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Topic 1: Distributed Artificial Intelligence in the Future of Smart Grids

Abstract: The smart grid is the transformation of the traditional power system to one that is conscious, intelligent, distributed, and flexible. Such an electric power grid architecture can facilitate the distributed and secure flow of power from renewable energy sources including solar and wind. Smart grid operations and control is complex, now dealing with variable power and energy sources, bidirectional power flows, and uncertainty in forecasting and real-time availability of generation, loads, energy storage and other operational resources. Furthermore, smart grid operations will involve flexible loads and energy storage including electric vehicles. This talk will address the potentials and promises of Distributed Artificial Intelligence (AI) for smart grid operations and control. AI has evolved over the last 50 years to impact complex systems operations and control in a meaningful way. Examples of distributed AI technologies for stable, secure, reliable, and efficient operations and control in for the evolving smart grid will be presented.

References:
1. Venayagamoorthy GK, "Dynamic, Stochastic, Computational, and Scalable Technologies for Smart Grids," Computational Intelligence Magazine, IEEE, vol.6, no.3, pp.22-35, Aug. 2011.
2. Jayawardene I, Venayagamoorthy GK, Zhong X, “Resilient and Sustainable Tie-line Bias Control for a Power System in Uncertain Environments”, IEEE Transactions on Emerging Topics in Computational Intelligence, Vol. 6, No. 1, February 2022, pp. 205-219, DOI: 10.1109/TETCI.2020.3042812.
3. Zhong X, Jayawardene I, Venayagamoorthy GK, Brooks R, “Denial of Service Attack on Tie-Line Bias Control in a Power System with PV Plant”, IEEE Transactions on Emerging Topics in Computational Intelligence, Vol. 1, Issue 5, October 2017, pp. 375-390

Topic 2: Swarm Intelligence and Applications in Power and Energy Systems

Abstract: Many areas in power and energy systems require solving one or more nonlinear optimization problems. While analytical methods might suffer from slow convergence and the curse of dimensionality, heuristics-based swarm intelligence can be an efficient alternative. Particle swarm optimization (PSO), part of the swarm intelligence family, is known to effectively solve large-scale nonlinear optimization problems. This talk will present a comprehensive overview of the basic concepts of swarm intelligence with emphasis on PSO and its variants. Also,

it will present power and energy systems applications that have benefited from the powerful nature of PSO as an optimization technique.

References:

1. Dharmawardena H, Venayagamoorthy GK, “Distributed Volt-Var Curve Optimization Using a Cellular Computational Network Representation of an Electric Power Distribution System”, *Energies*, Vol. 15, Issue 12, 4438, June 2022, pp. 1-18, https://doi.org/10.3390/en15124438.
2. Wei Y, Jayawardene I, Venayagamoorthy GK, “Optimal automatic generation controllers in a multi-area interconnected power system with utility-scale PV plants”, *IET Smart Grid*, Vol. 2, Issue 4, pp. 581-593, December 2019.
3. del Valle Y, Venayagamoorthy GK, Mohagheghi S, Hernandez JC, Harley RG, "Particle Swarm Optimization: Basic Concepts, Variants and Applications in Power Systems", *IEEE Transactions on Evolutionary Computation*, Vol. 12, Issue 2, April 2008, pp. 171 - 195.

Topic 3: Computational Intelligence (CI) with Emphasis on Undergraduate Education

Abstract: This talk will present five main paradigms of CI and their integration to develop hybrid intelligent systems. The paradigms covered are artificial immune systems (AISs), evolutionary computing (EC), fuzzy systems (FSs), neural networks (NNs) and swarm intelligence (SI). While individual CI paradigms have been applied successfully to solve real-world problems, the current trend is to develop hybrids of these paradigms since no one paradigm is superior to any other for solving all types of problems. In doing so, respective strengths of individual components in a hybrid CI system are capitalized while their weaknesses are eliminated. This talk is at introductory level and the objective is to excite undergraduate students and expose them at an early stage in their degree program and career to computational intelligence and real-world applications of CI including smart grid. Typical examples of undergraduate research projects in CI applied to different disciplines will be presented.

Reference:

1. Venayagamoorthy GK, A successful interdisciplinary course on computational intelligence, *IEEE Computational Intelligence Magazine*, Vol. 4, Issue 1, Feb. 2009, pp. 14-23.
2. Rosen S, Arunagirinathan, Jayawardene I, Venayagamoorthy GK, “Optimal Tuning of Governors on Synchronous Generators in a Multi-Area Power System with a Large Photovoltaic Plant”, *IEEE PES PowerAfrica Conference*, Livingstone, Zambia, June 28 – July 2, 2016.
3. Moore PW, Venayagamoorthy GK, “Evolving Combinational Logic Circuits Using Particle Swarm, Differential Evolution and Hybrid DEPSO, *International Journal of Neural Systems*, Vol. 16, No. 3, June 2006, pp. 163-177.