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Zulkifli, M.H.Z.[a] , Jasni, F.[a] , Ghazali, A.S.[a] , Nordin, N.H.D.[a] , Sidek, S.N.[a] , Shaharum, S.M.[b] , Zaman, F.H.K.[c]

EXPLORING THE EFFICACY OF PIEZOELECTRIC-BASED SENSORY SYSTEMS FOR HEART RATE MONITORING IN DIFFERENTIATING STRESS VS RELAX CONDITIONS

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[a] Department of Mechatronics, International Islamic University Malaysia, Kuala Lumpur, Malaysia
[b] Fakulti Teknologi Kejuruteraan Elektrik Dan Elektronik, Universiti Malaysia Pahang, Pahang, Malaysia
[c] School of Electrical Engineering, Universiti Teknologi MARA, Selangor, Malaysia

Abstract
Stress has diverse effects on human physiological reactions, and one such effect is on heart rate (HR). The established methods to acquire HR is by electrocardiogram (ECG) and photoplethysmogram (PPG). ECG electrodes need to be placed on the chest, which can cause inconvenience and is not practical in daily life, while PPG signals are known to contain more noise than ECG. Thus, this work aims to investigate the efficacy of a piezoelectric-based sensory system in measuring HR and using the signal to differentiate stressed and relaxed conditions by means of statistical analysis. Two activities were conducted to achieve the goal. The first experiment involved collecting and analysing piezoelectric signals to measure the pulse rate (bpm) and compare this with the HR from PPG. For the second experiment, the piezoelectric-based HR was calculated from 20 subjects (male and female, age ranging between 20 and 25) in relaxed and stressed conditions. The stress condition was triggered using two stressors: the Stroop Colour Word Test and the Digit Span Test. Statistical analyses reveal a strong positive correlation between piezoelectric-based heart rate (HR) and oximeter readings ($r(12) = 0.993$, $p < 0.001$), despite the fact that the values are not precisely identical. In addition, the findings also indicate that there are significant effects by the mental states (stressed and relaxed) on the piezoelectric-based HR readings ($p<0.05$). Employing a within-subject design condition, the results further illustrated that piezoelectric readings are elevated during stressed conditions (Mean±SD = 72.395±0.097) and diminished during relaxed conditions (Mean±SD = 71.615±0.126). Therefore, the suggested piezoelectric-based sensory system has been validated as an effective means of categorizing stress and relaxation based on heart rate signals.

Author Keywords
Heart Rate; Piezoelectric Sensor; Stress Detection

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Correspondence Address
Jasni F.; Department of Mechatronics, Malaysia; email: farahiyahjasni@iium.edu.my

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