

## Cooperative control of tank level with fuzzy controllers

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We identify the domain of intelligent, distributed control as a fertile area for application of DAI techniques. We use a tank level control problem (see Figure 1) to demonstrate how cooperative controllers can achieve quicker and more accurate control over independently acting controllers. We have used fuzzy rule-based controllers (Wang 1994).

### TANK LEVEL CONTROL PROBLEM

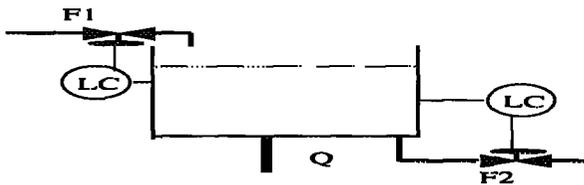


Figure 1: Valves on top/bottom of tank regulate inlet/outlet flows to maintain fluid level; a third outlet is the source of disturbance.

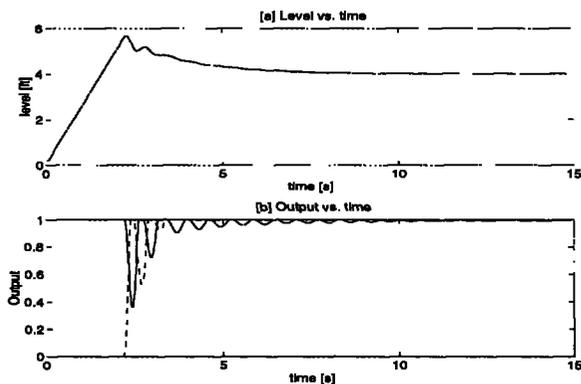


Figure 2: PI-controllers and step response.

A controller is used to control the state of a physical quantity, i.e., to manipulate control parameters such that a monitor parameter is kept at a set point or within a desired region (Dorf 1994). The most prevalent multiple controller systems used in traditional control literature consists of cascade control where the output of the primary (or master) controller changing the set point of the secondary (or slave) controller. In our

proposed method of *cooperative control* autonomous controllers collaborate with each other to optimize system performance. The distribution of control efforts at which the sum of the individual cost functions is minimum determines the allocation of control efforts between the cooperative controllers. We compared the performance of cooperative controllers against *independent controllers* where each controller sets its control output based on current system state without considering the effects of other controllers.

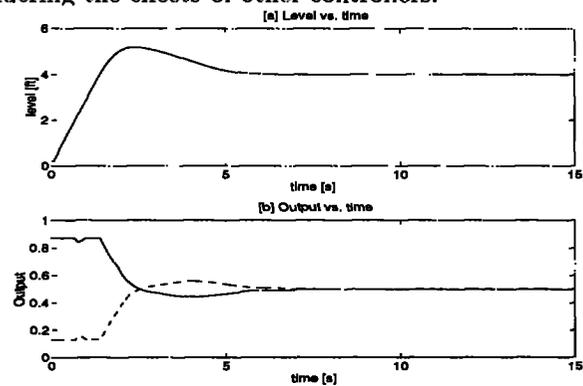


Figure 3: Fuzzy controllers and step response.

From Figures 2 and 3 (solid and dashed lines correspond to the two controller outputs in the bottom plots in these figures) we observe the following advantages of the cooperative controllers over the independent fuzzy controllers: (1) overshoots and undershoots are drastically reduced or almost eliminated; (2) controller outputs stay closer to the normal operating point providing greater control flexibility for future situations.

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### References

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- Wang, L.-X. 1994. *Adaptive Fuzzy Systems and Control: Design and Stability Analysis*. Englewood Cliffs, NJ: Prentice Hall.