Cooperative Control for Multi-Agent Systems in Microgrid Distributed Generation

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ABSTRACT

With aging power distribution systems and new opportunities for renewable energy generation, the smart grid and microgrid are becoming increasingly important. Microgrid allows the addition of local loads and local distributed generation (DG) including wind power, solar, hydroelectric, fuel cells, and micro-turbines. Microgrid holds out the hope of scalable growth in power distribution systems by distributed coordination of local loads and local DG so as not to overload existing power grid generation and transmission capabilities. Sample microgrids are smart buildings, isolated rural systems, and offshore drilling systems. Microgrid takes power from the main power grid when needed, and is able to provide power back to the main power system when there is local generation excess.

When connected to the main distribution grid, microgrid receives a frequency reference from grid synchronous generators. Standard operating procedures call for disconnecting microgrid from the main power grid when disturbances occur. On disconnection, or in islanded mode, the absence of rotating synchronous generation leads to a loss of frequency references. After islanding, it is necessary to return Microgrid DG frequencies to synchronization, provide voltage support, and ensure power quality.

In this talk we develop a new method of synchronization for cooperative systems linked by a communication graph topology that is based on a novel distributed feedback linearization technique. This cooperative feedback linearization approach allows for different dynamics of agents such as occur in the DGs of a microgrid. It is shown the new cooperative protocol design method allows for frequency synchronization, voltage synchronization, and distributed power balancing in a microgrid after a grid disconnection islanding event. The distributed nature of the cooperative feedback linearization method is shown to lead to sparse communication topologies that are more suited to microgrid control, more reliable, and more economical than standard centralized secondary power control methods.

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