Emotional Interaction (Human-Machine Influence)

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Doctoral Seminar, Linz, March 22 to 23, 2006

Abstract
The extensive propagation and usage of computers, cell phones, PDAs, MP3-players, etc. in our everydays-life (and particulary in almost any situation) causes the opportunity for interacting with computers away from the desktop in an increasing amount [4] - with the consequence, that the role of the user and his interactions in this environment become more and more variable.

In my PhD thesis i will propose a software framework with corresponding hardware to support the interaction between human and computer in an implicit (non invasive) way by measuring and processing biological signals (the intention is to detect emotional states and react on it) with the goal of controlling computing devices by this.

Keywords
Emotional Computing, Similarity Analysis, Emotional Interaction, Human-Centered Computing, Aesthetics and Computation.

Problem Statement and Research Question
Computers need to be able to sense and interpret emotions in order to respond intelligently to (complex) human interactions.

A big challenge is to unravel the "functionality" of human's emotion and to build devices that detect and reflect emotional states.

The terms affect, mood and emotion are fundamental aspects of human beeings and it is well-known that this "parameter of feelings" can influence cognition, perception, social judgement, behaviour, etc. [1].

Affect and emotion are often used as commonly understood neutral terms to represent mood, feelings, etc. in general – thus i want handle this in my work in the same way.

Approach and Methodology

My approach for measuring, classification and processing of signals with a corresponding feedback to the "real-life" system is to split the process into multiple, independent stages as accounted in the next subsection.

Multi-level emotion recognition

The action of emotion processing can be divided into several autonomous stages as depicted in the figure below.

1) Biophysical sensing

Emotions in people consist of a constellation of regulatory and biasing mechanisms. Emotions can affect the voice rate, the mode of sitting, standing or walking, the type of gesturing, the kind of communicate which one another, etc.

Until now, the most explored fields of human-machine interaction are automatic facial expression and vocal inflection recognition [2].

On biochemical and pysiological sensors are e. g. conceivable: electrocardiogram (ECG), bloodgas (blood oxygen)-sensor, skin-humidity sensor, skin-conductance sensor, blood sugar sensor, etc.

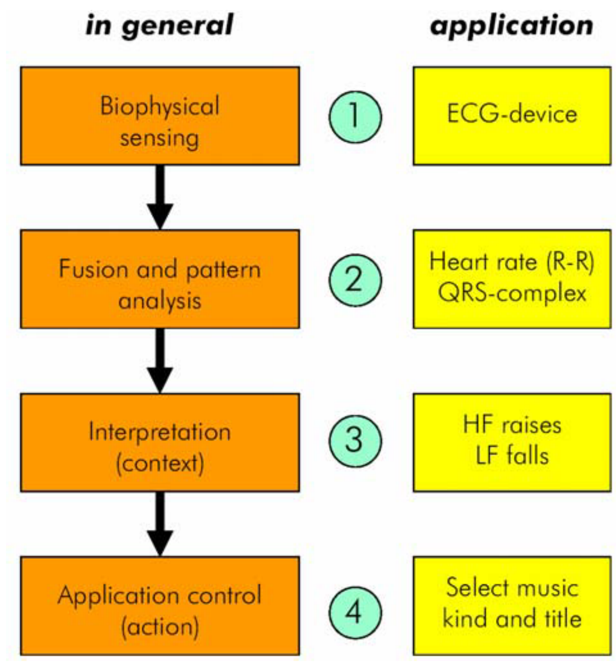

Fig. 1: Multi-level emotion recognition

2) Fusion and pattern analysis

In this stage the main functionality of the framework and the innovation is resided. (Multi) sensor values has to be evaluated, then classified based on dynamic or discriminative models and finally compared to a) other sensor values or b) data sets from a database to identify matching (emotional) patterns.

3) Interpretation of emotional states

For context constrained interpretation still frequently humans are necessary, but in the next step this should be independent performed from a computer system, eg. by aquiring cognitive informations from a knowledge base, etc.

4) Application control
With the result(s) from the previous stages the corresponding actions can be performed, give a direct user-feedback based on the measured sensor-values.

According to the person's interaction-interest and manner the systems state can be dynamic in a high degree (user action → change in systems state → user feedback → modified user action → …).

Related Work

Lots of work has been done in the last years, i think present existing approaches of emotion recognition could be classified in the following way:

1) **Emotional state recognition based on sitting, standing, walking and hand gestures**

2) **Face/Eye tracking, Speech/Voice recognition**

3) **Stress metrics (skin temperature, conductance and humidity, etc.)**

4) **Heart rate, Electrocardiogram**

5) **Multi sensor fusion systems**
   Measuring of lots of sensor values, classify and/or identify "isles of mood states" etc.

Preliminary Results

1) Impact of music on emotional states
In [3] as well as in figure 1 and 2 the impact of music on emotional states is shown.

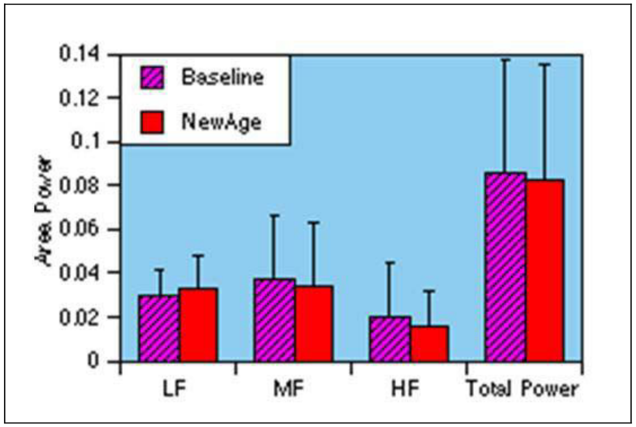

Fig. 2: Impact of Music to Heart rate variability (1)

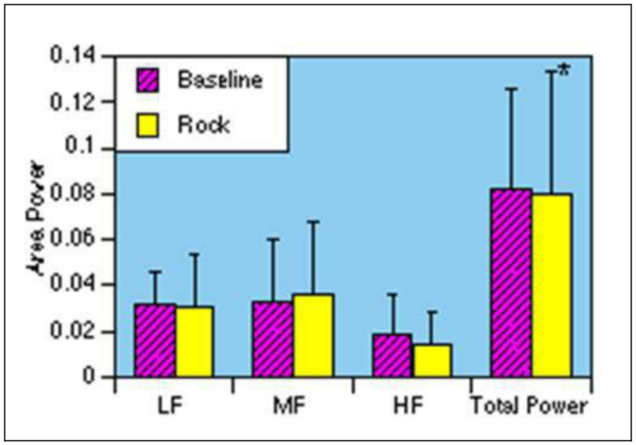

Fig. 3: Impact of Music to Heart rate variability (2)

The result of this confirmed series of tests should be extended, e.g by performing an evaluation how different titles and/or kinds of music (classic, rock, heavy metal, etc.) affects the biological state of a human (heart frequency, heart rate variability, skin humidity, running performance, and so on).

2) Empiric methods in emotional computing

Working in the field of emotional computing is not limited to measuring, recording, classifying and evaluating of biological signals (e.g. the ecg-signal as shown in the figure below); until now i still have recognized that is is also necessary to do research work in the field of empiric methods to get a fundamental base for the PhD thesis (commonly electrical biosignals are measured – e.g. the heart frequency, the heart rate variability HRV, the oxygen content in the blood, the skin resistance, etc. -, processed by a computing device; finally the results are depicted as visual or audio-visual output. But this approach still needs the classification and/or interpretation of the parameters/attributes by a human!).

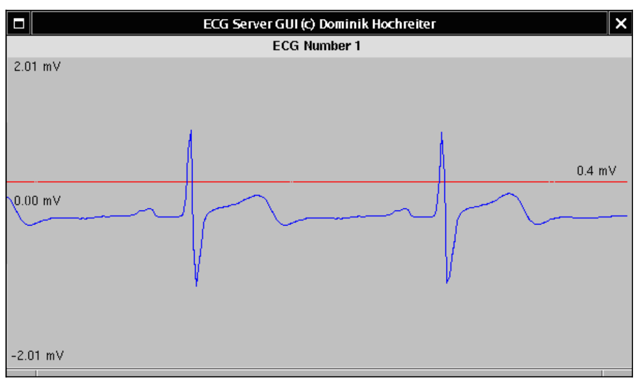

Fig. 4: ECG signal recorded from a “HeartMan” via bluetooth

To present the technical solution alone is unsufficient, even more it is absolut required to place the PhD-thesis on an empirical framework (music as modification parameter for emotional, mood states, as attribute for changing the heart rate variability, etc.).

3) Sensors and skills

Another important work package is a survey about (robust) “biophysical sensors” and their abilities. As the result a table consisting the various sensors with their price, degrees of freedom, accuracy, interfaces, power consumption, etc. should be presented.

Conclusions and Future Steps

Today i am quite at the beginning of my PhD, until now i have concentrated my work in recording and processing electrocardiogram (ECG) signals and performing similarity analysis on multiple ecg-streams (for details see figure 5 or the project “HeartBeat”, an installation in the course of the ars electronica festival 2005).

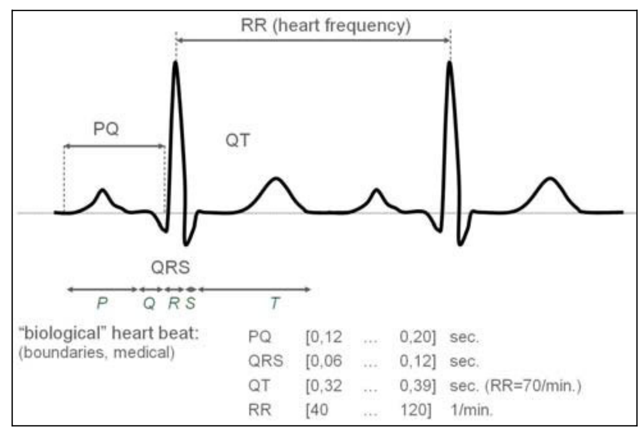

Fig. 5: Ecg features used for similarity analysis in "HeartBeat"

The next steps will be an empiric evaluation of the influence of music to emotional states (as discussed in [3]), the implementing of a similarity library for supporting pattern recognition and similarity analysis in biosignals.

A joint research project, titled "HeartMusic", which should be started in the next weeks, deals with the thematic field "feedback of a humans biological state to the playlist of a music playing device".

I im interested in cooperations as result of the international doctoral seminar, especially for discussing the step of processing and/or interpretation of biosignals, which are measured as (ordinary) electrial units.

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