Distributed model predictive control for control of irrigation channels

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ABSTRACT

Irrigation channels are large systems, consisting of many interacting components, and spanning vast geographical areas. For the most safe and efficient operation of these channels, maintaining the levels of the water flows close to pre-specified reference values is crucial, both under normal operating conditions as well as in extreme situations.

To manipulate the water flows in irrigation channels devices such as pumps and gates are used. Traditionally, these devices are equipped with local decentralized controllers. These controllers receive set-points from a human operator and use local information only to determine device settings, such as the flow of water through the device, that should result in achieving the set-points. The local controllers are not explicitly aware of one another's presence and no communication among them takes place. However, the actions that a single controller in an irrigation channel takes locally may affect the water levels of parts of the irrigation channel controlled by other controllers (both downstream and upstream). Hence, an obvious drawback of such a decentralized control scheme is that adequate performance at a system-wide level may be jeopardized, due to the unexpected and unanticipated interactions among the actions of the local controllers.

Due to the continuing developments in information and communication technology, exchange of information between local controllers becomes practically and economically possible. Local controllers may be designed in such that they do take into account the effects that local actions have at a system-wide level using such information exchange. The local controllers may employ communication exchange in order to perform cooperation and negotiation with other controllers in order to achieve the best system-wide performance.

In this paper we survey the state-of-the-art literature on distributed control for control of irrigation channels, and we discuss how communication among the local controllers can be included to improve the overall system's performance. In addition, we present a distributed control scheme in which each controller employs model predictive control to determine which actions to take. In order to obtain coordination and to improve decision making the local controllers communicate with each other using a Lagrange-based communication and decision making scheme. Using the presented distributed model predictive control scheme the local controllers cooperative strive for obtaining the best system wide performance.