Ubiquitous Neural Interface

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Outline

1. Ubiquitous Neural Interface
2. Current Research
3. Future Plan
1. Ubiquitous Neural Interface

1.1 Neural Interface

1.2 Why Ubiquitous

1.3 Collecting Emotional Data
1.1 Neural Interface

- Neural Interface aims to get users involved in interactive applications that utilize affective/cognitive expressions and possibilities for user to communicate their emotional states.

- With Neural Interface, system is capable to infer affective and mental states of humans and provide appropriate, timely feedbacks.

- Research shows that human intelligence is not independent of emotion. Emotion and cognitive functions are inextricably integrated into the human brain.
1.1 Neural Interface


- Building a bridge between highly emotional human and emotionally challenged computer systems/electronic devices - Systems capable of responding emotionally.

- The central issues are representation, detection, and classification of users emotions. (Abdulmotaleb, 2010)
1.2 Why Ubiquitous

- Hardware towards computers that are, in a way, 'closer' to the users body, by being either wearable or ubiquitous, opens the opportunity to monitor new parameters about the users state and to send them signals. (D PIERRAKOS, 2003)

- Ubiquitous computing and networks is accelerating the adoption and use of information and communication technology into our everyday lives. (L Shen, 2008)
### 1.3 Collecting Emotional Data

<table>
<thead>
<tr>
<th>Physiological</th>
<th>Psychological</th>
<th>Behavioral</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skin conductance</td>
<td>Verbal descriptions</td>
<td>Facial expressions</td>
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<tr>
<td>Blood pressure</td>
<td>Rating scales</td>
<td>Voice modulation</td>
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<tr>
<td>Respiration</td>
<td>Standardized checklists</td>
<td>Gestures</td>
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<tr>
<td>Electroencephalography (EEG)</td>
<td>Questionnaires</td>
<td>Posture</td>
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<tr>
<td>Muscle action potentials</td>
<td>Self-Assessment-Manikin(SAM)</td>
<td>Cognitive strategy</td>
</tr>
</tbody>
</table>
2. Current Research – EEG based UNI

Data Collection → De-noising → Feature Extraction and Selection → Classification → Ubiquitous Applications

- Nonlinear Dynamic Features
- Linear Features
- T-test
- ANOVA

- De-noise
- Basic Filters
- WPT/WT
- Modified De-noising Algorithm

- KNN Classifier
- Bayes Classifier

Music Therapy Platform

Attention Analysis Methodology

Other Applications in OPTIMI

Success Classification Rate
2.1 OPTIMI

Background:

- High incidence of Mental Disorder, especially depression
  - About one fourth of the world’s population will experience episodes of depression during their life time (WHO)

- Clinicians have fewer options for prevention of depression
  - Currently main treatments: drugs & evidence-based Cognitive Behavioural Therapy (CBT)
  - Only available diagnostic tools for diagnosis or measuring the interventions’ effectiveness: standard inventories
Online Predictive Tools for Intervention in Mental Illness

- Goals
  - Development of new tools to monitor coping behavior in high stress population
  - Development of online interventions to improve this behavior and reduce the incidence of depression

- Research fields
  - Psychological Instrument, EEG, ECG, ACT(activity), Cortisol, Speech, Self Diary, Sleep

Partners
- Everis Spain SL, Eidgenössische Technische Hochschule Zürich, University of Bristol, Universitaet Zuerich, Xiwrite srl, Ultrasis PLC, Universitat Jaume I de Castellon, Univesidad Politecnica de Valencia, Lanzhou University, Ma Systems and Control Limited, Universitaetsklinikum Freiburg
EEG Sensors in OPTIMI
EEG Sensors in OPTIMI
Refereed Works:

- **Projects:**
  - “Ubiquitous Contextual Mental Health Care (UMHC)”, sponsored by HEFCE Science Research Innovation Fund, UK. (2007, 2 M Equipments Bid, PI)
  - Integra (International Project on Fusing music and technology) (2008-2012, 400,000 Euro, the Culture Programme of the European Commission)
  - Industrial Funds (200,000 Pounds) and etc.

- **Papers:**
  - Hu, B., Majoe, D., Ratcliffe, M., etc. (2011) EEG-based Cognitive Interfaces for Ubiquitous Applications: Developments and Challenges, *IEEE Intelligent Systems* (Accepted)
  - etc.

## 2.2 Affective Learning Based on UNI

### Computer Technology
- Computer Network
- Multimedia
- Survey of AJAX
- Computer History

### Arith
- Discrete Mathematics
- Linear Algebra
- Advanced Mathematics
- Numerical Analysis

### English
- Listening
- Reading
- Writing
- Speaking

![EEG and Frequency Spectrum Diagram](image-url)
2.3 Music Therapy Based on UNI

**Background:**

Music therapy has been widely utilized to amend human mood against mental disorders while more and more people suffering negative moods like sadness or anxiety, which could develop into a serious mental problem.
Ubiquitous Music Therapy Delivery

Music therapy implementation through mobile phone

The EEG feature used as the measurement of emotion recognition

The user's information

The control panel

The expression feedback
2.4 UNI based Biometrics

**Background**

There is an increasing need for biometry nowadays. The report says total revenues for the biometrics market came to $364.4m in 2009, which estimates that this will rise to $1.59 billion by 2016.

**Advantages of EEG in Biometrics:**

- 1) The EEG signal is **universal** because every living human generates EEG spontaneous;
- 2) **It is hardly to be forged and mimic**, at least we haven’t heard any report about attacking EEG biometric system by faked EEG;
- 3) EEG signal can be recorded **non-invasively and safely** nowadays by patch electrode in scalp rather than by intracranial probe.
There are two kinds of tests in biometric system: client test and intruder test.
1) **Clients** mean ones who have been stored in the database and are supposed to be recognized.
2) **Intruders** mean who are not in database and should be excluded.
THANKS!