International Journal of Systems Signal Control and Engineering Application 9 (3-4): 55-59, 2016
ISSN: 1997-5422

Physiological Pattern of Basic Human Emotion State based on SPO2 Sensor

Adhi D. Wibawa and Mauridhi H. Purnomo
Department of Multimedia and Network Engineering,
Institut Teknologi Sepuluh Nopember, Surabaya, Indonesia

Abstract: The advance development of vital sign sensors technology nowadays has given impact significantly not only in the field of biomedical engineering but also in many disciplinesthat influence the human health. Monitoring physical condition of patients by using vital signs technology has been done by many researchers in the past extensively. However, study that focusing on monitoring the role of emotion to the human's health is very rare in the literature.This study is a preliminary step in exploring the physiological pattern of human emotion by using SPO2 sensor that monitors the level of oxigen in the blood.Three basic human emotions were tested, they were happy, sad and angry. Three video stimulations that associated with the three basic emotions have been prepared to trigger the 30 healthy volunteers. SPO2 sensor was used to record the level of oxigen in the blood during three phases of experiment: baseline, video stimulation and recovery phase. The behaviour of oxigen level during video stimulation among these three emotions were obtained. Sad emotion seemed to have the biggest impact in suppressing the level of oxigen, compared to happy and angry emotion. The >78% of participants showed a significant change in lowering oxigen level during sad emotion. In conclusion, among these three mostly used emotions, sad emotion seemed to have bigger potential in triggering asthma or hypoxia condition. This finding has also showed the potential of sad emotion in worsening the condition of patients with chronical diseases.

Key words: Technology, oxigen, blood, baseline, human emotions

INTRODUCTION

Recent development of vital signs sensors technology has changed significantly the way researchers and practitioners looking at the human health monitoring system. With this technology, the e-Health monitoring system can be done via network or internet, so that better understanding on human physiological data through vital signs sensors then can be obtained. So far, the attention of doctors or physicians in term of e-Health monitoring system are mainly on the patient's physical condition. However, there is still not enough attention that was given by the doctors in term of patient's emotional or psychological condition, even though it has been studied by many researchers that emotion has a significant effect on human's health (AlMejrad, 2010; Judge *et al*., 1998; Tauseef, 2012). It is a common knowledge that human emotion gives significant impact on human's health. Some studies have showed that negative emotion such as angry and sad could worsen the condition of patients with a chronical diseases like Diabetes Mellitus, High Blood Pressure or Cardiovascular disease (Brosschot and Thayer, 2003). Study done by Knapp *et al*. (1992) event showed that emotion can induce human immune system, meaning that negative emotion can decrease human immune system. We can say that most of patient's condition physically were worsened by their emotion's instability (Ostir *et al*., 2000). This emotion's instability could be caused by many factors in life such as bad news from their daily life or family matters, bad news from TV, stress from job and even from watching TV drama. All of those facts are real in causing the worse condition of human's health especially for those with chronical diseases.

The main goal of this study is focusing on studying the physiological pattern of human state emotion through SPO2 sensor, specifically the three most used and basic human emotions, angry, sad and happy (Ekman, 1999). In order to better understand and simulate such condition, in this study we implementedvideo stimulations that were chosen from our previous study (Rumpa *et al*., 2015) to trigger participant's emotion state and measure it by using SPO2 sensor. We hyphothesize that after stimulating the participants with some chosen videos, we would record some physiological pattern regarding their emotional state based on SPO2 sensor data such as a decrease or increase condition of oxigen level in the blood during or after stimulation. Moreover, through this esperiment we

Corresponding Author: Adhi D. Wibawa, Department of Multimedia and Network Engineering,
Institut Teknologi Sepuluh Nopember, Surabaya, Indonesia

would like to know which emotion that has great potential in influencing the condition of patient by suppressing the level of oxigen in the blood so that patient can have a hypoxia condition (low level of oxigen in the blood) or asthma. This new knowledge would be useful as the basic informationfor developing e-Health monitoring system, especially for elderly patients with chronical diseases so that in the future sudden death attack due to heart failure caused by patient's emotion's instability then can be decrease significantly.

MATERIALS AND METHODS

In this experiment, 30 healthy volunteers (13 male and 17 female) were involved in the measurement done in Telematics Laboratory, Institut Teknologi Sepuluh Nopember. The age of them was ranged from 17-25 year old. All of participants must be healthy and free from Cardiovascular disease. Inform consent and sufficient information regarding all the process of measurement and the possible effect of watching the video stimulation were delivered to them clearly. Every participant was free to stop and quit the measurement at any time they want if they feel unconfortable during video stimulation. All of video materials have been validated and tested in our previous experiment (Rumpa *et al*., 2015) and has also been published. Table 1 showed the composition of the video stimulation that were used.

Measurement set-up: In this study,we used SPO2 sensor from e-Health platform v2.0 sensor (Coocking Hack Libellium) to obtain the physiological data of each three emotional state, angry, sad and happy from the 30 participants. This SPO2 sensor was attached to the participant's fingertip as shown in Fig. 1. It is a non-invasive sensor to record the level of oxigen that was attached to the blood via haemoglobin. This sensor reads the light reflectionfrom the skin due to the colour of blood cell that passes below the vein under the fingertip skin. The normal level of oxigen in the blood is between 0.95-1.00. The <0.95 level would be categorized as hypoxia. This sensor is connected to a module in e-Health system then connected to Arduino board. The CPU then read the data that is transmitted from Arduino through serial communication. The data sampling frequency was 46 Hz.The data was then saved in txt format. The experiment wasdone in a quiet room, separated from any noise or human disturbances. The measurement was devided into 3 phase (Fig. 1). The first phase was about 1 minute recording. At this phase, the condition of the participants were at relax and stabil. The second phase was video stimulation, the duration depends on the length of the video files and the third phase was recovery. We set 1 min periode to record the data of SPO2 sensor in the recovery phase. From this 3rd phase, we will learn whether the recovery conditionhappens or not. The way we presenting the data was done by showing how much is the increase or the decrease level of oxigen in the blood of each emotion state due to video stimulation from baseline phase to video play phase and then compared to recovery phase condition. The level of SPO2 data during baseline for each participant was calculated from the mean of all baseline from all emotions, similar condition was done on the recovery phase. Increasing the level of SPO2 data is indicated as a good influence, oppositely decreasing the level of SPO2 was defined as a bad influence to the human's health.

Table 1: The composition of video stimulation

Type of video	Duration(min)	Video code
Happy	08:46	ICICI 11
Sad	07:01	ICICI 14
Angry	01:57	ICICI 9

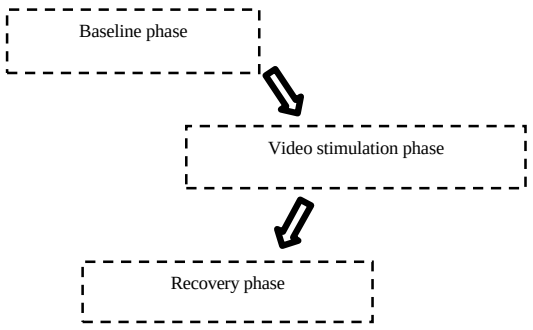

Fig. 1: Phases of measurement

RESULTS AND DISCUSSION

From the 30 participants who were involved in this study, 7 volunteers were removed due to error in SPO2 data, the value of their SPO2 data were both below 0.95 (0.45 and 0.36) meaning that this was a hypoxia condition which was impossible in normal condition of healthy volunteers. In total, there were only 23 participant's SPO2 data that were used for further analysis. Figure 1 shows the level of change (whether it was increasing or decreasing) from the baseline phase condition compared to the video stimulation phase. Positive value means that the oxigen level during video stimulation phase was higher than during baseline phase and vice versa condition happen for minus value (Fig. 2-5).

From the result we can see the behaviour of three emotion states (happy, sad and angry) from all 23 participants during baseline, video stimulation and

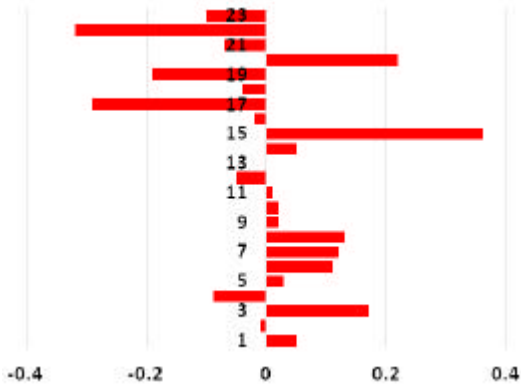

Fig. 2: The level of oxigen change from Baseline phase to video stimulation phase during Happy emotion state*(minus means that the level of oxigen is lower during video stimulation phase compared to the baseline phase)

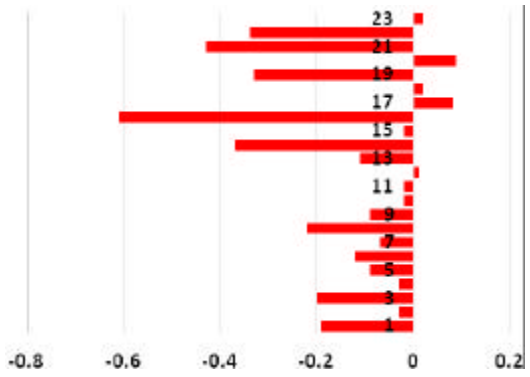

Fig. 3: The level of oxigen change from baseline phase to video stimulation phase during sad emotion state *(minus means that the level of oxigen is lower during video stimulation phase compared to the baseline phase)

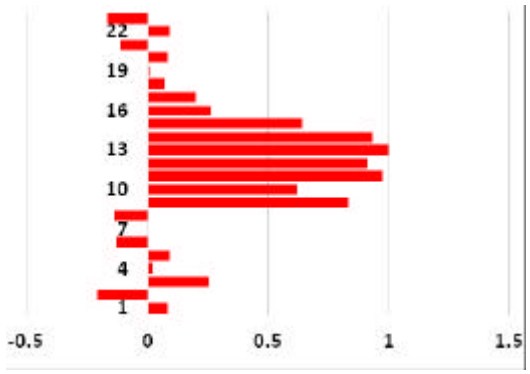

Fig. 4: The level of oxigen change from Baseline phase to video stimulation phase during Angry emotion state *(minus means that the level of oxigen is lower during video stimulation phase compared to the baseline phase)

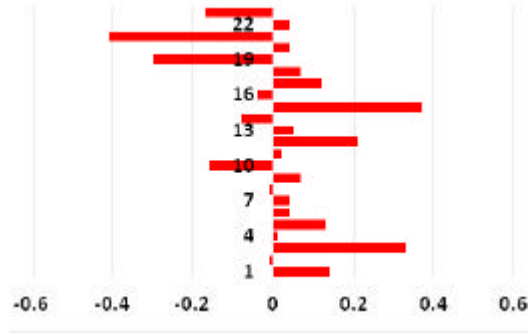

Fig. 5: Mean of change of SPO2 data from baseline phase to Recovery phase from all participants *(positive means that the level of oxigen is higher during recovery phase compared to the baseline phase)

recovery phase. Figure 2 showed that most of participants were increasing their level of oxigen in the blood during happy emotion, because there were 14 participants showed increase of SPO2 data while the other 9 participants showed a decrease oxigen level in the blood. Sad and Angry emotion showed clearly their behaviour. Most of participants showed a decrease level of oxigen during sad emotion (18 compared to 5 participants). Contrary condition happened during angry emotion, with contrary proportion (18 participants showed an increase level of oxigen while 5 other showed a decrease level of oxigen). In term of hypoxia condition, this result has showed that sad emotion has higher potential in contributing negative impact to the participant's health compared to happy and angry emotion. Sad emotion has suppressed the level of oxigen in the blood much lower compared to other emotion states. This result agrees with our previous study that exploring 6 basic human emotion by using ECG and Pulse sensor. In Wibawa we reported that sad emotion has higher potential in contributing more negative impact to human's health compared to other 5 emotions. When comparing the baseline condition with the recovery condition, Fig. 6 showed that most of participants had higher level of oxigen during recovery phase compare to their baseline. Moreover, Fig. 6 showed a comparison of level of change between the condition during recovery phase with the condition during video stimulation phase.

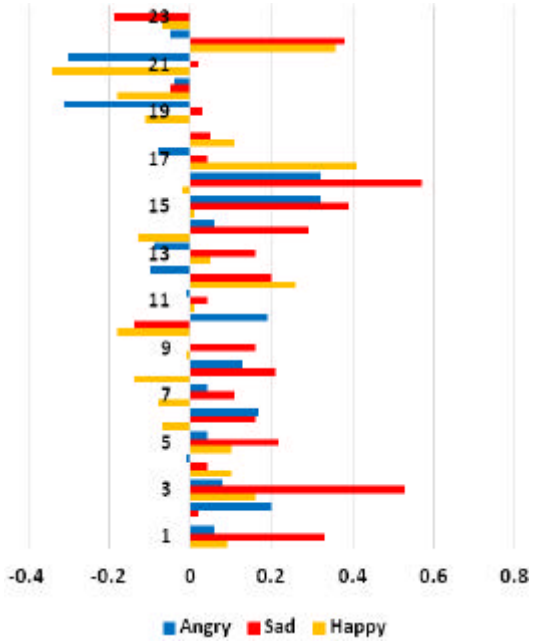

Fig. 6: Level of oxigen change from all three emotion states between video stimulation phase and recovery phase *(positive value means that the level of oxigen is higher in recovery phase compare to video stimulation phase)

We can see that sad emotion dominated the level of change. Sad emotion has showed its capability in suppressing the level of oxigen in the blood much lower than the other two emotions, meaning that during sad emotion the level of oxigen was pressed significantly and then rose up again to normal during recovery phase. For some people, this condition sometime could cause asthmatis and hypoxia (Affleck *et al*., 2000; Knapp *et al*., 1992).

From all of these results we can conclude that sad emotion again gave more negative impact to the human's health, especially for patients with chronical diseases. The suppressed level of oxigen in the blood that was shown by sad emotion can potentially harm the patients and give higher possibility ofthe patients to have hypoxia condition or triggering asthma. However, an interesting fact was also found during this experiment. Angry emotion increases the level of oxigen in the blood greater than happy emotion. Regarding this fact we speculate that during angry emotion, people tend to be more physically aggresive and this condition could triggers higher oxigen demand, thus causing high oxigen consumption.

CONCLUSION

Despite all of these results, some limitations of this study were also discussed such as the relative relationship between the duration of video stimulation with the level change of oxigen in the blood. This means that the longer the sad video stimulation was used to stimulate the participants the lower could be the level of oxigen as a result. Similar condition may also happen to other emotions and their video stimulations. However, further experiment need to be done to explore more on this problem so that better understanding can be obtained to make a better decision regarding monitoring the psychological condition of patients.In addition, this result to our opinion was relative to the type of video stimulation that we used, besides other cultural aspects that causing the participant's emotion to rise. However, the behaviour of the emotion changes during experiment and the change of oxigen level remain important in understanding human emotion state through physiological data recorded by vital sign sensor. For future work, longer periode of SPO2 monitoring is better to grab the exact baseline level of each individual, so that some anomali regarding the decrease or increase level of oxigen in the blood then can be precisely determined per subject.

ACKNOWLEDGEMENT

This study is funded by RISTEK-DIKTI, Ministry of Research and Technology-Directorate General of Higher Education, Republic of Indonesia

REFERENCES

Affleck, G., A. Apter, H. Tennen, S. Reisine and E. Barrows *et al*., 2000. Mood states associated with transitory changes in asthma symptoms and peak expiratory flow. Psychosomatic Med., 62: 61-68.

Almejrad A.S., 2010. Human emotions detection using brain wave signals: A challenging. Eur. J. Sci. Res., 44: 640-659.

Brosschot, J.F. and J.F. Thayer, 2003. Heart rate response is longer after negative emotions than after positive emotions. Int. J. Psychophysiology, 50: 181-187.

Ekman, P., 1999. Basic Emotions. In: The Handbook of Cognition and Emotion, Dalgleish, T. and T. Power (Eds.). Sussex, John Wiley and Sons, Ltd., UK., pp: 45-60.

Judge, T.A., A. Erez and J.E. Bono, 1998. The power of being positive: The relation between positive self-concept and job performance. Hum. Perform., 11: 167-187.

Knapp, P.H., E.M. Levy, R.G. Giorgi, P.H. Black and B.H. Fox *et al*., 1992. Short-term immunological effects of induced emotion. Psychosomatic Med., 54: 133-148.

Ostir, G.V., K.S. Markides, S.A. Black and J.S. Goodwin, 2000. Emotional well-being predicts subsequent functional independence and survival. J. Am. Geriatrics Soc., 48: 473-478.

Rumpa, L.D., A.D. Wibawa, M.H. Purnomo and H. Tulak, 2015. Validating video stimulus for eliciting human emotion: A preliminary study for e-Health monitoring system. Proceeding of the 2015 4th International Conference on Instrumentation, Communications, Information Technology and Biomedical Engineering (ICICI-BME), November 2-3, 2015, New York, USA., ISBN:978-1-4673-7800-0, pp: 208-213.

Tauseef, M.Q., 2012. Human emotion recognition using smart sensors. Master Thesis, The School of Engineering and Advance Technology, Massey University, Wellington, New Zealand.