IOT BASED STRESS MONITORING AND CONTROLLING FOR MENTAL WELLBEING DURING SELF-ISOLATION DUE PANDEMIC

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This report is submitted in partial fulfilment of the requirements for the degree of Bachelor of Electronic Engineering with Honours

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DEDICATION

Thanks to the support and prayers of my family and teachers as well as the encouragement of my peers and friends, I've made it this far and will hopefully inspire others to do the same in the future. I'm dedicating this report to all of them. My parents, teachers, and friends are the genuine eyes through which I see the world and guide myself and others.

ABSTRACT

Stress is so prevalent in our society that everyone must deal with it. During the Covid-19 Pandemic, stress become weighty as it caused stress because people had to deal with social disruptions and reorganise their job and home schedules. There have been many studies and methods developed to assess stress in the human body. However, few of these stress assessment methods are accompanied by stress controlling. Moreover, some products on the market are outrageously pricey with limited sensor and benefit. Most crucially, the products did not implement IoT technology. This project's goal is to create a low-cost system that can monitor and control user stress levels. It monitors EMG, GSR, and PPG signals to detect stress. Then an IoT platform was created to display the signals. The IoT platform also allows users to activate stress-relieving features. The system includes a speaker that plays soothing music, an RGB strip that emits calming blue light, and an aromatherapy water atomizer. Three peoples' EMG, GSR, and PPG signals were obtained after different levels of physical exercise. The results showed that different levels of physical activity resulted in varying levels of stress. These findings indicated that stress can be detected early before it is over and caused negative impact that can affect our mental, physical, and emotional detrimentally.

ABSTRAK

Tekanan berleluasa dalam masyarakat kita dan merupakan sesuatu yang kita mesti menghadapi. Pada Pandemik Covid-19, stress menjadi serius kerana orang ramai terpaksa berhadapan dengan gangguan sosial dan menyusun semula jadual mereka. Tidak banyak kaedah penilaian tekanan disertakan dengan kawalan tekanan dalam antara kajian yang dijalankan. Selain itu, produk di pasaran agak mahal dengan sensor dan faedah yang terhad. Seterusnya, produk tersebut tidak melaksanakan teknologi IoT. Matlamat projek ini adalah untuk mewujudkan sistem kos rendah yang boleh menilai dan mengawal tahap tekanan pengguna. Ia memantau isyarat EMG, GSR, dan PPG untuk mengesan tekanan. Kemudian platform IoT dicipta untuk memaparkan isyarat. Sistem ini juga termasuk pembesar suara yang memainkan muzik yang menenangkan, jalur RGB yang memancarkan cahaya biru yang menenangkan, dan pengabut air aromaterapi. Isyarat EMG, GSR, dan PPG tiga orang diperoleh selepas tahap senaman fizikal yang berbeza. Keputusan menunjukkan bahawa tahap aktiviti fizikal yang berbeza mengakibatkan tahap tekanan yang berbeza-beza. Penemuan ini menunjukkan bahawa tekanan dapat dikesan lebih awal sebelum ia berakhir dan menyebabkan kesan negatif yang boleh menjejaskan mental, fizikal dan emosi kita secara buruk.

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LIST OF SYMBOLS AND ABBREVIATIONS

IoT	:	Internet of Things
RGB	:	Red, Green, and Blue
LED	:	Light-Emitting Diode
EMG	:	Electromyography
GSR	:	Galvanic Skin Response
PPG	:	Photoplethysmography
ECG	:	Electrocardiogram
SD	:	Secure Digital
PAM	:	Power Amplifier Module
UART	:	Universal Asynchronous Receiver-Transmitter
MCU	:	Micro-Controller Unit
WPT	:	Wavelet Packet Transform
KNN	:	K Nearest Neighbour
SVM	:	Support Vector Machine
MLP	:	Multilayer Perceptron
RResp	:	Relaxation Response
GAPED	:	Genera Affective Picture Database
SAM	:	Self-Assessment Manikins

PSD	:	Power Spectral Density
HR	:	Heart Rate
HRV	:	Heart Rate Variability
PSS	:	Perceived Stress Scale
MAT	:	Mental Arithmetic Task
EDR	:	ECG Derived Respiration
BO	:	Burn-Out
HADS	:	Hospital Anxiety and Depression Scale
CRDI	:	Continuous Response Digital Interface
SEM	:	Standard Error and Mean
MIST	:	Montreal Imaging Stress Task
STAXI	:	State Anger Expression Inventory
RMSSD	:	Root Mean Square of Successive Difference
fEMG	:	Facial Electromyography
VU	:	Volume Unit
BPM	:	Beat Per Minute

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CHAPTER 1

INTRODUCTION

1.1 Background of project/Motivation

Stress has grown so common in modern culture that everyone must deal with it at some point. Those who live in urban areas are more likely to experience stress as a result of the various disappointments and demands they confront on a daily basis. Less time means more stress for students, who have lots of additional assignments due from their teachers. Stress had become weighty particularly during the Covid-19 Pandemic. People were stressed during the Covid-19 Pandemic because they didn't know when it would end, had to deal with social interruptions, and had to reorganize their work and home schedules. We already live a fast-paced lifestyle, and the epidemic seems to have accelerated it, and now work often seems to outweigh our mental and physical health.

PNI research [1] shows that persistent stress can cause or worsen mood disorders such as depression, bipolar disorder, and cognitive issues. Stress hormones have sedative properties. Excessive of these hormone byproducts might cause fatigue or depression. Stress might also increase bipolar symptoms. These are the two poles for bipolar disorder. Mania is euphoria. Manic is crestfallen. Stress can cause a manic mood state or depression in someone with Bipolar-disorder. Chronic stress hormone activation might also induce severe anxiety (e.g., racing heartbeat, nausea, sweaty palms, etc.) Anxiety can generate fear and worry about the future, especially if it persists. Stress hormones may also affect the nervous system's structure and function. Stress affects the hippocampus and frontal lobes in particular. It can cause confusion, trouble concentrating, learning new knowledge, or making decisions. The stress hormone, on the other hand, can change a person's personality. Therefore, people with personal changes during stress will act abnormally.

People today are incredibly concerned with maintaining good mental and physical health on a daily basis this can be seen from the forecast growth in the global biosensor [2]. There is also lot of research that have implemented sensor in detecting stress [6-18,20-21,34-36]. However, the least of them have combined the stress monitoring and controlling features in one system. Sometimes we must know the way to cope with stress other than just measuring or detecting them. If we do not deal with stress, it will impact our mental health detrimentally. We will live in depression and fatigue [3]. On the other hand, some products in the market had disadvantages in terms of cost, reliability, and wireless and network not capable. With the improvement of technologies nowadays, stress monitoring and controlling may be made with minimal expense coupled with a number of beneficial features.

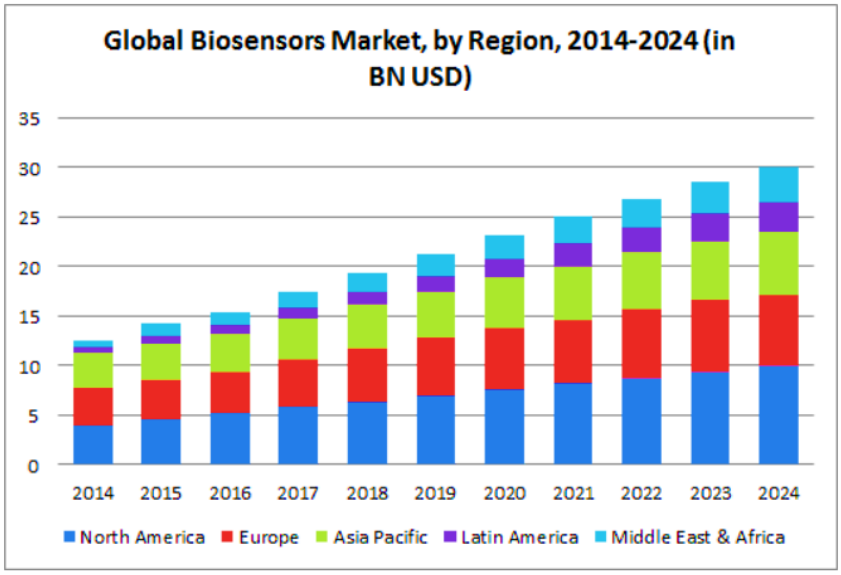

Figure 1. 1: Global Biosensors market, by region, 2014 to 2024 [2]**.**

The ultimate goal of this project is to develop a low-cost system that can both monitor and control stress levels in users. This initiative will assist us all in keeping track of our stress levels and adopting a variety of stress-reduction tactics that are appropriate for us. It is important to note that, despite the fact that this project was created with low cost, it included a sufficient number of sensors in order to monitor some of the crucial parts in our body in response to stress. Besides, the Internet of Things concept is employed to enable the system to be wireless and network-capable. The IoT platform can display users of their level of stress and which stress control/relief devices should be triggered to lower their level of stress. The stress-relieving devices included in this system are a speaker, an RGB LED strip, and a water atomizer.

This project's system is made of about three important entities First, the physical components (electronic equipment – sensors, microcontroller, electrical devices, etc.); Second, software, which usually builds a connection between sensor-microcontroller, microcontroller-electrical devices, microcontroller-serial monitor in this project; and

third, the web server or IoT platform that allow user to view data and control electrical devices that is linked to the microcontroller.

1.2 Problem Statement

Stress has a wide range of effects on people. Stress is something that everyone has to deal with at some point in their lives, but each person experiences it uniquely. Most importantly, during a pandemic, it has become critical to pay particular attention to mental and physical conditions caused by stress. When we're under a lot of stress, it can have a negative impact on our mental and physical health, as well as our relationships at home, at work, and in school. Mental stress has been linked to depression and neurological disorders such as stroke, according to research. Depressive feelings and memory loss are among the Early symptoms of stress. A device for monitoring mental stress and providing stress-controlling features before it harms the mind, body, and behavior is essential.

Up till now, researches have been done and a wide range of method has been used in accessing the stress in the human body, leveraging concepts ranging from the electronic sensor to stress assessment questionnaire like the PSS Stress assessment. Many products had also been created for stress monitoring. However, fewer of these stress assessment methods and products are accompanied by stress-controlling methods. Besides, some of the products in the market are prohibitively expensive with a limited number of sensors and beneficial features. Most importantly, the network and wireless capable functionalities that could make the stress monitoring more convenient are less implemented in the products. Thus, developing a low-cost network and internet-capable system to monitor and control one’s stress level with a sufficient number of sensors is important.

1.3 Objectives / Aims

1. To design a low-cost system that allows users to monitor and control stress all in one single system.
2. To analyze the behavior of EMG, GSR, and PPG signal during stress occurs.
3. To develop the system and make it wireless and network capable, allowing the user to monitor and control their stress level in real-time via an IoT platform user interface.

1.4 Scope of project

The final system of this project will allow the user to monitor and control/relieve their stress level via the Internet. From the sense of viewing, this project is going to achieve IoT, the Internet of Things concept that will allow the user to monitor and control via the internet easily. An IoT platform called the Arduino IoT cloud will be used as the user interface for this system, this platform is originated from Arduino. The reason for selecting this platform as an interface is that users can share the dashboard with other users. Customizing the platform appearance with the available widget can also be realized. The platform required no specified software. Besides, the data from the platform can be also synchronized to our mobile phone. In terms of authentication, users must log in with their user's name and password to utilize the system.

Arduino Uno, a microcontroller board that is based on the ATmega328P is used to collect data from EMG sensor, GSR sensor, and PPG sensor. Sample of data will be collected from 3 human volunteers based on different level of physical activities. The waveform will be displayed in the IoT platform as well as the stress score. Based on the stress score user can activate the stress relieving features of the system which are