

**Masters Project Interim Report**

**11th July 2015**

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**This should be your Project Title**

**M. Mayura Prakash Wijeyaratne**

**2015**

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Chapter 1: Introduction

Deadline! This is the one word every employee dreads of hearing. In the modern day where deadlines are inabundance, it has made employees work harder than ever before. Richard Boyatzis, Ph.D. has shown through Neuroimaging that deadlines often limit thinking, can lead to worse decision-making and can increase stress levels [1]. “Stress isn’t always bad, though. Stress within your comfort zone can help you perform under pressure, motivate you to do your best, even keep you safe when danger looms. But when stress becomes overwhelming, it can damage your health, mood, relationships, and quality of life” [2].

What is stress?

Stress is body’s way of responding to any threat by releasing stress hormones, including adrenaline to arouse to make an emergency reaction. This is also called “fight or flight”, this helps you to stay focused energetic and alert [2].

Why do we need stress at a certain level and why is it harmful if it you allow it to overwhelm you?

While, in emergency situations stress can save your life, however having stress all the time and more than your comfort zone will actually be detrimental to your mind and body [2]. Heart disease, sleep problems, depression, weight problems are some harmful effects of having stress for a long period of time at a level than a person can handle. "Over time, if you're constantly in fight-or-flight, if your heart muscles and valves are awash in the epinephrine, it causes changes in the arteries and in the way that cells are able to regenerate,” [3]. Due to the above-mentioned reasons, it is very important for people to maintain their stress level at healthy levels and not be stressful for long periods of time.

Nowadays many professionals interact with computers to do their work. Hence if the computer can detect stress of the employee while they work on the computer it will be very helpful to them.

If we could capture the facial features through the computer and monitor it over time, we could measure the stress level of the user. This would enable the system/computer to indicate to the user if the stress level is above normal healthy levels.

In the field of medical science there are numerous devices that could be used to detect human physiological features. A few of them are Heart Rate Variability (HRV), Blood Volume Pulse (BVP), Variations of Pupil Diameter (PD), Galvanic Skin Response (GSR), Fingertip skin temperature. These equipment need to be attached to the human body in order to gather information about the human body. Sun et.al in there research “Activity-aware Mental Stress Detection Using Physiological Sensors” have used Electrocardiogram (ECG), galvanic skin response (GSR), and accelerometer to gather physiological measurements to derive mental stress classification [13].

With the help of computer peripherals, we could gather some of the human physiological data in a non-invasive manner. Keyboard typing patterns, webcam footage of user/employee, variable pupil diameter using webcam are some of the better non-invasive techniques to measure stress.

In this thesis, I aim to use non-invasive physiological data gathering techniques to collect data from employees who are working in front of the computer for an extended period of time. With the collected data, I attempt to quantify the stress level of each user and indicate to the user if the stress level is rising with time.

1. Motivation

In today’s society stress has become a very big problem. People are getting many stress related illnesses due to working excessive amount of time under stress. In many of the professions the employee is more engaged with the computer to do their day to day work. Therefore the author was motivated to find the stress level of a employee without any interfering devices and to alert the user when the stress level is too high.

1. Problem Statement

Employees have so many tight deadlines to meet in their workplace. They are under constant stress to deliver the work on time. Therefore employees are working under duress for a long period of time and thereby are open to stress related illnesses easily. This has become a major problem in the current society.

In these workplaces, employees are often more engaged with computers to achieve their tight deadlines. They interact more time with the computer during their work hours. Author wants explore the possibility of gathering employee physiological data from a web camera fixed on the computer, and using data gathered the possibility of assessing the state of stress the user is in.

1. Aims and Objectives

The aims and objectives of this research is

1. Model stress index of an employee through non-invasive methods of physiological data gathering. Evaluate the stress index to find the fluctuations in stress over time
2. Investigate and review existing literature relating to non-invasive forms of data gathering, and stress related researches.
3. Using different machine learning techniques to find out what method would yield the better results in finding the person’s stress index.
4. Evaluate the research findings and conclude whether this method could be used the measure the stress level of a person effectively.
5. Scope and Limitations

The video footage used for this research comes from one workplace, and all the professionals are IT professionals. This is mainly due to the fact that, it was difficult to find any publicly available datasets with videos of professionals working in front of a computer.

For the research component, the data was collected as the video recordings. Using standard machine learning techniques part of the videos would be used for training while the other pat would be used for testing purposes. Even though in this research prior recorded videos are used, it could be extended for live video capturing and displaying the level of stress to the user as future work.

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5. Expected Contribution

This research is expected to contribute to the field of computer science in many ways.

Firstly this research will add knowledge about different ways of identifying emotions of a person’s face through machine learning. The research component will be to calculate the stress index through the results that is achieved through emotion identification.

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Summary

Stress has become a major problem in the society today. Most of the individuals encounter stress through frequently working with tough deadlines at work. Many of the professional nowadays engage with the computer to do their daily work, therefore identifying i f a person is stressed through non-invasive methods and notifying them of it will enable them to take necessary actions to reduce their stress.

Hope the summary is good enough

Chapter 2: Background

Researches on stress detection using computers with the help of other devices have been done from the early 2000s. In 2006 a research with the title “Stress recognition using non-invasive technology” by Jing Zhai and Armando Barreto [4] has been done using invasive technologies like Blood Volume Pulse (BVP), Galvanic Skin Response (GSR), Pupil Diameter (PD) and Skin Temperature (ST). The above mentioned technologies are could be categorised as minimal invasive ways of stress recognition. This is because the technology today has developed so much that we could have much more non-invasive methods of recognising stress. Some of those non-invasive techniques in the modern day are key stroke dynamics and pattern variations [3], mouse track movements, web cam footage.

In a research to measure stress on e-learning students [5], the information acquired from key strokes and mouse clicks. Some of the sources of information gathered in this research comprise of click accuracy, click duration, mouse movement and also key strokes. In this research they have made an observation that if the student is stressed backspace key and right shift key will pressed more often.

The above researches are minimal invasive and non-invasive methods of detecting stress. There have been researches done to find out if players of a particular game develop stress. One such research is “PokerMetrics: Stress and Lie Detection through Non-Invasive Physiological Sensing”[5]. In this research too, they have used minimal invasive stress recognition methods such as skin conductance peaks and HRV and non-invasive method of voice pitch variation in their research to find if poker players develop stress.

The author’s research is to recognise stress in a working environment with webcam footage. There have been researches done to recognise the emotions of people through the video footage. In the research “Unsupervised Emotional Scene Detection for Lifelog Video Retrieval Based on Gaussian Mixture Model (2013)” [6]

Chapter 3: Methodology

Chapter 4: Implementation

In order to implement the methodology mentioned in the previous chapter, it is necessary to look at the technologies available and analyse which of those are relevant for the project.

**4.1 Selection of the coding languages and libraries**

There are many computer languages available to implement a design concept. However there are some factors that would short list them and choose one or several of them to be used to implement the concept. Similarly there are many software libraries that would do similar functionality, however many of the advanced libraries are proprietary while some others are free to use and a handful of proprietary libraries give evaluation keys for research purposes.

One of the essential section to start this research is to detect facial feature points from the video feed. In the market there are many proprietary software libraries that would provide this feature. Some of those software products are

EmoVu - Learning based emotion recognition software that could read the emotions of people [14].

Emotient - On demand emotion analysis of videos using facial expression recognition [15].

nViso - 3D Facial Imaging software [16]

Even though the products mentioned above are technically advanced, it is not possible to use these as they are proprietary. Therefore to work on this project, a free API should be used. There are only a handful of free API libraries to choose from to recognise facial features.

OpenCV - This open source library provides functionality to do many projects in computer vision [17]. However using this library, the facial feature identification will have to be coded and it doesn’t come as off the shelf functionality. This library is also not very easy to use unlike the other libraries.

flandmark - Open source C library (with interface to MATLAB) implementing a facial landmark detector in static images[18].

There are few proprietary software that gives an evaluation key for research projects. Evaluating several of such software, I chose Luxand face recognition API [8] for detection of facial features.

Luxand face recognition API also known as FaceSDK is a high-performance, multi-platform face recognition, identification and facial feature detection solution [8]. The main reasons why FaceSDK was picked over other software are that,

* 1. They provide a evaluation key for research purposes.
  2. It detects 66 facial features in still pictures and videos.
  3. It is compatible with many different coding languages such as Visual C++, C#, Objective C, VB, Java and Delphi
  4. It is compatible with many operating systems such as Microsoft Windows, MacOS X, Linux, iOS, Android.

Machine learning component of the project is one of the most important components of the project. Its best to use a software package that exists in the market rather than implementing it since it is not the research component of the project. There are many such packages available. Some of the packages considered are

MATLAB - Proprietary software which has many different components including a component for machine learning. It has many different modules such as classification, regression and clustering [19]. It is a very powerful too, however it is not practical to use this tool as it is proprietary.

GoLearn - GoLearn is a 'batteries included' machine learning library for Go [20]. This does seem to have proper documentation and how to use it therefore even though it is a open source project, it not easy to work with this tool.

The package that works the best for machine learning component of this project is scikit-learn package. There are a number of reasons why scikit-learn machine learning package was chosen over other packages. Firstly it’s a free software package. Secondly it has many different modules such as classification, regression, clustering, preprocessing and a lot more just like MATLAB. Thirdly the documentation of the software package is extensive, thereby making it easier to work with it. Most importantly scikit-learn is a python machine learning package which is where most of the calculations are done in this project, thereby sending data to scikit-learn is easy.

Python is considered as the one of the best languages for crunching, the best bring ‘R’ [9]. Python is also easier to learn than R. Another reason to chose python is that to convert the facial feature points extracted by Luxand API need to be used to calculate facial features. Nomiya et.al has defined the following ten types of facial features using the facial feature points in order to detect discriminative movement of facial feature points in the appearance of various facial expressions [7]. The paper discusses 10 mathematical formula to calculate each of the 10 features. Considering the requirement, python was considered to be the best coding language for the data preprocessing and machine learning part of the project.

Another coding language needed to be considered to implement Luxand API to extract the facial feature points it offered as it doesn’t support python. In this section of the project, it focuses on collection of data rather than the actual research part, therefore it is necessary to implement it speedily. Hence Java was selected as the coding language since it is more familiar to the author.

As the operating system to implement this project, author decided to use Mac OS. The reason for this is because its the operating system that is available.

**4.2 Collection of data**

There is a multitude of publicly available datasets that could be used for various data mining projects [10] [11]. Since, the specific area that the author is considering in this thesis is very specific to work related stress with webcam footage, it was difficult to find any publicly available datasets. Unfortunately, the one database that is quite inline with what the author is working on, Lifelog videos [7] has been discontinued now. Therefore a system application had to be implemented in order to gather the necessary data to work on the project

A java application was built using a generic webcam Java API called ‘Webcam capture’ [12]. While the application is running it records the users’ face and actions. The author was able to gather videos of colleagues doing their daily work at office, thereby creating some data to work with for the project.

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