EVALUATION OF STUDENTS PSYCHOPHYSICAL INVOLVEMENT DURING E-LEARNING PROCESS, THROUGH PHYSIOLOGICAL AND PSYCHOLOGICAL DATA ACQUISITION

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Abstract: The research goal of this paper is to find out the algorithm for recognizing human emotions starting from four physiological indexes: Skin Conductance, Heart Rate, EKG and EEG. Some wearable and not invasive biosensors communicating with a PC, are applied to user body of 30 students, during the exposure to 3 different computer-mediated content stimuli: stressing, relaxing and engaging. After each exposure, subjects are told to answer to clinical self-questionnaires that measure the level of stress. The PC acquires the body signals and process them: combining the configuration of physiological indexes with the scores of clinical self-reports, it will be possible to identify the physiological pattern statistically expressing: stress, relax and engagement. After deriving this *ad hoc* algorithm, the PC will be allowed to detect the user affective state. Up to now, we are focusing the attention on a distance learning application, in order to have an instrument which gives a real-time feedback of student affective states, during the fruition of distance learning contents.

Introduction

In this research we are studying the student's learning process during synchronous and asynchronous distance learning, focussing the attention on student's emotions during the process.

The research aim is to design and develop an automatic tool performed through personal computer, able to recognize, by means of student's biological signals, several affective patterns involved in the learning process.

This objective will be reached through biological signal recording performed with four biometric sensors, including GSR (Galvanic Skin Response), BVP (Blood Volume Pulse), EKG (Electro Cardio Grapy) and EEG (Electro Encephalon Grapy), applied to students; signals processed will be analysed by psychological experts. Comparing validated psychological results to process biological acquired data, it will be possible to build an index.

This mapping process will be automated through signals processing techniques that will allow to extract three different states in order to identify the emotional state of the student during the e-learning process along the activation/non activation channel of arousal: e-stress (frustration situation), e-engagement (situation of optimal involvement) and e-relax (easy subject).

This emotional states will be induced through opportune distance learning stimuli simulated in the acquisition signals Lab. Data acquired on reasonable number of students involved in a controlled protocol will allow us to extract an index based on acquired data after the experimental phase. This index will be able to provide, according to a certain percentage of error, the emotional state of the analysed student.

The output characterised of these three emotional states will allow us to realise a tool for providing feed back during synchronous and asynchronous e-learning. In this way tutor will be able to get feed back about the virtual class emotional state during the e-learning process.

Materials, Methods and Protocol

Materials: The data acquisition has been performed through Procomp Infinity, a 8 channels USB PC peripheral of Thought Technology. 256 Hz sample rate of every channel with two channels enhanced at 2048 Hz, they ensure a correct data acquisition without aliasing. The Emotion Lab is equipped with two portable PC, one for delivering stimuli and the other for acquiring data; a system, constituted by two web cams, is monitoring the student facial expression, the environmental situation and the user interface; these video inputs are fundamental in the "pre-test phase", in order to correctly discriminate the student affective response to stimuli from other undesired influences (e.g. responses inducted by the environment).

Methods: The methodology is essentially based on three phases. During the first phase an experimental protocol is defined, through some reasoning about distance learning, physiological data processing and psychological questionnaires evaluation. Then a preliminary phase has been carried out ("pre-test phase"), in order to tune the protocol and to define the first findings. A second laboratory phase, where first finding are validated has been carried out. In this paper will be published a part of results related to the "second

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phase", results related to "pre-test phase" are the object of reference [2]. After data acquisitions according to a certain protocol, data are processed. Aim of this phase is to identify a quantitative index for automatic recognition of stress, relax and engagement during distance learning processes. In order to achieve the automatic emotion state recognition a statistical multimodality model is applied, based on a first classification phase and on a second phase of combination. The methodology is depicted in figure 1.

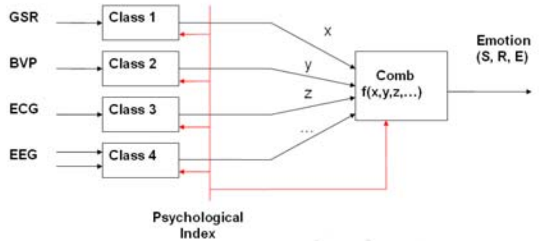

Figure 1: Methodology flow chart

E-Learning objects, protocol and procedure: A series of digital stimuli are the core of the e-learning protocol definition. Stimuli are created in order to trigger specific emotions in 30 selected students. The METID Centre methodology, as better explained in the reference [4], has been our inspiration procedure in order to define the protocol and the structure of the Learning Object interface. Furthermore reference [5] played a fundamental role in order to enrich stimuli with particular component in order to trigger in students specific psychological reaction.

Figure 2: The Emotion Lab at Metid

The protocol is constituted by five phases: baseline, relax induction, stress induction, engagement induction and performance evaluation. Every student accesses the laboratory briefing in order to allow student to adapt itself with the new environment. This is mainly made for avoiding stress induction, that could corrupt the test. In the laboratory, student physiological signals are acquired during a baseline phase. Then physiological reactions are acquired during the delivery of the four digital randomized stimuli: stress, relax, engagement and performance. Data as GSR, BVP, EKG and EEG are continuously recorded through sensors opportunely placed on student. In addition, student facial expression and student-content interactions are recorded for successive analysis and post-processing.

Psychological self-reports and Physiological acquisitions: After each digital stimulus, the student is asked to fill in a psychological self-reports, in order to score the affective state; during the pre-test, several questionnaires have been evaluated to chose the best psychological input for every protocol phase; these questionnaires are EMAS (Endler Multidimensional Anxiety Scales), STAI (State Trait Anxiety Iventory), PANAS (Positive Affect Negative Affect Scale). The STAI scale was selected, because it was the most responsiveness according the correlation among physio/psyco data.

Physiological data acquisition has been made in the Emotion Lab at METID (see figure 2), the e-learning Center of Polytechnic of Milan.

Results

The experiment has been conducted on 30 students (age ranged from 20 to 25 years) of Polytechnic of Milan.

The data has been recorded and processed. Some indicators has been studied in order to extract some trends as findings and results.

In this paper only processed data of distal signals as BVP and GSR are reported. In particular these findings are plotted in the three diagrams of figure 3.

In the first diagram, means values of HR (Heart Rate) and GSR are plotted red and yellow respectively.

In the second diagram, green histograms represent simpato-vagal balance obtained processing the BVP. Unfortunately due to the presence of noise in the case of performance stimulus the relative histogram cannot be plotted, because it wasn't possible to find the component of high frequency and low frequency in the spectra.

The last diagram is STAI divided in four psychological contributions (violet is affective component, purple is cognitive component, yellow is the addition of the previous components and green is the percentage).

Observing the histograms in figure 3, it is possible to find a significant correlation between *psychological stress* and *HR/GSR*. The highest value of HR and GSR are related to psychological stress rate, while relax stimuli are diminishing these values; finally, engage/performance stimuli bring these values in the middle, coherently as indicated in the psycho histograms. Furthermore, the same reasoning, comparing the simpato-vagal balance with STAI mean rates, shows similar results (except for the performance phase that is not reported), as the green histograms highlight. The processing of proximal ECG signal will be necessary in order to get information from the simpato-vagal balance during performance.

Figure 3: The diagrams shows the results of this research for each condition (baseline; relax; engagement, stress, performance). In the first, the red histograms represent the HR mean and the blue histograms the GSR mean. In the second, the diagram shows the simpato-vagal balance (LF/HF). The third diagram shows the psychological self-report scores STAI: the violet histograms represents the affective subscale scores; the purple one the cognitive subscale scores; the yellow the total scores (derived by adding affective and cognitive scores) and the last is the transformation in per cent scores.

Conclusions

Two different applications will be the output of this research. The first output is the quantitative index, defined through our methodology and the statistical model. This index will be the core of the second output, that is an application developed with Java technology: it is a traffic light, in order to give a visual student emotional feedback during distance learning process as reported in figure 4.

Figure 4. The figures represent the affective state of the student and the real-time interface by means of biological signal computation and "translation" using a traffic light interface: tutor will be allowed to know if the student is stressed, not involved or engaged by lesson contents.

Since the system is able to identify these three different emotion, during performance (that to say while student is performing distance learning indifferently in synchronous or asynchronous way), tutor can get real time feedback. In this way, we can easily express and visualize, through a traffic light interface, this kind of interaction between students and tutor during distance learning.

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