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Stress Detection in Working People

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Abstract

Stress detector classifies a stressed individual from a normal one by acquiring his/her physiological signals through appropriate sensors such as Electrocardiogram (ECG), Galvanic Skin Response (GSR) etc,. These signals are pre-processed to extract the desired features which depicts the stress level in working individuals. Support Vector Machine (SVM) and K-Nearest Neighbour (KNN) are investigated to classify these extracted feature set. The result indicates feature vector with best features having a strong influence in stress identification. An attempt is made to determine the best feature set that results in maximum classification accuracy. Proposed techniques are applied on benchmark SWELL-KW dataset and state-of-art results are obtained.

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Keywords: Stress;ECG;GSR;Machine learning;SVM(support vector machines);K-Nearest Neighbour (KNN);

1. Introduction

Stress management systems play a significant role to detect the stress levels which disrupts our socio economic lifestyle. As World Health Organization (WHO) says, Stress is a mental health problem affecting the life of one in four citizens [1]. Human stress leads to mental as well as socio-fiscal problems, lack of clarity in work, poor working relationship, depression and finally commitment of suicide in severe cases. This demands counselling to be provided for the stressed individuals cope up against stress. Stress avoidance is impossible but preventive actions helps to overcome the stress [2]. Currently, only medical and physiological experts can determine whether one is under depressed state (stressed) or not. One of the traditional method to detect stress is based on questionnaire [3]. This method completely depends on the answers given by the individuals, people will be tremulous to say whether they are stressed or normal. Automatic detection of stress minimizes the risk of health issues and improves the welfare of the society. This paves the way for the necessity of a scientific tool, which uses physiological signals thereby automating the detection of stress levels in individuals.

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The organization of this paper is as follows. Section II gives overview on related state of art. Section III describes the framework carried out in this research. A simple stress prediction algorithm is also presented in this section. Section IV discusses the obtained results on the application of SWELL-KW dataset. Finally conclusions are drawn in section V.

2. Related Literature

Stress detection is discussed in various literatures as it is a significant societal contribution that enhances the lifestyle of individuals. Ghaderi et al. [4] analysed stress using Respiration, Heart rate (HR), facial electromyography (EMG), Galvanic skin response (GSR) foot and GSR hand data with a conclusion that, features pertaining to respiration process are substantial in stress detection. Maria Viqueira et al.[5] describes mental stress prediction using a standalone stress sensing hardware by interfacing GSR as the only physiological sensor . David Liu et al.[6] proposed a research to predict stress levels solely from Electrocardiogram (ECG).

Multimodal sensor efficacy to detect stress of working people is experimentally discussed in [7]. This employs the sensor data from sensors such as pressure distribution, HR,Blood Volume Pulse (BVP) and Electrodermal activity (EDA). An eye tracker sensor is also used which systematically analyses the eye movements with the stressors like Stroop word test and information related to pickup tasks.The authors of [8] performed perceived stress detection by a set of non-invasive sensors which collects the physiological signals such as ECG [9], GSR, Electroencephalography (EEG), EMG, and Saturation of peripheral oxygen (SpO2). Continuous stress levels are estimated using the physiological sensor data such as GSR, EMG, HR, Respiration in [10]. The stress detection is carried out effectively using Skin conductance level (SCL), HR, Facial EMG sensors [11] by creating ICT related Stressors.

Automated stress detection is made possible by several pattern recognition algorithms. Every sensor data is compared with a stress index which is a threshold value used for detecting the stress level. The authors of [5] collected data from 16 individuals under four stressor conditions which were tested with Bayesian Network, J48 algorithm and Sequential Minimal Optimization (SMO) algorithm for predicting stress. Statistical features of heart rate [12], GSR [3], frequency domain features of heart rate [13] and its variability (HRV) [6], and the power spectral components of ECG [7] were used to govern the stress levels. Various features are extracted from the commonly used physiological signals such as ECG, EMG, GSR, BVP etc., measured using appropriate sensors and selected features are grouped into clusters for further detection of anxiety levels . In [8], it is concluded that smaller clusters result in better balance in stress detection using the selected General Regression Neural Network (GRNN) model. This results in the fact that different combinations of the extracted features from the sensor signals provide better solutions to predict the continuous anxiety level [14]. Frequency domain features like LF power (low frequency power from 0.04 Hz to0.15Hz), HF power (High frequency power from 0.15Hz to 0.4 Hz) , LF/HF (ratio of LF to the HF). and time domain features like Mean , Median, standard deviation of heart signal are considered for continuous real time stress detection in [10].

Classification using decision tree such as PLDA is performed using two stressors namely pickup task and stroop based word test wherein the authors concluded that the stressor based classification proves unsatisfactory [15]. In 2016, Gjoreski et al. created laboratory based stress detection classifiers from ECG signal and HRV features [10]. Features of ECG are analysed using GRNN model to measure the stress level [8]. Heart rate variability (HRV) features and RR (cycle length variability interval length between two successive Rs) interval features are used to classify the stress level [12]. It is noticed that Support Vector Machine (SVM) was used as the classification algorithm predominantly due to its generalization ability and sound mathematical background [16] Various kernels were used to develop models using SVM and it is concluded in [17] that a linear SVM on both ECG frequency features and HRV features performed best, outperforming other model choices [18].