DETERMINATION AND CLASSIFICATION OF STRESS LEVEL USING EEG SIGNAL AND AUDIO MODALITIES

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UNIVERSITI MALAYSIA PERLIS

2011

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A thesis submitted
in fulfillment of the requirement for the degree of
Master of Science (Mechatronic Engineering)

SCHOOL OF MECHATRONIC ENGINEERING
UNIVERSITI MALAYSIA PERLIS

2011

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Academic Session	:	2/2011

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ACKNOWLEDGMENTS

بسم الله الرحمن الرحيم

I am very thankful to a numbers of people in seeing the successful completion of this research work. Firstly, I would like to thank Allah S.W.T for the endless blessings and gifts He has bestowed upon me. Without His blessing love, comfort, and guidance, not to mention answered prayers, I would never have made it to this point in my life.

I am very fortunate to have a kindhearted person to guide me throughout my research work and here I would like to show my heartfelt sincere gratitude to my respectful mentor which is my first supervisor Prof Dr. Sazali Yaacob for his invaluable guidance and support. I am very indebted for his inspiration and continuous motivation which really help me in completing my research work successfully.

I also extend heartfelt thanks to my guru which is my co-supervisor Assoc. Prof. Dr. Paul raj MP. I owe him a great deal for his valuable guidance and informative suggestion which been really a great help for me to complete my research work.

I wish to extend my sincere gratitude to Assoc. Prof. Ku Halim Ku Ariffin for his support and guidance as he is also one of my co-supervisor. His useful idea and suggestion really a great help for me in construct the items for subjective evaluation and questionnaire form.

Friendships formed at Intelligence Signal Processing Cluster, UniMAP have also helped to keep my motivation and momentum during completing my research work. I would like to extend my thanks to Saateesh Kumar Nataraj, Muhammad Naufal Mansor and all the cluster members who have ever been such a great help for me in giving technical and moral support. I thank them for their useful help.

I would like to extend my deep gratitude to the students of Electrical Department from Politeknik Tuanku Syed Sirajuddin and Biomedical Deparment Of University Malaysia Perlis as for their willingness to be my subjects. Without their strong cooperation it would have been much harder to complete this research work.

Finally I would also like to thank my beloved parents for giving me the support and confidence during the entire this research work. For my lovely and beloved family, my wife and cute daughter, it is a truly blessing for me having them in my life as they are my inspiration and motivation.

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LIST OF ABBREVIATIONS

ACTH	Adrenocorticotropic Hormone
A/D	Analog Digital Converter
ANN	Artificial Neural Network
ANS	Autonomic Nervous System
AVP	Arginine Vasopressin
BP	Blood Pressure
BS	Blank Screen
BTH	Breathing Exercise
BVP	Blood Volume Pulse
C	Number of Level in Column Variable
CRH	Corticotropin Releasing Hormone
CWT	Color Word Test
DASS	Divided Attention Steering Simulator
dB	Decibel
DBP	Diastolic Blood Pressure
dF	Degree of Freedom
DFT	Discrete Fourier Transform
ECG	Electrocardiograph
EEG	Electroencephalogram
EMG	Electromyograph
F_e	Expected Frequency
F_o	Observe Frequency
F_r	Product of Row

FFT	Fast Fourier Transform
GAS	General Adaptation Syndrome
GSR	Galvanic Skin Response
H_a	Alternative Hypothesis
H_o	Null Hypothesis
HFF	High Frequency Filter
HR	Heart Rate
HRV	Heart Rate Variability
HPA	Hypothonomic Pituatary Adrenal
IIR	Infinite Impulse Response
kNN	k-Nearest Neighbor Hood
LDA	Linear Discrimminat Analisis
LFF	Low Frequency Filter
NN	Neural Network
PD	Pupil Diameter
PNS	Parasympathetic Nervous System
PPG	Photoplenthysmograph
PSD	Power Spectral Density
R	Number of Row
RMS	Root Mean Square
SBP	Systolic Blood Pressure
SC	Sound Clip
SKL	Skin Conductance Level
ST	Skin Temperature
T1-T6	Number of Trial

TCs	Test Contraction
TNSD	True Non Stress Detection
TSD	True Stress Detection

LIST OF SYMBOLS

d	Distance
E	Energy
e	Frame Energy
F	Frontal Lobe
fs	Sampling Frequency
$f(x)$	Activation function
k	Number of Neighbors
N	EEG's Stress Signal
N	Number of Features
N	Samples Features Dimensions
n	Number of Frames
nfft	Length of The FFT to Perform on each Segment of Data
[Pxx, f]	Power Spectral Density
$\Phi^{m}(r) - \Phi^{m+1}(r)$	Approximate Entropy (m, r, N)
r	Noise Level Filter
SD	Standard Deviation
T	Temporal Lobe
V_{ij}	Weight between Input and Hidden Layer
W_{jk}	Weight between Hidden Layer and Output
window	Window to Apply to x
x	Input Sequence
x	Input Data
x	Coordinate of x Value

X^2	Chi Square Value
X_k	Amplitude and Phase of the Sinusoidal Components of Signal X_n
X_n	Input Signal
y	Coordinate of y Value
$\sum$	Covariance
μ	*Mikro*

Penentuan dan Pengkelasan Tahap Tekanan Jiwa menggunakan Isyarat EEG dan Pendekatan Klip Audio

ABSTRAK

Tekanan jiwa ditakrifkan sebagai gangguan keseimbangan hormon oleh faktor fizikal mahupun faktor psikologikal. Tekanan jiwa boleh wujud melalui 2 pendekatan yang berbeza, samada pendekatan positif yang dikenali sebagai eustres dan pendekatan negatif yang dikenali sebagai distres. Lazimnya eustres berkisar kepada pemangkinan terhadap insiden yang penting dan dikehendaki dalam hidup seseorang manakala distres akan membawa implikasi buruk terhadap kesihatan. Oleh yang demikian, ia adalah amat penting bagi memahami dan menghasilkan tahap bagi tekanan jiwa. Kesedaran ini akan mendorong kepada kaedah yang cekap dan berkesan bagi menangani dan mengatasi tekanan jiwa. Kajian ini bertujuan untuk menentukan tahap bagi tekanan jiwa (normal, tekanan jiwa pada tahap sangat rendah, tekanan jiwa pada tahap rendah, tekanan jiwa pada tahap sangat sederhana, tekanan jiwa pada tahap sederhana, tekanan jiwa pada tahap tinggi, dan tekanan jiwa pada tahap sangat tinggi) pada 3 tahap kekuatan bunyi (60 desibel, 70 desibel dan 80 desibel) melalui pengukuran isyarat biologi elektroensefalogram (EEG). Bagi tujuan untuk merangsang keadaan tekanan jiwa, pendekatan menggunakan klip bunyi digunakan. Sebanyak 36 klip bunyi yang dicampurkan dengan hingar yang dipilih daripada hasil kajian rintis dimainkan pada 3 tahap bunyi tersebut dan diselaraskan dengan borang soal selidik yang diisi oleh 30 orang responden. Isyarat elektroensefalogram (EEG) direkodkan serentak pada masa yang sama ketika responden mendengar klip bunyi tersebut. Isyarat elektroensefalogram (EEG) yang direkodkan, dianalisa dan diproses di mana kriteria penting diekstrak melalui kaedah analisa domain masa (Kumpulan Tenaga/Band Energy dan Penghampiran Entropi/ Approximate Entropy) dan kaedah analisa domain frekuensi (Ketumpatan Spektral Kuasa/Power Spectral Density). Kriteria yang diekstrak ini kemudian diklasifikasi oleh pengklasifikasi linear (Pembeza Analisis Lurus/ LDA) dan pengklasifikasi tidak linear (Rangkaian Neural/NN dan Jiran Terdekat k/kNN). Keputusan klasifikasi terhadap kriteria yang telah diekstrak menunjukkan ketepatan penetapan tahap terhadap tekanan jiwa. Keputusan klasifikasi menunjukkan tahap ketepatan pada 88.29% sehingga 99.87%. Berdasarkan keputusan ini, ia menunjukkan tahap bagi tekanan jiwa telah berjaya diwujudkan melalui pendekatan klip audio dan pengukuran isyarat biologi.

Determination and Classification of Stress Level Using EEG Signal and Audio Modalities

ABSTRACT

Stress is defined as the disruption of homeostasis by physical or psychological stimuli. It can occur in two different approaches either positive way or negative way. Positive stress is called eustress and negative stress is called distress. Eustress is a positive form of stress, usually related to desirable event in person life, while distress will bring negative implication towards health on life. Thus it is essential to comprehend and come out with stress index. By knowing this, it will lead towards effective stress management and the efficiencies way of suppressing stress. This research work intends to determine the stress level (normal, very low stress, low stress, very moderate stress, moderate stress, high stress and very high stress) at 3 different sound pressure levels (60 dB, 70 dB and 80 dB) through physiological signal measurement which is Electroencephalogram signal (EEG). For stress state inducement audio clip modalities is being used. 36 sound clips which are mixed with noise selected from pilot test result, played at 3 different sound pressure levels and associated with the subjective evaluation obtained from the 30 participating subjects. EEG signal was simultaneously recorded while subjects were exposed to the played sound clips. The recorded EEG signal were analyzed and processed where features were extracted through time domain analysis (Band Energy and Approximate Entropy feature) and frequency domain analysis (Power Spectral Density feature). Theses extracted features classified through linear classifier (Linear Discriminated Analysis classifier) and non linear classifier (Neural Network and k-Nearest Neighbor classifier). The classification results by this classifier on the extracted features show the classification accuracy of the developed stress level at 3 different sound pressure levels. The classification accuracy results dwell within the range of 88.29% to 99.87%. These promising results show that the stress level were successfully developed using audio clip modalities through physiological signal measurement.

CHAPTER 1

INTRODUCTION

1.1 Research Background

Mental and emotional stress is normal physical responses to both internal and external events that drive people feel fatigued or threatened. Mental and emotional stress also affects every day human life and human work performance. After a certain point, it may also cause major damage to the nervous system and may severely affect a person's productivity in work and their quality of life. The effects of stress can be seen physically, mentally and emotionally through memory problems, inability to concentrate, poor judgment, negative thinking and constant worrying.

Stress is very common in daily life and it is defined as the body's reaction to a perceived mental, emotional or physical distress (Campbell and Bagshaw, 2002). Stress is an undeniable part of human life. It is impossible to live without experiencing some degrees of stress and the effects of stress in people are seen physically, mentally as well as emotionally (Zhang et al, 2009). Stress affects health and causes burnout. Body continuously releases stress hormones when the stress factor is repetitive or persistent and this translates into constant high blood pressure levels as well as other functional adjustments. The effect of these hormones is harmful for the body. They may cause irreversible physiological damage of the brain and other effects such as tiredness, lack of concentration, headaches, fever, irritability, muscular tension and short term loss of memory (Frankenhaeuser, 1986).

Now days there have been numbers of research regarding effect of noise in order to induce stress and its implication towards health affect. There are many types of visual and audio noise that can cause distractions that break concentration and increase the stress level. Environmental noise is one of the most pervasive, annoying, and costly residuals of human activity. Minimizing the environmental noise can lead to better concentration, increased productivity and can reduce humans overall stress level (Frankenhaeuser, 1986; Lundberg, 1995; Babisch, 2002).

In this research work, as an initial step towards the development of stress level identification system based on the features extracted from the EEG, signals emanated from the scalp while hearing a sound clip simultaneously recorded. The suitable features from recorded signals is associated to the level of stress and by using classifier method, stress will be categorized into 7 types of stress domain namely very low stress, low stress, very moderate stress, moderate stress, high stress, very high stress and normal.

1.2 Problem Statement and Significance of Research

Stress at chronic level can inflict negative implication toward health and life. Thus, within these past 5 year many researches have been conducted for detection and measurement of distress. Generally distress can be measured through experimental and non experimental methods.

Using experimental method, stress state is induced using visual modalities (Lizawati et al, 2007), audio modalities and audio visual modalities (Seo et al, 2008) and mental task (Taelman et al, 2008). Distress is measured through physiological signals such as brain electrical activity (Krantz et al, 2004), eye-related activity (Zhai and Barreto, 2006), respiratory, blood pressure and cardiac function (Jeong et al, 2007; Kim et al, 2007; Lizawati et al, 2007). Although experimental method manage to detect