Abstract

The increase in world population and the increasing demand for food pose a challenge for agricultural systems. In agriculture, the water used in irrigation is crucial throughout the crop cycle to ensure favorable yields and production quality. However, agricultural activities represent approximately 70% of freshwater consumption globally, and in the context of climate change, the medium and long-term availability of this resource is uncertain. Additionally, restrictions on transporting water to areas suitable for agriculture limit its potential exploitation. In this context, control systems can provide solutions from modeling and control to improve the performance of irrigation systems. This work addresses two of the current challenges of agricultural systems focused on applying the resource once it is close to the crop (i.e., water transport is outside the scope of this work). On the one hand, the interpretation of the interactions between the crop and the soil when the terrain is heterogeneous (in its composition and topography). On the other hand, the efficient monitoring of a large area crop when deploying sensors under economic and technical restrictions. This work starts with identifying the essential components of agricultural systems to propose an agent-based model (ABM). This model interprets the land heterogeneity and allows the monitoring of large crops. Then, efficient monitoring is achieved with the adaptation of an estimator based on the Kalman filter (KF). The significant advantage of the agent-based model is its flexibility to incorporate information from different sources and its scalability based on the topography of the terrain to improve the interpretation of water movements.

Finally, the agent-based framework is integrated with a model predictive control (MPC) system to show the potential for water savings when environmental and economic constraints. As case studies, typical scenarios of Colombian topography are considered, and the computational tool is developed in Matlab and Python.