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CLOSED-LOOP CONTROL OF AMPLITUDE FOR NMES DURING KNEE EXTENSION

D.B.Lázari, M.C.F.Castro, L.Gallo Jr., A. Cliquet Jr .
Dept. de Engenharia Biomédica - Fac. de Engenharia Elétrica - UNICAMP
Caixa Postal 6040 - CEP (13081-970) - Campinas - SP - Brazil

[Introduction] When applying NMES for therapeutic purposes in spinal cord injured patients, the therapist has to alter the signal amplitude when fatigue is observed. To solve this problem, a closed-loop control system has been implemented for automatic NMES signal amplitude variation.
[Materials and Methods] The control signal responsible for amplitude modulation of the stimulator output is generated by a computer, through a D/A board. The induced degree of knee extension is obtained by digitizing an electrogoniometer signal simultaneously to quadriceps stimulation. Data analysis is then performed and if maximum knee extension is twice below a previously set threshold, the control signal will be increased, thus resulting in a higher amplitude for the stimuli applied to the patient. The software was written in C language and an IBM compatible microcomputer, was used, working as an acquisition and generation controller and deciding when to increase the stimuli intensity.
[Results] This system was applied to a patient with C5 lesion, with no voluntary control of knee extension. The generated wave had a duty cycle of 33%. The initial control signal was 7.5V. The threshold in volts was 0.5 and the control signal increment was 0.5V. There follows below some of results obtained during therapeutic exercises:

Control Signal	7.50	7.50	8.00	8.00	8.00	8.00	8,50
Maximum Extension	0.63	0.60	0.48	0.47	0.55	0.61	0,45

[Conclusions] The system showed efficiency. It was the first step to get a closed-loop ambulation system. The system could be improved by using other sensors and a more complex algorithm with the goal of getting smooth movements.

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