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COMPARING P, PD, PI AND PDI CONTROLLERS IN CONTROLLING A BRAIN COMPUTER INTERFACE FOR CLINICAL APPLICATION

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Summary: Neurobiofeedback based systems have given important contributions in psychological and rehabilitation treatments, correcting disturbances in brain functioning, and stimulating and developing the abilities of the individuals under treatment. Hence, these systems have gained high attention in many clinical applications, including in improvement motor performance, in the treatment of several disorders, such as depression, anxiety, attention deficit, hyperactivity, dyslexia, learning difficulties, seizures in epilepsy, chronic pain, headache and schizophrenia, and in the reduction of long-term symptoms in cancer survivors. To make these systems faster and more accurate, digital controllers are used in order to obtain better responses to the stimuli used throughout the treatment undergone, being the parameters of the controller drivers used of significant influence on the success achieved. This work focused on the automatic calculation of the parameters and the corresponding system response to an input having into account four types of digital controllers, which are the most used to control a Brain Computer Interface (BCI) with Neurobiofeedback using Steady State Visually Evoked Potential (SSVEP): proportional (P), proportional-derivative (PD), proportional-integrative (PI) and proportional-integral-derivative (PID) controllers. For the automatic determination of the PID controlers parameters, we performed tests using the Ziegler-Nichols Rule Reaction Curve method, and determined and analyzed the transfer functions of each controller under study. Thus, it was possible to decompose the Signal-Noise Ratio (SNR) data obtained using an electroencephalogram cap with 34 channels in eleven healthy individuals. As a result, all controlers parameters was calculated and it was possible to conclude that, for the studied samples, the PID and PI controllers generated more efficient system responses, since there was no significant difference between the stabilization values of these controllers regarding the desired output value. However, the PID controller presented responses faster than the PI controller, reaching the desired value (SNR = 1) in approximately one-third of the time of the PI controller. Therefore, the PID controller and the optimization of its parameters can contribute strongly to the efficient of a SSVEP system, leading to quite satisfactory clinical results.