Announces the Ph.D. Dissertation Defense of

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for the degree of Doctor of Philosophy (Ph.D.)

“Modeling, Path Planning, and Control Co-Design of Marine Current Turbines”

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Electrical Engineering and Computer Science

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ABSTRACT OF DISSERTATION
Marine and hydrokinetic (MHK) energy systems, including marine current turbines and wave energy converters, could contribute significantly to reducing reliance on fossil fuels and improving energy security while accelerating progress in the blue economy. However, technologies to capture them are nascent in development due to several technical and economic challenges. For example, for capturing ocean flows, the fluid velocity is low, but density is high, resulting in early boundary layer separation and high torque. This dissertation addresses critical challenges in modeling, optimization, and control co-design of MHK energy systems, with a specific case study of a variable buoyancy-controlled marine current turbine (MCT). Specifically, this dissertation presents (a) comprehensive dynamic modeling of the MCT, where data recorded by an acoustic Doppler current profiler are used as the real ocean environment. Numerical simulations results of the turbine performance for normal, hurricane, and fault conditions are presented and discussed; (b) vertical path planning of the MCT, where the problem is formulated as a novel spatial-temporal optimization problem to maximize the total harvested power of the system in an uncertain oceanic environment. Reinforcement learning-based method is designed to explore the optimal control actions, and results are quantitatively compared with a model predictive control-based strategy; (c) control co-design of the MCT, where the physical device geometry and turbine path control are optimized simultaneously. Bi-directional coupling between plant design and path control is formulated and optimized in a nested co-optimization framework to maximize key performance index, e.g., the power-to-weight ratio. Evaluations are carried out using field-collected ocean current data and simulation in the Matlab/Simulink. Comparative studies with baseline designs validate the superiority of our proposed innovations.

BIOGRAPHICAL SKETCH
Born in Tehran, Iran
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CONCERNING PERIOD OF PREPARATION & QUALIFYING EXAMINATION

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Published Papers:


