MULTICHANNEL EMOTION ASSESSMENT FRAMEWORK
Positive and Negative Emotional Dichotomy

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Abstract: While affective computing and the entertainment industry still maintain a substantial gap between themselves, biosignals are subject of digital acquisition through low budget technologic solutions at neglectable invasive levels preventing users from focusing their awareness in the equipment. The integration of electroencephalography, galvanic skin response and oximeter in a multichannel framework constitutes an effort in the path to identify emotional states via biosignals expression. In order to induce and detect specific emotions, gender specific sessions were defined based on the International Affective Picture System and performed in a controlled environment. Results granted by distinct analysis techniques showed that high frequency EEG waves are strongly related to emotions and are a solid ground to perform accurate emotion classification. They have also given strong indications that females are more sensitive to emotion induction. On the other hand, one might conclude that the attained success levels concerning relating emotions to biosignals are extremely encouraging not only to the continuation of this research topic but also to the application of these results in domains such as multimedia entertainment, advertising and medical treatments.

1 INTRODUCTION

Affective computing is consistently becoming a confirmed scientific domain with practical applications while the entertainment industry as a whole, and specially the cinematographic and videogame branches, which have been closing the semantic gap between them, constitute an economic giant. Having this macrocontextualization in mind, the authors have already engaged a research project with the main intention of using emotion assessment through biosignals to promote both subconscious interaction and individual specific appropriated content delivery.

The presented study finds itself integrated in this scope, as it perfectly falls in the emotion assessment research module. The proposed system constitutes a solid technologic framework that intends to enable biological information acquisition in a controlled environment having as initial hypothesis the existence of human physical expression of emotional states that can be objectively measured by relatively inexpensive equipment. The multichannel structure was defined by exploiting known techniques, namely electroencephalography, galvanic skin response and heart rate monitoring, and emotional states were induced using third-party catalogued pictures.

The first goal was to effectively define, build and test an experimental session framework where subjects followed a given strict protocol in order to visualize and/or interact with multimedia content. This framework was designed not only to collect data but also to constitute a validation environment. The second objective was to, using the given platform, identify specific, controlled and extractable biological signals that could be used as emotion index factors applied to all subjects or to a characteristic group of equals.

The confirmation of the initial hypothesis and project goals would enable its immediate application in developing a full or semi-automatic emotion classification engine that would be able to apply and use the identified signal patterns to, in real-time, identify

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the subject's emotional states with high accuracy.

In order to better detail the presented study, this document is structured as follows: the domain state of the art is described in the next section, in section 3 the multichannel emotion assessment framework is presented with special emphasis in the most significant decisions. Still in that section, results are presented and related conclusions are extracted in section 4 as well as are identified future work areas and practical domains of application are suggested.

2 STATE OF THE ART

The emotional state of human beings belongs to a complex theme since its definition is not unique and its essence not consensual. An overview of the emotion assessment is presented in the next subsection, as well as a brief description of the most common approaches to emotional induction, and finally a reference to equipment solutions.

2.1 Emotion Assessment

The emotion itself can be seen as a consequence of an action or an environment cause so that the induction of a specific emotional state is tightly connected with an arousal procedure. In order to identify and assess an emotion, patterns are used and they constitute different approaches to the emotional induction, which will be discussed in the next subsection. Apart from the induction, the classification is essential, and can be accomplished based on a coincidence of values on a strategic number of dimensions (Logothetis, 1957). Based on this study, the emotion assessment can be analyzed through three distinct dimensions. The two primary levels are the valence and the arousal, and the secondary one is the dominance, which has a weaker relationship with the others (P.J. Lang, 2005)(A. Mehrabian, 1974).

In order to best analyze the assessment of the pictures, it is generally used an affective space. This is a standardized method to graphically display the emotional assessment results of the pictures. According to the valence and arousal mean values, it is plotted a bidimensional graph where the horizontal-axis represents the arousal and the vertical-axis the valence, both scaled from 1 to 9.

2.2 Generic Approach to Emotion Induction

There is not a process for emotional induction that is perfectly suitable for all cases, but a group of different approaches to achieve the same objective. A prevalent method to induce emotional processes consists of asking an actor to feel or express a particular mood. This strategy has been widely used for emotion assessment from facial expressions and to some extent from physiological signals (G. Chanel, 2005). However, even for expert actors for whom the capacity to achieve a specific emotional state is obvious, it is hard to guarantee that the physiological responses are consistent and reproducible by other non-actor people.

An alternative approach to the emotional induction is composed by multimedia stimuli. Music, images, videos and video-games belongs to a category of stimuli that has significant advantages compared with the induction through actors, since there is no need of actors and the quality of the induced emotions is greater as they are more realistic.

2.3 Equipment Solutions

Emotions' assessment needs reliable and accurate communications with the subject so that the results are conclusive and the emotions correctly classified. This communication can occur through several channels and is supported by specific equipment. The BCI - Brain Computer Interface - is directly connected to this area and uses two different approaches, invasive and non-invasive methods. The invasive methods are clearly more precise, however more dangerous and will not be considered for this study. On the other hand, non invasive methods such as EEG, fMRI, GSR, oximeter and others have shorten the distance between the utopia and the truth of understanding the human brain behaviour, gathering together the advantages of inexpensive equipment and non-medical environments.

Due to the medical community skepticism, EEG, in clinical use, it is considered a *gross correlate of brain activity* (Ebersole, 2002). In spite of this reality, recent medical research studies (Pascalis, 1998)(Aftanas, 1997) have been trying to revert this scenario by suggesting that increased cortical dynamics, up to a certain level, are probably necessary for emotion functioning and by relating EEG activity and heart rate during recall of emotional events. Similar efforts, but using invasive technology like Electrocorticography (ECoG), have enable complex BCI like playing a videogame or operating a robot (Leuthardt, 2004).

Some more recent studies have successfully used just EEG information for emotion assessment (K. Ishino, 2003). These approaches have the great advantage of being based on non-invasive solutions, enabling its usage in general population in a non-medical environment. Encouraged by these results, the current research direction seems to be the addition of other inexpensive, non-invasive hardware to the equation. Practical examples of this are the introduction of GSR and oximeters by Takahashi (Takahashi, 2004) and Chanel et al(G. Chanel, 2005).

On this study three non-invasive equipments will be used in parallel so that the reliability of all the procedures is guaranteed. A Neurobit Lite EEG device with one active electrode and two references, a Thoughtstream biofeedback system Galvanic Skin Response with two dry electrodes and an oximeter with a finger sensor.

3 PROJECT DESCRIPTION AND RESULTS

In this section it will be given a brief overview of the whole project development.The procedures and methods involved on this study were grouped into two parts. The first one deals with the emotional induction approach used on this study and the last one reveals the experimental conditions used along the experimental sessions.

A good experimental control and an easy, yet efficient, method for results comparison are key factors that demand an effective set of visual stimuli. The IAPS library is so the most indicated emotional induction method, as it has been widely used through the research community and all the pictures classified according to valence, arousal and dominance (L. Aftanas, 2001)(G. Chanel, 2005)(M. Muller, 1999).

The experimental conditions are an essential issue to the validation and acceptance of the results obtained.

A total of twenty eight subjects, seventeen males and eleven females, all right-handed aged eighteen-thirty years old took part in this study. All subjects had access to an introductory text for the experimental session in order to access the essential information about the main procedures involved and a questionnaire filled before each session to avoid possible barriers as mental diseases.

The experimental results of this study are based on a statistical analysis.

This analysis indicates that mens behaviour is different from the womens one, since the mean amplitude of the high frequency brain waves is higher along the entire experimental session.

Considering the GSR data, it is presented the slope variation between the three stages - happiness, neutral and sadness - and analyzed its behaviour along the complete session.

The heart rate analysis indicates an unexpected and almost undetectable variation of its value.

4 CONCLUSIONS

In what regards to the first topic, one ought to assert that the initial study's main goals were completed undertaken. The described experiments achieved to develop and test a solid framework to conduct controlled emotionally-evocative experiments enabling flexible capability of recording and monitoring biosignals in real-time.

At a more detailed level, it was possible to define dynamic gender-designed emotional sessions, with fine tuning capabilities, in order to trigger specific emotional states. The data provided from the conducted experiments was input to the detailed system's architecture that proved to be able to supply sessions with biosignals real-time monitoring and storage for physical and temporal independent processing. The achieved results also demonstrated that the postsession data processing techniques were efficient and effective in what concerns to emotional states/biosignals correlation identification.

Having the study's results, presented in the previous section, as solid ground, it is possible to confirm that basic emotional states have biological manifestations capable of being captured and recorded by the selected equipments, specially with EEG and GSR techniques.

Concerning subject variables, it is plausible to state that females react more aggressively to the presented pictures, triggering with more expression and effectiveness the desired emotional states. These objective data was also corroborated by the interviews conducted at the end of each sessions, where female subjects consistently stated that they felt happy and in a good mood in the first stage of the session and sad at the end. In the same interviews, a high percentage of male subjects affirmed that they did not felt a deep emotional commitment along the picture presentation.

The fact that gender is a key factor in what concerns emotional state triggering through multimedia content constitutes the first major contribution of the present study.

Exploiting the evidence that EEG signals were strongly influenced by the subject's emotional states, a more detailed data analysis was performed, as illustrated in the previous section, with special focus to high frequency signals, namely beta and gamma waves. The data provided strongly suggests that, specially in female subjects, high frequency relative

EEG values are directly correlated to valence, independently of their initial standard level. The data provided suggests that beta and gamma waves strongly seam to vary directly with valence, enabling, indirectly and with conjugation with other inputs, emotional state detection.

Despite the described positive outcome, there were identified some features that, although did not match the initial assumptions, have already been subject of turnaround strategy definition. The first one is related to the inexistence of generic significative changes in heart rate values along experimental sessions and the second resides in the fact that the expected GSR readings curve – high conductivity with high arousal situations – was not recorded as often as predicted. The authors believe that the existence of these issues is grounded on the fact that the designed emotionally-evocative sessions based only on pictures do not trigger such strong emotions capable of significantly influence biosignals such as heart rate. It is believed that it would be necessary much strong multimedia content provided in a more immersive environment so that subjects could be more deeply involved.

4.1 Future Work

The main future work topics are not only related to this particular study, once it is a spin off/module of a major one, but also with the main global project. With this in mind, there were identified the following areas:

- More Sophisticated Equipment Reinforcement: It is intended to acquire more sophisticated equipment, specially and specifically in what concerns to a multi-channel EEG and a more sensible and reliable GSR;
- Equipment Diversity: It would be useful to integrate in the developed framework new equipments capable of reading and extract more biosignals, namely pupil dilatation, voice analysis and facial expression recognition;
- More Detailed Emotion Classification: using the depicted key factors with conjugation with others provided by the study continuation and data volume and diversity enhancement brought, by new equipment acquisition, it would be plausible to perform automatic subject emotion classification with deeper detail levels.
- Software Control: The accomplishment of the previous items would enable both conscious and subconscious control of several tools and/or multimedia contents;

Considering the studied problem as a whole, specifically the emotion classification topic, several practical domain applications are not only feasible but also attractive. Most of the immediate technology adaptations shall reside in the entertainment industry, both in audiovisual and videogame branches through multimedia content adaptability to user's emotional states. Other possible application areas are user interface enhancement, direct advertising and medical applications, namely in phobia treatments and psychological evaluations.

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