Evolution in Electrical and Electronic Engineering Vol. 2 No. 1 (2021) 203-212
© Universiti Tun Hussein Onn Malaysia Publisher's Office

EEEE

Homepage: http://publisher.uthm.edu.my/periodicals/index.php/eeee
e-ISSN : 2756-8458

Abnormal Respiration and Stress Disorder Monitoring System

Nur Adlina Jumain[1], **Nor Surayahani Suriani**[1*]

[1]Department of Electronics Engineering, Faculty of Electrical and Electronics Engineering,
Universiti Tun Hussein Onn, Batu Pahat, 84600, MALAYSIA

*Corresponding Author Designation

DOI: https://doi.org/10.30880/eeee.2021.02.01.023
Received 19 February 2021; Accepted 19 April 2021; Available online 30 April 2021

Abstract: The high stress disorder in daily routines may increase the number of sudden death cases. This project aims to study the effect of abnormal respiration rate on the body stress index. Therefore, this paper purposed to develop a respiration monitoring system detector based on respiration rate and stress index by using temperature sensor (DS18B20), Galvanic Skin Response (GSR) sensor, and pulse sensor. The three variable data collected from 30 subjects by using the sensors were used to evaluate the correlation of abnormal respiration towards body stress index. The program was designed using threshold parameters for three variables data in Arduino IDE to ease the abnormality classification process. The analysis found out that correlation of abnormal respiration towards stress body index is not correlated as in the past research papers. Overall, the respiration system monitoring was designed and successfully validate that abnormal respiration rate leads to body stress detection.

Keywords: Body Stress Index, Galvanic Skin Response, Pulse Rate

1. Introduction

The abnormal respiration may be due to an unbalanced body stress level which can affect the health condition. Normally, people are not aware of their health conditions and continue their lifestyles as usual. Thus, many cases of immediate death happened caused by abnormal respiration systems due to high levels of stress [1]. Furthermore, people are lack of awareness to maintain their respiratory system due to their busy daily lifestyle [2]. The Global Burden of Disease Study (GBOD 1990) reported in 2010, mental and substance disorder was one of the causes of the leading to the disease [3]. Also, in Malaysia, National Health and Morbidity Survey (NHMS) recorded data on prevalence of generalized anxiety disorder (GAD), major depressive illness, and suicidality among the adult of sixteen years old and above increasing to 6.8% on 2012 [4]. Abnormal respiration is one of cardiovascular disease that affected from stress occurred in daily life such as emotional distress, anxiety and shock [16].

In this project, the respiration monitoring system detector is developed based on respiration rate and body stress index. The system is better than conversional method because of the quality of evidence for the main results of conversional method systematic review is low because there are serious discrepancies and significant potential for bias. Previous researches work only either based on respiration rate or body

*Corresponding author: nsuraya@uthm.edu.my

stress index monitoring systems individually. The hypotheses for this project are made based on the past research papers [5][6][7]. The hypotheses are when the GSR reading of subjects increases, the respiration of subjects will be increasing on average and when the pulse rate of subjects increases, the respiration of subjects is also increased on average.

2. Related Works

From the past research papers, mostly the input used for the respiration rate system is body temperature measurement and the output will be displayed on LCD. In every research paper, the materials and methods used are different to get the respiration rate data such as LM35 [8], flex sensor [9], thermometer sensor [10] and AD590 temperature sensors [11]. Thus, in this project, the material and method used are a temperature sensor DS18B20 module collecting the temperature body by using threshold method.

The body stress index system in the project used a pulse rate sensor to detect the heart beats and a GSR sensor to collect human conductivity skin during inhale and exhale. The inputs are pre-processed by using threshold method in Arduino coding. The materials used in the body stress index system was chosen based on the ability of the materials to collect and detected raw inputs from human body. Next, threshold method used to determine the abnormality of respiration rate and body stress index by referring research papers conducted by Josephin et.al. [12] and Sreedevi et.al. [13]. Other optional sensors are SEN11574 [9], ADS1292R ECG module [13] and combination of visual sensor, physiological sensor, behavioural sensors and performance sensors [14].

For the abnormality of GSR rate, temperature rate and heart beat rate detected using thresholding method. The coding will be fed into an Arduino and the result is displayed on a LCD. Microcontroller Arduino Uno R3 used for processing the raw inputs. Moreover, the Arduino is provided the libraries that contain coding for testing [15]. Liquid-Crystal Display (LCD) is be implemented in the system to display the data by connecting with Arduino board. By doing so, the user easily to monitor the data of their health conditions.

3. Respiration and Stress Monitoring System

This section presents the experimental setup design and the overall project block diagram of the monitoring system.

3.1 Project Block Diagram

The system consists of three input sensors which are temperature sensor, pulse sensor, and GSR sensor. All the sensors are connected with the analog pins in the microcontroller. The raw input signal for respiration rate will be read when the temperature sensor is put under the nostrils. While the heart rate data was collected from the input signal coming from the pulse sensor and GSR sensor which are attached to the user's fingertips. The range was set in Arduino coding for every each of the sensors.

While collecting the data, the monitoring system controlled by the Arduino starts the data preprocessing. The designed algorithm evaluated and identified the state condition of normal or abnormal based on the thresholding method. The range of each parameter had been set in the coding previously. Next, the LCD displayed the results for the respective user's respiration rate, pulse rate, and GSR reading. The reading values of the sensors must be within the normal range for every sensor's parameter reading value for the normal conditions. If the reading values of the sensors is out of normal range, the result will display either normal or abnormal condition on the LCD.

Figure 1 shows the block diagram of the project. The hardware elements consist of two (2) module which is respiration rate module and the body stress module. This modules function to measure the parameters from the three measurement sensors. The software elements consist of Arduino software for data collection and preprocessing of raw data and evaluate the data.

The respiration rate module can be worn under the nostril and it consists of a DS18B20 temperature sensor. The DS18B20 sensor is connected to the Arduino board to measure the changes in temperature while breathing. The body stress module consists of a pulse sensor and GSR sensor which to measures the heart rate and skin conductance. The sensors collect the data and fed it to the microcontroller which is Arduino Uno R3.

The data from the sensors are processed for evaluation purposes in Arduino software. In Arduino software, the evaluation process will happen to determine the respiration rate and the body stress index are normal or abnormal. The final processed data is then sent to the LCD by connecting the LCD board by wire jumper. Finally, the user can view the values displayed on the LCD board to determine the health status of that person.

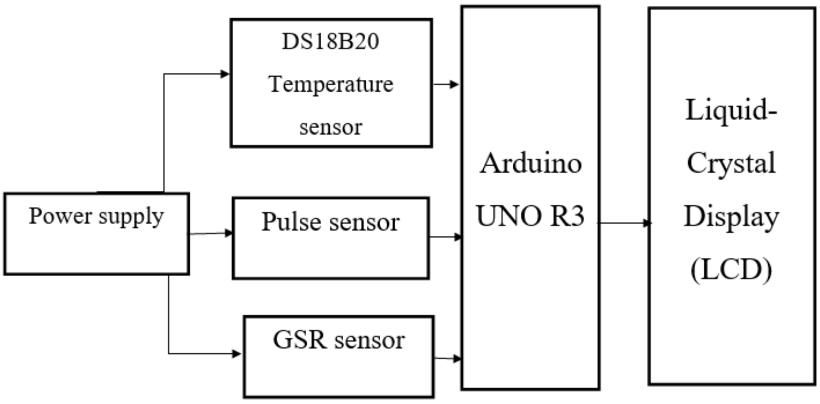

Figure 1: Block diagram of respiration and stress monitoring system

3.2 Project Prototype

The functionality of abnormal respiration and stress disorder monitoring system by using Arduino UNO as the microcontroller of the system has been experimentally observed. The monitoring system used a recharging battery so that it can be used from 2 hours up to 3 hours period. The battery acted as a power supply to switch on the Arduino UNO microcontroller that connected with the system. The Arduino UNO adapts to 5V until 12V power supply. Figure 2 shows the prototype of the respiration and stress monitoring system.

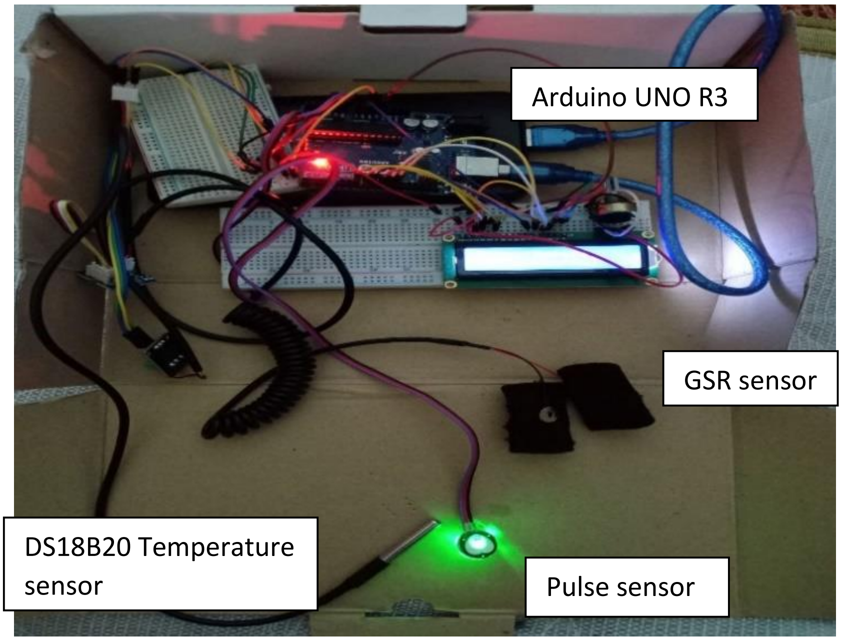

Figure 2: The prototype of respiration and stress monitoring system

3.3 Threshold Parameters

There are three threshold parameters used in this project to determine the range of values of the variables either in normal or abnormal conditions for respiration rate shown in Table 1, GSR reading shown in Table 2 and heart rate shown in Table 3 respectively. The threshold parameters referring the journal and official website. [17][18][19].

Table 1: Respiration Rate Classification

Classification of Respiration Rate	Range of Respiration Rate
Normal RR (normal condition)	12-20 BPM
Slow RR (abnormal condition)	<12 BPM
Fast RR (abnormal condition)	>20 BPM

Table 2: GSR Reading

Body Conditions	Range of Reading in Siemens
Normal condition	<4.0 Siemens
Abnormal condition	>4.0 Siemens

Table 3: Pulse Rate Classification

Heart rate Conditions	Range of pulse beat per minute
Normal Condition	60-100 BPM
Bradycardia (abnormal condition)	<60 BPM
Tachycardia (abnormal condition)	>100 BPM

4. Results and Analysis

The first subsection will discuss the data results collected after testing 4 subjects in 2 conditions which is in relax condition and stress condition to show the differences normal condition and abnormal condition. However, the project had been tested on 30 subjects with their age is within the range of 19-25 years old. There are three tests that should be done by the subjects to get the normal data and abnormal data. The first test is done when the subject is in a relaxed condition. The second test is when the subject completed their walking exercise within 1 minute. Then, the final test is conducted when the subjects doing stair exercises within 1 minute. Initially, the first test is conducted to get the normal data and the remaining tests are conducted to get the abnormal data.

Figure 3 shows the reading of three parameters which are Galvanic Skin Response reading in Siemens unit, pulse rate in BPM, and respiration rate also in BPM. The monitoring system will determine the condition of the user every 60 seconds after collecting the data. Then, the condition of the user will be displayed.

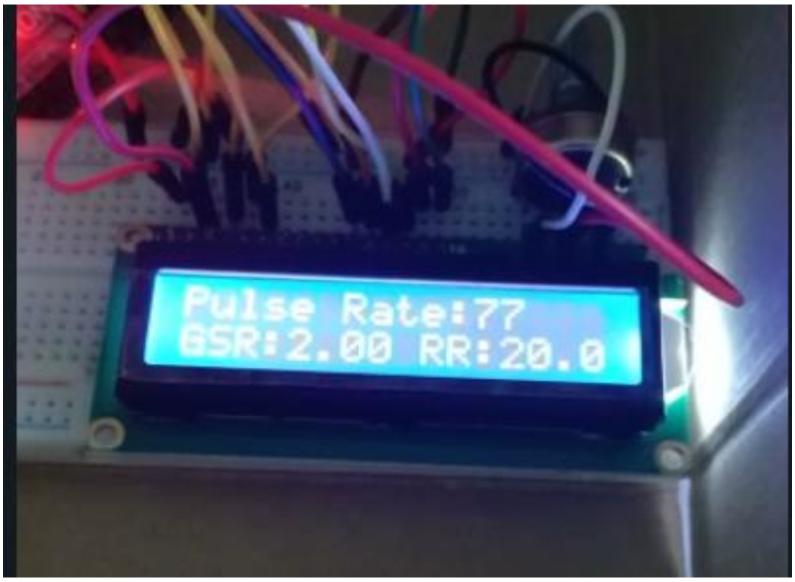

Figure 3: The reading of three parameters

Based on the result obtained in Figure 4, the condition of the subject is shown as "Resp.: Normal, Stress: Normal". The status of the condition is recognized by the system by referring to the threshold of the sensors parameters that have been set in the Arduino IDE coding based on the abnormal condition of the user. The result will show as normal condition when the data collected is below the threshold given in Table I, Table II, and Table III. Otherwise, the display will show an abnormal condition when the collected data is beyond the range of the passing threshold as shown in Figure 5.

Figure 4: Display for Normal condition

Figure 5: Display for Abnormal condition

4.1 Testing result for pulse rate classification

The results were compared with the theories and threshold parameters. Figure 6 shows the result of pulse rate of subjects after done three tests which are test for (i) relaxed condition, (ii) after doing walking exercise and (ii) after doing stairs exercise. The 4 subjects above consists of 2 subjects in normal condition which are Subject 12 and Subject 14, and 2 subjects in an abnormal condition which are Subject 9 and Subject 5, for two tests.

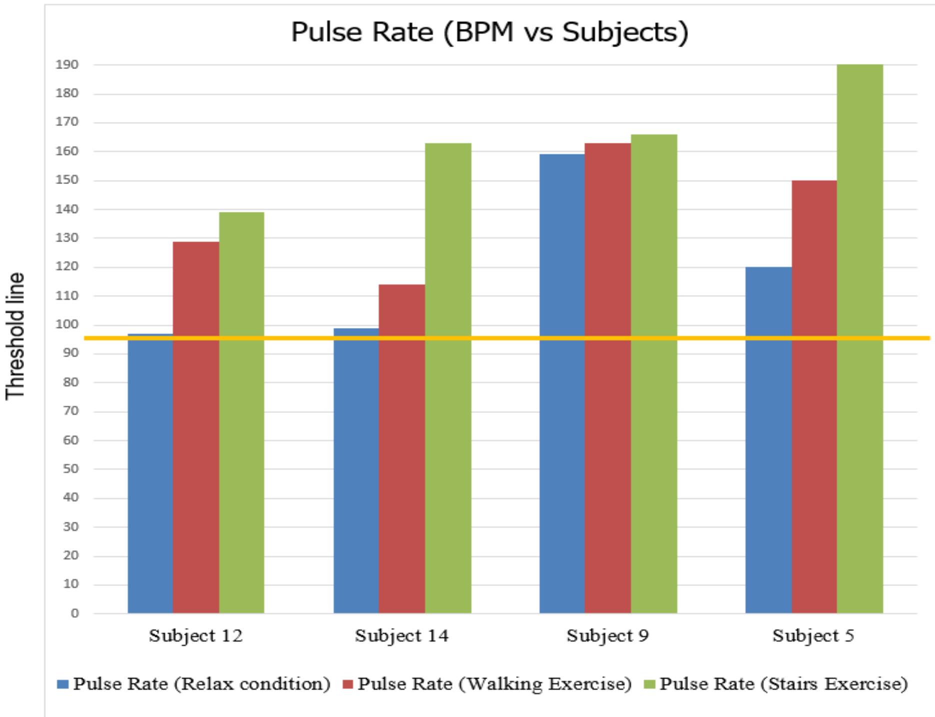

Figure 6: The the result of pulse rate of subjects after done three tests

Subject 12's pulse rate and Subject 14's pulse rate in relax condition are 97 BPM and 99 BPM that were normal pulse rate while in relax condition. The pulse rate for Subject 12 and Subject 14 after doing walking are 129 BPM and 139 BPM. While for the stairs exercise, Subject 12 and Subject 14 readings are 114 BPM and 163. Both pulse rate reading after doing exercises are should be higher than 100 BPM because human body need more oxygen while doing exercises and that make heartbeat beats faster.

Next, the abnormal condition can be seen on Subject 9 and Subject 5's pulse rate. In relax condition, Subject 9's pulse rate is 159 BPM and Subject 5's pulse rate is 120 BPM. Even though in relaxed condition, that pulse rate readings were abnormal. Then, the pulse rate reading for Subject 9 and Subject 5 after doing walking exercise are above 160 BPM. For the stairs exercise, Subject 9 and Subject 5 pulse readings are 150 BPM and 232 BPM respectively. Logically, the pulse rate after doing exercises should be higher than 100 BPM because the human body needs more oxygen while doing exercises and that make the heartbeat beats faster. But in this case, even though the pulse rate of Subject 9 after both exercises is normal, but the fitness of this subject should be taken into consideration. According to the health screening form, Subject 9 and Subject 5 are having asthma. Subjects that having asthma or other serious illness required careful observation and awareness of the significance of any emergency conditions and situations. Therefore, a healthy screening before doing the tests on subjects is needed.

4.2 Testing result for GSR reading classification

Figure 7 shows the result of GSR reading of subjects after done three tests. The subjects are using same subjects as before. As shown in the graph above, the GSR reading values are different for each subject.

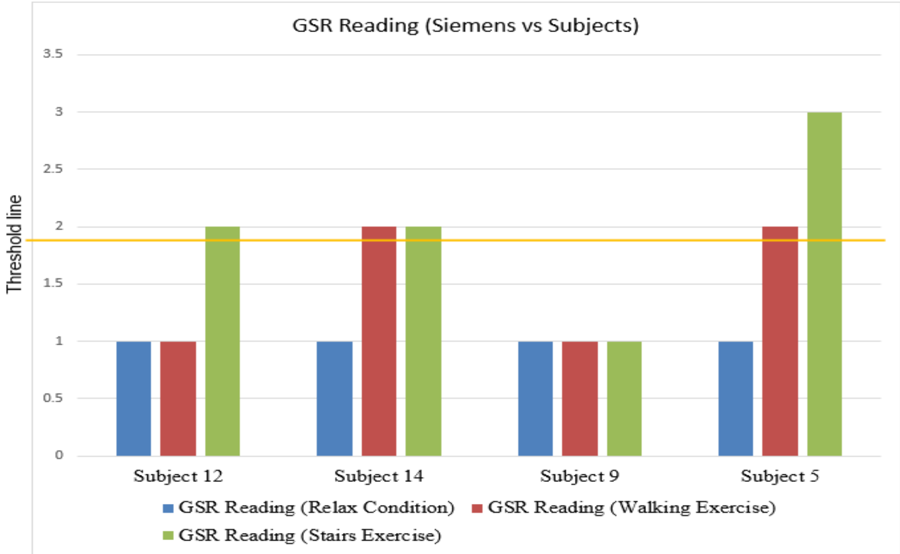

Figure 7: The result of GSR reading of subjects after done three tests

Subject 12's GSR reading is 1.0 Siemens in relax condition and after walking exercise, and 2.0 Siemens after stairs exercise. Subject 14's GSR reading is 1.0 Siemens in relax condition, 2.0 Siemens in both after exercises. Subject 9's GSR reading is 1.0 Siemens in 2 tests. The GSR readings for that 3 subjects are normal even after doing exercise. This is because when we are doing exercises, we will be more relax, not getting pressure. If that person is getting pressure after doing exercise, it may cause by incapability of that person to do that exercises or in other word they may have respiratory illness or other illness that caused they feel pressured. That condition can be seen in Subject 5's GSR reading.

By observed Subject 5's GSR reading after doing stairs exercise, the reading is abnormal where the value is 3.0 Siemens. As we know, Subject 5 having asthma. When subject doing stairs exercise, subject felt pressured even subject doing in lower speed. The GSR sensor will detect the human resistance value through two fingers to detect the condition human body.

4.3 Testing result for respiration rate classification

Figure 8 shows the result of respiration rate of 4 subjects after done three tests which are test for are relax condition, after doing walking exercise and after doing stairs exercise. The 4 subjects are same as before, Subject 12 and Subject 14, normal subjects and Subject 9 and Subject 5, abnormal subjects.

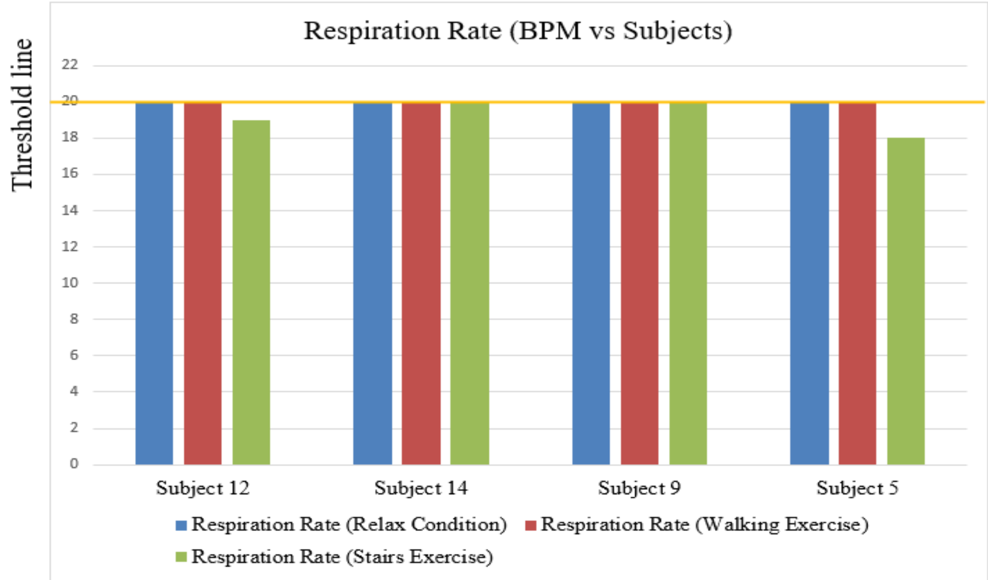

Figure 8:The result of respiration rate of 4 subjects after done three tests

As shown in Figure 8, the respiration rate reading values are quite same for each subject. By observed the graph, the respiration rate values of Subject 12 are decreasing where the last reading is 19 BPM. Respiration rate values for Subject 14 and Subject 9 are same on all states condition. Next, the respiration rate values for Subject 5 are also normal even at stairs exercise value is decreasing to 18 BPM. However, all respiration rate of subjects is normal where they do not over the threshold of respiration rate.

5. Conclusion

From the project can be concluded that the project had been met all the objectives of the project. The respiration monitoring system detector based on respiration rate and stress index succussed developed. The system is developed based on the scopes of the project. A few recommendations for this project for the future research. Replace the sensors with the high quality one. Due to low quality, it will affect the result that obtained that caused the error and conflict happened during the test. Moreover, the sensors also sensitive to the surrounding condition. Second, the design of the system can be improved with more suitable and with high safety design to keep the system safe. Third, improving the monitoring system by implement the authorization account for privacy of user data. Forth, implement the machine learning method in the monitoring system for determine the data collected. Lastly, the measuring method for respiration rate change to by using PPG signals for more precisely and accuracy.

Acknowledgement

This research was made possible by the continues support and funding from Universiti Tun Hussein Onn Malaysia through TIER1 Grant (H756).

References

[1] S. Labott-Stewart, "Stress Effects on the Body," American Psychological Association, 2020. [Online]. Available: https://www.apa.org/helpcenter/stress/effects-respiratory [Accessed: 5 May 2020]

[2] E. Kempen, E. A. Symington, H. Muller and T. V. Eeden, "A Study of the Relationship Between Health Awareness, Lifestyle Behaviour and Food Label Usage in Gauteng," South African Journal of Clinical Nutrition, vol. 25, no. 3, pp. 15-21, 2012.

[3] H. A. Whiteford, A. J. Ferrari, L. Degenhardt, V. Feigin and T. Vos, "The Global Burden of Mental, Neurological and Substance Use Disorders: An Analysis from the Global Burden of Disease Study," PloS one, vol. 10, no. 2, 2015.

[4] F. Yusoff et al. "National Health and Morbidity Survey 2012 (NHMS 2012): Global School-Based Student Health Survey 2012," Institute for Public Health, 2013.

[5] J. H. Hee, L. Sina, L. B. Jessica, D. Nikil and M. R. Amir, "Objective Stress Monitoring Based on Wearable Sensors in Everday Settings," Journal of Medical Engineering & Technology, Taylor & Francis Group, vol. 44, no. 4, pp. 177-189, 2020.

[6] F. Atlee, H. Rakesh, R. Lokesh, T. Tushar and V. S. Ashwini, "Determination of Stress using Blood Pressure and Galvanic Skin Response," Shree Rayeshwar Institute of Engineering and Information Technology, International Coference on Communication and Network Technologies, 2014

[7] Hindra K., Alexandr V. M. & Mykola P., "Stress Detection from Speaech and Galvanic Response Signals", Proc. IEEE International Symposium on Computer-Based Medical System, 2013.

[8] A. Singh & A. Chaudhary, "Real Time Respiration Rate Measurement using Temperature Sensor," International Journal on Recent and Innovation Trends in Computing and Communication, vol. 5, no. 6, 2017

[9] G. K. Demtania, T. Triwiyanto, C. N. Priyambada et al., "Measuring of Vital Signs using Internet of Things Technology," IEEE Xplore, International Seminar on Application for Technology of Information and Communication, 2019

[10] R. B. Prasetiyo, K. Choi & G. Yang, "Design and Implementation of Respiration Rate Measurement System using an Information Filter on an Embedded Device," MDPI, University of Science and Technology, Daejeon, 2018.

[11] A. D. Cantara & A. M. Ceniza, "Stress Sensor Prototype: Determining the Stress Level in using a Computer through Validated Self-Made Heart Rate (HR) and Galvanic Skin Response (GSR) Sensors and Fuzzy Logic Algorithm," International Journal of Engineering Research & Technology, vol. 5, no. 3, 2016,

[12] J. A. Dhivya, S. Akshaya, U. Rithikka & Fathima, "Stress Meter using Pulse and Sweet Sensor," International Journal of Recent Technology and Engineering, vol. 8, no. 4, pp. 12386-12390, 2019

[13] S. Uday, C. Jyotsna & J. Amudha, "Detection of Stress using Wearable Sensors in IoT Platform," International Conference on Inventive Communication and Computational Technologies, 2018,

[14] L. Wenhui, Z. Weihong, Z. Zhiwei & J. Qiang, "A Real-Time Human Stress Monitoring System using Dynamic Bayesian Network," IEEE Xplore, Department of Electric, Computer and Systems Engineering Rensselaer Polytechnic Institute, Troy, New York, 2006

[15] K. M. Rajesh, T. Ranjith, P. Saran & S. Surendar, "IoT Based Physiological Stress Monitoring and Managing Device," Academia, International Journal of Innovative Research in Advanced Engineering (IJIRAE), vol. 6, no. 3, 2019.

[16] "Respiratory Rate 3: How to Take an Accurate Measurement" *Nursing Times*, 2018. [Online]. Available: https://www.nursingtimes.net/clinical-archive/respiratory-clinical-archive/respiratory-rate-3-how-to-take-an-accurate-measurement-25-06-2018/ [Accessed: 10 March 2020].

[17] J. Chen and A. Flabouris, "Respiratory Rate: The Neglected Vital Sign," The Medical Journal of Australia, vol.188, no. 11, pp. 657, 2008, doi: 10.5694/j.1326-5377.2008.tb01825.x

[18] "PALS Algorithms 2020 (Pediatric Advanced Life Support)" *United Medical Education*, 2020. [Online]. Available: https://www.acls-pals-bls.com/algorithms/pals/ [Accessed: 10 March 2020].

[19] P. K. Hadya, S. T. Rasmana & M. C. Wibowo, "Rancangan Bangun Alat Pengukur Tingkat Stres Menggunakan Metode Fuzzy Logic," Journal of Control and Network Systems, vol. 4, no. 1, 2015.