A Framework of Human Emotion Prediction Based on a Multi-Dimensional Emotion Model

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Abstract. In this paper, we propose a framework of emotion prediction based on a multi-dimensional emotion model using object similarity. The proposed framework predicts the user's level of emotional response to an emotional stimulus, based on a sensitivity database that consists of self-assessment manikin-based integer-scale data, rated on various object stimulations by many users. We experimented on 72 users, with 1,073 stimulation objects, based on the International Affective Picture System, and used Thayer's arousal-valence 2-dimensional emotion model to verify the proposed framework. As a result, we have confirmed that the proposed framework can predict user emotion using an arousal-valence model.

Keywords: Affective Computing, Emotion Prediction, HCI

1 Introduction

A method of approach in electronic, electric and computer engineering fields consists of the emotion recognition of humans. These use facial images, speech and bio-signals that contain heartbeat, state of tension, skin temperature and circulation of the blood, to recognize human emotions [1-3]. Above all, electroencephalogram (EEG) of brain wave was noted by many human-computer interaction (HCI) researchers [4], because the brain wave should have the inner working of a human. These kinds of existing works have a critical problem or limitation, from the viewpoint of realization for affective computing, which is hard pressed to quantitatively verify the emotion recognition method. Because we do not know the real emotion of a target user, it is difficult to find the basis of recognition success. A method of approach in cognitive science and psychology field consists in the emotional modeling of humans [5, 6]. Many psychology researchers have been studying visualization and the principles of emotion for a long time. In effect, various multi-dimensional emotion models have been proposed by Russell and Thayer, among others [7, 8].

In this paper, we propose a novel method that is based on psychological theory. The proposed method is a framework to predict human emotion before stimulation. We use Thayer's 2-dimensional model, which consists of arousal and valence. The arousal and valence rating of many users of various stimuli are used as a sensitivity database for each user. The proposed framework can be used for existing studies, with the purpose of improving the emotion recognition ratio and confidence of the emotion recognition result.

2 Proposed Framework of Emotion Prediction

Fig. 1 shows the architecture of the proposed framework. It basically consists of 2 steps. In the first step, it predicts the level of emotional response (ER) of a target user, based on the multi-dimensional emotion model. Then it maps a combination of the predicted level of ER to the emotion model. The details are described below.

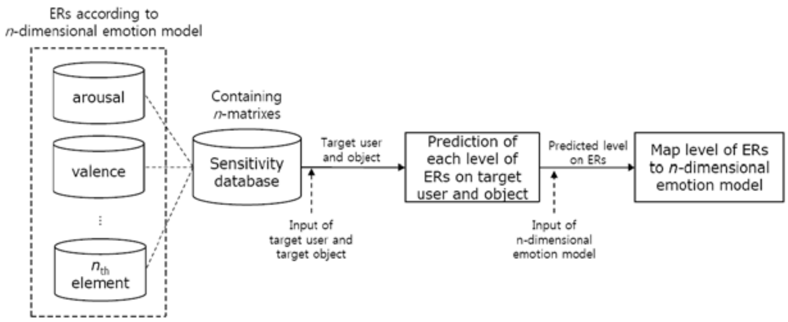

Fig. 1. The architecture of the proposed framework

The sensitivity database consists of *n*-ER elements, which can contain emotional response elements, based on elements of the emotion model that are based on psychological principle. For example, Thayer's 2-dimensional emotion model consists of arousal and valence, and Russell's 2-dimensional emotion model consists of activation and pleasant [7, 8]. Content of the sensitivity database is constructed by integer rating of many users of various stimulations with objects. In psychology, the self-assessment manikin (SAM) is widely used as a rating method [9]. The SAM is useful, regardless of the nationality, ethnicity, language or illiteracy of a human individual. The rating scale of SAM is from 1 to 9, as integer number. A subject for constructing the database evaluates the response level, after stimulation with an object. The rating of each user is inputted to the emotional response. Namely, the rating of the m_{th} user on the k_{th} object is stored in a matrix of relevant emotional response elements.

A prediction of ERs on the target user and target object is calculated by object similarity in each ER. A similarity between the target object and each other object is used as a weight for prediction. We can consider the Pearson Correlation Coefficient, Cosine Coefficient, Euclidean Distance as similarity methods of linear variables, and the weighted average as a prediction. In prediction, a threshold for neighbor selection is necessary, to predict the rating of a target user on a target object.

3 Experimental Result

We have collected subjective emotions of individual users using SAM over IAPS of an often-used emotion induction dataset from 72 users, to build individual emotional sensibility data. The International Affective Picture System (IAPS) consists of just 1,200 photographs of commonly seen objects from human life. Extremely suggestive or cruel photographs were excluded; 1,073 visual stimulation objects were composed randomly into 8:2 ratios, with 80 % of total objects as training data, and 20 % as test data.

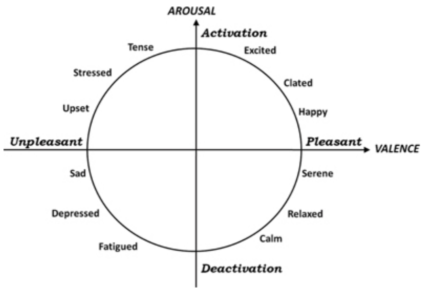

Fig. 2. Thayer's arousal-valence emotion model

Table 1. Experimental result of emotion prediction

Performance Rank	Similarity	Optimal Neighborhood Size	Error Distance
3	COS	100	2.461
2	PCC	50	2.372
1	RMS	50	2.248
4	N. Avg.	150	2.682

In Table 1, is to observe the error distance of emotion model in Fig. 2 which is Thayer's 2-dimensional emotion model, widely used by psychological works, the reason being that it is very intuitive, manageable, and useful for combinations of SAM evaluation. This experiment predicts arousal and valence ratings regarding target objects, and marks real values and predicted values on Thayer’s 2-dimensional emotion model. We then measured the lineal absolute distance error between the two points. Euclidean distance was used as a distance measurement. Table 1 shows the results and experimental conditions, which contain the optimal neighborhood size per similarity method. As a result, we were able to confirm the effectiveness of the proposed framework, because the diagonal length in a 3 by 3 square is 2.449, and the diagonal length of one quadrant in the 2-dimensional emotion model is 2.828 on the 1-9 integer scale level, which is the standard type. Each quadrant is representative of human feelings, which contain joy, anger, sorrow or happiness.

4 Conclusion

We propose a novel framework for emotion prediction, based on a multi-dimensional emotion model using object similarity. The proposed framework predicts a level of emotional response element, based on a collective sensitivity database, which consists of multiple matrixes, according to the number of emotional response elements. From the experimental results, the proposed framework showed greater prediction accuracy. In the future, we will study convergence, fusion and combination of the proposed framework, and a multimodal emotion recognition method using facial expression or speech. This approach will be an optimal recognition method that uses external and internal human elements in affective computing.

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