ELDERLY PATIENT MONITORING SYSTEM

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DECLARATION

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The above candidate has carried out research for the B.Sc Dissertation under my supervision.

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Mr. Yashas Mallawarachchi

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Table 1: List of Abbreviations

LPQ	Local Phase Quantization
DoG	Difference of Gaussians
HD	Histogram Differencing
SVM	Support Vector Machine
CK +	Cohn Kanade
JAFFE	Japanese Female Facial Expression
SVMC	Support Vector Machine Classification
ROI	Region of Interest

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1. INTRODUCTION

Major challenge faced by the people in nowadays are, taking care of the ageing people. Because nowadays people are really busy with their job due to the economic situation in the world and they don't have time even to enjoy their family life. Because of this issue they are not able to take care of ageing population conscientiously. Since the rate of growth in ageing population is high, there should be a way to take care of the ageing population. With the ageing, most of the people are barred to bed due to different kinds of diseases and ultimately they become bedridden patients. Majority of the elderly patient are getting directly affected by the air pollution in the domestic environment due to limited outdoor activities. Since the respiratory disorder for elderly people are common, they have been untreated to some extent [1]. As a result of air pollution, globalization and other many more factors ageing people are easily affected with respiratory system related diseases. Since considering internal health parameters in a domestic environment is not an easy task, caregivers can monitor the patient's facial emotions and get to know whether the patient is in a critical situation by having breathing difficulties. But monitoring the patient in every minute is not practical task for human beings.

1.1 Background context (Literature Survey)

There was a research done by Fadzilah Siraj and others from the faculty Information Technology, University of Utara Malaysia to classify emotion using neural network. Nowadays emotion is a major network for the communication between human and machines. By detecting the emotion of the human machines can make decisions, learning and do various cognitive tasks [2]. In this study they classified six major human emotions using neural network as shown in the following figure.

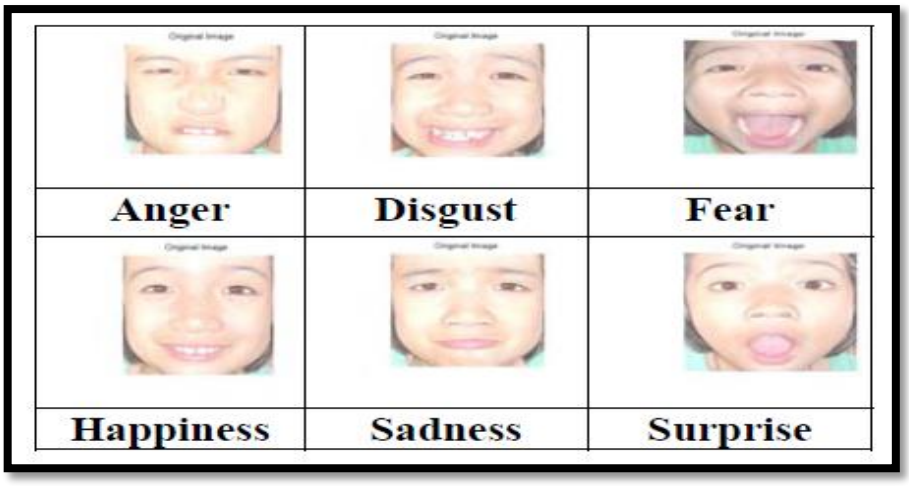


Figure 1.1 Six universal emotions

Source: [2]

In here the particular image is processed in a flow as mentioned below.

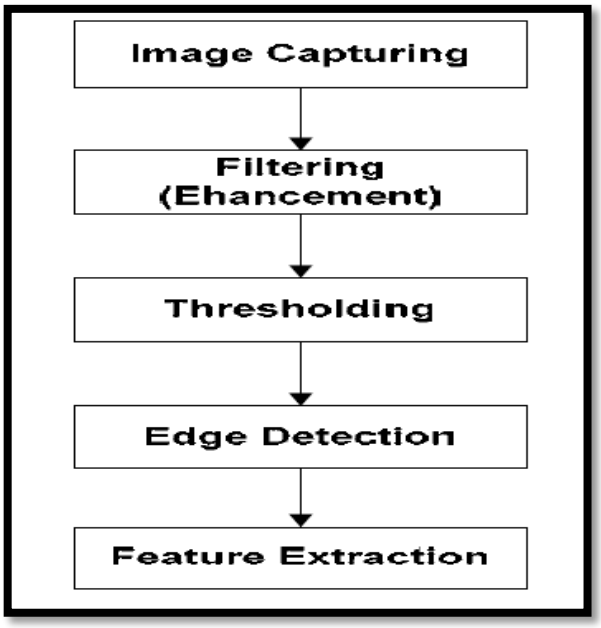


Figure 1.2 The Flow of Process of Image Processing

Source: [2]

They had used a Sony Cybershot DSC U50 digital camera for the capturing purposes of the image. And use image filtering for the training and the testing. They have used

Otsu's method for thresholding and Sobel technique for edge detection. The magnitude of the gradient is then calculated from following equation.

$$|G| = \sqrt{Gx^2 + Gy^2}$$

Group of researchers Patrick Lucy (Member, IEEE), Jrffrey F.Cohn(Associate member, IEEE) and some other researches described a research about Automatically Detecting Pain in video through facial Action Units. Here they use videos of patients with shoulder injuries. They proposed an Active Appearance Model (AAM) which can automatically detect the patients' pain in a video at a frame-by-frame level based on Action units. In here, they used UNBC-McMaster Shoulder Pain Archive (which contains data on patients moving both their injured and uninjured shoulders) database which can detect the spontaneous emotions with respect to reaction of the patient's pain. By using this system they were able to find whether a patient is currently suffering from a pain or not [3].

A research, "Automated coding software outperforms people in recognizing neutral from neutral faces as neutral from standardized datasets" was done by Peter Lewinski in the Amsterdam School of Communication Research, Department of communication Science, University of Amsterdam, Amsterdam, Netherland. Automated Facial Coding Software (AFC software) is a software which can detect human's neutral faces via a computer. Here he had used two data sets Karolinska Directed Emotional Faces and Warsaw set of emotional express pictures to analyze neutral faces using his AFC software. Following figure shows how the face reader of the AFC is analyzing a neutral face [4].

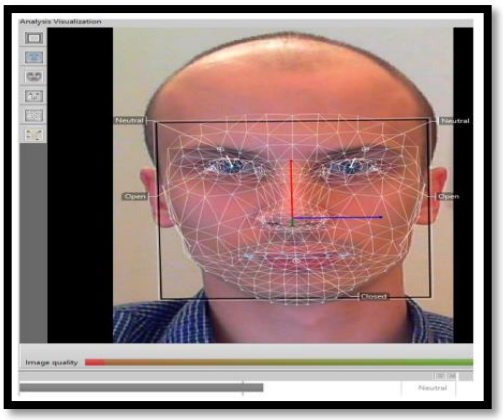


Figure 1.3 Face Reader analysis of a neutral face

Source: [4]

Here, the face reader in AFC works in three steps.

1. It detects a face in the image.
2. Identifies 500 key landmarks in the face through Active Appearance Model, visualized as a 3D superimposed virtual mesh.
3. The image is classified according to how likely the emotion is present in a person's face.

This AFC software was tests with 100 human participants images and the face reader has analyze all of them without any failure.

There was a research "Real-Time System for Facial Emotion Detection Using GPSO Algorithm" done by Bashir Mohommed Ghandhi, R.Nagarajan and Harry Desa in the School Mechatronics Engineering, University of Malaysia Perlis, Malaysia. Here they proposed an algorithm called Guided Particle Swarm Optimization (GPSO) which is a modification of Particle Swarm Optimization (PSO) algorithm. PSO algorithm is designed for facial emotion detection while GPSO algorithm designed for keep track of relevant points, called Action Units which are specified on the face of a subject. They have used Lucas-Kandade (LK) Algorithm to keep track of the action units in

each iteration of GPSO algorithm. LK algorithm was derived on three assumptions [5].

1. Brightness Constancy
2. Temporal Persistence
3. Spatial coherence

The combination of above algorithms helps them to detect six basic emotions in a real-time and they say this is easy to deploy in a robot or any computer system for real time applications.

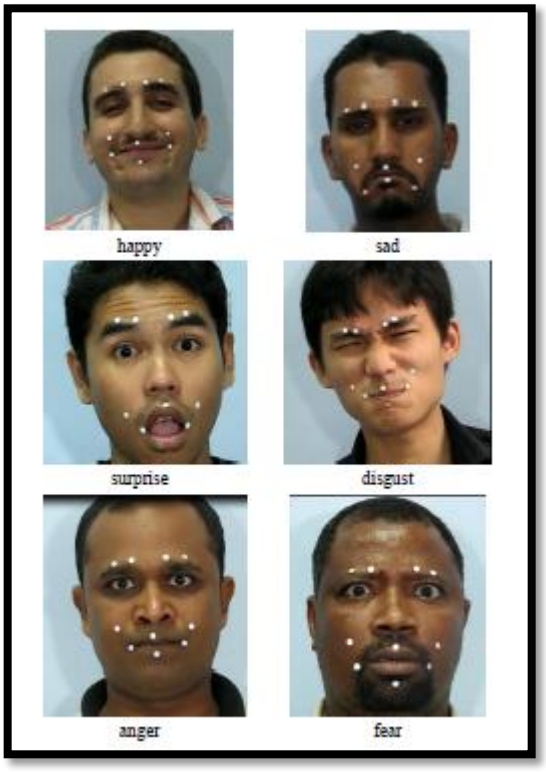
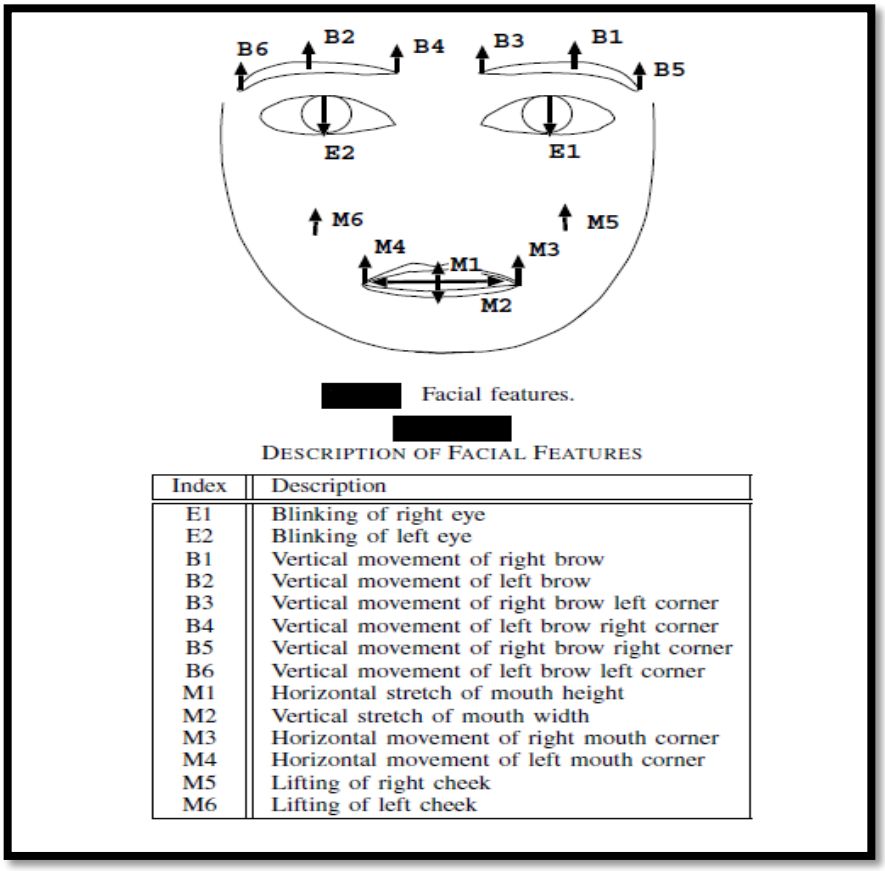


Figure 1.4 Samples of the six basic universal emotions

Source: [5]

A group of researches in department of Computer Science And Engineering, Nagoya Institute of Technology, Japan done a research to detect facial emotion by considering

partial Occlusion of face using Bayesian Network. In real world it is possible that the face can be partially covered by some ornamentation materials such as caps, scarfs glasses and many more materials. In this type of a situation detecting facial emotions is difficult. Here in this research they proposed an emotion detection system taking into consideration partial occlusion of face using casual relations between facial features. They used Bayesian network to detect emotions without filling in the gaps of occluded features. Because this Bayesian network classifiers figure out from the dependencies among the target attribute and explanatory variables. The figure following shows how Bayesian network detect human facial features and their descriptions [6].



DESCRIPTION OF FACIAL FEATURES

Index	Description
E1	Blinking of right eye
E2	Blinking of left eye
B1	Vertical movement of right brow
B2	Vertical movement of left brow
B3	Vertical movement of right brow left corner
B4	Vertical movement of left brow right corner
B5	Vertical movement of right brow right corner
B6	Vertical movement of left brow left corner
M1	Horizontal stretch of mouth height
M2	Vertical stretch of mouth width
M3	Horizontal movement of right mouth corner
M4	Horizontal movement of left mouth corner
M5	Lifting of right cheek
M6	Lifting of left cheek

Figure 1.5 Facial features with their Descriptions

Source: [6]

A research, “Facial Emotion Recognition in Continuous Video” done by Albert Cruz, Bir Bhanu and Ninad Thakoor in Center for Research in Intelligent Systems, University of California, Riverside, CA, USA. They had compute a derivative of features with histogram differencing and derivative of Gaussians and model the changes with a hidden Markov model. The following figure shows the system overview.

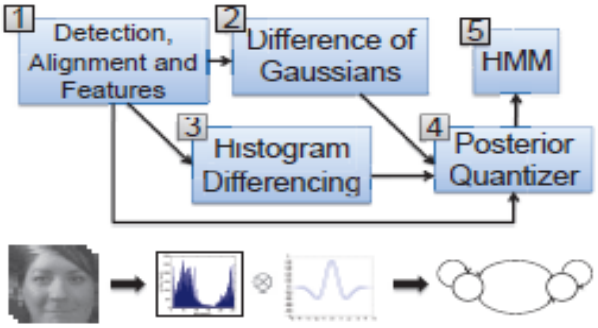


Figure 1.6 System Overview

Source: [7]

They had detected the face ROI with a boosted cascade of Haar-like features with SWIFT flow to reference image, and Local Phase Quantization (LPQ) texture features are extracted. The derivative of features are estimated with two methods: with a fine spatial granularity with Difference of Gaussians (DoG) and with a course spatial granularity with histogram differencing (HD) of LPQ histograms. A support vector machine (SVM) outputs posterior probabilities for emotion labels from each of the three feature vectors and the posterior probabilities are quantized into a single observation vector. A hidden Markov model computes the optimal emotion labels, taking of advantage of the co-occurrences between two time ranges. [7]

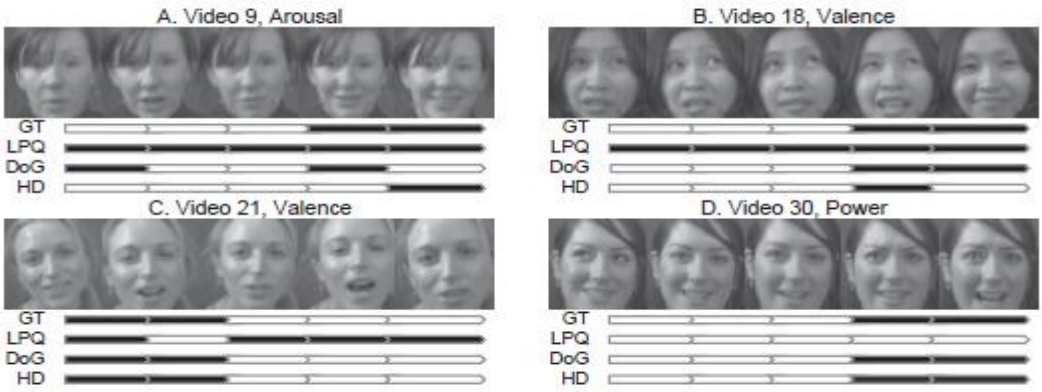


Figure 1.7 Examples of a co-occurrences

Source: [7]

A group of researches Dan Duncan, Gautam Shine and Chris English were done a research "Facial Emotion Recognition in Real Time". They have developed a convolutional neural network for classifying human emotions from dynamic expressions in real time. They have used two different freely available repositories: Cohn Kanade (CK+) dataset, and the Japanese Female Facial Expression (JAFFE) database and their own unique image dataset. They also applied Haar-Cascade filter(Figure 1.8) provided by the Open CV to crop the input image faces, which significantly improved test and training accuracy.

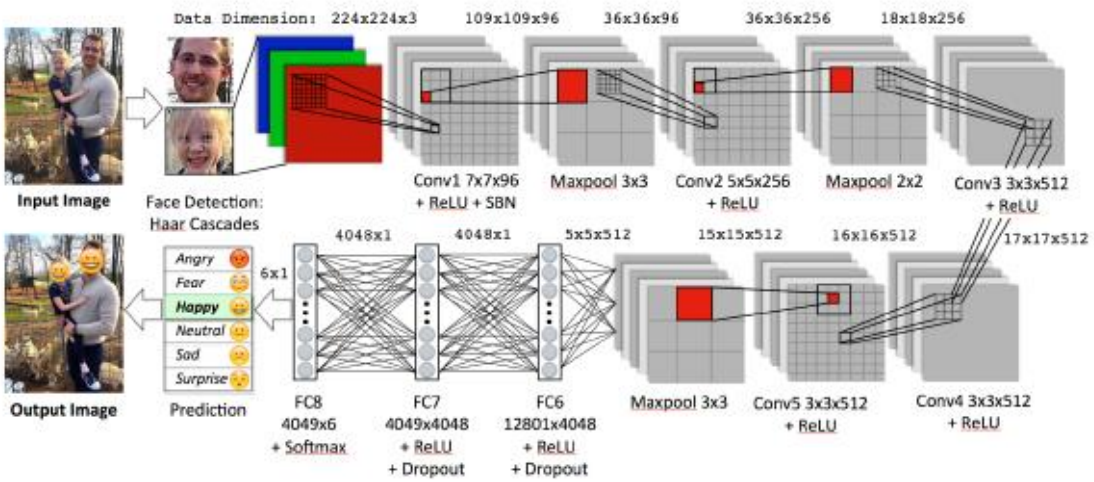


Figure 1.8 Architecture of the convolutional neural network used in this project.

Source: [8]

The input image and the cropped faces using a Haar-Cascade detector are also shown. The resulting classification from the network chooses a particular emoji to apply the subjects' faces.

2. METHODOLOGY

2.1 Methodology

The identification of emotions of a bedridden patient is a must where as she/he may not have the ability to convey their breathing difficulties in an absence of the caregiver. Therefore figuring out the breathing difficulties which are shown by the patient is a must.

High resolution video camera has been used to detect the abnormality in emotions of a bedridden patient. To get the continuous video from the video camera, it should be escalated on the top of the wall directed to the patient's bed in the room. The captured video will be sent to the PC in order to detect the abnormality.

Making of dataset

Dataset is mainly divided in to two different folders as normal facial expressions and abnormal facial expressions. CK+ (Cohn-Kanade) repository is used to obtain normal facial emotions of the people. Separate repository was made for abnormal facial emotions using a captured video of patients.

Training and classification

Database was separated to two parts for the training and prediction purposes. First 80% of the images from the image file list were taken for the training and last 20% were taken for predictions. Frontal face detector and shape predictor of the dlib library is used to detect the face of the patient and identify landmarks respectively.

Face is detected from the capturing video and get coordinates for each detected face. Facial landmarks were taken from the shape predictor of the dlib library. If the face of the captured image is titled, classifier is confused. Therefore the landmarks will be taken after re-orienting the particular image.

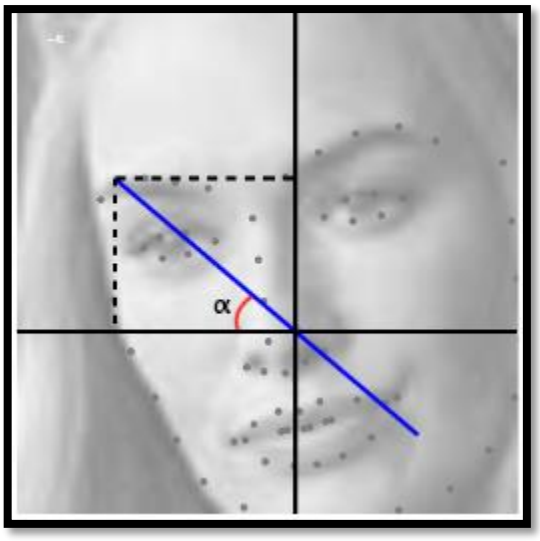


Figure 2.1 Tilted image which should re-orient

Then the Images will be classified using Support Vector Machine Classification (SVMC). When the system detect the patient's facial emotion, it will recognize whether the patient is having a normal facial emotion or an abnormal facial emotion. The result will be analyze by taking into number of groups having 10 values. If the seven out of ten are given as abnormal, then it will be informed to the care giver through a message to the mobile.

2.2 Testing & Implementation

Development Platform

Backend of the system is developed on Windows environment using Python as the developing language and OpenCV libraries.

Implementation

The implementation stage of any project is a true display of the defining moments that make a project a success or a failure. The implementation stage is as the system

or system modifications being installed and made operational in a production environment. This is an important phase of the system development life cycle as coding of the system being from here.

When describing the implementation process of detection of abnormality in facial emotion is;

Here a high resolution video camera has been used to detect the abnormality in emotions of the bedridden patient. Video camera should be escalate on the top of the wall directed to the patient bed and should focused the patient face.

Patient's face was captured from the video camera. Then the face ROI (Region of Interest) is captured from that particular image. Face ROI is taken for the analyzing of abnormality. When an abnormality is detected it will be notified to the caregiver through a text message to his/her mobile phone.

3. RESULTS & DISCUSSION

In this section the whole process of detecting abnormality in facial emotions will be discussed.

In the very beginning the video camera should directed to the bed and focused to the patient's face as mentioned in an above section. Then the face ROI is used for the analyzing purposes. Face landmarks will be taken from the face ROI get analyzed. If the detected face ROI is inclined to a direction, land marks will be taken after re-orienting the image.

Here to get the accuracy level, ten sets were made and get the get the accuracy using SVMC. Then get the mean accuracy which is around 96% from the ten outputs.

As mentioned above in a section, when the output is coming and if abnormal sounds seven or more that, a text message will be automatically send to the care giver.

Figure 3.1 Result of Abnormality Detection in Facial Emotions

Some predictions of SVM training model is given below.

Figure 3.2 SVM identified emotion as Normal in breathing

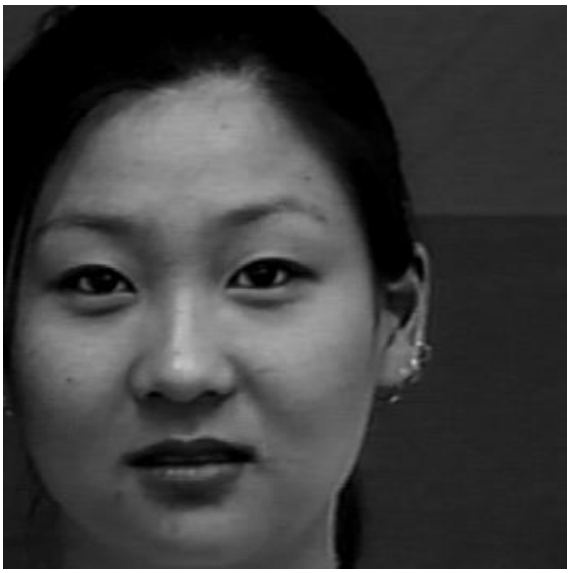


Figure 3.3 SVM identified emotion as Normal in breathing

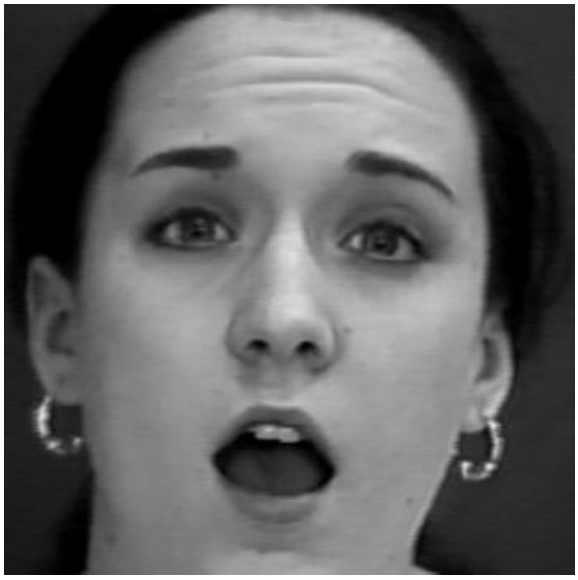


Figure 3.4 SVM identified Emotion as Abnormal in breathing (Have breathing Difficulties)

Figure 3.5 SVM identified Emotion as Abnormal in breathing (Have breathing Difficulties)

Figure 3.6 SVM identified Emotion as Abnormal in breathing (Have breathing Difficulties)

4. CONCLUSION

The main focus of our application is to monitor bedridden elderly patients who are having respiratory disorders. In this section it is mainly focused on detecting abnormality via facial emotions. Here the, Frontal face detector of the dlib library is used Frontal face detector and Facial landmarks of the face ROI were taken from the shape predictor of the dlib library. Support Vector Machine is used to training and classification purposes. 96% of accuracy was obtained by this when classified using Support Vector Machine Classification.

5. REFERENCES

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GLOSSARY

APPENDICES