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Partial Differential Equation-Constrained Optimal Control of Flood Dynamics in Nigeria Using Physics-Informed Neural Networks

Communication Info

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Abstract

The flooding in Nigeria is made worse by the nonlinear interactions between the overland flow, riverine systems, drainage systems in urban areas, and the management of reservoirs [1,2], while the existing models for forecasting are still mainly reactive and loosely coupled with control actions [3,4]. The paper aims to propose an integrated framework for predictive control[3,4]. A framework for PDE-constrained optimal control using Physics-Informed Neural Networks is proposed, where different neural networks are used to approximate the flood states and control. The physics of hydrodynamics are incorporated using loss functions, in addition to boundary conditions, data, and control regularization. The framework also predicts the evolution of floods and the optimal control measures simultaneously through a unified differentiable model, which has been shown to be extensible to river routing, sewer modeling, and reservoir dynamics by using Nigerian hydro-meteorological data. The proposed method provides a scalable decision-support system for real-time flood forecasting and adaptive control in data-scarce situations.

References

[1] Ugwu Okwudili J., Emmanuel Udo A., Uzoeshi Samson, Benison Yason, Geoffrey Ogbonna , Flood Susceptibility Mapping and Urban Resilience Assessment in Lagos State Using a Machine Learning Approach Nwodo, Anthony Okoroji, American Journal of Geographic Information System , 14, 2025,1-13.

[2] Jude Okeibunor Nwambuonwo, Ogheneovo Maureen Atie, Mariam Reuben-Okoye, Impact of Flood on Bayelsa State, Nigeria: Causes, Consequence, and Management Strategies, International Journal of Multidisciplinary Approach Research and Science, 3, 2025, 1101-1114.

[3] Che, D., Mays, L.W., Development of an Optimization/Simulation Model for Real-Time Flood-Control Operation of River-Reservoirs Systems, Water Resour Manage, 29, 2015, 3987–4005.

[4] Luis Fernando Nazari, Eduardo Camponogara, Laio Oriel Seman, Physics-informed neural control for mitigating flood effects: A case study based on a simulated hydrographic basin Applied Soft Computing, 186, 2026.