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CAAI Transactions on Intelligence Technology 2 (2017) 56–61
http://www.journals.elsevier.com/caai-transactions-on-intelligence-technology/

Original Article

Cognitive-affective regulation process for micro-expressions based on Gaussian cloud distribution

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Available online 22 December 2016

Abstract

In this paper, we explore the process of emotional state transition. And the process is impacted by emotional state of interaction objects. First of all, the cognitive reasoning process and the micro-expressions recognition is the basis of affective computing adjustment process. Secondly, the threshold function and attenuation function are proposed to quantify the emotional changes. In the actual environment, the emotional state of the robot and external stimulus are also quantified as the transferring probability. Finally, the Gaussian cloud distribution is introduced to the Gross model to calculate the emotional transitional probabilities. The experimental results show that the model in human–computer interaction can effectively regulate the emotional states, and can significantly improve the humanoid and intelligent ability of the robot. This model is consistent with experimental and emulational significance of the psychology, and allows the robot to get rid of the mechanical emotional transfer process.

Keywords: Micro-expression; Cognitive-affective regulation; Gaussian cloud distribution; Transferring probability; Emotional intensity

1. Introduction

Micro-expressions is a short facial expression that cannot be independently controlled by brain, and it is trying to suppress or hide the true human emotion [1]. In 1966, Haggard and Isaaes found a quick facial expression that is not so noticeable. They believe the expression is related to the self-defense mechanisms and shows some pent-up emotions. In 1969, Ekman and Friesen also independently discovered the facial expressions, and have a name for it: micro-expressions [2].

Micro-expression is closely related to the process of emotional information for human, it can't be forged and can't be controlled by conscious. At the same time, micro-expressions is reflecting the true feelings in the human's heart, but it is difficult for people to perceive [3]. In this paper, we establish affective computing model based on the micro-expression recognition in the human–robot interaction. Then we verify the regulation process of robot emotion by experiment. To filter out the human's disguise, micro-expression recognition and emotion modeling are intended to analyze the real emotions.

1.1. Connection between micro-expressions and emotion

Sentiment exists in people's lives all the time. Although emotion is some kind of inner emotional experience, there are some external performances in touch with it—the expression is the external representation of emotion [4]. But micro-expression is different with common expression, it is a very quick look, the duration is only 1/4 s. Therefore, its existence is imperceptible for most people. And Ekman think that the micro-expression may contain all muscle action of general expressions [5], or may contain only a part of the muscle movements. It often occurs when a person is lying, and it expresses the real emotions that people is trying to suppress and hide. It is a spontaneous expression and action, and it also express the six basic facial expressions [6]. Shown in the following Table 1.

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Peer review under responsibility of Chongqing University of Technology.

http://dx.doi.org/10.1016/j.trit.2016.12.002

Table 1
Comparison table of the facial muscle movement of micro-expression and basic emotions [6].

Basic emotion	Facial muscle movement of micro-expression	Facial image
Anger	Nostrils tighten; comers of the mouth are pointing downward; eyes widened; Brows knitted;	
Disgust	Lower lip down; upper lip thrust forward; eyebrows under pressure; eyes squeeze; tongue sticking out;	
Fear	Eyes open wide; mouth opens wide; eyebrows improve; Lips retract;	
Happy	Eyes get bright; wrinkles round eyes; cheekbones get prominent;	
Sad	Eyes close; eyebrow furrow; comers of the mouth are pointing downward; mouth close tightly;	
Surprise	Eyebrows rising; eyes open wide; mouth opened;	

1.2. Emotional cognitive control

Cognitive model is the criteria of personal information processing. In addition, the criterion is the basic principle of cognitive reasoning. According to these principles, the changes of emotional state can be inferred from the effective factors in specific circumstance. And the factors include the human (H) and the environment (E) [7].

Emotional is a physiological state caused by the individual and the experience. Sometimes individual emotional reactions consistent with the change of the environment, and sometimes conflict with the environment and the social intervention. When the mood is incompatible with the specific case, they need to adapt to the situation by adjusting. Currently, there are a lot of emotional computing model was put forward based on cognition. The OCC model could be realized in computer with the universal emotion cognition [8]. After that, emotional computing model based on HMM has been put forward by Pau- Choo Chung [9]. Xin Lun has obtained the analysis of emotion model by extending emotion process to continuous space, which enriches the robot's intermediate state making the man–machine interaction more harmonious [10]. By the above, we found that the method of combining the cognitive psychology and information science is the effective measure to improve robot emotion analysis. Gross Emotional regulation strategy gets more and more attentions due to the computability. Gross came up with five emotion regulation strategies: 1) the situation selection—is the top priority adjustment method; 2) the situation correction—refers to change the scenario that lead to the emotional events; 3) the attention distribution—includes distraction and concentration; 4) the cognitive change—the different interpretations of emotional events will lead to different personal emotions. 5) the adjustment of reaction —suppresses emotional behavior by self-control and response-focused emotion regulation [11,12].

Among them, the first four are carried out prior to the formation of emotional response. And they are antecedent-focused emotion regulation. The adjustment of reaction is carried out after the formation of the emotional response, so it is response-focused emotion regulation. Gross proposed the process model of emotion regulation [13]. Moreover, he identified two major subdued ways of emotion regulation—the cognitive reappraisal and the suppression of expression.

These two different emotion regulation strategies have different effects on the emotional, cognitive and social behavior [11]. What's more, the different regulations have important implications for Individual emotional experience and happiness in a relationship. For example, people who is accustomed to using cognitive reappraisal will experience fewer negative emotions and more positive emotions. But the one who is accustomed to using suppression of expression is just the opposite.

For the robot in human–computer interaction be more positive dynamic, the affect regulation come true based on cognitive reappraisal of response-focused regulation [14]. The cognitive reappraisal aims at understanding and rationalizing negative emotional events through a positive way.

Because the ability of 3D gradient vector to capture the inter-linkages is stronger, we get the key frames of micro-expression through 3D gradient projection descriptor [15]. Then we can quickly and efficiently extract the features in each image area by wavelet method. Finally, as a foundation of following affective computing, the features of micro-expression are classified by the nearest neighbor algorithm. Based on the identification and classification of micro-expressions, we propose a Gaussian cloud model to implement the cognitive-affective process [16]. The specific model shown in Fig. 1 we mainly analysis and calculation for the