Avenues for the application of data-driven machine learning for enhanced microgrid operations

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INTRODUCTION

Microgrids, particularly, promote local usage of renewable energy and develop the efficiency of distributed power. Moreover, microgrids have brought both opportunities and challenges for the development of electrical vehicle charging stations. Distributed generation based on renewable energy sources, has characteristics of volatility, randomness, intermittence that will cause voltage and frequency deviation, voltage waveform distortion and three-phase voltage unbalance and other power quality problems for microgrids. The accurate and real-time detection of harmonics and voltage flicker is the basis of harmonic analysis and it has a very important practical significance for the operation of microgrids.

FRAMEWORK

- Grid implementation:
  - **IEEE 13 Node** System; as the main distribution grid
  - **CIGRE Microgrid** Benchmark; connected at node N634 on the low voltage side
  - **MATLAB/Simulink for simulation**
- Case study:
  - All the generators in CIGRE system are **PV systems.**
  - Improved Hilbert-Huang Transform **(HHT)** to analyze and process the **voltage waveform** at the point of common coupling (PCC)
  - Machine Learning (ML) algorithm to be trained based on RMS voltage values at the PCC, together with real PV generation, real irradiance & temperature data, and real load data (from Fort Collins)
- Objectives
  - To identify **when, where** and **how much** power the PV systems are generated (PV simulated)
  - To train a **Machine Learning** (ML) algorithm to predict voltage level control via OLTC. (PV real data)

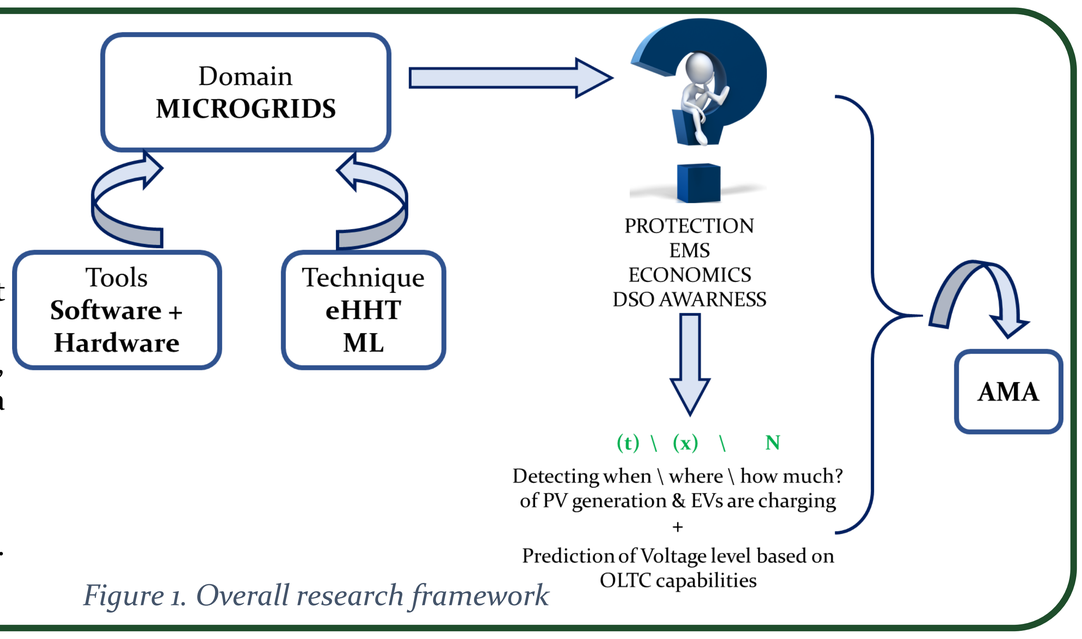

Figure 1. Overall research framework

Using voltage measurements to detect, locate, and determine spatial-temporal presence of PVs and EVs in microgrids

Scan the code for more information

HILBERT – HUANG METHOD

MACHINE LEARNING TECHNIQUE

HINTS FOR FUTURE WORK

- Both algorithms are under development but with promising results so far.
- First stage for deploying and testing the evolved HHT algorithm was done using only PV systems as distorting source for PQ signals. Next step is to add EV charging stations, tune and update the algorithm to study their impact on the distorted voltage signal in terms of instantaneous frequencies and amplitude of the constituent modes of variation.
- The ability of estimation the voltage level and tap changing of the transformer, based on the variables in the microgrid, has also economical aspects from the point of view of planning and operation;
- Those tools might be used by the microgrid operator or by the DSO to increase the awareness in operation over the grid.