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Synthesising life-sciences and control engineering: an outline survey and a practical example

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There is an increasing interest in life science related areas in the electrical and control engineering community [1]. One manifestation of this interest is the development of interdisciplinary programmes, such as the B.Sc. in Medical Physics and Bioengineering, offered by the Dublin Institute of Technology from September 2005. A significant amount of research work in control engineering has focused on aspects of human physiological system, for example blood glucose regulation [2], cardiovascular modelling and control [3], and limb control [4]. There is an increasing emphasis on interdisciplinary research; in recognition of this, the Institute of Electrical Engineers (IEE) has starting publishing, from June 2004, a new journal entitled IEE Proceedings on Systems Biology [5], which aims to study intra- and inter-cellular dynamics, using systems and signals oriented approaches.

The poster presentation provides an outline survey, of the synergistic work between life sciences and control engineering, which has been performed. The author contends that this work fits well under the 'Emerging Technologies' theme of the conference. In addition, the author details his own work on the specific example of control engineering concepts applied to the human eye, in three sections. Section 1 describes a control systems engineering interpretation of the visual accommodation feature of the human eye; the "block diagram" in Figure 1 is developed.

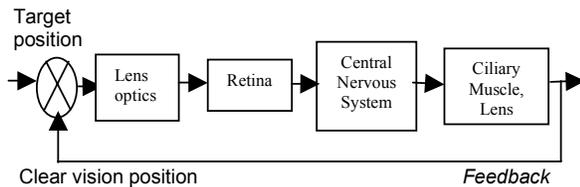


Figure 1: Block diagram: vision accommodation

Section 2 describes how the parameters of a model of the pupil reflex of the human eye to light may be estimated from an appropriate number of data points on its frequency response. Stark et al. [6], in an elegant experiment, obtain such data; this data is graphed on a *Bode plot*, in Figure 2, and is labelled *process*. Two types of methods are explored for parameter estimation: standard methods based on graphical fitting and new methods, developed by the author, which combine an analytical approach with a least squares

approach, which provide more accurate estimates of the parameters. The parameters of a number of models for the pupil light reflex are subsequently developed and validated against the process. The results show excellent fitting between the process and the model using the methods developed by the author, and superior fitting to that achieved with standard graphical methods. Further details are provided in the poster presentation.

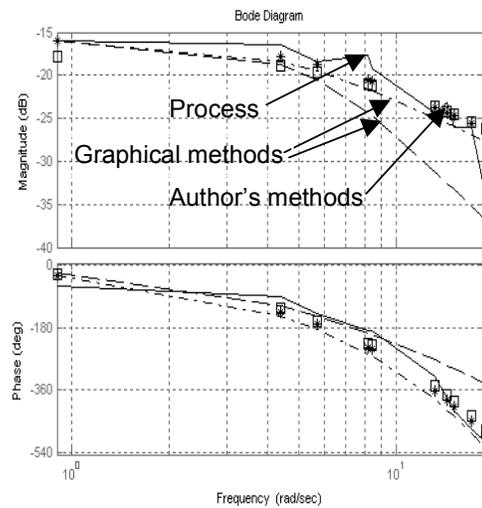


Figure 2: Bode plot of process and models

In Section 3, recent control engineering research advances into the ongoing development of an artificial eye are described in detail in the poster presentation.

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