Emotion Recognition on the Go: Providing Personalized Services Based on Emotional States

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ABSTRACT

Personalized products and services are the basic need to attract more customers and to gain a competitive advantage as most of the products available in the market place are similar in technical characteristics, quality, and price. Currently, most of the products and services don't consider the emotional state of the users before offering personalized services which is a big drawback. User emotional state acts as an important context in perception and decision making, and hence should be taken into consideration for offering personalized services. This applies particularly in mobile scenarios, during which people rapidly change places and environments and hence experience rapid changes of emotionally stimulating situations. Adaption to this rapid change of the emotional state promises to be an efficient way to offer personalized emotion-aware services.

This paper reports about an ongoing project investigating the possibility of providing personalized services based on the emotional state of users. The model described in the paper uses emotion-related bio-data and physical activity as input to determine the likely emotional state of the user. Based on the computed emotional state, the model chooses an appropriate personalized service to provide. In order to evaluate the model, an experimental prototype is developed. Successful development and test of the model shows that emotional states can be determined with mobile technology and effectively utilized to offer better personalized products and services. The model can further lead to the possibility of developing emotionally intelligent interactive systems.

Categories and Subject Descriptors

Affective computing, intelligent interactive systems, mobile HCI

General Terms

Design and development of model, Experimental prototype, Human Factors, Personalized product and services.

Keywords

Affective Computing, Emotions Recognition, HCI, Emotion Aware, Physiology Sensors, Emotion Detection, Bio Feedback, EREC System, Personalized Products and Services, DiaTrace.

1. Introduction

Research carried out in the field of HCI (Human–computer interaction) shows that humans have an intrinsic affinity to communicate with computers in ausual and social way just like they interact with other people in usual and social situations [4, 15]. Recognition of human emotion as part of affective computing has become an increasingly important field in HCI. The ability to recognize, understand and express emotions can play a vital role in human communication and increasingly in HCI [10, 12, 18]. The advantages of emotional computing are manifold. From a scientific perspective, emotions can play a vital role in human decision making, as well as in perception and learning. Furthermore, human emotions have the tendency to influence rational thinking and therefore can become a part of rational agents as proposed by artificial intelligence research [16]. Another possible use of emotions is on creating lively human-computer interfaces like avatars which comprise credible animations of interface agents , cf. [16].

With the advancement of mobile technologies and the need to provide personalized products and services to customers, emotion aware personalized services gain more importance as they are directly based on customer's current emotional experiences. Customer emotion consideration can enhance the pleasure of buying, owning, and using the products and services offered to the customer. Considering the experiential or emotional quality of products also helps in gaining differential advantage in the marketplace as most of the products nowadays are similar with respect to technical characteristics, quality, and price.

Providing personalized services based on emotions is quite a difficult task faced by the researchers due to the high level of complexity associated with sensing users current emotional state. Human beings in order to assess a person emotion's uses different information channels like monitoring a person's recognizable bodily reactions (face, gestures, posture…), individual traits, and causal information context. But, on the other hand, computer systems cannot yet easily evaluate information like individual traits or associate environment information with observed behavior [18].

The paper presents a model for providing personalized services based on emotional state. The model computes the current emotional state of the user through affective computing techniques. The computed emotional state is utilized by the service used in the model to transform itself according to the current emotional state of the user. In order to evaluate the model an experimental prototype system is developed which will provide mobile device services based on the emotional state of the user.

The next chapter will present a short overview of the background and related work to the project. Chapter 3 introduces the model for providing emotion-based personalized services, while chapter 4 shortly describes the experimental system prototype implementing the model.

2. Background & Related Work

The concept of providing personalized product and services emerged from the idea of "Web Personalization" [9]. Web personalization aims to transform the websites to reflect user's explicit and/or implicit interests and desires which motivates the idea of providing personalized product and services to customers. Personalization observes the user as a physical person, and it develops user profiles which consist of information or personal data about the user. More and more web stores and services use personalization to better serve their customers, Google and Amazon are just two examples.

Researches like Picard [12-14], and Essa and Pentland [7, 8] have been researching on the use of various techniques to deduce a user emotional state for providing personalized services directly based on human emotions. Various researchers have been working with computational perception techniques in order to predict human emotions by matching voice features or facial expressions with some prescribed expressions representing the current emotional state of the human (e.g. smiling, frowning, surprised, etc.) [1, 2, 7, 8, 10, 11]. Though the work is not a 100% correct way to predict human emotions, it clearly suggests the possible improvements and associated perception research by improving the quality of contextual information that can be collected. Picard's work on affective computing [14, 15] proposes a similar purpose of measuring human emotions using bio-electric signals feedback of physiological parameters like: skin conductance, skin temperature, heart beat rate, blood volume pressure (BVP), respiration, electroencephalography (EEG) and muscle tension in correlation to change in emotion. Picard's work is based on theories of emotion and cognition.

3. Model

3.1 Model Overview

The model for providing emotion based personalized services targets mobile devices such as mobile phones. Biosensors are used to measure emotion-related physiological parameters of the user and calculations are performed to deduce the emotional state of the person based on those measurements. The model classifies emotional states based on training data which can contain any emotional categorization like: Ekman's basic emotions [5], emotional dimensions such as valence (pleasure) and arousal [19], or self-specified ones like: good, bad, ok. The model uses statistical methods to determine the current emotional state of the user. After having calculated the emotional state, the model chooses an appropriate adaptation and passes it to the mobile device used for providing personalized emotion based service.

3.2 Components of the Model

For easy processing of the data, the overall model is built using a modular approach. The figure below represents the different modules involved in the model followed by a brief overview for each module.

3.2.1. Emotional Data Acquisition

This module makes use of any biofeedback device for collecting physiological data, or even vision or sound based input devices like: cameras or microphones for collecting other emotion-related data. Collecting auxiliary data such as activity data of the person or environmental temperature is beneficial to gauge the sensor readings. Also, during the training phase, user input on the currently experienced emotion is acquired to find out the likely emotional state of the user. All the collected data is provided with a time stamp and sent to the input preprocessing module.

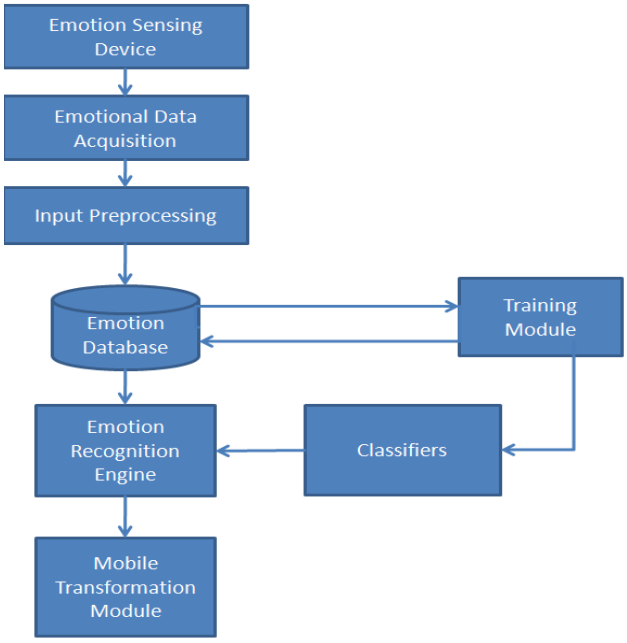

Figure 1 Representation of different modules in the model

3.2.2 Input Preprocessing

During the emotion preprocessing phase, the collected data is synchronized based on their timestamp. User input is associated with emotion-related data like physiological readings, and auxiliary data. After the data has been preprocessed the module passes the preprocessed data to the training module and/or to the emotion recognition engine.

3.2.3 Training Module

The training module is responsible for training the model to recognize emotions based on the emotion-related sensor data (e.g. physiological readings), user input, and auxiliary data received from the input preprocessing module. A training sample consists of different sensor values along with auxiliary and user input data, for a particular emotional state. The collected training data is then processed by statistical algorithms to form emotion classifiers. The emotion classifiers are stored as templates in the emotion database for later use in the emotion recognition process.

3.2.4 Emotion Database

The model stores all the data in the database present on the server. There are separate tables for storing training data, and emotion-to-mobile device service mapping. The table for storing training data contains sensor readings, auxiliary data as well as user input data. The table for emotion classifiers stores necessary information in form of templates for emotion pattern matching. Table for emotion-to-mobile device service mapping stores the mapping of the mobile device service to provide against the measured emotional state of the user.

3.2.5 Emotion Recognition Engine

The emotion recognition engine is the heart of the model it makes use of the statistical approach for analyzing and classifying the

emotion. The recognition engine uses the classifiers generated in the training module to examine the input data. The input data is matched with the emotional templates stored in the database for a particular emotional state. In case of a match the suitable adaption command for that particular emotional state is sent to the mobile.

3.2.6 Classifiers

Multiple classifiers will be created in the training module; each classifier would be classifying the incoming data for particular emotional states. E.g. when going for states labeled "good", "bad", and "okay", three classifiers would be created, one for "good", one for "bad" and one for "okay". Possibly a fourth could be used for "no emotion" for cases of no emotion being observable.

3.2.7 Mobile Transformation Module

The mobile transformation module is the output module of the model. Input for this module is the appropriate personalization command received from server as a result of measured emotional state of the user. Based on the received command the mobile device will transform itself accordingly to provide the personalized service based on the received emotional state.

4. Prototype Implementation

4.1 System Overview

The model has been tested by setting up a test prototype. The prototype system consists of three physical components:

i. Emotion sensing device for emotional data acquisition
ii. Mobile phone device collecting the emotional data and affective adaptation according to the received transformation command.
iii. Server which contains database for storing data, input preprocessing module, training module, and emotion recognition module.

The components communicate wirelessly with each other, either through Bluetooth or GSM/UMTS. It is also conceivable to use WLAN to make use of free WLAN Internet access for communicating the data. The figure below shows the overall prototype system and the interaction of components between them.

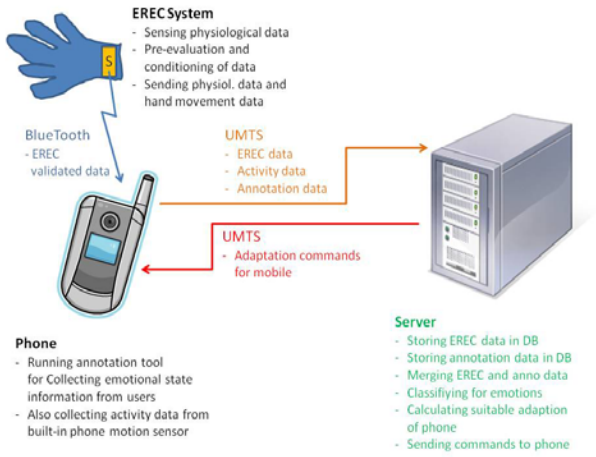

Figure 2. Prototype system overview

4.2 Data Acquisition

For gathering emotion-related data we use the Fraunhofer EREC System [6, 12]. EREC is a wearable device in form of a glove and allows online and offline access to physiology data. The version used in this project sends out physiological readings (***skin temperature, skin resistance, and pulse***), plus hand movement data via Bluetooth to any receiving device, which in our case is a mobile phone device. Figure 3 below shows the EREC system used in the project.

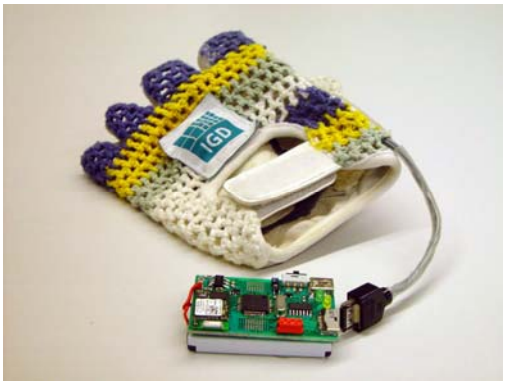

Figure 3.The ERECblue system used.

The mobile device receives data from the EREC system and adds activity data through motion sensors integrated in the mobile phone. Collecting activity data allows determining the different activity state of the user like: ***running, walking, cycling, car driving or relaxing***, which helps to check sensor values against current activity. During the training phase of the model in order to obtain user input on the current emotional state, the mobile phone runs a simple application, allowing the user to enter his current state using the emotional dimensions valence ("feel good") and arousal, through the keys of the mobile phone. All the data received from the EREC system, along with activity by the subsystem DiaTrace [3] and user input data, is provided with a time stamp and sent to the preprocessing module.

4.3 Input Preprocessing

The preprocessing of the input data received takes place at the server. The server receives all the data from the mobile device via GPRS/WLAN. During the emotion preprocessing, all the emotion related data is synchronized with user input data based on their timestamp. The input preprocessing module passes preprocessed data to training module and/or to the emotion recognition engine for determining the current emotional state of the user.

4.4 Training Module

The training module is responsible for training the model so that it performs emotion recognition afterwards. The training modules receives training samples from input preprocessing module which consists of different sensor values for physiological data attributes along with movement, annotation and activity data for a particular emotional state. The collected training data is then processed by statistical algorithms to calculate different statistical values like: mean (m) and standard deviations (s) of all the sensors values for the current emotional state entered by user. The results are stored as emotion classifiers inform of templates for later use in the emotion recognition process.

4.5 Emotion Database

The model stores all of the data in the emotion database present on the server. We use a mySQL database in the project. The table for training data stores all the training data along with user current emotional state. The table for emotion classifiers stores e.g. mean (m) and standard deviations (s) of all the sensors for an emotional state along with the emotion id inform of a template to represent the particular emotional state. This table is used for emotion pattern matching. There is also a third table for emotion-to-mobile device service mapping which contains emotion id and the corresponding adaption to provide. The recognized emotion is matched with the emotion id present in this table to pick the suitable adaption against that particular emotional state.

4.6 Emotion Recognition Engine

The emotion recognition engine runs on the server and it classifies the emotion based on the received data. Emotion recognition engine classifies a particular emotion by matching the data with the emotion template stored in the emotion database created during the training phase. In case a match is found an appropriate personalization command is picked from the database against that particular emotional state and sent to the mobile device.

4.7 Mobile Transformation Module

The mobile transformation module is the output module of the model. The mobile device receives the appropriate personalization command from the server via UMTS and provides personalized service based on it. In our model depending on the current emotional state, the mobile device sets the appropriate ring tone for the user. The mobile device ring tone volume is set high for happy state, low for sad state and normal for normal emotional state of the user.

5. Conclusion

The core idea behind this project work is to present a model for providing personalized services and products based on the user current emotional state. The model measures the user current emotional state by collecting and analyzing emotion related data from the user. Based on the input sensor data the model determines the current emotional state of the user. Depending on that the model decides what type of personalized service should be offered to user. The service is offered in form of mobile device ring tone service and is directly based on user current emotional state.

Considering the customer emotion in providing personalized product and services on one hand can enhance the pleasure of buying, owning, and using the products and services offered to the customer while on the other hand considering the experiential or emotional quality of products can help in gaining differential advantage in the marketplace as most of the products now days are similar with respect to technical characteristics, quality, and price.

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