OPEN-LOOP OPTIMAL TEMPERATURE CONTROL IN GREENHOUSES: CHOOSING THE LENGTH OF THE SAMPLE INTERVAL IN A CONTROL PARAMETERIZATION SOLUTION

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Abstract

Various researchers have shown that considerable energy savings can be achieved by maintaining an average temperature in the greenhouse in stead of maintaining rigid pre-defined temperature 'blue-prints'. The main feature of the former approach is that, heating is shifted from periods with large energy losses to periods with smaller energy losses whilst maintaining an average temperature during a predefined period of time. A model based optimal control approach has proven to be a suitable framework to tackle these kind of control problems (Gutman et al., 1993; Chalabi et al., 1996). Chalabi et al. (1996) have shown that this approach can be implemented on-line in a greenhouse with success. But, when on-line optimal temperature control is considered, interesting questions arise, some of which are still unresolved. The question tackled in this paper is: 'What is the relation between the resolution of the control strategy (sample time) and energy savings?'. One would expect that an accurate and frequent anticipation to changing outdoor climate conditions might result in reduced energy consumption. Chalabi et al. (1996) calculated hourly optimum temperature setpoints but did not motivate this choice of the sample time. Gutman et al. (1993) indicated that a sample interval of 0.25 h was sufficiently short. However, they used a steady-state model of the greenhouse air temperature and static or slowly varying data of outdoor climatic conditions. In this research, the relation between the control resolution and energy savings was quantitatively investigated using a dynamic greenhouse climate model and realistic Dutch outdoor climate conditions containing high-frequency components. It was found that sample times smaller than 15 minutes, hardly had any

effect on the energy consumption. So, for this particular control problem, changing the control settings every 15 minutes seems justified from the point of view of energy consumption.

References

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