Chapter 14
Computing with Words Model for Emotion Recognition Using Interval Type-2 Fuzzy Sets

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ABSTRACT

This chapter provides a novel approach to emotion recognition of subjects from the user-specified word description of their facial features. The problem is solved in two phases. In the first phase, an interval type-2 fuzzy membership space for each facial feature in different linguistic grades for different emotions is created. In the second phase, a set of fuzzy emotion-classifier rules is instantiated with fuzzy word description about facial features to infer the winning emotion class. The most attractive part of this research is to autonomously transform user-specified word descriptions into membership functions and construction of footprint of uncertainty for each facial feature in different linguistic grades. The proposed technique for emotion classification is very robust as it is sensitive to changes in word description only, rather than the absolute measurement of features. Besides it offers a good classification accuracy over 87% and is thus comparable with existing techniques.

1. INTRODUCTION

Emotion recognition is currently gaining popularity for its increasing applications in human-computer interfaces (HCI). Several modalities of emotion recognition have been reported in the literature. Of these, the modality of facial expression analysis is given priority for its simplicity in realization in current generation HCI-system. This chapter attempts to provide a novel solution to the well-known emotion recognition problem by facial expression analysis.

In a more recent work (Mandal, R., Halder, A., Bhowmik, P., Konar, A., Chakraborty, A., & Nagar, A. K. (2011, June), researchers considered type-2 fuzzy sets as a basic model for facial expression representation of subjects (carrying same/similar emotions), and later employed type-2 fuzzy reasoning to classify unknown facial expression into one of five known emotion classes. The latter method requires measurements of facial features to determine the emotion class of the subject by type-2 fuzzy analysis. Unfortunately, the precise measurements of the facial features requires segmentation, localization and feature extraction on the unknown facial image of the subject, and thus adds overhead to the computational complexity of the classifier algorithm.

The present chapter, however, overcomes the above problem by labeling the features of a facial image into fuzzy word descriptions, which are directly submitted to a fuzzy classifier for emotion recognition. Fuzzy quantifiers like Large, Small and Moderate, and fuzzy linguistic hedges like VERY, NOT SO etc. are used to describe the qualitative variation in the fuzzy quantification.

A user on observing an unknown facial expression describes the facial features using the fuzzy linguistic hedges and quantifiers. A computer receives the linguistic descriptions about the face and classifies the emotion of the subject to one of five distinct emotion classes through a process of Interval Type-2 Fuzzy Reasoning (IT2FR). The contribution of the present chapter is briefly outlined below.

First, the chapter proposes a novel approach to translate user-defined word descriptions about facial features into emotion using IT2FR. Automatic transformation of word description of features into emotions being human-like enhances the scope of interaction between humans and machines in the next generation human-computer interface (HCI).

Second, construction of the space of footprint of uncertainty (FOU) for each facial feature (such as mouth-opening) in different linguistic grades (such as LARGE) for different emotions from the available word description obtained from several assessors carries novelty in the literature of Affective Computing.

Third, the proposed scheme does not require absolute measurement of facial features as input to the emotion classifier system. Rather, it requires only word description of facial features of a subject by a user. Naturally, the proposed method saves significant computational overhead required due to pre-processing, segmentation and localization of the facial features.

Lastly, the lack of precision in word description of features in comparison to absolute measurement of features does not significantly influence the classification accuracy, indicating the robustness of the word description models.

The chapter is divided into seven sections. In section II, the preliminaries of Type 2 fuzzy sets are given. Section III is concerned with the principles and methodology. Section IV provides the details of the fuzzy classifier. Experimental details are given in section V. Performance Analysis is given in section VI. Conclusions are listed in section VII.