Design of Emotional Space Modeling using Neuro-Fuzzy

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Abstract. As IT becomes highly efficient, ICT (information and communications technology) began to evolve into a direction to maximize convenience or tangibility. ICT, especially, develops into a direction for the qualitative improvement of emotion-based personalization and tangibility maximization. Actually, studies on the emotion model to express human emotion quantitatively and structurally for the qualitative improvement of emotion-based personalization service need to be preceded. In addition, high level inference on human emotional transference is required in order to maximize the tangibility of service. Also, emotion modeling equipped with learning ability is demanded for personalized emotion modeling. To this end, this study proposes an adaptation-style emotion model structure suitable for personalization service using Thayer’s V-A emotion model, fuzzy inference system and neuro-fuzzy system.

Keywords: Emotion Space, Fuzzy, Neuro Fuzzy, V-A Emotion model

1 Introduction

Due to high efficiency of IT, ICT is connected with interest in personalization service to maximize the convenience or tangibility of services. In particular, studies on emotion-oriented service taking into account individual subjective disposition are on the rise. As study results on human emotions, various types of models emerge to express them in a quantitative and structural manner, starting from a psychological aspect. For emotion-oriented personalization service, studies are conducted on the emotion inference model and emotion modeling method equipped with learning ability for the personalization of emotion.

This study uses the 2D emotion model proposed by Thayer as the emotional space model for user emotion modeling. This study also uses fuzzy logic for the efficient processing of verbal variables to express human emotions used in the emotional space. For high level inference on emotional transference, a fuzzy inference system

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applies. For personalized modeling of emotional transference and inferred emotion information in the fuzzy inference system without learning ability, this study proposes a neuro fuzzy system-based emotion model structure. Such a structure enables personalized emotional space and inference modeling equipped with adaptation and learning ability in a new environment.

2 Fuzzy and Neuro-Fuzzy

Fuzzy logic targets fuzziness, which is based on subjectivity, an issue that cannot be clearly judged, and fuzzy logic expresses membership intensity to a specific set using the fuzzy set, not the crisp set. The size and intensity of emotion in the V-A (Valence-Arousal) emotion model to be used in this study change, according to the V-A values, the value and change boundaries are vague. For this reason, there is a difficulty to process with the crisp set. Consequently, this study applies fuzzy logic to process the fuzziness of verbal variables that the emotional expression language has and the vagueness of boundaries between emotions [1].

Fuzzy logic and artificial neural network can play a role in supplementing each other naturally. The artificial neural network is a low level operation structure operated in handling unprocessed data, while the fuzzy logic deals with high level inference using the verbal information acquired from experts in specific fields. The fuzzy system, however, has no learning ability, and thus it cannot adapt to a new environment for itself. Meanwhile, the artificial neural network can learn, but the results cannot be easily understood, unlike the fuzzy logic results. As a result, parallel operation, learning ability, fuzzy system’s knowledge expression and explanation capabilities can be combined through a neuro-fuzzy system that has combined the artificial neuro network and fuzzy system. With this, the artificial neuro network gets more clarified by reducing unintelligibility, and the fuzzy system gets equipped with learning ability. This study proposes the neuro-fuzzy system structure for personalized emotion inference through which learning is possible, and for emotional space modeling [2].

3 FIS-based Emotional Space and Inference Model

Thayer’s emotion model is also called V-A (Valence-Arousal) emotion model that uses 2D space. Arousal is intensity of emotion between exciting and calm in emotions, and indicates transference from excited emotion to calm emotion, as the arousal value increases. Valence indicates intensity on the positive and negative aspects. As the valence value increases, positive emotion is indicated, and as the valence value decreases, negative emotion is indicated. There are 12 types of emotions that can be indicated. According to the V-A value size, expression on intensity of each emotion can even be made [Figure 1]. This study conducts fuzzy logic-based emotional space modeling to process verbal variables on emotional expressions used in the V-A emotion model and also fuzziness that the boundary between emotions has [3].
The emotion information in the V-A emotion model is defined as verbal expression like “happy.” Boundary between adjacent emotions in terms of structure is also vague. To properly process the V-A emotion model having the features above, modeling was conducted with FIS system as shown in Figure 1. The V-A values (input values) were defined with seven types of fuzzy membership functions, respectively, and 12 types of emotions were defined to be processed as output values, according to intensity. The entire FIS system consists of two types of input, 12 types of output and 49 types of inference rules.

The following rule is the one actually used in this study. In the first part, the V-A values were processed with fuzzy membership function. The second part was set as the fuzzy membership function on 12 types of emotion values[4].

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\text{IF Valence is Positive-High and Arousal is Exciting-High, Then Happy is Happy-Strong} \rightarrow \text{IF A1 and B1, then C2}
\]

Figure 2 shows the construction of the neuro-fuzzy system, based on the rule and fuzzy membership function.

The neuro-fuzzy system has a structure similar to multilayer artificial neural network. The proposed system in this study consists of one input layer, one output layer and 3 hidden layers. Using these, the membership functions and fuzzy rules are indicated. For the FIS system used for inference, the Mamdani-type inference model can be used. For input, the input values of the V-A model (valence and arousal values) were used, and 12 emotional expressions were used for output value.

Through the proposed method, the FIS system enables fuzzy values that emotion information has to be fuzzified, and the modeling of emotional space equipped with advanced features.
neuro-fuzzy system-based learning ability was conducted to be utilized for personalization service.

Fig. 2. Neuro-Fuzzy System for Personalization Emotion Modeling

4 Conclusion

This study is on the design of neuro-fuzzy system for emotional space for emotion-based personalization service and personalized emotion modeling through emotion learning. To process the fuzziness of verbal variables for emotions and emotional expressions, fuzzy logic applied, and FIS applied for emotion transference and inference modeling in this study. To make continuous personalization service feasible by learning individual emotions, this study proposes a neuro-fuzzy system-based emotion model through which learning is possible. Through this, it is decided that individual emotional modeling and the emotion model realization, through which appropriate quantitative inference and learning are possible, can be conducted.

References