

Recognition of Emotions in Gait Patterns Using Discrete Wavelet Transform

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ABSTRACT

Emotion is a natural instinctive state of mind deriving from one's circumstances, mood, or relationships with others. Emotion can be characterized primarily by the psycho-physiological expressions, biological reactions, body interaction, and mental states. The emotional component is to be important for social interaction to serve the communication, response, and conveying information. The problem in controlling and maintaining human emotion can lead to emotional disorder. According to the National Institute of Mental Health (NIMH), approximation of 10-15% of the children tend to have an emotional and behavioral disorder. In this paper, discrete wavelet transform (DWT) was proposed to recognize human emotions in gait patterns. Four discrete categories of emotion such as fear, happy, normal, and sad were analyzed. Data was extracted from a single stride of gait. Daubechies wavelet of order 1 and order 4 was utilized to investigate their performance in recognizing emotional expression in gait patterns. Six statistical features namely mean, maximum, minimum, standard deviation, skewness, and kurtosis were derived from both approximation and detail coefficients at every level of decomposition. The discrete emotion was classified using kNN and fkNN classifier. The maximum classification accuracy of 96.07% was obtained at the first level of decomposition using kNN.

Keywords: Discrete Wavelet Transform (DWT), Emotion, Fuzzy K Nearest Neighbor (fkNN), Gait, K Nearest Neighbor (kNN), Personality

INTRODUCTION

Human lives involve with social judgment and bring us to elicit reliable judgment of emotion, and personality from human raters (Andrea et

al., 2004). Emotion and personality depend on a series of processes including the perception of the stimuli, observable behavior to prior knowledge and inferring the state or trait that relatively automatic component towards of a body (Bodenhausen & Hugenberg, 2011; Adolphs, 2002). Hans Eysenck (1916) classifies personality into three categories of super

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traits (extraversion–introversion), neuroticism and psychoticism stability. The problem with thoughts and behavior of humans comes from uncontrolled emotion that can lead to personality disorders such as borderline, antisocial, narcissistic and others (Zuckerman, 1991)

An article from Pacer Centre has explicated that the childhood of teenager who experiences an emotional disorder will most likely have difficulties in growing up. In addition from DSM-IVR diagnostic criteria, there are several types of emotional disorder that affect a child and youth. In psychosocial aspects, emotional disorders are quite complex. Many psychologists will normally investigate the patient emotional states through questionnaires and counseling and this technique are more subjective. In order to develop objective method to understand the emotional state of an individual, several studies using physiological signal, facial expressions, acoustic analysis of speech, gesture and body motion were investigated (Hassan et al., 2010; Reddy et al., 2011; Russo et al., 2009; Yamada & Watanabe, 2007; Asha et al., 2005; Friberg, 2004; Kobayashi, 2007; Kleinsmith et al., 2011; Omlor et al., 2006; Karg et al., 2010; Roether et al., 2009; Janssen et al., 2008; Venture, 2010). Although several studies are available in the literature, there is still some limitation. Physiological signal is hard to deal with since it can be affected by internal factors of a user. External factor on the other hand deals with the different physiological or acoustic signal characteristic where they are easily exposed to the environmental noise during experimental session. In order to improve the performance to develop the removable method, the researchers used motion capture based marker techniques. The data obtained is considered more accurate since it could represent the orientations of the joints and bone structure as presented in previous works.

Developing machine learning models for recognizing human emotion is far more challenging and it is an active research field which generally referred to as affective computing. Table 1 depicts some of the significant research

works that was conducted in the human emotions for various types of motion.

There are different methods presented in previous work as shown in Table 1. Body expressions have recently been recognized as an important matter of nonverbal communication. Many studies have examined the configurations of body expressions to evaluate specific features of the body that can be attributed to the recognition of emotional states (Kleinsmith & Bianchi, 2012). From the previous work, two main things were highlighted which are features extraction and classification. In this paper, different techniques of feature extraction using Discrete Wavelet Transform (DWT) were proposed to investigate the emotional states from the gait patterns. The reason behind using gait for this study is due to its possibility as a source to provide useful social information as explained by Montepare et al. (1987). Gait patterns were recorded under different emotional conditions collected from Carnegie Mellon University (CMU) human gait database. Four emotional expressions have been selected. Statistical features were extracted from the decomposed gait patterns. To investigate the usefulness of the statistical parameter, kNN and fkNN were used as a classifier. From the results, it can be concluded that the proposed method can recognize the human emotions from their gait patterns efficiently.

The database used in this paper is described in “Database” section. In “Feature Extraction using Discrete Wavelet Transform (DWT)” section, the introduction of designing DWT and feature extraction are explained. In “Classification” section, the fundamental of kNN and fkNN are presented. The experimental results of emotion gait recognition are discussed in “Result and Discussion” section. The conclusion of the paper is given in “Conclusion” section.

DATABASE

Here, the original database obtained from CMU Graphics Lab Motion Capture Database is available at <http://mocap.cs.cmu.edu/>. The database

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