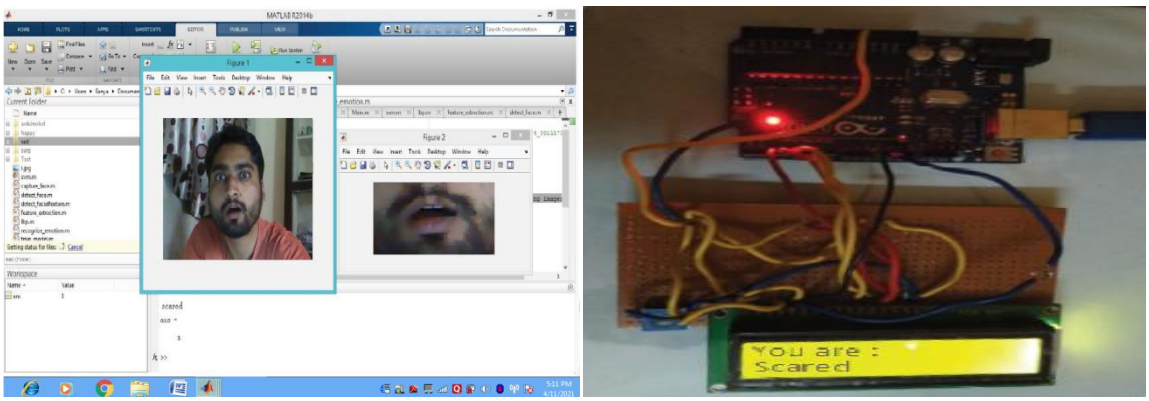

Fig 8.1 Scared

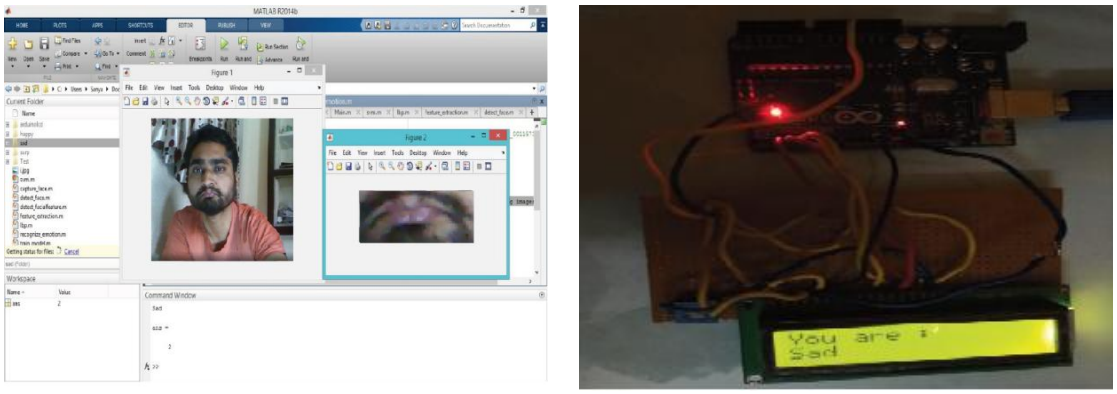

Fig 8.2 Sad

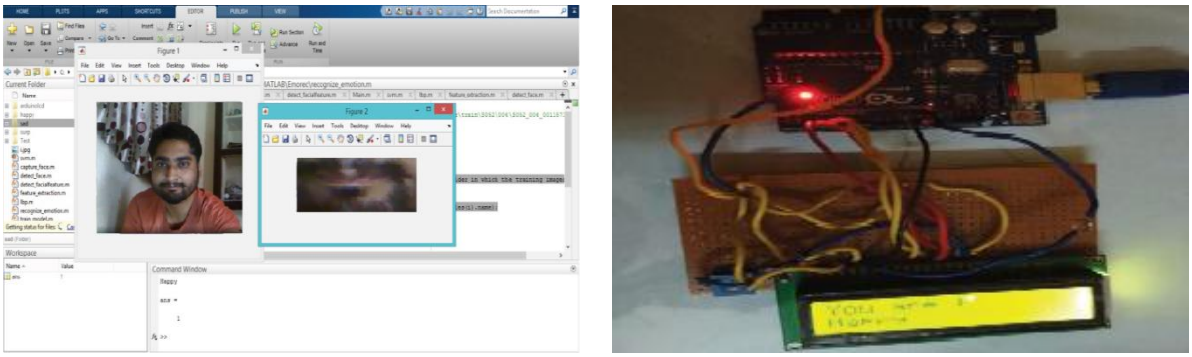

Fig 8.3 Happy

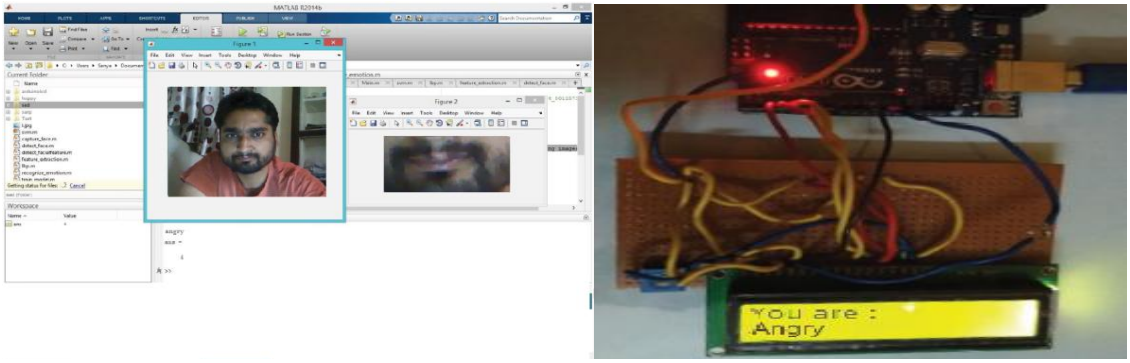

Fig 8.4 Angry

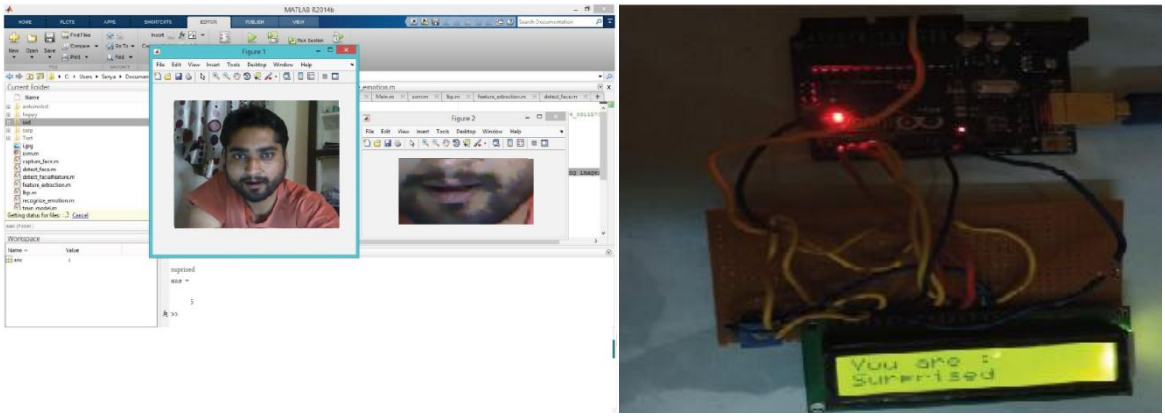

Fig 8.5 Surprised

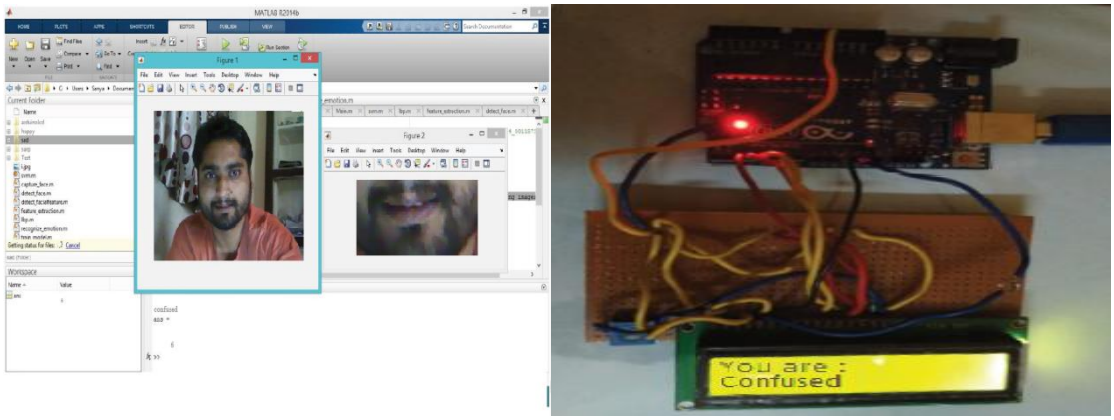

Fig 8.6 Confused

VI. Conclusion

In presented work, the approaches and techniques of human facial expressions is implemented. Here we examine the different facial human expressions related to their emotions, its helps to classify the person's activity for secure society. The viola jones algorithm has been used because it is a well structured model for facial detection and emotions identification at fast rate. A special command is used and program is set up on MATLAB with the help of camera, which can reads out from the live video streaming and locate the human face movements by tracking, examine and shows result in six imitating facial expression identification. These all can be done by using MATLAB-Ardunio microcontroller serial communication; it uses the facial co-ordinates moves in a particular range by control signals, so that the co-ordinates should be in given range depends on behavior it shows imitating facial expression like sad, sacred, confused, surprised, happy and angry.

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