COLLEGE OF ENGINEERING AND COMPUTER SCIENCE
FLORIDA ATLANTIC UNIVERSITY

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

"Learning and Optimization for Real-Time Microgrid Energy Management Systems"

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Virtual Dissertation

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ABSTRACT OF DISSERTATION
Learning and Optimization for Real-Time Microgrid Energy Management Systems

Abstract:

Participation of intermittent distributed renewable generation (RG) in the microgrid is increasing rapidly due to its environment and economic friendly features and imposing great challenges to microgrid scheduling and real-time/online dispatch. The control and optimization performances of the existing microgrid online approaches degrade significantly, especially with missing forecast information, large state space, and multiple probabilistic events. This dissertation focuses on these challenges and proposes efficient online learning and optimization-based approaches with theoretical and experimental validations. A novel fitted rolling horizon control (fitted-RHC) approach is proposed for addressing the missing forecast challenges on online microgrid operations. The proposed fitted-RHC framework is designed with a regression algorithm that utilizes the empirical knowledge to make microgrid real-time decisions whenever the intra-day forecast data is unavailable. For efficiently solving microgrid problems with large state-spaces, an innovative approximate dynamic programming method is proposed and applied in an islanded microgrid application with intermittent RG. The proposed method integrates the policy function approximation with value function approximation in a double-pass value iteration process to improve the optimization performance and speed up the iterative learning process. A Q-learning approach with multiple local agents is also proposed for ensuring a cost-effective microgrid resilient operation during weather-related incidents and natural disasters. Different local Q-learning agents are employed to learn different microgrid events and aggregate the learned value functions to the global agent who handles the overall microgrid energy scheduling in a probabilistic way. Overall, this dissertation provides potential solutions for solving microgrid optimization challenges associated with real-time uncertainties by proposing novel optimization and learning-based approaches. The proposed approaches are presented with theoretical explanations and experimental justifications and are expected to be promising approaches for ensuring economic, reliable, and resilient microgrid operations.

BIOGRAPHICAL SKETCH
Born in Dhaka, Bangladesh
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Time in Preparation: 2017 - 2020

Qualifying Examination Passed: Summer 2019

Published Papers:

- A. Das, and Z. Ni, "A Novel Fitted Rolling Horizon Control Approach for Real-Time Policy Making in Microgrid," *IEEE Transactions on Smart Grid*, Vol. 11, Issue 4, pp. 3535-3544, 2020.
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