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Fuzzy Multi-Agent Based Voltage and Reactive Power Control

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Abstract. Variations in load and generation profiles cause overvoltages leading to equipment insulation failure and undervoltages, which impact voltage stability margin. Voltage and reactive power control aims to keep the voltage profiles within desired limits and reduce power losses. In this paper multi-agent system based on Java technology and adaptive fuzzy logics algorithms are implemented to control voltage and reactive power. Agents communicate with each other using Foundation for Intelligent Physical Agents (FIPA) to be able to achieve their objectives. A fuzzy agent controls the voltage at the busbars. Multi-agent systems make it possible to do three hierarchal voltage control in distribution systems.

Key words

Fuzzy Agent, Java Agent Development (JADE), Multi-Agent Systems, Voltage Control.

1. Introduction

"We cannot solve problems by using the same kind of thinking we used when we created them." (Albert Einstein). This was supported by the illustration for a need of different voltage control methods after major power system blackouts throughout the world in 2003. Furthermore, the distribution network is becoming populated with DGs and thus changing the character from uni-directional to bi-directional flow. The voltage and reactive power equipment are operated with the assumption that the voltage decreases along the feeder. Distributed generators alter the feeder voltage profiles and this will affect the way voltage is controlled in distribution systems [1].This brings a need for new control methods.
In conventional distribution systems, voltage and reactive power control is normally done by on-load tap changers (OLTC) and switched shunt capacitors. OLTC keep the substation secondary bus voltage constant by adjusting the tap position. The switched shunt capacitor is used to compensate the reactive power demand and thereby decrease the voltage drop. The problem with the conventional methods is that power losses may not be minimized. DGs are not involved in voltage control although they are faster in operation than the OLTC and mechanically switched shunt capacitors. If DGs are involved in the voltage control, the voltage control will be similar to the transmission's one where it is deployed in three hierarchical levels [2].
SVCs which use local control method have been used for voltage control previously. The disadvantage of this method for voltage control is that the control performance of SVC degrades after great changes in power network configuration.
Traditional voltage control methods like decreasing of OLTC set point voltage, altering the capacitor control or limiting the DG size according to the worst case scenario are all local control methods which will not be capable of fast voltage regulation in a decentralized generation scenario. The effect of the DGs to increase voltage at their terminals can be harnessed to contribute to voltage control.
In using the DG in coordinated voltage control, three level hierarchical level of control can be used in distribution systems. Primary control will be performed by DGs, secondary control by locally operated OLTCs and switched capacitors and the tertiary control by remotely adjusting DG, OLTC and substation capacitors.
To ensure that fast reactive power reserves near the bus where voltage collapse occurs because of a large disturbance, the multi-agent technology can be applied to Secondary Voltage Control (SVC) of the power system. The primary voltage controllers and the SVCs will be represented as a set of executive agents and co-ordination