ABSTRACT

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This dissertation will present the use of nonlinear control techniques, such as adaptive and robust control in order to design a Functional Electrical Stimulation (FES) system developed by Biomedical Engineering Laboratory at COPPE/UFRJ. Basically, a FES on the stimulation of motor nerves via skin electrodes in order to contract or stretch the muscles such that the amplitude and quality of the limbs movement can be maintained, reducing muscular atrophy as well. Consequently, the muscle strength can be improved and new neural pathways may be activated. Here, the goals of the proposed control system is to move the arm of the patient via electrical stimulation to achieve some desired trajectory related to the elbow angles of reference. Since we have a priori no deep knowledge of human neuro-motor model, the use of advanced and robust control schemes seems to be useful to stabilize this kind of systems which may be completely different for each individual, being time-varying, nonlinear, uncertain and subject to disturbances. The main objective is to experimentally verify the effectiveness of the proposed nonlinear and adaptive controllers when compared to classical ones in order to achieve faster, robust and better control performance. It is expected to spread the application of adaptive and robust controllers and other intelligent system tools, such as genetic algorithms, to the field of biological and biomedical engineering. Thus, we believe that the developed control system may help the improvement of the patients treatment involved in the research carried out by Biomedical Engineering Laboratory at COPPE/UFRJ.

Keywords: Nonlinear and time-varying systems; Time-delay systems; Functional electrical stimulation; Robust and adaptive control; Extremum seeking; PID; Genetic algorithms; Time scalling; Sliding mode control.