EMOTION EXPRESSION MODEL ON A SOCIAL MEDIA PLATFORM USING MOBILE BRAIN-COMPUTER INTERFACE

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DEDICATION

“Thank you to God!

Thank you to my pillar of strength amma, appa, akka, atha,

Kuhaan, for being my number one critic and supporter and for being patient with all the mood swings that was thrown whilst working on this research,

Divya, for making THIS possible and being there at all times,

Kushalini Nair and Dr.Priyangka.

And to my students who gave me the unconditional

love I needed.”

This is for each and every one of you

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ABSTRACT

Today, expressing emotions via social media can be done by manually choosing the closest emoji to their emotion from the selection of emojis. No real-time emotion detection is applied to provide the user with a personalized experience. This study explored the possibility, and the readiness, of using mobile Brain-Computer Interface (BCI) to improve user's experience in social media platforms. To understand how users perceive emotional expression on social media, the study conducted an online survey involving 50 participants. Interview sessions with eight participants followed this to elicit their perspectives on selecting emojis for expressing emotions. A qualitative analysis was applied to analyse the transcript from the interview session. The findings indicated that users preferred to express their emotions indirectly and elaborately, supported by emojis and stickers. An emotion expression model on a social media platform using a mobile brain-computer interface was proposed due to the absence of such a model in facilitating social media integration with BCI. The model consisted of the input, translation from the input and the output. The proposed model was evaluated through experts' review. Further, to exemplify the usage of the proposed model, a prototype was developed as a platform for users to detect and express their emotions based on their preferences and for emotional engagement. The evaluation of the proposed prototype was divided into two: emotion expression and emotion detection. For emotion detection, the accuracy was evaluated using user rating, and for emotion expression, Retrospective Thinking aloud (RTA) and Usability testing using the System Usability Scale (SUS) form was performed. The evaluation results stated that the user rating accuracy was 87.5 %, and the SUS score was 81.6, which fell on the excellent rating. This work pushes the boundaries of typical BCI into a leisurely usage of emotion detection and expression on social media platforms.

ABSTRAK

Pada masa kini, meluahkan emosi melalui media sosial boleh dilakukan dengan memilih emoji yang paling hampir dengan emosi tersebut secara manual daripada pemilihan emoji dan tiada pengesanan emosi masa nyata digunakan untuk memberikan pengguna pengalaman peribadi. Kajian ini meneroka kemungkinan, dan kesediaan, menggunakan Brain Computer Interface (BCI) mudah alih untuk memperbaiki pengalaman pengguna yang menggunakan platform media sosial Untuk memahami bagaimana pengguna melihat ekspresi emosi di media sosial, kajian ini menjalankan tinjauan atas talian yang melibatkan 50 orang peserta. Seterusnya, sesi temu bual dengan lapan orang peserta dijalankan untuk mengetahui perspektif mereka tentang pemilihan emoji bagi meluahkan emosi. Analisis kualitatif digunakan untuk memahami dan mendapatkan perspektif peserta menggunakan transkrip daripada sesi temu bual. Dapatan kajian, menunjukkan bahawa pengguna lebih suka meluahkan emosi mereka secara tidak langsung dan terperinci dengan pengunaan emoji dan stiker. Model ekspresi emosi untuk platform media sosial dengan pengunaan BCI mudah alih dicadangkan kerana ketiadaan model sedemikian dalam memudahkan integrasi media sosial dengan BCI. Model ini terdiri daripada input, terjemahan daripada input dan output. Model yang dicadangkan dinilai melalui kajian pakar. Selanjutnya, sebagai contoh penggunaan model yang dicadangkan, prototaip dibangunkan sebagai platform untuk pengguna mengesan dan meluahkan emosi mereka berdasarkan pilihan mereka dan untuk penglibatan emosi. Penilaian prototaip yang dicadangkan dibahagi kepada dua, iaitu ekspresi emosi dan pengesanan emosi. Untuk pengesanan emosi, ketepatan dinilai menggunakan penilaian pengguna manakala untuk ekspresi emosi, Retrospektif Fikir Ujar (RTA) dan ujian kebolehgunaan menggunakan Borang Skala Kebolehgunaan Sistem (SUS) dijalankan. Keputusan daripada penilaian menunjukkan ketepatan penarafan pengguna adalah 87.5 % dan skor SUS adalah 81.6, yang bertaraf cemerlang. Kajian ini meneroka sempadan dalam penggunaan pengesanan dan ekspresi emosi secara santai pada platform media sosial.

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LIST OF ABBREVIATIONS

ADHD	-	Attention Deficit Hyperactivity Disorder
BCI	-	Brain Computer Interface
BMI	-	Brain-machine interface
CNI	-	Neural-control interface
CNN-LSTM	-	CNN Long Short-Term Memory Network
C3D	-	Civil 3D
CTA	-	Concurrent Think Aloud
DSRM	-	Design Science Research Methodology
DNI	-	Direct neural interface
ECG	-	Electrocardiography
EEG	-	Electroencephalography
EMG	-	Electromyogram
fMRI	-	Functional magnetic resonance imaging
HCI	-	Human Computer Interaction
KNN	-	K-Nearest Neighbours
MMI	-	Mind-machine interface
MEG	-	Magnetoencephalography
MEMS	-	Micro-Electro-Mechanical Systems
RTA	-	Retrospective Think Aloud
SUS	-	System Usability Scale
UTM	-	Universiti Teknologi Malaysia
UUM	-	Universiti Utara Malaysia
VR	-	Virtual Reality

LIST OF SYMBOLS

Σx	-	Total Number of Score for each of the Questions
N	-	Number of questions

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CHAPTER 1

INTRODUCTION

1.1 Overview

In today's world, everyone from young kids to adults uses at least one social media platform. We all seem to be linked to social media no matter where we go, whether it is school, university, or the workplace. There are a lot of social media applications available for people of different generations such as, Instagram, Facebook, Twitter and TikTok. Facebook is one of the top three social media with the highest number of users that is stated to be almost 2.5 billion users as shown as Figure 1.1. The most active group of users range from 18-30 years old as shown in Figure 1.2. These users share their pictures and thoughts in post or story or support other network member's post by liking or reacting to their post (Raad et al., 2019). This is a form of interacting and expressing emotions on the social media platform. Social media can provide the support, inclusivity, and a sense of relief. Emotional engagement in social media can provide inclusivity because people of different age group can share their thought and interact with each other (Schofield Clark, 2015).

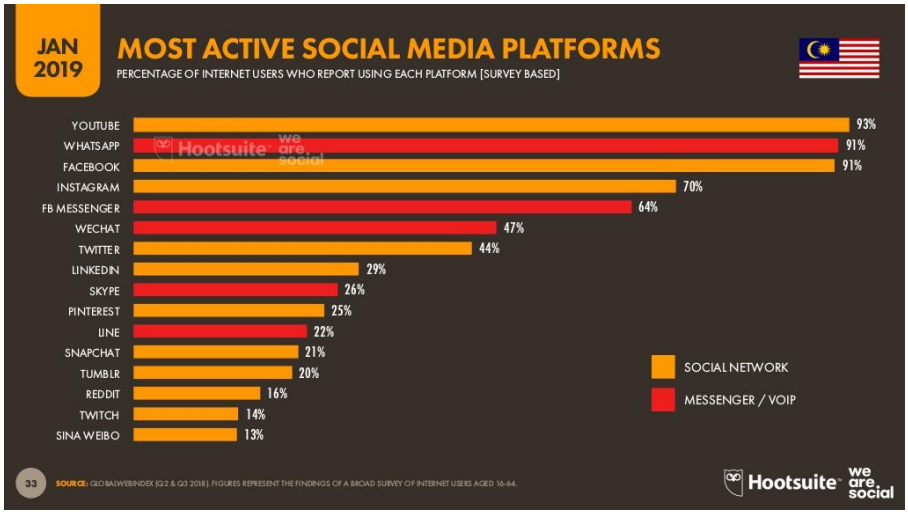

Figure 1.1 Most Active Social Media Platform (HootSuite, 2019)

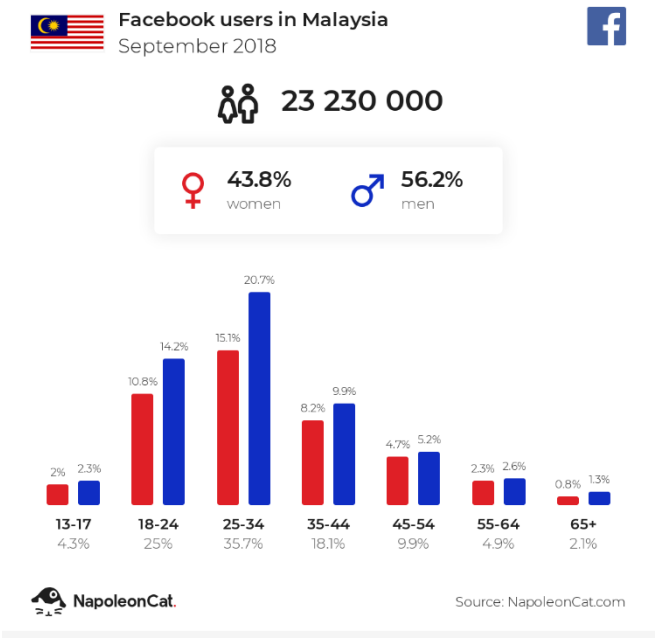

Figure 1.2 Active age group users in Facebook (NapoleonCat, 2018)

Emotions play a significant and magnanimous part when people communicate with each other. The emotion exchange that is done through a text message or a comment in an informal way has said to be a challenge for the machine to comprehend (Andalibi & Buss, 2020). Thus, that is why, back in 2013, Facebook company introduced new status update to help users share how they are feeling in a visual way (NBCNews, 2013). The users utilize the new feature during any status update to express specific emotion such as feeling happy, sad, angry, etc. Users choose the emotion from the drop-down menu or by typing in the word to find the feeling.

Research on detecting and recognizing emotions and emotional states in social media is currently being vastly looked into. With the recognition of emotion, mental health of an individual could be monitored with the stress level. Stress is a concept that refers to the amount of force applied to an object, and it is relevant to our lives because some problems put pressure on us (Wheeler et al., 2007). Emotion recognition researches done are mostly based on the post and messages typed out by users or from facial recognition (Kosch et al., 2020). Emotion recognition could now be used to deliver a more visual and personalized content in social media platform. There is research study that have been conducted to identify negative post and removes them as it promotes negative mental health impacts such as promoting self-harm (Ruensuk

et al., 2019). According to the 2017 National Health and Morbidity Survey, 29% of Malaysians had depression and anxiety disorder (The Star Online, 2018). The stress level is in alarming state and it is leading towards depression. Many users who struggle with mental health problem are more inclined to find solace and support in social media (McCosker & Gerrard, 2021). This in overall, could prevent individual from going into depression or from committing suicide.

Human-Computer interactions (HCI) has allowed the birth of many kind of interaction that is proven to ease a user's life. HCI focuses on the functionality and usability of a design (Te'eni et al., 2007). Brain Computer Interface (BCI) has been used in a variety of circumstances under the umbrella of HCI, such as assisting physically disabled individuals in controlling their movements, locomotion, and so on. This contact opens up a channel for direct communication between the human brain and the object (Hwang et al., 2013). The electrical signals stimulated by neurons are processed and synchronised by the human brain, and BCI is used to determine the electrical activity in the brain. Electroencephalogram (EEG) can be monitored and brainwave frequencies such as Beta, Alpha, Theta, and Delta can be displayed in real-time using a BCI wearable headset that is connected to our smartphones through Bluetooth. With the signal acquisition, emotions of a user can be detected and could be expressed (Bos, 2006).

However, there are limited current existing researches under mobile BCI integrated with social media which is further discussed in Section 1.2. Researchers have looked at how users regulate their emotions on social media, but little is known about why certain users especially adolescents utilise specific platforms for emotion management while others do not (Vermeulen et al., 2018a). Although many social media platforms share features such as profile pages and the ability to communicate with others despite being physically separated, there are significant distinctions, such as the degree to which communication is public or private. Not many people are able to express their emotions on these social media platforms (Vermeulen et al., 2018a). This research looks into how emotion expression on social media platform such as Facebook can be further utilised via mobile BCI.

1.2 Problem Background

A survey conducted in Malaysia in 2022 shows that the number of Facebook users in Malaysia were estimated to reach 24.31 million users (Statista, 2022). Another study conducted in 2022 shows that about 3.96 billion users in US use Facebook for approximately 31 minutes day especially during the pandemic when the user growth rate rose up to 8.7 percent on the same year (Oberlo, 2022). While it has become a need to use social media in everyday life, Facebook has become a platform for emotional engagement and to provide inclusivity to users regardless of nationality, background and race. With the advancement of emotion detection and expression in other field such as in gaming, users has been able to receive personalised experience and real time results.

According to a poll conducted by University of Texas, users on a digital platform want personalization because it gives them a sense of greater choice, which reduces their perception of information overload because it implies that the content provided in a personalised online environment is catered to their requirements (Bright, 2008). With personalisation, users are able to enjoy a much exclusive user experience especially in social media platform. As of now, real time emotion detection has not been implemented in any social media platform yet including Facebook. However, Facebook platform do provide user to express their emotion by choosing from the option provided as shown in Figure 1.3. One of the major drawbacks of this option is that, there is a limited number of emotion options provided and it is not personalised.

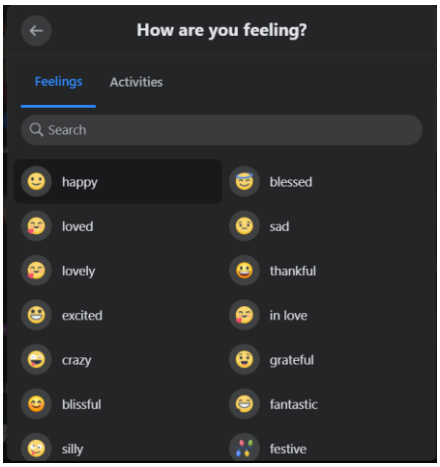

Figure 1.3 Current way to express Emotion on Facebook

While emotion recognition being widely looked into and the many ways that it could be used, there are still less number of researches with emotion recognition using BCI and this field is in need of more exploration. The Figure 1.4 below shows the trend in BCI papers from the past 10 years from Scopus.

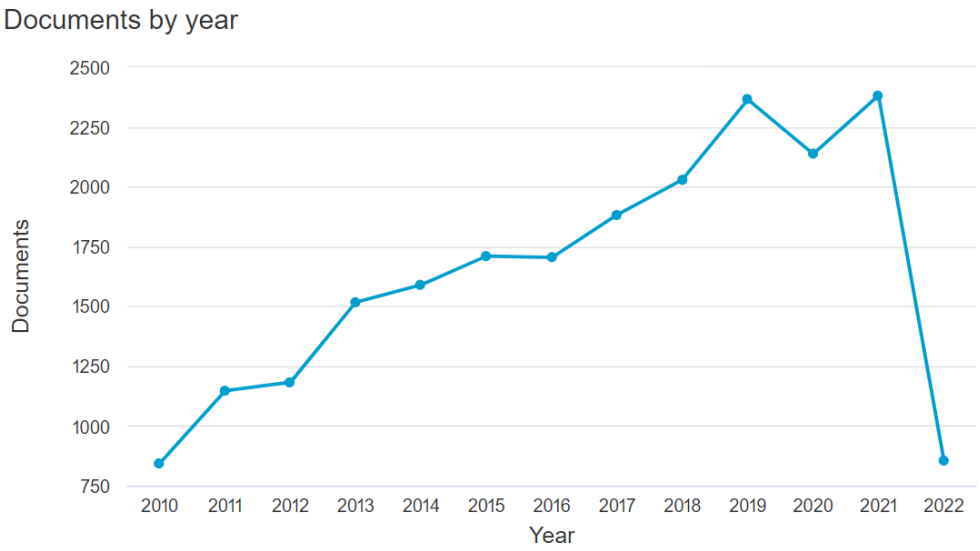

Figure 1.4 Trend of BCI research papers from Scopus

With the number of BCI paper collected, researches relating to emotion recognition using BCI were filtered through which is detailed out in Table1.1 which shows the number of papers for each year. The highest number of BCI and emotion recognition paper is on year 2020. Other than that, on year 2020, out of 2137 papers,

only 77 papers were related to emotion detection which is only 3.6%. When further narrowed on emotion recognition using BCI on social media platform, the search results findings were only 3 papers. This statistic clearly proves and supports the statement that there are only a limited number of researches done in this area.

Table 1.1 Number of research papers by year from Scopus

Year	**Number of research papers of emotion recognition using BCI**
2017	40
2018	37
2019	62
2020	77
2021	47

Now that BCI technology is improved and BCI applications are now able to connect to laptop via Bluetooth, it is more hassle-free and more users friendly to use as all that is needed is BCI headgear and a laptop or a smartphone. A model would come in handy to develop and understand the development of an application better. However, currently, there is no interaction model that displays the usage of BCI for emotions detection and expression on a social media platform

1.3 Problem Statement

There are no real time emotion detection and expression using BCI implemented on a social media platform. Many ways of using BCI to interact on social media platform is available, however there are a limited numbers of research on using mobile BCI to express emotion real time on social media platform based on the detected signals. Not only that, there is no current model that shows mobile BCI in detecting and expressing emotions on a social media platform. With the absence of model, upcoming researchers and developers would not have any reference to

benchmark. Hence, this study proposes a model would consist of input and the transition details to the output. With this model, upcoming researchers and developers would be able to use as a reference for similar applications related to mobile BCI.

1.4 Research Aim and Goal

The main goal of this study is to explore and utilize the capabilities of mobile BCI and introduce a new purpose to integrate BCI and social media platforms. The main research aim of this study is:

"To identify the requirements to detect and express emotion using mobile Brain-Computer Interface on social media platform".

In order to achieve this aim, an intensive study of the emotion recognition using EEG signals was conducted to understand and to integrate with social media platform.

1.5 Research Questions

There are three research questions that should be investigated in order to conduct the study. These questions will aid the research aim to be achieved.

(a) What are the requirements to detect and express emotions of users using BCI to social media?

(b) How to model a mobile BCI based interaction that detect and express emotions of an individual on a social media?

(c) How to evaluate the emotion detection and emotion expression of the proposed prototype?

1.6 Research Objectives

There three objective that will be expected from the output of the research are:

(a) To identify requirements to detect and express emotions via mobile BCI to social media.

(b) To propose a model that illustrates the identified requirements to identify and express emotion using mobile BCI and develop a prototype based on the model.

(c) To evaluate the accuracy of mapping of the signal and emotion types for the emotion detection, and, the user satisfaction for the emotion expression.

1.7 Scope of the study

The scope of study is limited to the following:

(a) The social media platform used is Facebook. This platform is chosen because it is the most active social media platform used as shown in Figure 1.1 and it also currently provide an option for user to express feeling by choosing the emotion from a list of option given.

(b) The participants of the study range from 18-30 years old because that is two highest active age group on Facebook platform as shown in Figure 1.2.

(c) The participants of the study that was selected consists of undergraduate and postgraduate students from different course of School of Computing, Faculty of Engineering. study as this study was conducted during pandemic and students from different faculty were not reachable and accessible.

(d) The gender and culture of participants of the study that were selected is mostly male and female who are non-Muslim as the headgear would require the female Muslim participants to remove their hijab to wear their headgear. More males

were selected as they have shorter hair and the headgear can touch the scalp of with not much hassle and it is easier to achieve optimum contact quality.

(e) The users of the study must have prior knowledge of using a computer so they would not face any difficulties to answer the survey or test the prototype.

(f) The type of Brain Computer Interface used is non-invasive and mobile headgear as it available off-shelf and wearable by users.

1.8 Research Significance

The findings of this research would be able to benefit different groups of users. First and foremost, the HCI community, future researchers, working on the same field of research would be able to use the model as a reference for further study. Secondly, for BCI companies, the proposed prototype could be a start-up idea for real-time emotion detection and expression to be integrated with social media platform such as Facebook as it could be providing a new experience for user. Thirdly, for users of social media platform, real-time emotion detection and expression would be a new upgrade and would provide more emotional engagement and inclusivity.

1.9 Research Contribution

The research contribution of this study is outlined as follows:

(a) The proposed model could be used as a reference by the HCI developers and researchers who are pursuing in mobile BCI research and its usage in expressing emotions to social media.

(b) The proposed prototype could be used to provide inclusivity as it provides a platform for many users as possible for emotion engagement.

1.10 Thesis Organization

Description and a brief content of each chapter are summarized as below:

(a) Chapter 2 details about previous studies and research. The emphasis will be on currently available technologies and web applications that can be used in this research.

(b) Chapter 3 explains on the research methodology which includes the phases and approaches using Design Science Research Framework.

(c) Chapter 4 discusses on the experimental set-up and the methods used to conduct an experiment to find out how to integrate BCI with social media platform to detect and express user's emotion.

(d) Chapter 5 details about the evaluation. The experiment results and usability testing are analysed.

(e) Chapter 6 concludes the thesis with a discussion of the study's overall observations and outcomes, as well as recommendations for future research.

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