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Biotechnology, life sciences and control engineering:some synthesis issues

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The synthesis of biotechnology, life sciences and control engineering is receiving increasing interest. The purpose of this contribution (and the associated poster) is to raise awareness of some of this synthesis work, and report some of the authors work in the area. Though relevant synthesis examples have been reported for almost forty years (e.g. the dynamical modelling of genetic feedback control systems [1] and the control of enzyme activity [2]), the application of control and systems theory to biology (now labelled *systems biology*) has received increasing impetus in the past five years. A number of strands of activity are outlined.

Firstly, an influential U.S. "future trends" report has signalled, for example, the importance of the role of control theory in understanding the working of cell networks (in molecular biology) [3].

Secondly, journals and conferences in systems biology have been established. For example, the Institute of Electrical Engineers (IEE) has starting publishing, from June 2004, a new journal entitled IEE Proceedings on Systems Biology, which aims to study intra- and inter-cellular dynamics, using systems and signals oriented approaches (http://www.iee.org/Publish/Journals/ProfJourn/Proc/SYB/index.cfm). The influential IEEE Control Systems Magazine has recently devoted most of one full issue (Vol. 24, No. 4, August 2004) to systems biology, focusing on control and co-ordination in biochemical networks. Recent conferences on the topic have included the IFAC Conference on the Foundations of Systems Biology in Engineering (www.fosbe.org); in addition, the Control of Biotechnological Processes was one of the major themes of the 2005 IFAC World Congress in Automatic Control.

Thirdly, it is worth briefly indicating some of the significant recent contributions to the topic. These are a systems approach to analysing behaviour in biochemical networks [4], gene regulation [5], the modelling of drug treatment for the HIV/Aids virus [6] and the recent advances in biochemical measurement technology that have enabled the development of advanced process control systems in the biotechnology industry [7].

Finally, the advances in life sciences and the increasing synergy with other technological areas are having an impact on third level education and research. The IEEE Transactions in Education recently published a guest editorial [8] arguing that engineering students should receive some exposure to life sciences in their curriculum. At DIT, the author has included life sciences examples (transfer function modelling of the thyroid gland, pupil light reflex and human motor response) in his teaching of the existing control engineering courses; the author intends to include more focused biotechnological applications in the future. In the wider perspective (in Ireland), the recent establishment of the (Irish) National Institute of Bioprocessing Research and Training (http://www.nibrt.ie/), whose mission includes training and research for the biotechnology industry, is facilitating further synergies. With this body, the author is centrally involved in the preparation of process control modules for a post-graduate programme in bioprocess engineering; in addition, a module in systems biology is been mooted for this programme.

The poster presentation expands on the topics briefly outlined above. In addition, some work done by the author in modelling biological responses in transfer function form is presented.

References:

1. Rosen, R. (1968). Int. Review Cytology, 23, 25.
2. Heinmets, F. (1970). Quantitative Cellular Biology, Marcel Decker, New York.
3. Murray, R. (2002). Control in an Information Rich World.
4. Schmidt, H. et al. (2004). IEEE Control Syst. Mag., 24, 91.
5. Khammash, M. et al. (2004). IEEE Control Syst. Mag., 24, 62.
6. Craig, I. et al. (2005). IEEE Control Syst. Mag., 25, 80.
7. Henson, M.A. (2006). IEEE Control Sys. Mag., August, 54.
8. Smith, M.J.T. et al. (2005). IEEE Trans. Edu., 48, 341-344.