Summary of the doctoral dissertation

CONTRIBUTIONS ON THE COMMAND AND CONTROL OF REMOTE MOVEMENT IN TECHNICAL MILITARY SYSTEMS

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The thematic approached in the doctoral dissertation, through its research importance, falls within the field of mechatronics, brain-computer interface techniques (BCI), in using movement command and control, remotely, by biofeedback, in military technical systems. Worldwide, there is a number of researches concerning the constitution of brain-computer interfaces used for remote transmission of movement command and control. All these techniques are based on EEG biosignals (electroencephalography) and in defining a BCI interface command system, particularly important is to train the operator, a procedure that several times fail. In order to give consistency to a biosignal-based remote command and control system, we have to expand the research also to other types of biological signals, which can be used in the brain-computer interface and introducing some safe methods of preliminary assessment of one's native capacity to operate such an interface.

The purpose of the doctoral dissertation is a comparative study between the EEG and the EDA (electrodermal activity) biosignals, for an advanced understanding of the similar electrical aspects, but also of the complementarity, in order to use them to give consistency to the BCI interfaces, but also to establish the criteria based on which one could make the difference between an operator capable of operating BCI devices and one who does not have such ability.

The main objectives of the doctoral dissertation are to design and achieve an electronic device specializing in neuro-stimulating the EDA biosignals, by means of which, within a technical integrated system containing professional equipment for measuring EEG signals, we can experiment simultaneous take-over of EDA and EEG patterns under the action of some multiple stimuli, in order to achieve a statistic survey on the correlation between distinct types of biosignals and of an advanced method of selection for the BCI interface operating personnel.

THE STRUCTURE OF THIS WORK

In the achievement of the proposed objectives, I have organized the dissertation on six chapters, as follows:

Chapter I: *"Biological systems and signals*" is dedicated to a *study concerning the features of the biological systems and of the biosignals* that can be involved in remote movement command and control, whereby I accomplished a systematization scheme thereof, but I also showed and classified various categories of sensors that can be used in measuring them.

Chapter II: "*Foundations of the neural activity*" shows an analysis of the neural activity of the human brain, whereby I highlighted the physiology of the bio-signals and screened the historical milestones that marked the development stages of the current techniques and technologies of use. Also, across this chapter I have performed a study on the bio-signals of the electrodermal response, necessary for the research in the dissertation and I reviewed a series of extremely valuable considerations in connection with the *psychophysiological inference*.

Chapter III: "*The interaction between biosignal and remote movement control" includes a study of the concept of remote movement command and control*, whereby I performed an analysis on the psychophysiological coordinates of the interaction between biosignal and the remote movement control, of the elements of the chain of command and control through feedback, in technical systems. Also in this context, I presented and achieved, for experimental purposes, the neuro-stimulation electronic equipment, with examples for some patterns acquired during the research.

Chapter IV: "*Signal processing and classification methods*" is intended to make a *study on the current stage of the bio-signal processing methods and techniques*, where I showed on a detailed level the neural features of electro-physiological control used in the BCI interfaces, and how to extract, select and classify them. In this systematization framework I also inserted an original mathematic pattern on the psychophysiological inference from the EDA response biosignals, a pattern that deals with the concept of inferential function, cognitive function, bipolar indicators, inferential patterns and cognitive classes.

Chapter V: *"Processing the experimental data" includes a statistic analysis of the action of some multiple stimuli on the EDA and EEG biosignals*, a study where I presented the statistic tools used in disseminating the experimental data and I reasoned with such statistical data the level of correlation between the electrodermal functions and the λ factor of electrodermal lability, but also the level of correlation between two types of physiologically-distinct biosignals, acquired under the effect of the same stimuli. I also established and presented in this chapter, in experimental results, the criteria of selection for the BCI interface operating personnel, through using the λ factor and the concept of cognitive class.

Chapter VI: *"Conclusions, contributions and prospects"* shows the achievements of the scientific endeavour of the doctoral dissertation. This section provides the main conclusions, occurring in sequence with approaching every chapter in part, highlights the important personal contributions in the comparative study of the two types of biosignals, but also the future prospects considered to be necessary in continuing this endeavour. A particularly importance place in this chapter is given by reasoning the *applicability in the military field*, given the increase of individual and group security in combat technique exploitation, by equipping it with BCI, but also the original criteria proposed in the dissertation for an objective selection of the military personnel operating BCI interfaces.