Monitoring Occupational Stress and Analysis by Capturing Facial Expressions and Heart Rate - (MSA)

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Declaration

We declare that this thesis is our own work and has not been submitted in any form for another degree or diploma at any university or other institution of tertiary education. Information derived from the published or unpublished work of others has been acknowledged in the text and a list of references is given.

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Dedication

To **my beloved parents -**

For their endless support, love, understanding

Acknowledgement

MSA is the result of work whereby I have been encouraged and supported by many people. We take this opportunity to express my deep sense of gratitude and appreciation to all those who were with me during this project.

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Abstract

In a medical or biological context, stress is a physical, mental, or emotional factor that causes bodily or mental tension. Stress can be caused externally (from the environment, psychological, or social situations) or internally (illness or from a medical procedure). In fact, sometimes stress may be necessary to get you motivated and mobilized. There are some symptoms which indicate too much stress that can arise from yourself, or caused by the work and/or home environment. It can be caused by any combination of, or all three of these factors. Some such symptoms are heart problems/high blood pressure, panic attacks, physical tiredness, angry, mood swings, defensive, memory lapses etc. The human body begins to suffer as a result of excess stress, however with the busy life styles of most people, they do not immediately realize this.

An in depth literature survey was done in order to obtain a better understanding about the current problem domain and the solution identified. The findings indicate there are limited resources available for measuring occupational stress. The expansion of Information and Communication Technology has obstructed all aspects of the human life, therefore we intend to solve this problem by using heart rate detectable wearable device together with facial expression detectable Information Technology solution.

Monitoring Occupational Stress and Analysis by Capturing Facial Expressions and Heart Rate (MSA) is a psychology based research, that has been conducted to track variations in occupational facial expressions and heart rate with and without project deadline. It is hypothesized that level of occupational stress has fluctuated during project deadlines. The overall design of the solution include three modules, namely, Facial Expression Monitor, Heart Rate Monitor and Result Analysis Module. These modules are developed using .NET framework 4.0 with Microsoft SQL and third party libraries, including a wearable sensible device useful to capturing the heart rate variation. The FEM is capable of detecting individual facial characteristics in each video frame and the decision on the stress level is made on the sequence level. Moreover another module, HRM, is developed for detecting heart rate variation at the given durations. Also stored result has been analysis with module RAM. Testing is based on 20 subjects from two different department within the organization. The study lasted more than one week and was conducted in real working environment. Our expected results depend on human facial expression and heart rate vary with number of days remaining to the project deadline. The result shows that our solution can evaluated the human stress variation by using facial expression and heart rate with high accuracy.

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Chapter 1

Introduction to Monitoring Occupational Stress and Analysis by Capturing Facial Expressions and Heart Rate

1.1 Prolegomena

Occupational stress is one of the major health threats of the any work place. It accounts for much of the physical illness, substance abuse, and family problems. Moreover stress and stressful working conditions have been linked to low productivity, absenteeism, off the job etc.

Stress can be defined as physical and mental responses to an unacceptable difference between real or imagined personal experience and personal expectations. By this definition, stress is a response which includes both physical and mental components. Typically, stress is our reaction to things. People's response to stress varies amongst individuals, and it can be either a positive or negative influence in their lives. As symptom vary from person to person, it is important to figure out what causes stress in our personal life [1]. Furthermore tracking stress can help identify the causes, and severity, of the stress experienced by an individual. Then actions can be taken to reduce the stress or handle it better.

1.2 Background and motivation

Monitoring Occupational Stress and Analysis by Capturing Facial Expressions and Heart Rate (MSA) is developed for those individuals who difficulty managing their stress level at the work place. Reducing stress levels can not only make us feel better right now, but may also protect human health long term. This is going to be a supporting system for them to protecting their life. Furthermore management can make decisions to reduce the occupational stress level at workplace.

At the present there are many existing tools and stress related research. Some of them are Automatic stress detection in working environments from smartphones' accelerometer data: A First Step [2], Multimodal behavioral analysis for non-invasive stress detection [3], Using

Activity-Related Behavioral Features towards More Effective Automatic Stress Detection [4] and Stress Sense: Detecting Stress in Unconstrained Acoustic Environments using Smartphones [5]. Other than ones mentioned there are large number of physiological based projects and research published on related to this area. Some of the drawbacks and enhancements identified in these research are address in my research.

1.3 Problem definition

The ancient study show limited resources available for identify occupational stress. We intend to solve this problem by using a wearable heart rate monitoring device together with facial expression detecting application. Monitoring Occupational Stress and Analysis by Capturing Facial Expressions and Heart Rate (MSA) is intend to solving problem for those individuals who difficulty detecting and managing their stress level at the work place. Reducing stress levels can not only make us feel better right now, but may also protect human health long term.

1.4 Aim and Objectives

1.4.1 Main aim

Occupational stress is thought to affect individual's psychological and physical health, as well as organization's effectiveness, in an adverse manner. The main aim of this research is to build up hypothesis and in order to support hypothesis, develop a software solution. Furthermore developed system use as a supporting tool for those individuals who difficulty managing their stress level at the work place.

1.4.2 Main objectives

- **Identifying variation of the facial expression when the stress increase or decrease. (Ex: eye brows, mouth movement changes etc.)**
  Identify specific facial emotional states and sequence level (Ex: surprise, sadness, fear, anger, happy, disgust) with related to stress variations.

- **Monitoring heart rate variation with stress.**
  For each record submitted by the user, system should be capable of identifying heart rate and understand level of stress depend on the parameter variation.
- **Monitoring stress is affected by project deadlines.**
  Depend on the project deadline induce differential levels of stress. Hence each record submitted by facial expression and heart rate variations, stress level may vary.
- **Identifying co-relation between two parameters (facial expressions vs heart rate) effecting when the stress level changed.**
  The results (data) collected from using two parameters and mapping co-relation between each parameter to identify stress level variation, with and without project deadlines. Furthermore expected to performance testing using above each parameters separately.

1.4.3 Other objectives

Following are the additional objectives to be achieved for the system development by functioning on this research project.

- Improve my technical skills and learning new concepts related to new technologies.
- Improve self-confidence.

1.5 Hypothesis

Occupational stress will vary according to project deadlines, and be identifiable by unobtrusively monitoring the heart rate and the facial expressions of computer users.

1.6 Structure of the thesis

The rest of the thesis structured as follows. Chapter 2 is on critical review of the area of stress related practices and challenging in MSA. Chapter 3 present technologies adapted for MSA. Chapter 4 provides the overall picture of our novel approach to MSA. Chapter 5 discusses the design of the solution. Chapter 6 is about the hardware, platforms, software and algorithms related to implementation of the design. Chapter 07 report on the evaluation of the proposed solution. Chapter 8 concludes the thesis with a note on further work.

1.7 Summary

This chapter gave description of the overall picture of the entire thesis. The background and motivation, problem definition, aim and objectives, hypothesis based on this research and the structure of the thesis discussed under this chapter. Next chapter elaborates the related works to MSA.

Chapter 2

Practices and challenging in MSA

2.1 Introduction

The research by Garcia-Ceja et al, practiced data from the smartphone's with accelerometer sensor to detect behavior that correlates with human stress [2]. The recruited subjects reported there perceived stress levels three times during their working hours and using combination of statistical models to classify self-reported stress level. This research has based on single accelerometer sensor because it low power consumption and open the possibility to implement a stress recognition system in personal fitness devices, which currently track physical activities. The main limitation of this work is they analyzed only the captured data from the triaxial accelerometer.

Carneiro et al, has presents and approach to measure the levels of acute stress in humans by analyzing their behavioral patterns when interacting with technological devices [3]. In their study, identified the effects of stress on eight behavioral, physical and cognitive features. Moreover a non-parametric statistical hypothesis test is used to determine which features more related to stress are the acceleration and the mean and maximum intensity of the touch. The main limitation of this work includes followed a non-invasive approach to estimate the level of stress.

Furthermore, Giakoumis et al, have studied about activity-related behavioral features together with physiological measures that can be automatically extracted from a computer system, with the way of increasing the effectiveness of automatic stress detection [4]. This research is based on processing the appropriate video and accelerometer recordings taken from the monitored subjects. Moreover, experimental evaluation showed that several of behavioral features significantly correlate to self-reported stress. The main limitation of this work by Giakoumis et al can be seen as research is focus on detect foot trembling and electrocardiogram sensors to measure the level of stress.

Recently, Frauendorfer et al, have implemented an application running in a smart phone to unobtrusively detect stress by using voice as input [5]. Furthermore they used one-size-fits-all approach, where one universal stress classifier is trained for all users. It is the most widely adopted scheme in many mobile inference systems due to its simplicity. The main limitation of this work by Frauendorfer et al it uses only the human voice for measuring the level of stress.

Furthermore Sano & Picard, find physiological or behavioral markers for stress. In this research they collected by using a wrist sensor (accelerometer and skin conductance), mobile phone (call, short message service, location and screen on/off) and surveys (stress, mood, sleep, tiredness, general health, alcohol or decaffeinated beverage intake and electronics usage) [6]. Moreover, correlation analysis was applied to find statistically significant features associated with stress and used machine learning to classify whether the participants were stressed or not. The main limitation of this research is there is no specific participants group and study is limited to stress.

Andrey Bogomolov et al, proposed an alternative approach other than obtrusive sensors to providing evidence that daily stress can be reliably recognized based on behavioral metrics, derived from the user's mobile phone activity and from additional indicators, such as the weather conditions (data pertaining to transitory properties of the environment) and the personality traits (data concerning permanent dispositions of individuals) [7]. Furthermore in this research proposed a multi-factorial data-driven approach to the prediction of individual daily stress. The main limitation of this work is one of the above information sources is dropped, the recognition performances decrease drastically.

Hua Gao et al, has developed which detects the emotional states of the driver by analyzing facial expression[8]. This system consider two negative basic emotions, anger and disgust, as stress related emotions. They proposed system capable of detect an individual emotion in each frame and the decision on the stress level is made on sequence. The enhancement of this work is, the accuracy of the emotional detection.

David et al, have researched, an application of computer vision to track changes in human facial expressions during low and high stressor performance [9]. They have applied Optical Computer Recognition (OCR) algorithms for detecting facial expression during head movement. Furthermore, the validity of the workload paradigm to make differential level of stress in facial expression was established. This provided the basic stress related facial expressions required to establish a prototypical OCR algorithm to detect such changes. One potential barrier to developing this work is alexithymia, which refers to having difficulty identifying and describing one's feelings, difficulty distinguishing between feelings and bodily sensations, and a preoccupation with external events. They found that alexithymia was related to stress responses and it will have to be more fully evaluated relative to OCR of facial expressions.

Rosalind et al, built a wearable monitoring system that communicates through a Motorola iDEN phone, facilitating active monitoring of heart signal information in healthy people as well as patients with cardiovascular disease [10]. This research could also potentially serve as the foundation for further development of early diagnosis and warning systems for household healthcare. The main restriction of this research is the quality of the signal and scalability issues with FitSense devices.

Gloria et al, have researched computer activity and used biosensors to measure stress of 48 students for 7 days for all waking hours [11]. They founded a significant positive relationship with stress and daily time spent on computers. Furthermore they shows that stress is positively associated with the amount of multitasking and negatively associated with Facebook and social media use. Also they study shows that college students multitask at twice the frequency compared to studies of information workers. These results can be beneficial for stress management of college students. There are several limitations of this work, including the installing of computer logging software on each participant's computer. As a result, they could not capture the time spent on other personal laptops (if any) or public computers in school libraries or computer labs. Thus end of day surveys were sent via email (potentially increasing their email use).

Limitations and problems identified in current research

The above study show limited resources available for identify occupational stress. We intend to solve this problem by using a wearable heart rate monitoring device together with facial expression detecting application. Monitoring Occupational Stress and Analysis by Capturing Facial Expressions and Heart Rate (MSA) is intend to solving problem for those individuals who difficulty detecting and managing their stress level at the work place. Reducing stress levels can not only make us feel better right now, but may also protect human health long term. These issues are summarized in Table 2.1.

Table 2.1: Represent Research and the limitations

Research	Limitations
Automatic stress detection in working environments from smartphones' accelerometer data: A First Step	Analyzed only the captured data from the triaxial accelerometer.
Multimodal behavioral analysis for non-invasive stress detection	Followed a non-invasive approach to detect the level of stress.
Using Activity-Related Behavioral Features towards More Effective Automatic Stress Detection	Detect foot trembling and used electrocardiogram sensor to measure the level of stress.
Stress Sense: Detecting Stress in Unconstrained Acoustic Environments using Smartphones	Use only the human voice for measuring the level of stress.
Stress Recognition using Wearable Sensors and Mobile Phones.	No specific participants group and study is limited to stress.
Daily Stress Recognition from Mobile Phone Data, Weather Conditions and Individual Traits	Stress can be reliably predicted from the combination of smartphone usage data, weather conditions and individual dispositions. If one of these information sources is dropped, the recognition performances decrease drastically.
Detecting emotional stress from facial expressions for driving safety	The accuracy of the emotional detection.
Optical Computer Recognition of Facial Expressions Associated with Stress Induced by Performance Demands	Potential barrier to developing this work is alexithymia.

Monitoring Stress and Heart Health with a Phone and Wearable Computer	Quality of the signal and scalability issues with FitSense devices.
Stress and Multitasking in Everyday College Life: An Empirical Study of Online Activity	Installed the computer logging software on one personal laptop per participant. Also they could not capture the time spent on other personal laptops or public computers in school libraries. Thus end of day surveys were sent via email (potentially increasing their email use)

Based on the above, there is still no holistic mechanism to detect occupational stress level at the work place.

2.2 Summary

In this chapter we have explained how MSA is evolved from the previous similar attempts and we have clearly described the distinguishable differences of our system from theirs. In next chapter, we will be discussing the technology adapted in this project.

Chapter 3

Technologies adapted for MSA

3.1 Introduction

Chapter 2 presented the limitations of researches literature review for detect and measure level of stress in various situations. This chapter is exploring that technology adapted during this project. Section 3.2 is on detail description of software technologies that we use in MSA and section 3.3 describe hardware technologies used to implement the MSA. Section 3.4 covers the database technologies used during the project.

3.2 Software Technologies

3.2.1 C#.Net

C# is a sophisticated and type-safe object-oriented language that enables developers to build a variety of secure and robust applications run on the .NET Framework. You can use C# to create windows client applications, XML web services, distributed components, client-server applications, database applications, and much more. Visual C# provides an advanced code editor, convenient user interface designers, integrated debugger, and many other tools to make it easier to develop applications based on the C# language and the .NET Framework. Front layer (UI) and the middleware layer of the FEM module, HRM module and RAM module is developed by using Microsoft Visual studio 2010 with .Net framework 4.0. Moreover the system compatible for beyond versions other than .Net framework 4.0.

3.2.2 Multimedia Technologies

We are heavily dependent on the multimedia technologies during this project. Multimedia in computer science is the presentation of information using the combination of text, sounds, pictures, animation and videos. MSA is dependent on a branch of multimedia technologies that is computer graphics which deals with the theory and technology for computerized image synthesis. The part of the solution that we address is directly related to the computer graphics.

3.2.3 NCH Suite video capture software

NCH Software is where users turn for reliable software applications for any need categories include applications for audio, video, business, dictation and other software utilities. Used for capturing the individual facial expression and the behaviors for selected time duration. The software capable of capturing video from any mobile device, DV camcorder, VHS, webcam, or import most video file formats including avi, mp4, mpv and mov [16].

3.2.4 Multi-Threading

C# supports parallel execution of code through multithreading. A thread is an independent execution path, able to run simultaneously with other threads. MSA used multi-threading to simultaneous access to multiple applications, reduced number of required servers, improved performance and concurrency.

3.2.5 Third party libraries

- OpenCV

  The concepts of computer graphics are brought to the computers through graphic APIs. Without using a graphic API, it's hardly imaginable to create a computer graphics application. Graphics APIs which we are using for this project is OpenCV [14]. OpenCV (Open Source Computer Vision Library) is an open source computer vision and machine learning software library. The library has more than 2500 optimized algorithms, which includes a comprehensive set of both classic and state-of-the-art computer vision and machine learning algorithms. These algorithms can be used to detect and recognize faces, identify objects, classify human actions in videos, track camera movements, track moving objects, extract 3D models of objects, produce 3D point clouds from stereo cameras, stitch images together to produce a high resolution image of an entire scene, find similar images from an image database, remove red eyes from images taken using flash, follow eye movements, recognize scenery and establish markers to overlay it with augmented reality, etc.

- Emgu.CV

  Emgu CV is a cross platform .Net wrapper to the OpenCV image processing library [15]. Allowing OpenCV functions to be called from .NET compatible languages such as C#, VB, VC++, IronPython etc. The wrapper can be compiled in Mono and run on Windows, Linux, Mac OS X, iPhone, iPad and Android devices.

3.3 Hardware Technologies

- Wireless Heart Rate Monitor Chest Strap Watch Fitness Belt

  This is wearable sensible device useful to capturing the pulse rate variation in human body. Using a heart rate monitor is the easiest way to ensure you're reaching your optimal heart rate during workouts or to track stress levels during the day [17][18].

3.4 Database Technologies for MSA

MSA uses separate database for keeping the records from participant ID, facial expression for the given time duration, average pulse rate for the given duration, project deadline etc. The technology selected need to be providing the full support to Microsoft .Net platform. There are a number of high tech DBMS packages available for this implementation such as Oracle database server, MySQL database server, DB2 database server. We have chosen MS-SQL server 2008 to implement the MSA database. Because of the immense support provided by the .Net platform for MS-SQL server.

3.5 Summary

This chapter was mainly focused on describing the technology adapted during the project MSA. Section 3.2 is on detail description of software technologies that we use in MSA and section 3.3 describe hardware technologies used to implement the MSA. Section 3.4 covers the database technologies used during the project. Next chapter is on our approach to MSA.

Chapter 4

A novel approach to MSA

4.1 Introduction

Chapter 3 discussed the technology for MSA system. This chapter presents our approach to developing the MSA system under several heading, namely, hypothesis, input output, process, users and features. Moreover to build up hypothesis of the stress variation in the organization and identify system detectable parameters, a questionnaire was distributed.

4.2 Requirement Gathering

In order to obtain an overall idea about the presence and awareness of occupational stress among computer users (specially in software development companies), a questionnaire survey was conducted. The questionnaire consists of number of questions with two parts to highlights working stress existing problem in the organization and some of the symptoms that are indicators of too much stress that can come from our self. The questionnaire was distributed among 32 employees at a well reputed organization. Then the questionnaire results were analyzed. By analyzing part 1 of the questionnaire, 43% employees strongly agreed that lot of responsibilities in their job, 28% employees agreed that constant time pressure due to heavy workload and majority of employees 56% agreed that stress is affected by project deadlines.

By analyzing result set of the part 1, there is no evidence to say that working stress remaining problem in the organization.

By analyzing part 2 of the questionnaire, considering the psychological signs, inability to concentrate or make simple decision and depression and anxiety got 28% result. But worrying got the highest result (40%) when considering overall psychological sign results. Furthermore analyzing the emotional signs, anger got highest rate (44%) out of listed emotional sign. Also anger can be detected systematically.

The physical signs got the highest results from panic attacks (28%), physical tiredness (40%), increase heart rate /high blood pressure (25%). When considering these three signs it was difficult for us to identify panic attacks and physical tiredness in a systematic manner. But variation of the heart rate/blood pressure can be easily identified by using proper indicators.

By considering result list of behavior signs, poor time management and/or poor standards of work and no time for relaxation or pleasurable activities got the highest results. This result can be changed by decisions making on strategic level. Analyzing overall results from part 2, can say that some of the stress symptoms can detectable by using systematic indicators.

4.3 Input

MSA depend on three input parameters. Such as

1. Human facial expressions
2. Human heart rate
3. Number of days remaining for the project deadline

4.4 Out put

Final outcome of this research is occupational stress level with and without project deadline. The results collected from using three input parameters and mapping co-relation between each parameter with identified stress level, with and without project deadlines.

4.5 Technologies & Process

We intend to solve this problem by using heart rate detectable wearable device together with facial expression detectable software solution. The system consider three input parameters, highlighted in section 4.3. We detect individual facial expression and the average pulse rate at the given duration. In RAM module is capable of analyzing collected outputs. Also this analyze based on the assumptions and dependences.

4.6 Users

The sensor data was collected from 20 healthy subjects and analyzed with self-reported data from the period of one week. Furthermore we chose to recruit participants from two different departments. The study involved 18 males and 2 females.

4.7 Summary

This chapter presented our novel approach to develop the said problem. After questionnaire results were analyzed, can be realized that working stress remaining problem in the organization and some of the stress symptoms can detectable by using systematic manner. We describe questioner and it final outcome under section 4.2. We described the input to MSA in the section 4.3. Section 4.4 discussed on the output of MSA. The processing made on MSA and adapted technologies was described under section 4.5. Finally we discussed about the users of the MSA in the section 4.6. The next chapter shows the design of the novel approach presented here.

Chapter 5

Design of the MSA system

5.1 Introduction

Chapter 4 presented the approach to develop a Monitoring Occupational Stress and Analysis by Capturing Facial Expressions and Heart Rate system. This chapter elaborate the approach and describe the architecture of the solution. Top level architecture of the MSA includes 3 modules, namely, FEM module, HRM module and RAM module. In bellow sections describe design of each modules.

5.2 Top Level Architecture

The top level architecture of the MSA system is shown in figure 5.1. Within the architecture, FEM and HRM modules are depend on the project deadline. Furthermore result will analyze inside the RAM module. Next we briefly describe the function of each module.

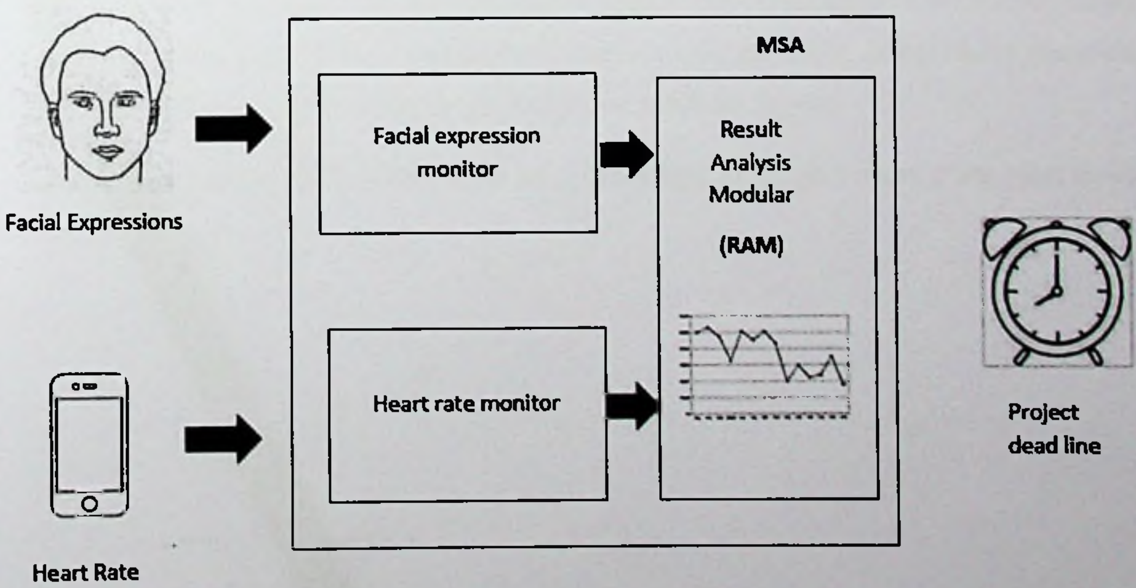

Figure 5.1: Top level architecture of the MSA system

5.2.1 Facial Expression Monitor (FEM)

This module has five main functions. Such as recording human facial expression by the given period, framing uploaded video, analyzing each frames, identifying human face and identify facial expressions. Moreover accomplished for stored results into the database.

5.2.2 Heart rate Module (HRM)

With a wearable device, this module capable of identifying the average heart rate variation in unobtrusively. The result submitted by individuals, the system talented for detect the signal that the wearable device provides and store result into the database.

5.2.3 Result Analyzer Module (RAM)

This module responsible for analyzing results collected from two modules. Moreover decision can be made based on the results gave by this module.

5.3 Use Case Diagram

Use case diagram is used to capture the requirements of the participants. They basically display what the participants do with the system. It has be noted that MSA doesn't have many user type and activities performed by the participant of MSA are limited.

The diagram depicted below shows the use cases related to the participant. Participant is who use the MSA.

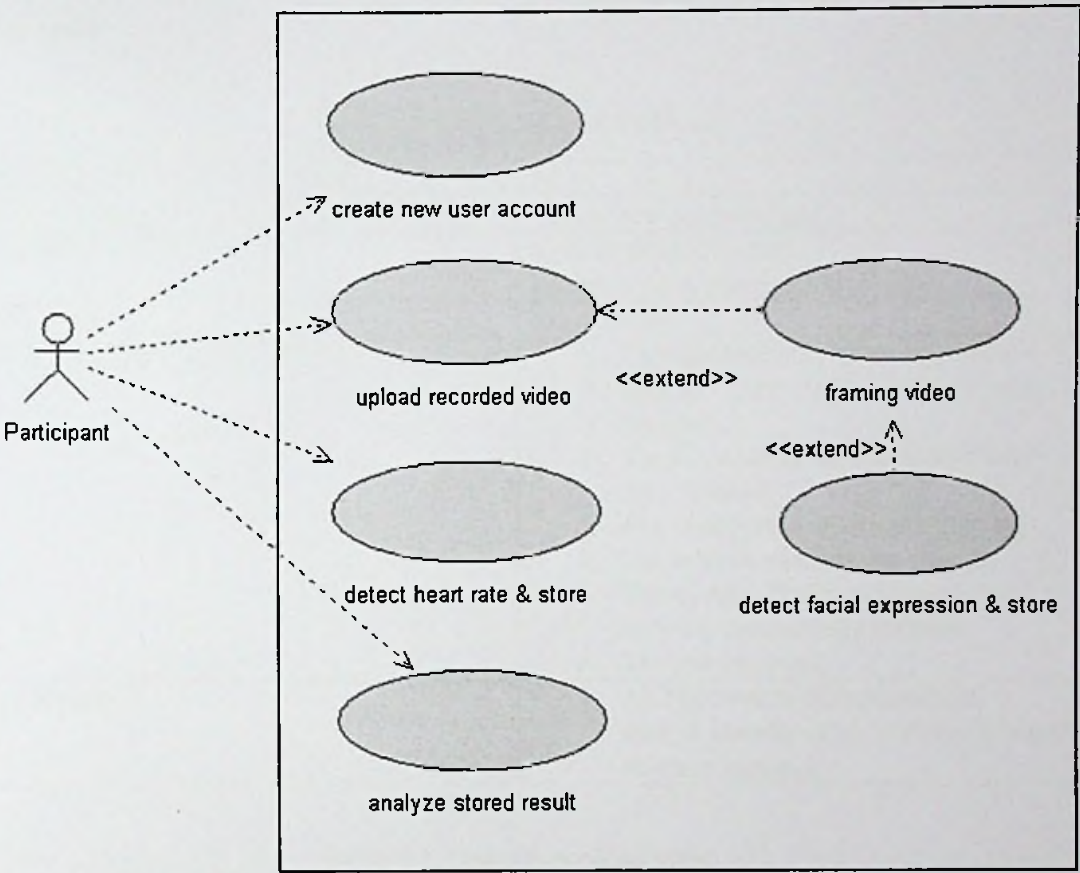

Figure 5.2: Use Case Diagram of MSA

5.4 Use cases

Table 5.1: Create new user account

USE CASE ID	01
USE CASE NAME	Create new user account
PRE CONDITION	System should be run No one else is using the machine
ACTOR	Occupation
MAIN SUCCESS SCENARIO	1. The use case start when the system displays "new user" window to the occupation. 2. The occupation should select" new user "button. 3. The occupation enters the user id. 4. The system validate the user id. 5. The system display a message user account successfully created. 6. The use case end.
EXTENSIONS	4. A) The system discovered the user id already exist, system displays an error message.

Table 5.2: Upload recorded video

USE CASE ID	02
USE CASE NAME	Upload recorded video
PRE CONDITION	System should be run No one else is using the machine
ACTOR	Occupation
MAIN SUCCESS SCENARIO	1. The use case start when the system displays "upload video" window to the occupation. 2. Select the "Brows" button and select the location of the recorded video. 3. Click the "OK" button. 4. The use case end.
EXTENSIONS	3. A) The system discovered the occupation has selected incorrect video format, system displays an error message.

Table 5.3: Detect heart rate and store

USE CASE ID	03
USE CASE NAME	Detect heart rate and store
PRE CONDITION	The computer is switch on. No one else is using the machine. Chest Strap Watch Fitness Belt should be wear and work. Smart watch should be work. Bluetooth enable from the PC. System should be run.
ACTOR	Occupation
MAIN SUCCESS SCENARIO	1. The use case start when the smart watch displays pulse rate window to the occupation. 2. Click the "OK" button on the smart watch. 3. The use case end.
EXTENSIONS	4. A) The Bluetooth not available, The system displays an error message.

Table 5.4: Analyze stored result- Facial expressions

USE CASE ID	04
USE CASE NAME	Analyze stored result- Facial expressions
PRE CONDITION	System should be run No one else is using the machine. Records should be available on the database.
ACTOR	Occupation
MAIN SUCCESS SCENARIO	1. The use case start when the system displays "Data Analyzer" window to the occupation. 2. Select the date duration wants to be generate graph. 3. Click the "OK" button. 4. The use case end.
EXTENSIONS	5. A) The data not available, The system displays an error message.

Table 5.5: Analyze stored result- Heart rate

USE CASE ID	05
USE CASE NAME	Analyze stored result- Heart rate
PRE CONDITION	System should be run No one else is using the machine. Records should be available on the database.
ACTOR	Occupation
MAIN SUCCESS SCENARIO	1. The use case start when the system displays "Data Analyzer" window to the occupation. 2. Select the date and UID wants to be generate graph. 3. Click the "OK" button. 4. The use case end.
EXTENSIONS	5. A) The Data not available, The system displays an error message.

5.5 Class diagram

Class diagram shown below depict the classes that are used in MSA. Since the entire FEM module is a software based solution and shown below is the entire class diagram of FEM module.

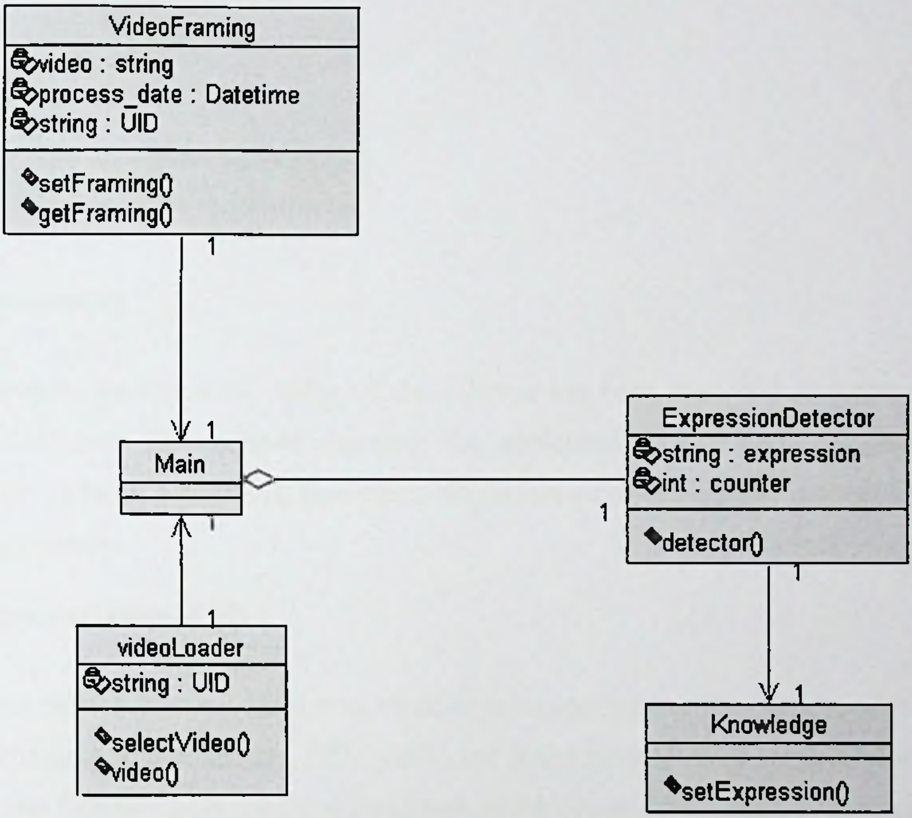

Figure 5.3: Class diagram of the FEM module

5.6 Summary

Chapter 5 was dedicated on the system analysis and designing of MSA. Section 5.2 covered the top level architecture of MSA. In section 5.3 showed how the overall system structure by using use case. Section 5.4 presented the class diagram of the FEM module. Next chapter is on the implementation of MSA and we will be covering the implementation details of each module discussed under this chapter (chapter 5) there.

Chapter 6

Implementation of MSA

6.1 Introduction

In chapter 5, the top level design of the solution has been described in terms of what each component does. This chapter describes the implementation of each component regarding hardware, software algorithms, flow charts etc. In that sense this chapter is about how the system is implemented.

6.2 Implementation of MSA

MSA has been implemented to run on windows operating system. The overall design of the system include three modules, namely, FEM, HRM and RAM module. Each modules developed on the top of .Net framework platform and it has been develop with C# language. Moreover each module has specific input variable, process and the output. Let's discuss the individual module in detail.

6.2.1 Implementation of FEM

This is the one of the module that detect and identify the facial expression in MSA. The module developed using .Net framework and integrated some third party libraries to identifying the human face and facial expression (OpenCV.dll, Emgu.CV.dll) [14][15]. FEM module implementation based on the skin color segmentation and three detection, namely, face detection, eyes detection, and lips detection.

6.2.1.1 Skin color segmentation

Initially contrast the detected image and perform skin color segmentation, is shown in figure 6.2. Then, we have to find the largest connected region of the detected image. Also checked the probability to become a face of the largest connected region. If the largest connected region has the probability to become a face, if the largest connected regions height and width is larger or equal than 50 and the ratio of height/width is between 1 to 2 then it may be face.

Figure 6.2: skin color segmentation

6.2.1.2 Face detection

To find a continuous white pixels after a continuous black pixel should be scan the detected image. Then classify the maximum width of the white pixel by searching vertical both left and right site. If new width is smaller half of the previous maximum width, then break the scan because if we reach the eyebrow then this situation will arise. Then we cut the face from the starting position of the forehead and its high will be 1.5 multiply of its width X will be equal to the maximum width of the forehead. After the above process, will have an image which will contain only eyes, nose and lip.

6.2.1.3 Eyes detection

For eyes detection, convert the RGB face to the binary face. Now, we consider the face width as W. Then scan from the W/4 to (W-W/4) to find the middle position of the two eyes. The highest white continuous pixel along the height between the ranges is the middle position of the two eyes. Then identify the starting high or upper position of the two eyebrows by searching vertical. For left eye, we search I/8 to mid and for right eye we search mid to I – I/8. Here I is the width of the image and mid is the middle position of the two eyes. There may be some white pixels between the eyebrow and the eye. To make the eyebrow and eye connected, we place some continuous black pixels vertically from eyebrow to the eye. For left eye, the vertical black pixel-lines are placed in between mid/2 to mid/4 and for right eye the lines are in between mid+(I-mid)/ 4 to mid+3*(I-mid)/ 4 and height of the black pixel-lines are from the eyebrow starting height to (h-eyebrow starting position)/4. Here also I is the width of the image and mid is the middle position of the two eyes and h is the height of the image. Then we find the lower position of the two eyes by searching black pixel vertically. For left eye, we search from the mid/4 to mid - mid/4 width. And for right eye, search mid + (w-mid)/ 4 to mid+3*(I- mid)/ 4 width from image lower end to starting position of the eyebrow. Then we find the right side of the left eye by searching black pixel horizontally from the mid position to the starting position of black pixels in between the upper position and lower position of the left eye. And left side for right eye we search mid to the starting position of black pixels in between the upper position and lower position of right eye. The left side of the left eye is the starting width of the image and the right side of the right eye is the ending width of the image. See the code segment for Appendix D and Appendix F, shown below. Finally separate the upper position, lower position, left side and the right side of the two eyes from the RGB image.

6.2.1.4 Lip detection

For lip detection, determine the lip box. And consider that lip must be inside the lip box. So, initially determine the distance between the forehead and eyes. Then add the distance with the lower height of the eye to determine the upper height of the box which will contain the lip. Now, the starting point of the box will be the 1/4 position of the left eye box and ending point will be the 3/4 position of the right eye box. And the ending height of the box will be the lower end of the face image. So, this box will contain only lip and may some part of the nose. Finally separate the RGB image according the box.

Identify the emotion of the face, draws bezier curve for eyes & lips [19]. Then it compares the bezier curve of eyes and lips to the bezier curves of eyes & lips that are stored in the database. If the finds the nearest bezier curve from the database & gives that database stored bezier curve emotion as this image emotion.

6.2.2 Implementation of HRM Module

This is the one of the module that detect and measure the human heart rate in MSA. According to the American Heart Association (AHA) [12]. For adults 18 and older, a normal resting heart rate is between 60 and 100 beats per minute (bpm), depending on the person's physical condition and age. For children ages 6 to 15, the normal resting heart rate is between 70 and 100 bpm, according to the AHA.

Wearable sensible device useful to calculate the heart rate variation in automatically. Wireless Heart Rate Monitor Chest Strap, is one of a special sensible device can monitor heart rate work under both modes.

1) Online Mode: Bluetooth heart rate belt keeps connecting with the Bluetooth mobile phone or PC, and transmits data to mobile or PC in real time.
2) Offline Mode: It means when the heart rate belt doesn't connect to Bluetooth mobile phone or PC. It will collect a variety of heart rate & other data and save them automatically.

Furthermore part of the module HRM is developed using .Net framework and integrated some third party libraries.

Figure 6.3: Wireless Heart Rate Monitor Chest Strap Watch Fitness Belt

6.2.3 Implementation of RAM Module

This is the one of the module that analyze the collected data by using various parameters. The module developed using .Net framework, Microsoft chart and integrated some third party libraries to analyze the human facial expression and the heart rate, is shows in figure 6.4 and 6.5

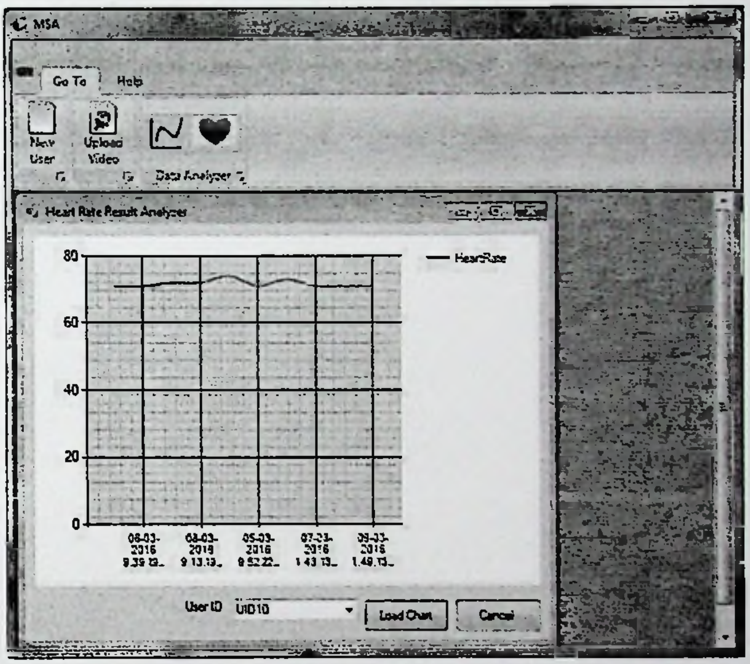

Figure 6.4: Heart rate analyzer

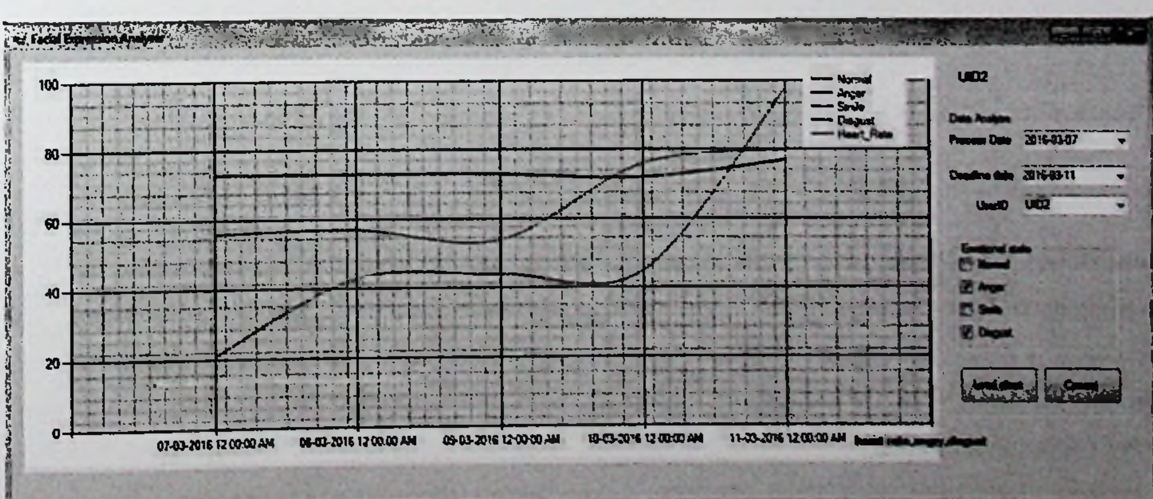

Figure 6.5: Facial expression analyzer

6.3 Summary

As we have mentioned in the introduction of this chapter, it covered the implementation details of MSA. In section 6.2.1 it looked at the implementation details of FEM module. Section 6.2.2 concentrated on HRM module. Section 6.2.3 covered the implementation details of RAM module. Next this will be looking at the evaluation details of MSA in chapter 7.

Chapter 7

Evaluation of MSA

7.1 Introduction

Chapter 6 presented the implementation details of the MSA. Evaluation of the project MSA will be discussed under this chapter. Furthermore chapter describes how the software solution is tested in terms of uses, test cases and the testing strategies. This dissertation will be discussing on the experimental design of MSA in section 7.2. It will describe section of participants under section 7.3. Interview techniques will be discussed under section 7.4. Since MSA is a physiological base research project, the evaluation is done in a different manner than a normal development task. Development testing was done by the developer and it followed white box testing paradigm. Moreover experimental testing was done by occupations and it followed black box testing paradigm.

7.2 Evaluation strategy/mechanism

To evaluate the performance of the developed system, we collected data and carried out quantitative experimental evaluation. The data collection strategy and the collected results are justified in this section.

7.3 Data Collection

Two data sets were recorded to evaluate stress detection. Set 1 was recorded in a workplace with the web camera placed on a desk in front of the recorded subjects. Before starting the experiment, the stress detection questionnaire was distributed. The distributed questionnaire can be referred to in Appendix C, below. It is a useful way to gather their present health, status and get a momentary understand about their stress level. This data is collected in an unobtrusive environment. Furthermore, the recorded video were used for model adaptation in the later experiments. Each recording captures 30 minutes of video with a resolution of 480*640. In total 20 subjects were recorded in set 1.

Set 2 was recorded with heart rate monitoring wearable device, where the Heart Rate Monitor Chest Strap placed exactly as illustrated Figure 6.3. This data also collected unobtrusive environment and same subjects were involved.

7.4 Selection of Participants

The data was collected from 20 healthy subjects and we analyzed the self-reported stress data and questionnaire results for a period of more than one week. We chose to recruit participants from two different departments located in the same company. The study involved 18 males and 2 females aged between 30 to 40 years. Participants were informed that the main purpose of the experiment was to monitor facial expressions and pulse rate relevant to the stress related research. Furthermore, they were informed that all the collected data was unobtrusive, not harmful to the body, anonymous and will be used for research purposes only.

7.5 Interview Techniques

The Interview tool was a questionnaire. A questionnaire is a research instrument consisting of a series of questions and other prompts for the purpose of gathering information from responses. Before starting the experiment, stress detection questionnaire was distributed. See the distributed questionnaire for Appendix C, below. See the gathered results for Appendix G, below.

7.6 Experimental Results

This section illustrates results of the experiments and developments conducted during the evaluation and testing period. Furthermore experimental results are tested and evaluated under the objectives we highlighted.

7.6.1. Identifying variation of the facial expressions and heart with project deadline

MSA is a proficient of identify specific facial emotional states (e.g. normal, smile, anger, disgust) and heart rate variation with project deadline. The reviews determine anger and disgust, against the rest of the emotions within the days remaining to project deadline. Also our first questionnaire results and past observations were highlighted anger and the disgust is the negative basic stress related emotions.

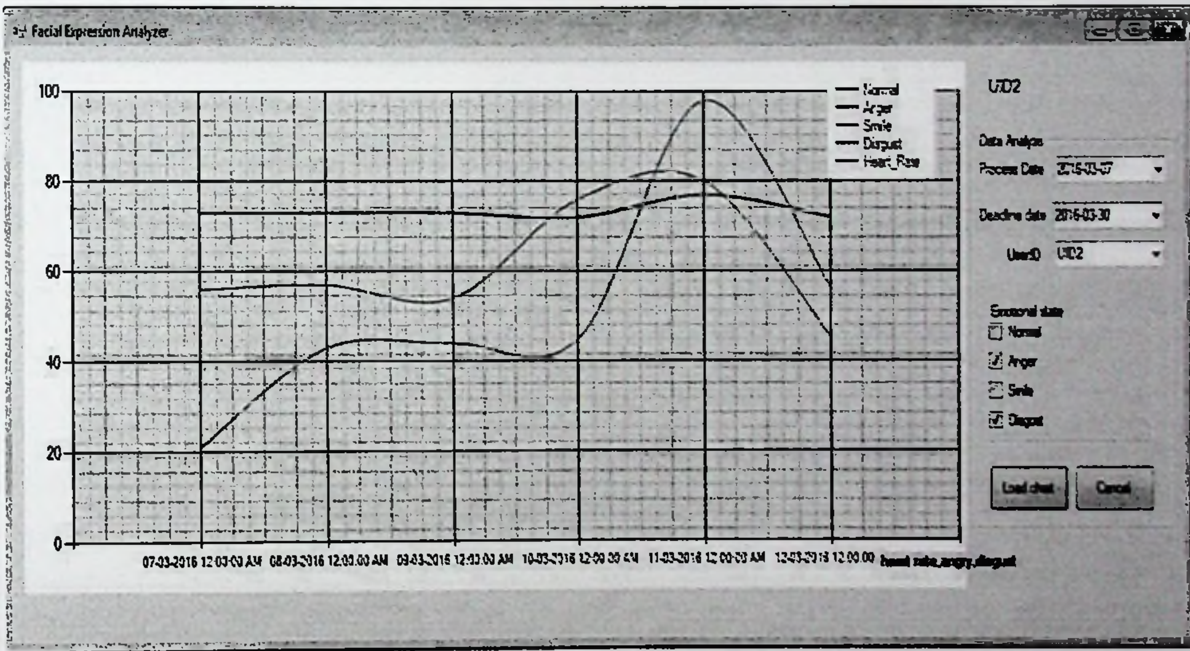

Figure 7.6.1: Anger, disgust and heart rate variation with project deadline

Figure 7.6.1 shows the results for the anger, disgust and heart rate variation with number of days remaining to project deadline. The graph shows highlighted emotions with heart rate becoming increased when close to the project deadline.

7.6.2. Identifying co-relation between anger, disgust and heart rate effecting with the stress level changed.

Average anger summary of the occupations- (Date of the Deadline AVG day 11)								
User ID	AVG day05	AVG day06	AVG day7	AVG day8	AVG day9	AVG day10	AVG day11	Average anger for 7 days
UID1	112	12	86	21	44	70	100	63
UID2	23	76	21	43	44	45	58	50
UID3	72	76	54	53	97	65	170	83
UID4	75	65	43	34	53	75	38	63
UID5	50	54	42	34	54	45	70	63
UID6	65	35	46	54	65	57	100	60
UID7	78	38	24	56	75	45	67	54
UID8	76	58	24	32	54	54	87	55
UID9	45	48	46	25	98	65	76	57
UID10	58	92	65	44	58	57	67	68
UID11	48	34	56	35	63	34	78	49
UID12	45	76	34	56	65	43	65	54
UID13	40	43	67	54	68	72	76	55
UID14	40	87	87	24	75	76	85	62
UID15	46	34	42	76	56	75	75	57
UID16	23	32	78	46	87	67	78	58
UID17	21	76	67	65	65	65	88	61
UID18	34	45	46	76	81	56	71	58
UID19	32	35	46	46	21	54	78	44
UID20	43	35	34	56	45	23	23	37
Average score result group wise	51.3	52.55	50.4	46.5	65.45	57.2	82.5	57.55

Figure 7.6.2: Number of anger expression arise at the given period, with and without project deadline

Figure 7.6.2 shows the summary result of anger expression vary with and without project deadline. The data was collected from 20 healthy subjects. Moreover this figure illustrates the average anger expression from each experimental day. Note that highlighted experimental days includes project deadline date also. For evaluating the above result set, higher average result will score from the date of project deadline comparing with other experimental days.

Average Disgust summary of the occupations- (Date of the Deadline AVG day 11)								
User ID	AVG day05	AVG day06	AVG day7	AVG day8	AVG day9	AVG day10	AVG day11	Average disgust for 7 days
UID1	93	41	47	83	53	90	71	68
UID2	14	34	56	57	54	76	80	53
UID3	84	54	86	12	36	87	73	54
UID4	69	34	36	76	23	35	65	48
UID5	71	86	38	64	25	31	90	57
UID6	72	67	67	23	87	75	71	66
UID7	70	34	56	21	35	77	89	54
UID8	45	87	87	87	47	73	65	70
UID9	50	39	32	76	78	87	56	59
UID10	97	21	23	52	35	76	35	56
UID11	82	76	33	21	65	53	98	61
UID12	87	75	22	35	56	56	87	59
UID13	45	18	86	24	75	61	97	58
UID14	35	24	35	65	91	54	86	55
UID15	86	53	45	34	76	64	87	63
UID16	31	65	66	86	43	45	98	62
UID17	34	47	43	76	56	63	90	58
UID18	87	86	64	45	54	43	88	66
UID19	86	32	64	32	76	56	98	63
UID20	39	86	86	87	38	45	75	63
Average score result group wise	63.85	52.95	53.6	52.8	55.15	62.6	82.9	59.75

Figure 7.6.3: Number of disgust expression arise at the given period, with and without project deadline

Figure 7.6.3 shows the summary result of disgust expression variation with and without project deadline. The data was collected from same 20 healthy subjects as previous experiment. Furthermore this figure also illustrated that average disgust expression arise from each experimental day with project deadline. For evaluating the above result set, we can identify that the higher average result will score under the project deadline date comparing with other experimental days.

Average heart rate summary of the occupations- (Date of the Deadline AVG day 11)								
User ID	AVG day05	AVG day06	AVG day7	AVG day8	AVG day9	AVG day10	AVG day11	Average pulse rate for 7 days
UID1	71	71	72	72	74	71	75	72.285714
UID2	73	73	73	73	73	72	77	73.428571
UID3	71	70	74	72	71	72	74	72
UID4	74	72	70	71	71	73	76	72.428571
UID5	73	71	73	70	71	71	72	71.571428
UID6	71	72	74	69	71	72	72	71.571428
UID7	72	70	71	76	73	71	73	72.285714
UID8	75	72	70	75	75	72	72	73
UID9	72	73	71	72	73	72	74	72.428571
UID10	71	73	71	71	71	73	74	72
UID11	71	72	72	73	71	73	72	72
UID12	75	70	71	74	72	71	73	72.285714
UID13	73	74	74	76	74	70	74	73.571428
UID14	70	73	75	72	73	72	74	72.714285
UID15	70	71	72	71	77	72	73	72.285714
UID16	75	72	76	71	74	72	74	73.428571
UID17	72	71	70	71	71	71	75	71.571428
UID18	71	73	71	70	70	72	74	71.571428
UID19	71	70	72	76	72	72	76	72.714285
UID20	71	72	71	76	71	71	75	72.428571
Group wise Total average	72.1	71.75	72.15	72.55	72.4	71.75	73.95	72.37857105

Figure 7.6.4: Average pulse rate arise at the given period, with and without project deadline

Figure 7.6.4 shows the summary result of average pulse rate vary with and without project deadline. The data was collected from same 20 healthy subjects as previous experiment. Moreover this figure also illustrated that average pulse rate vary from each experimental day with project deadline date. For evaluating the above result set, we can identifying that the higher average result will score under the date of the project deadline comparing with other experimental days.

User ID	day05	day06	day7	day8	day9	day10	day11	Avg result score for individual
UID1	4	4	3	4	3	4	4	3.714285714
UID2	3	4	4	4	4	4	4	3.857142857
UID3	4	3	3	4	4	5	3	3.714285714
UID4	4	3	3	4	4	5	3	3.714285714
UID5	3	3	4	3	3	3	4	3.285714286
UID6	4	3	4	3	3	4	4	3.571428571
UID7	3	3	3	4	3	3	5	3.428571429
UID8	4	4	4	3	3	4	4	3.714285714
UID9	3	3	4	4	4	4	5	3.857142857
UID10	4	3	3	3	4	4	5	3.714285714
UID11	3	3	4	3	3	3	5	3.428571429
UID12	4	4	4	4	3	4	3	3.714285714
UID13	3	3	3	3	4	4	4	3.428571429
UID14	3	4	3	4	3	3	5	3.571428571
UID15	3	4	4	3	4	3	3	3.428571429
UID16	3	3	3	4	3	4	4	3.428571429
UID17	3	4	3	3	3	5	5	3.714285714
UID18	4	3	3	3	4	4	5	3.714285714
UID19	4	4	4	3	3	4	4	3.714285714
UID20	4	4	3	3	3	4	4	3.571428571
Average score result group wise	3.5	3.45	3.45	3.45	3.4	3.9	4.15	3.614285714

Figure 7.6.5: Average stress level rates allocation at the given period, with and without project deadline

Figure 7.6.5 shows observations for the questionnaire. Before starting the system evaluation, stress detection questionnaire was distributed. See the distributed questionnaire for Appendix C, below. The questionnaire result was collected from 20 healthy subjects per day as previous evaluations. Subjects were allocated rates, based on the stress related statements in the questionnaire. Table 7.1 shows the ratings and the assigned stress level in each proportion.

Table 7.1: represent ratings and assign stress level

Rate	Stress level
1	Low
2	Medium
3	Average medium
4	Average high
5	high

Final evaluation of the above result set, identifying that higher average result will score the date of the project deadline comparing with other experimental days.

SUMMARY OUTPUT	
Regression Statistics	
Multiple R	0.122332309
R Square	0.014965194
Adjusted R Square	-0.169728832
Standard Error	0.174371474
Observations	20

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	0.007390973	0.002463658	0.081026951	0.959337955
Residual	16	0.486486576	0.030405411		
Total	19	0.493877549			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	1.868482721	5.274713738	0.354233957	0.72778534	-9.313410883	13.05037633	-9.313410883	13.05037633
X Variable 1	0.02213641	0.069644172	0.317850137	0.754709316	-0.125502639	0.169775458	-0.125502639	0.169775458
X Variable 2	0.002152717	0.004899907	0.439338342	0.666292181	-0.008234622	0.012540056	-0.008234622	0.012540056
X Variable 3	0.000329915	0.007683973	0.042935456	0.966254218	-0.015959381	0.016619211	-0.015959381	0.016619211

Multiple Linear Regression
Y=(B1*X1)+(B2*X2)+(B3*X3)+A
Y=0.02213641X1+0.002152717X2+0.000329915X3+1.868482721
If X1=72
X2=55
X3=60
Y=(0.02213641*72)+(0.002152717*55)+(0.000329915*60)+1.868482721
Y=3.600498576

Figure 7.6.6: Multiple Linear Regression Testing

As a predictive analysis, the multiple linear regression is used to explain the relationship between one continuous dependent variable from two or more independent variables. In this regression testing, attempts to model the relationship between three variables (anger, disgust, heart rate) and a response variable (stress level) by fitting a linear equation to observed data. Every value of the independent variables is associated with a value of the dependent variable. Observation are 20 participants. To test whether the difference in means is statistically significant we can perform analysis of variance (ANOVA) using the R function. Studying the output of the ANOVA table in above, we see that the F-statistic is 0.081. Therefore we cannot ignore that the null hypothesis of stress level can be detected by using three variables (anger, disgust and heart rate). That means stress level changes is statistically equal for angry, disgust and heart rate. Final predicted value will highlighted at the end.

7.7 Summary

This chapter looked at the evaluation of the project MSA. Section 7.2 was on evaluation strategy, while section 7.3 was on data collection of MSA. Selection of participants highlighted under the section 7.4. The interviewing techniques that it has used in the evaluation process were described under the section 7.5. Finally under the section 7.6, it was shown the experimental results. In next chapter this dissertation will be discussing on the overall achievements of the project aims and objectives. It will be highlighting about the problems encountered, limitations of MSA and some further work as an extension to current work.

Chapter 8

Conclusion and Further work

8.1 Introduction

Chapter 7 presented the Evaluation of the MSA. This chapter describes the overall achievement of the project in quantitative terms under the section 8.2. Section 8.3 will elaborate on further works. It will be talking about the problems encountered and the limitations of its solution under the section 8.4.

8.2 Overall achievements of MSA

Work stress is recognized world-wide as a major challenge to workers' health and the healthiness of their organizations. Workers who are stressed also more likely to be unhealthy, poorly motivated, less productive and feel less safe at work. It's important to figure out what causes stress in our personal life. Furthermore tracking stress can help identify the causes and severity of the stress experienced by an individual. Then, actions can be taken to reduce the stress or handle it better.

Monitoring Occupational Stress and Analysis by Capturing Facial Expressions and Heart Rate (MSA) is developed for those individuals who have difficulty in managing their stress level at the work place. The information requirements related to MSA are collected mainly through the literature survey and questionnaires.

The main intention is to gather information from previously carried out research work to study their methodologies, features, and achievements which should be functioning in a stress monitoring system. In the literature survey, we found similar researches carried out in this problem domain. We planned to develop a similar kind of system but my aim is to analyzing monitored records from each parameters, mapping with stress level and identifying co-relation with considering two parameters.

At the end of the questionnaire, two detectable and measurable parameters of stress were identified. System design and development is based on detecting stress by support with those parameters. It is planned in four phases; questionnaire, facial expression module, heart rate module and result analyzer. The system is developed as a standalone application. Interactive user interfaces are used in the system where the individuals have to enter the detected result. All the phases are successfully completed as expected at the beginning.

8.3 Further work

We believe it is necessary to investigate further the definition and subject dependent characteristics of emotional stress. Furthermore expected to increase the performance of the time duration in video framing. To assess the detection performance, we expected to run experiment on number of individuals within the work place at multiple times.

8.4 Problems encountered and Limitations

It was difficult to find the requested subjects at the initiation of the project. But with the support of the staff of the company, we were able to increase the performance to some extent.

The solution is only workable under the machines installed .NET platform and expensiveness of the sensible devices, are the limitations of this project.

Due to the time, scope and technical barriers; assumptions, dependencies and research constraints will be considered. The main dependency through this research is the accuracy of the external devices.

8.5 Summary

This chapter was dedicated on discussing the achievements and the further work on MSA. Under the section 8.2 this report discussed about the overall achievements of MSA. Some further works were listed down under the section 8.3. Section 8.4 of this report discussed about the limitations of the MSA.

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Appendix A- Questionnaire

QUESTIONNAIRE

This questionnaire is prepared for my educational purposes. The answers will be treated as confidential and anonymous.

Gender: [ ] Male [ ] Female

Department: [ ] HR [ ] Finance [ ] IT [ ] ....

Please circle a number on each line to indicate how much you agree or disagree with each of the following statements.

1	Strongly agree
2	Agree
3	Neither agree or disagree
4	Disagree
5	Strongly disagree

S.No	Statement	Ratings				
1	I have lot of responsibilities in my job	1	2	3	4	5
2	There are interruptions and disturbances in my job	1	2	3	4	5
3	I have constant time pressure due to heavy workload.	1	2	3	4	5
4	I have unpredictable working hours	1	2	3	4	5
5	Work stress is a factor in health problems	1	2	3	4	5
6	Work stress always bad	1	2	3	4	5
7	My stress is affected by project deadlines	1	2	3	4	5
8	Stress affects my mood at the workplace	1	2	3	4	5
9	My behavior in the workplace is affected by stress	1	2	3	4	5

Please answer the following questions.

1. How do you feel when facing stress in your workplace? (Please circle all applicable descriptions)

PSYCHOLOGICAL SIGNS	EMOTIONAL SIGNS
1. Inability to concentrate or make simple decisions 2. Memory lapses 3. Becoming rather vague 4. Less intuitive & creative 5. Worrying 6. Negative thinking 7. Depression & anxiety	1.Tearful 2. Irritable 3. Mood swings 4. Extra sensitive to criticism 5. Feeling out of control 6. Lack of motivation 7. Anger 8. Lack of self-esteem
PHYSICAL SIGNS 1. Aches/pains & muscle tension/grinding teeth 2. Frequent colds/infections 3. Allergies/rashes/skin irritations 4. Weight loss or gain 5. Panic attacks 6. Physical tiredness 7. Increase heart rate /high blood pressure	BEHAVIOURAL SIGNS 1. No time for relaxation or pleasurable activities 2. Increased reliance on alcohol, smoking, caffeine, recreational or illegal drugs 3. Becoming a workaholic 4. Poor time management and/or poor standards of work 5. Absenteeism 6. Self-neglect/change in appearance 7. Social withdrawal 8. Aggressive/anger outbursts 9. Nervous

2. Describe how you manage occupational stress during your working hours.

Appendix B-Survey Result

Table B.1-survey I

	Strongly agree	Agree	Neither agree or disagree	Disagree	Strongly disagree
My Stress is affected by project deadlines.	0%	56%	34%	3%	6%
Work stress is a factor in health problems.	22%	31%	12%	34%	0%
I have lot of responsibilities in my job	41%	41%	19%	0%	0%
There are interruptions and disturbances in my job.	3%	34%	41%	22%	0%
I have constant time pressure due to heavy workload.	6%	28%	28%	34%	0%
I have unpredictable working hours.	3%	3%	25%	25%	6%
Work stress always bad.	3%	31%	12%	25%	9%
Stress affects my mood at the workplace.	3%	60%	18%	16%	3%
My behavior in the workplace is affected by stress.	9%	47%	25%	12%	6%

PSYCHOLOGICAL SIGNS	**RESULT**	**Percentage**
Inability to concentrate or make simple decisions	9	28%
Memory lapses	6	19%
Becoming rather vague	4	12%
Less intuitive & creative	9	28%
Worrying	13	40%
Negative thinking	6	18%
Depression & anxiety	9	28%

EMOTIONAL SIGNS	5	16%
Irritable	4	12%
Mood swings	6	19%
Extra sensitive to criticism	1	3%
Feeling out of control	13	40%
Lack of motivation	14	44%
Anger		

Lack of self-esteem	3	9%

PHYSICAL SIGNS

Aches/pains & muscle tension/grinding teeth	1	3%
Frequent colds/infections	3	9%
Allergies/rashes/skin irritations	1	3%
Weight loss or gain	4	12%
Panic attacks	9	28%
Physical tiredness	13	40%
Increase heart rate /high blood pressure	8	25%

BEHAVIOURAL SIGNS

No time for relaxation or pleasurable activities	16	50%
Increased reliance on alcohol, smoking, caffeine, recreational or illegal drugs	1	3%
Becoming a workaholic	6	19%
Poor time management and/or poor standards of work	14	44%
Absenteeism	2	6%
Self-neglect/change in appearance	5	16%
Social withdrawal	6	19%
Aggressive/anger outbursts	9	28%
Nervous	7	22%

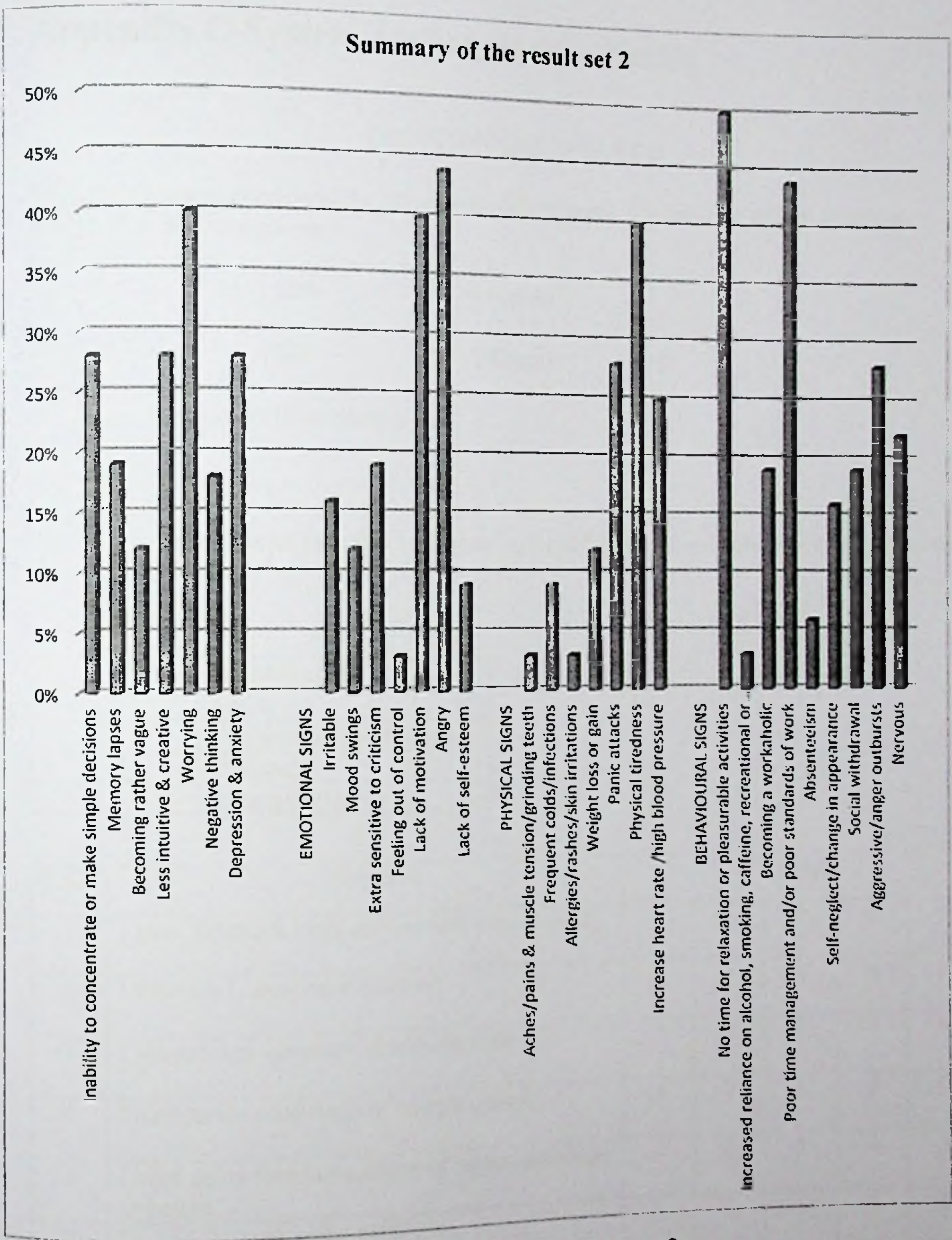


Figure B.1: Summary of the result set 2

Appendix C-System Testing Survey Result

QUESTIONNAIRE- PART II

This questionnaire is prepared for my educational purposes. The answers will be treated as confidential and anonymous.

Gender: [ ] Male [ ] Female

Department: [ ] HR [ ] Finance [ ] IT [ ] ....

Due date of the project (If available): ....

Date of participate: ....

Please circle a number on each line to indicate how much you agree or disagree with each of the following statements.

1	Strongly agree
2	Agree
3	Neither agree or disagree
4	Disagree
5	Strongly disagree

S.No	Statement	Ratings				
1	I have too much work and too little time to do it	1	2	3	4	5
2	I feel like I never have a day off	1	2	3	4	5
3	I haven't any symptom of a health issue	1	2	3	4	5
4	I have never used drugs or energetic drink	1	2	3	4	5
5	I have never face heart failure or related problems in before.	1	2	3	4	5
6	I regularly work under pressure.	1	2	3	4	5
7	I regularly feel tired, depressed, and anxious	1	2	3	4	5
8	Testing this system does not interfere my current work	1	2	3	4	5

Please answer the following questions.

3. Describe how you manage occupational stress during your working hours.

4. Any comment of this project

Appendix D- Bit map of the left eye

```
public Bitmap left_eye(Bitmap b)
        {

            b = black_white(b);
            int i, j, max, x, h, w, y;
            max = 0;
            x = 0;

            h = b.Height;
            w = b.Width;
            y = h - 1;
            for (i = 2; i < 2 * h / 3; i++)
            {
                for (j = 0; j < w; j++)
                {
                    if (b.GetPixel(j, i).R == 0 && b.GetPixel(j, i).G == 0 &&
b.GetPixel(j, i).B == 0)
                        break;
                }
                if (j == w)
                    j = w - 1;
                if (max <= j && j != 0)
                {
                    max = j;
                    x = i;
                }
                if (i >= h / 2 && j < w / 3)
                    break;
            }

            for (i = h - 1; i >= h / 2; i--)
            {
                int count = 0;
                for (j = w / 4; j <= 3 * w / 4; j++)
                    if (b.GetPixel(j, i).R == 0 && b.GetPixel(j, i).G == 0 &&
b.GetPixel(j, i).B == 0)
                        count++;
                if (count * 2 >= w / 2)
                    break;
            }
            if (i != h - 1)
                y = i + 1;

            int le_1 = 0, ri_1 = w - 1, ttt = 0;
            ttt = 0;
            for (j = 0; j < w; j++)
            {
                for (i = 0; i < h; i++)
                    if (b.GetPixel(j, i).R == 0 && b.GetPixel(j, i).G == 0 &&
b.GetPixel(j, i).B == 0)
                    {
                        ttt = 1;
                        break;
                    }
```

```
        if (ttt == 1)
        {
            le_1 = j;
            break;
        }
    }
    ttt = 0;
    for (j = w - 1; j >= 0; j--)
    {
        for (i = 0; i < h; i++)
            if (b.GetPixel(j, i).R == 0 && b.GetPixel(j, i).G == 0 &&
b.GetPixel(j, i).B == 0)
            {
                ttt = 1;
                break;
            }
        if (ttt == 1)
        {
            ri_1 = j;
            break;
        }
    }

    ttt = 0;
    for (i = x; i < y; i++)
    {
        for (j = w / 4; j < w - w / 4; j++)
            if (b.GetPixel(j, i).R == 0 && b.GetPixel(j, i).G == 0 &&
b.GetPixel(j, i).B == 0)
            {
                ttt = 1;
                break;
            }
        if (ttt == 1)
        {
            x = i;
            break;
        }
    }

    ttt = 0;
    for (i = y; i >= x; i--)
    {
        for (j = w / 4; j < w - w / 4; j++)
            if (b.GetPixel(j, i).R == 0 && b.GetPixel(j, i).G == 0 &&
b.GetPixel(j, i).B == 0)
            {
                ttt = 1;
                break;
            }
        if (ttt == 1)
        {
            y = i;
            break;
        }
    }
```

```
    b = new Bitmap(pictureBox3.Image);
    Bitmap BB = new Bitmap(w - le_1, h - x);

    for (i = le_1; i < w; i++)
        for (j = x; j < h; j++)
            BB.SetPixel(i - le_1, j - x, b.GetPixel(i, j));

    return BB;

}
```

Appendix E- Bit map of the right eye

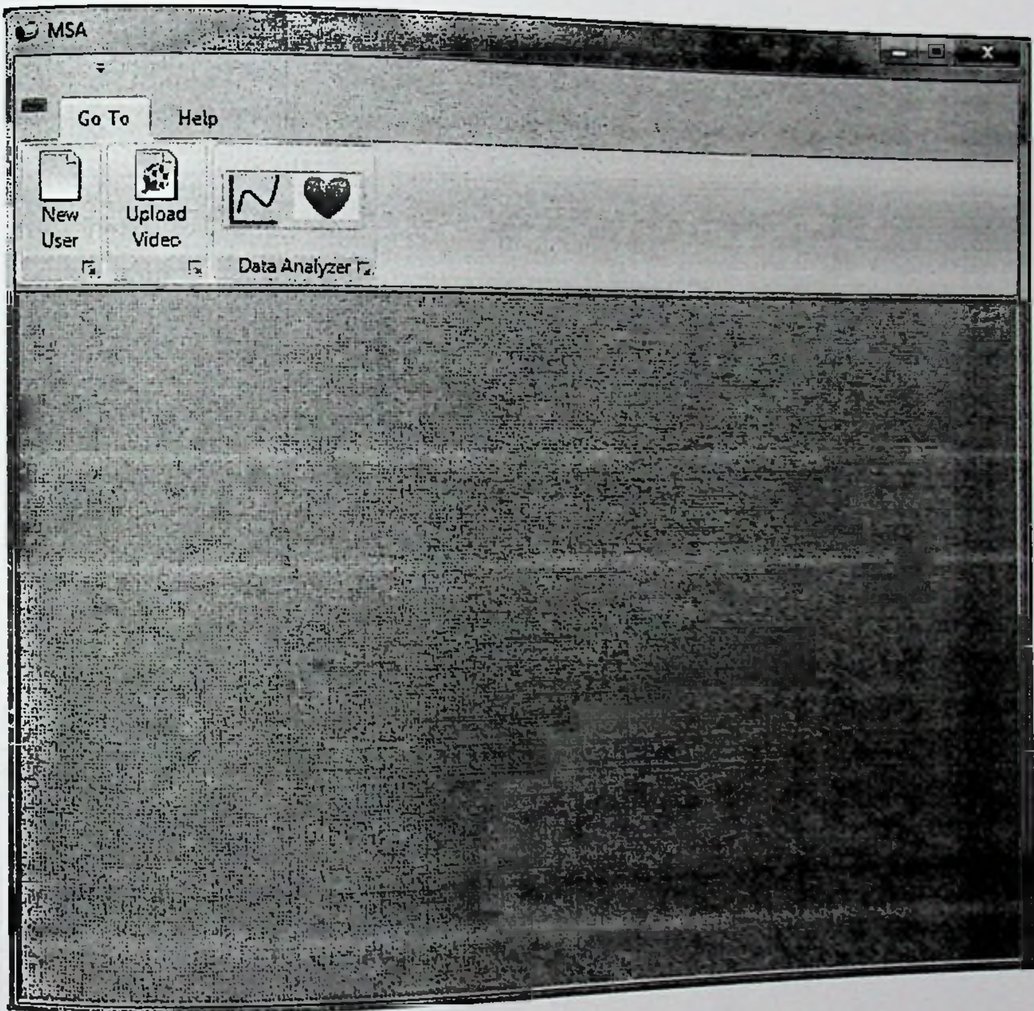
```
public Bitmap right_eye(Bitmap b)
        {

            b = black_white(b);
            int i, j, max, x, h, w, y;
            max = 0;
            x = 0;

            h = b.Height;
            w = b.Width;
            y = h - 1;
            for (i = 2; i < 2 * h / 3; i++)
            {
                for (j = w - 1; j >= 0; j--)
                {
                    if (b.GetPixel(j, i).R == 0 && b.GetPixel(j, i).G == 0 &&
b.GetPixel(j, i).B == 0)
                        break;
                }
                j = w - j;
                if (j == w)
                    j = w - 1;
                if (max <= j && j != 0)
                {
                    max = j;
                    x = i;
                }
                if (i >= h / 2 && j < w / 3)
                    break;
            }

            for (i = h - 1; i >= h / 2; i--)
            {
                int count = 0;
                for (j = w / 4; j <= 3 * w / 4; j++)
                    if (b.GetPixel(j, i).R == 0 && b.GetPixel(j, i).G == 0 &&
b.GetPixel(j, i).B == 0)
                        count++;
                if (count * 2 >= w / 2)
                    break;
            }
            if (i != h - 1)
                y = i + 1;

            int le_1 = 0, ri_1 = w - 1, ttt = 0;
            ttt = 0;
            for (j = 0; j < w; j++)
            {
                for (i = 0; i < h; i++)
                    if (b.GetPixel(j, i).R == 0 && b.GetPixel(j, i).G == 0 &&
b.GetPixel(j, i).B == 0)
                    {
```

```
                    ttt = 1;
                    break;
                }
            if (ttt == 1)
            {
                le_1 = j;
                break;
            }
        }
        ttt = 0;
        for (j = w - 1; j >= 0; j--)
        {
            for (i = 0; i < h; i++)
                if (b.GetPixel(j, i).R == 0 && b.GetPixel(j, i).G == 0 &&
b.GetPixel(j, i).B == 0)
                {
                    ttt = 1;
                    break;
                }
            if (ttt == 1)
            {
                ri_1 = j;
                break;
            }
        }


        ttt = 0;
        for (i = x; i < y; i++)
        {
            for (j = w / 4; j < w - w / 4; j++)
                if (b.GetPixel(j, i).R == 0 && b.GetPixel(j, i).G == 0 &&
b.GetPixel(j, i).B == 0)
                {
                    ttt = 1;
                    break;
                }
            if (ttt == 1)
            {
                x = i;
                break;
            }
        }

        ttt = 0;
        for (i = y; i >= x; i--)
        {
            for (j = w / 4; j < w - w / 4; j++)
                if (b.GetPixel(j, i).R == 0 && b.GetPixel(j, i).G == 0 &&
b.GetPixel(j, i).B == 0)
                {
                    ttt = 1;
                    break;
                }
            if (ttt == 1)
            {
                y = i;
                break;
```

```
        }
    }



    b = new Bitmap(pictureBox4.Image);
    if (x >= y)
        x = y - 2;

    le_1 -= 3;
    if (le_1 < 0)
        le_1 = 0;
    x -= 3;
    if (x < 0)
        x = 0;

    le_1 -= 3;
    if (le_1 < 0)
        le_1 = 0;
    x -= 3;
    if (x < 0)
        x = 0;

    Bitmap BB = new Bitmap(w - le_1, h - x);

    for (i = le_1; i < w; i++)
        for (j = x; j < h; j++)
            BB.SetPixel(i - le_1, j - x, b.GetPixel(i, j));

    return BB;

}
```

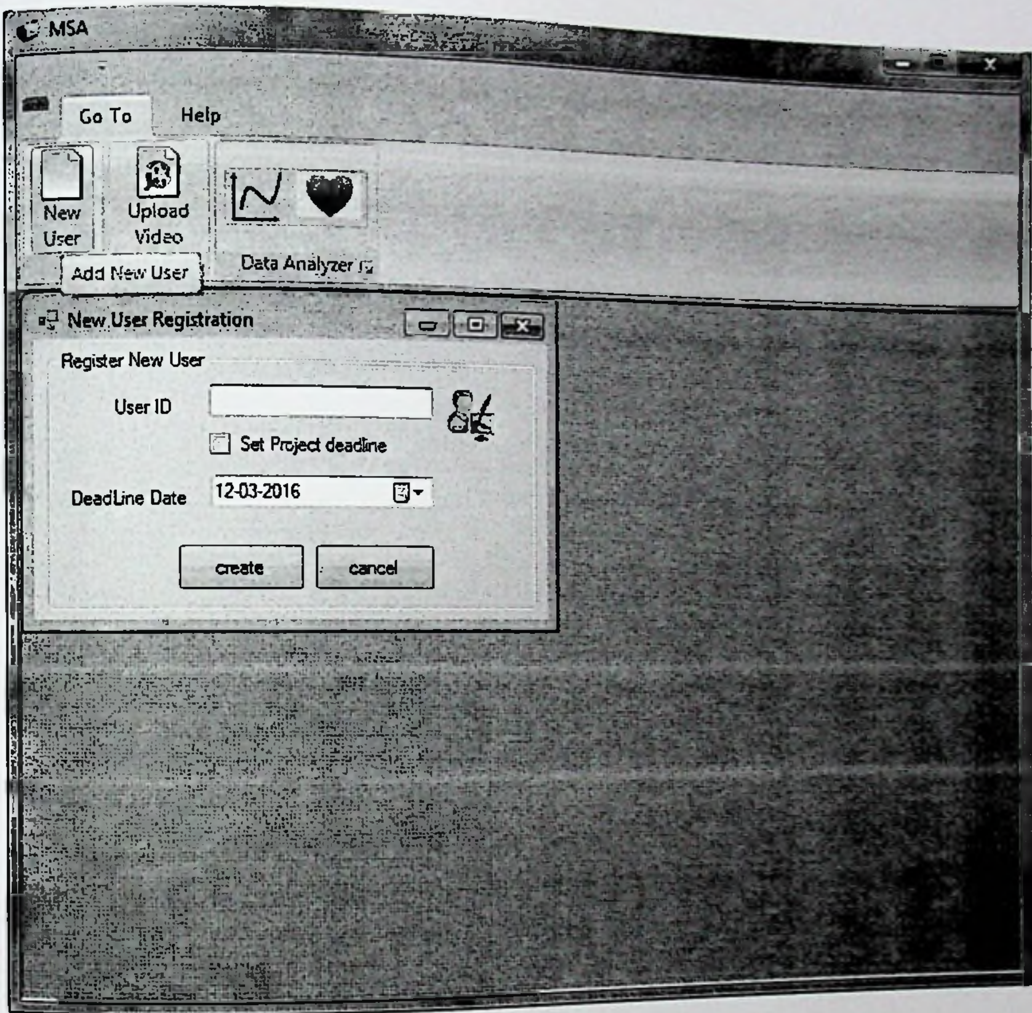
Appendix F- User Interfaces of MSA

F.1 Main User Interface of MSA



F.1: Main User Interface

F.2 New user registration Interface of MSA



F.2: New user Registration

F.3 Upload video Interface of MSA

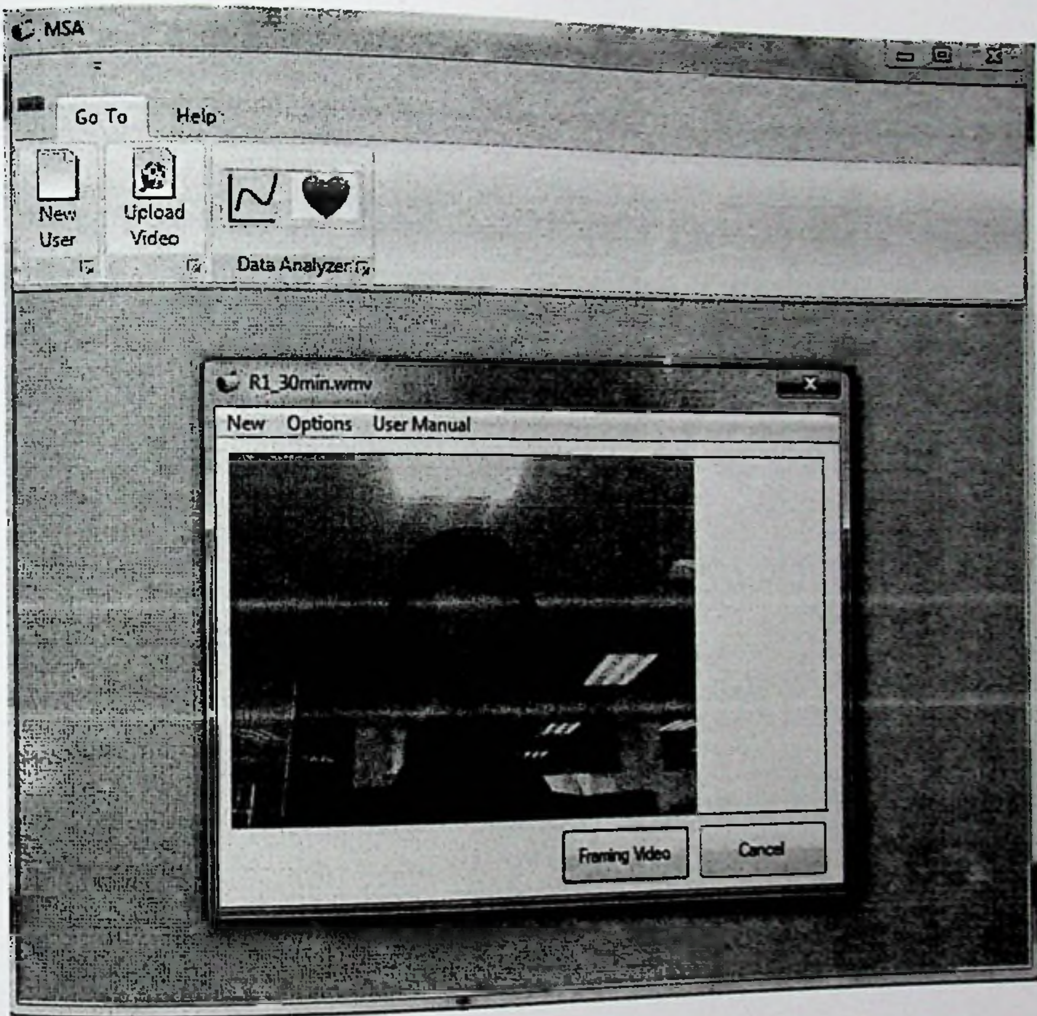


Figure F.3: Upload video

F.4 loading video Interface of MSA

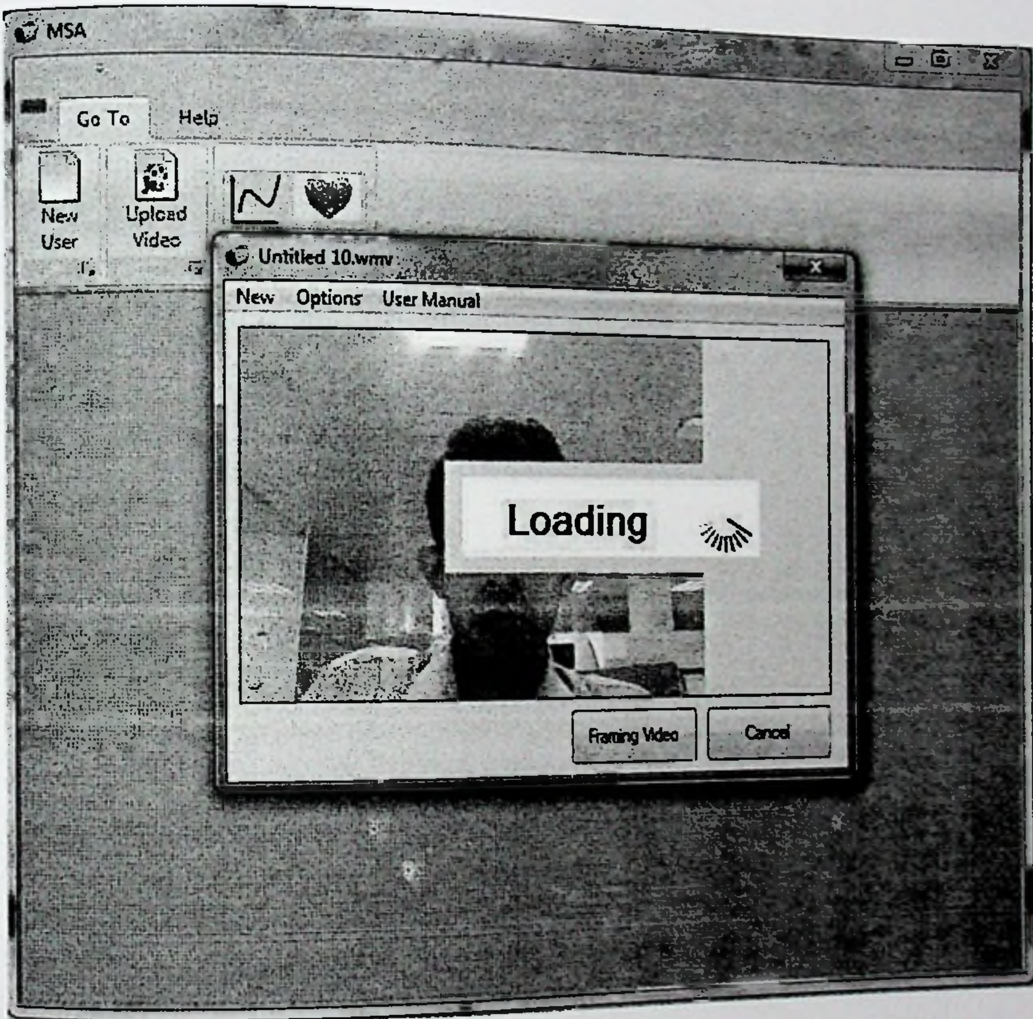


Figure F.4: Loading video

F.5 Facial expression detection Interface of MSA

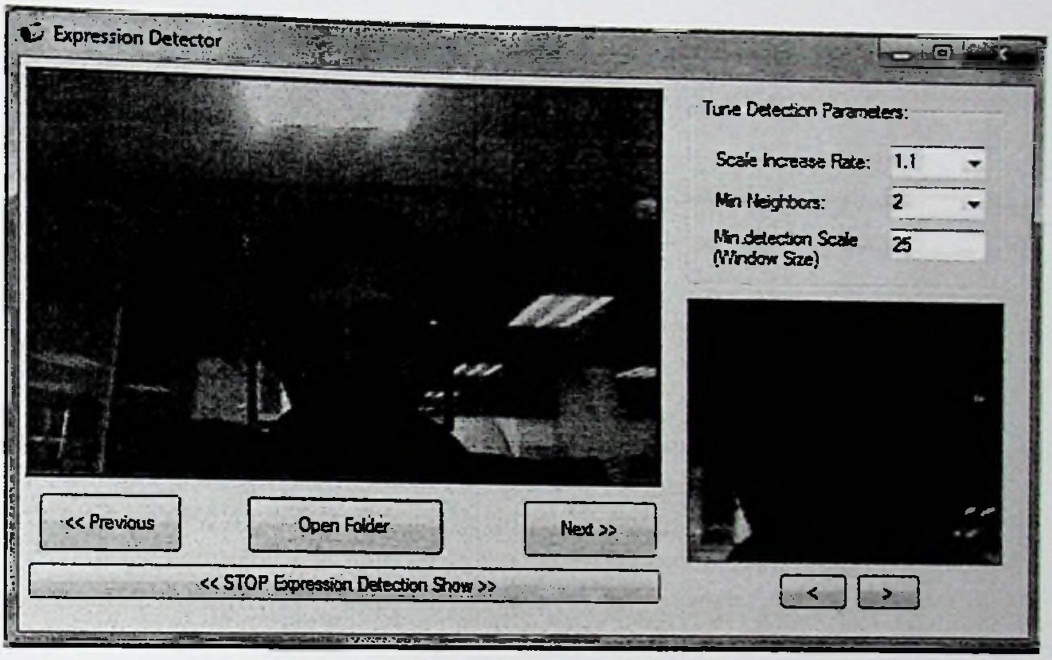


Figure F.5: Facial expression detection

F.6 Facial Expression Analyzer of MSA

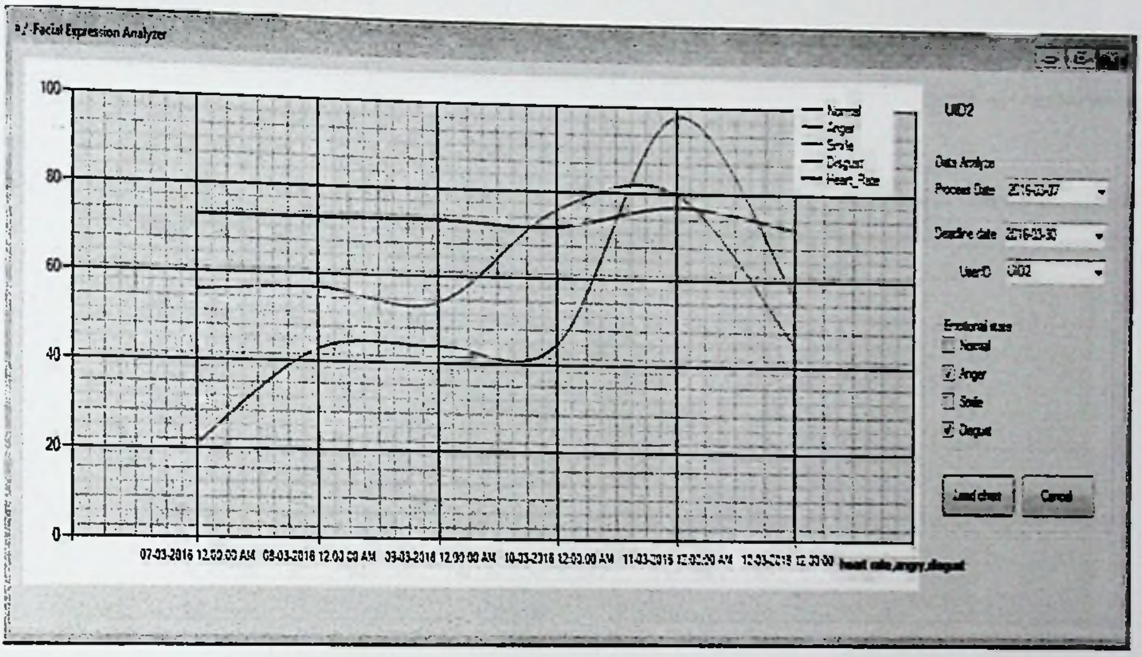


Figure F.6: Facial expression and heart rate analyzer

F.7 Heart Rate Analyzer of MSA

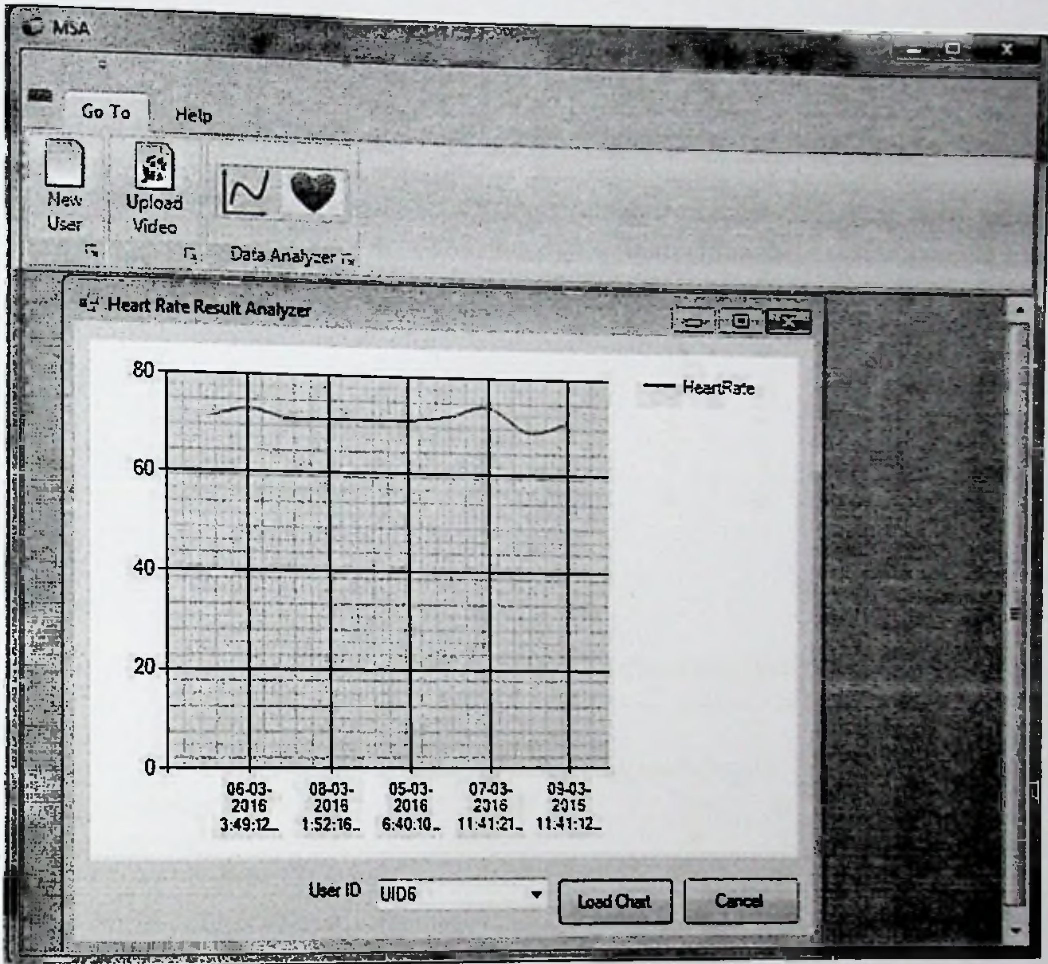


Figure F.7: Heart Rate Analyzer

Appendix G- Survey Results Summary for Stress Level Detection

Table G.1-survey II-with deadline

Statements		Result				
	Project Deadline Date	Strongly agree(%)	Agree(%)	Neither agree or disagree (%)	Disagree(%)	Strongly disagree(%)
I have too much work and too little time to do it	-	35	55	10	0	0
I feel like I never have a day off	-	6	25	54	15	0
I haven't any symptom of a health issue	-	5	95	0	0	0
I have never used drugs or energetic drink	-	8	92	0	0	0
I have never face heart failure or related problems in before.	-	95	5	0	0	0
I regularly work under pressure.	-	5	35	48	12	0
I regularly feel tired, depressed, and anxious	-	0	2	87	11	0
Testing this system does not interfere my current work	-	28	68	4	0	0

Table G.2-survey II-without deadline

Statements		Result				
	Project Deadline Date	Strongly agree(%)	Agree(%)	Neither agree or disagree	Disagree(%)	Strongly disagree(%)
I have too much work and too little time to do it	11-03-2016	40	56	4	0	0
I feel like I never have a day off	11-03-2016	20	45	20	15	0
I haven't any symptom of a health issue	11-03-2016	4	96	0	0	0
I have never used drugs or energetic drink	11-03-2016	10	90	0	0	0
I have never face heart failure or related problems in before.	11-03-2016	15	85	0	0	0
I regularly work under pressure.	11-03-2016	45	52	3	0	0
I regularly feel tired, depressed, and anxious	11-03-2016	0	5	86	9	0
Testing this system does not interfere my current work	11-03-2016	30	65	5	0	0