

CHARACTERIZATION OF DICHOTOMOUS EMOTIONAL STATES USING ELECTRODERMAL ACTIVITY BASED GEOMETRIC FEATURES

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ABSTRACT

In this work, an attempt has been made to classify dichotomous emotional states using Electrodermal activity (EDA) and geometric features. For this, the annotated happy and sad EDA is obtained from the online public database. The EDA is subjected to discrete Fourier transform, and Fourier coefficients in the complex plane are obtained. The envelope of the complex plane is identified using the α-shape method. Five geometric features, namely center of gravity, eccentricity, convexity, rectangularity, and convex hull area are computed from the envelope and statistical analysis is performed. Two machine-learning algorithms, namely random forest (RF) and support vector machine, are considered for the classification. The results show that the proposed approach is able to classify the dichotomous emotional states. The rectangularity feature is found to be distinct and shows a statistically significant difference between the happy and sad emotional states ($p<0.05$). The RF classifier yields the highest F-m and AUC of 87.8% and 93.8%, respectively in differentiating emotional states. Thus, it appears that the proposed method could be used to understand the neurological, psychiatric, and biobehavioral mechanisms associated with happy and sad emotional states.

Keywords: Emotion, Electrodermal activity, geometric features, classification

INTRODUCTION

Emotion is a complex multidimensional phenomenon that influences behavior and cognitive processes [1]. Emotions play a significant role in a wide range of human activities. The basic emotions that all humans universally experience are happiness, sadness, fear, disgust, anger, and surprise [2]. Traditionally, basic emotions are categorized negatively or positively dichotomously [3]. Positive emotion such as happiness is pleasant to experience, and negative emotion such as sadness is unpleasant to experience [4]. Sadness and happiness are regarded as diametric opposites, with differences in nearly every aspect, including behavior, physical movements, brain activity, and facial expression. Happiness is associated with problem-solving, physical well-being, and prosocial behavior [5], [6]. On the other hand, sadness has adverse effects on human health [7], [8]. Studies have shown that sadness can lead to anxiety, suicidal attempts, depression, sleep disorders, and a negative impact on cardiovascular activity [9], [10].

Emotion recognition may be divided into two approaches: physiological and non-physiological traits [11]. Non-physiological traits include voices, bodily gestures, and facial expressions. The emotional responses induced by these traits, on the other hand, may not adequately reflect the persons' genuine emotional state [12]. On the other hand, physiological traits such as Electrocardiogram, Electrodermal activity (EDA), electroencephalogram, Electromyogram, and Photoplethysmogram are effective since they directly reflect the sympathetic nervous system activity [12]. EDA is a non-invasive and easily