Adapting SWMM Hydraulic Features for a Conservative Finite-Volume Method

Sazzad Sharior

B.S. in Water Resources Engineering, Bangladesh University of Engineering and Technology, Dhaka, Bangladesh
M.S. in Civil Engineering, Marquette University, Milwaukee, WI
Advisor: Dr. Ben Hodges

The EPA SWMM hydraulic model uses a discrete link-node system where nodes are defined by head and links by flowrate. Link elements include conduits, open channels, pumps and flow regulating devices. Node elements include manholes, junctions, ponds/storage and outfalls. SWMM has a long history of creative algorithm development to fit these features into the link-node paradigm (e.g., a manhole with connections at different elevations that requires multiple heads). As a further complication, SWMM solves the Saint-Venant equations for conduits, open channels and junctions, whereas other hydraulic elements use ad hoc flow or head equations.

NCIMM is developing a mass-conservative finite-volume computational engine for SWMM that solves flow and head on every element, which provides a more consistent way to represent complex hydraulic features. The SWMM code and algorithms contain a wealth of intellectual history in quantitative representation of various features in a stormwater network, which we seek to document and preserve. Herein, we present the methods being investigated to adapt the SWMM link-node elements to fit into the finite-volume framework.

Accelerating the Method of Characteristics for Transient Flow Modeling with Parallel Computing

Gerardo Riano

B.S. in Civil and Electrical Engineering and M.S. in Electrical Engineering, University of Los Andes in Colombia
Advisor: Dr. Lina Sela

Modeling transient flow in networked dynamical systems characterized by hyperbolic partial differential equations (PDEs) is essential to engineering applications. Solutions of hyperbolic PDEs are commonly found using the method of characteristics (MOC), particularly when modeling the water hammer phenomenon in water distribution systems (WDSs). For applications that require fast modeling, existing methods for speeding up traditional MOC simulations either trade-off accuracy for simulation time or do not scale properly due to memory restrictions and prolonged computational times.

We propose a novel parallel implementation of the method of characteristics for networked systems, which relies on vectorization and distributed parallel computing to evaluate the transient dynamics of WDSs. The proposed method, referred to as distributed and vectorized MOC (DV-MOC), relies on aligned memory-allocation for vectorization, and distributed-memory parallelization to further accelerate vectorized operations and ensure scalability for arbitrary network topologies.