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FCM clustering of emotional stress using ECG features

Abstract

Emotional stress refers to the inducement of stress due to the consequence of a continuous experience of negative emotions (sad, anger, fear and disgust). This work aims to investigate the effect of negative emotions in emotional stress inducement through Electrocardiogram (ECG). 20 university students with a mean age of 24-years have participated in this study. Audio-visual stimuli (video clips) are used to design a data acquisition protocol for inducing the emotional stress on the subjects. Perceived Stress Scale (PSS-10) questionnaire is used to evaluate the subject's initial stress behavior. Self Assessment Manikin (SAM) and Self Assessment Form is used to evaluate the subject emotional response during and after the data acquisition, respectively. Statistical features such as heart rate (HR), approximate entropy (ApEn), mean R amplitude (MRA), mean R-R interval (MRRI), standard deviation of normal to normal R-R intervals (SDNN) and root mean square of successive heartbeat interval differences (RMSSD) are extracted from HRV signals. Finally, the emotional stress assessment on this work consists of two stages namely; three valence classification (positive emotions, negative emotions and neutral) and emotional stress classification where negative emotions are further classified into either emotional stress or non emotional stress. To visually observe the distance between each class, Fuzzy C Means (FCM) Clustering plot is implemented and Euclidean distance measure. In FCM, the centroid, distance between each cluster, and objective function is used for performance evaluation. Among the different types of features, HR plays a significant role on distinguishing three valence states and emotional stress states.

Keywords — Electrocardiogram (ECG), emotional stress, fuzzy c-means clustering, negative emotions