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Simulation of a Feedback Control Technique Through Irrigation Canal Junctions

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Abstract: A linear quadratic controller based algorithm was developed for simulating the dynamics of a single-reach irrigation canal with a channel junction. Using the concepts of feedback control theory, an expression for an upstream gate opening of an irrigation canal reach with a channel junction operated based upon a constant-level control was obtained. In the derivation, the canal reach between 2 gates was divided into 5 nodes, and the finite difference forms of the continuity and momentum equations were written for each node. The Taylor series was applied to linearize the equations around equilibrium conditions. At the third node of the canal reach, a channel junction occured and the equations were derived based on the channel junction parameters. The hydraulic description of flow at channel junctions is difficult because of flow approaching angles, energy losses and turbulence. An example problem with a single pool was considered for evaluating the technique used to design a linear quadratic controller (LQR) for irrigation canals with a channel junction. Considering the computational complexity and the accuracy of the results obtained, the LQR feedback control theory was found to be adequate for irrigation canals with channel junctions.

Key Words: channel junctions, linear quadratic controller, mathematical modeling, open-channel flow

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