論文の内容の要旨

論文題目 BROAFERENCE －

A Study on Automatic Support for Building Emotion Oriented Networked Communities

（感性共有情報を用いたネットワークコミュニティ構築自動支援に関する研究）

氏　　名　　コヴァリク　ウーヴェ　ミヒャエル

Facial expressions are playing an important role in communication between people. Related research from behavioral science provides strong evidence that facial expressions are tightly related to emotions. There are six basic emotions that are communicated by facial expressions, i.e. joy, sadness, surprise, anger, fear and disgust. It is a challenge to enable machines to automatically detect and classify facial expressions in order to adapt to the current emotional state of users. This will lead to improved quality of human-machine interfaces in the future. New technologies such as e.g. the Internet are recently gaining more and more popularity as a channel for human communication. One can say we are on the way to a ubiquitous network society. Therefore social rules have to be applied to networked user environments. In this context it is very important to consider the emotional component in networked communities. Current solutions for networked communities do mainly not reflect this issue. There are existing solutions for communicating emotions in the case that a networked community has been already established. However, as in real-life emotions are very important for even establishing a communication or community respectively. Currently there exists no solution that takes the emotional component for the process of community building in networked environments into account. The research presented here in this thesis was motivated by this situation. As a result of this work a user grouping mechanism has been developed, that provides users in a commonly shared context with the means to find other, so far unknown users based on a so called *Emotion History*. The new method enables people to find and connect to others that are of similar type or character as oneself. The benefit of this new method for user grouping is that a pre-selection of users can be made prior establishing a communication channel. This pre-selection is based on similar emotions derived from facial expressions and previously experienced in a shared context of a networked

community. The *Emotion History* stores knowledge about previously experienced emotions of *joy* and *surprise*. Both emotions are derived directly from the intensities of facial expressions. A similarity measure is applied to the *Emotion Histories* of different users in order to provide a suggestion, whether to people will match or not based on the stored knowledge of emotions.

In the last decades much research has been done in the area of automatic facial expression recognition. The common approach is to detect facial features, track them over time and classify changes of the features in order to identify a certain expression. A necessary constraint is, to separate the feature changes caused by rigid head movement from those caused by the actual change in the human face. More specifically it is important to compensate in-plane and out-of plane head rotations in order to provide the classification task with reliable and stable features. Since this research focused on classification of facial expressions, this issue became an important matter. As a solution and third contribution of the work presented here, the *Adaptive Depth Map* algorithm is proposed as a solution for the above problem. The main goal of the algorithm is to provide a compensation of feature position displacement caused by the surface structure of the face, i.e. different depth of feature points. This natural property of a human face causes the problem of moving features during out-of plane head rotations. This displacement is obviously not caused by changes in facial expressions and has to be therefore compensated. The compensation term is derived from observed displacement of features in the camera's image plane by referencing to a stored frontal face view. Each feature will be assigned with a compensation term in a dynamic process. This term will be used further to compensate out-of-plane head rotations for each feature. The benefit of this approach is that no camera calibration is necessary and furthermore it is adaptive to new users, i.e. user independent. Moreover the *Adaptive Depth Map* algorithm is easy to implement and has it advantages over other approaches such as e.g. using adaptive customized 3D head models in cases were the head rotation parameters are known.

The Facial Action Coding System developed by Ekman and Friesen allows a systematic and detailed description of facial mimics via so called *action units.* One feature of these action units is that they encode different levels of intensity. In this research a set of neural network classifiers has been developed, that allows in contrast to other related works in the area an explicit training of these intensity levels. Each classifier outputs an intensity value accordingly to the trained shape of facial features. This allows a dynamic analysis of facial expressions which is a crucial requirement for detecting blends of different emotions displayed in a human's face.

During the research presented in this thesis the *BROAFERENCE* frame work has been developed and implemented as a flexible platform for media distribution in networked communities. It served as a major tool for creating a networked community and provides a set of realized methods for facial expression analysis, shared context creation and user grouping. Several experiments of this research have been conducted on top of the *BROAFERENCE* framework.