A Review Paper On Transient Stability Enhancement Using Multi-Agent System

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Abstract: This paper reviews *recent technological advance in power industry by use of intelligent technologies. An intelligent agent based technology is used for fault diagnosis during faulty condition for transient stability enhancement. Agents are flexible enough to dynamically adapt the changes in the system. This review paper is study of Multi-Agent System for enhance transient stability using switching control algorithm; protection devices are operated by switching algorithm to maintain the stability of the system*.

Keywords: Multi-Agent System, electrical power system, fault diagnosis, transient stability.

1. Introduction

Sustained interruption and faults will cause serious problems in power system. The estimation of future possible faults in power system can be employed by using evolving technology. An intelligent Agent-based technology is one of the evolving which is widely adapted by the power industry.

Agent based technology can be applied in power domain for many applications including fault diagnostics [1], condition monitoring [2], power system restoration [3], market simulation [4],[5], network control [6], [7], automation [8], transient stability enhancement[13],[14] etc.

Due to the distributed environment of modern power system operation performed within this environment become extremely complex. Centralized computing on large scale distributed environment only provides limited capabilities, decentralized decision making process are more suitable for distributed environment. A possible solution to this problem is use Multi-Agent System in distributed environment.

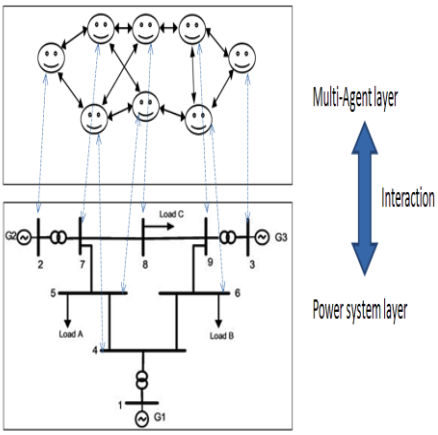
Multi-Agent System is considers as an aggregation of networked agents [9], agents coordinates and communicates with other agents within the network for achieving system goal. Multi-Agent System [10] are fully decentralized and are implemented in Foundation for Intelligent Physical Agent (FIPA)-complaint language. FIPA is an IEEE Computer Society standards organization that promotes agent-based technology. This paper reviews on used of Agent based technology in power system for fault diagnosis during unfavorable condition and enhancing the transient stability with better coordination of protective devices agents, these agents can dynamically adapt changes in the system and thus they have fully flexibility to act accordingly.

The remaining paper is organized as follows. Section 2 briefly explain framework of Multi-Agent System for power

system. Section 3 explains the impact of Multi-Agent System on fault diagnosis. Section 4 explains use of Multi-Agent System for enhancement transient stability. Section 5 examines related work on Multi-Agent System in the field
of transient stability. Section 6 finally concludes the work and explains future work in this field.

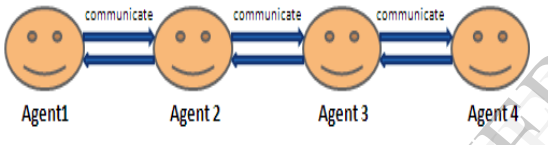
2. Framework For Multi-Agent System

Multi-Agent System technology has been used in many areas of power engineering in a decentralized manner. Some of the major problems of power system industry are distributed computing, communication and data integration. The problems can be easily solved using MAS technique as MAS solve this problem in distributed manner. This technology offer modular, flexibility and integrated approach in many problems in power system area. In MAS based power system, Multi Agent layer is integrated with power system layer and each component in power system layer like generator; load, nodes switches etc are monitored and controlled by the agents in the agent's layer. The interaction of Multi-Agent System with power system is shown in fig[1.a].



Fig[1.a] Multi-agent system and power system interaction.

Agents communicate with its neighboring agent only, for taking appropriate decision. For communication with one another agents uses Agent Communication Language (ACL). Fig[1.b] shows how communication between agents
take place.



Fig[1.b] Multi-agent communication.

3. Impact of Multi-Agent System on fault diagnosis

Disturbances like faults or sudden change in load when occur in power system may cause serious problem. A single fault may lead to multiple faults and can collapse the whole system, therefore it become necessary to detect fault and find out it cause and protect the system from it. Fault diagnosis is a process of detection of fault, isolating the faulty portion and restoring the power system to it stable condition. Cause of faults are many and most of faults are cleared by protective systems [11] as power system is distributed in nature still some faults may occur and can cause complete blackout. In distributed environment some advance and intelligent technology must be employed in the power system for diagnosis faults for this Multi-Agent System (MAS) are being widely used. When a fault occur Multi-Agent System (MAS) uses its distributed characteristics simultaneously and efficiently make decision for performing appropriate operation related to fault diagnosis. The Multi-Agent Technology uses intelligent and autonomous properties for decision making process. Multi-Agent System uses agents to represent the electrical components such as loads, switches breakers etc. Agents senses the components and communicate with other agents and share information related to that components status if any disturbance occur in any component of the power system its corresponding agent will sense the fault and then it inform other agents about the fault and make decision for resolving the fault. The design and implementation of Multi-Agent System provides an efficient mean of integrating protection analysis into a flexible and scalable architecture to meet the requirements for automated fault diagnosis.

4. Enhancement of Transient stability using Multi-Agent System

In traditional, power system Transient stability is performed off-line to understand the system's ability to withstand specific disturbances and the system's response characteristics, such as damping of generator oscillations, as the system returns to normal operation. Equal area criterion and critical clearing time play an important role for evaluating transient stability of the system. For assessment of transient stability Equal area criteria [12] is used, for this critical clearing time (CCT) can be calculated. As CCT is a key factor for transient stability of a system. If the circuit breaker operation time is greater than the CCT, then the system may go in unstable condition resulting in whole network failure. IF the protection devices are fast enough to trip the circuit breaker before CCT and reclose circuit breaker after the fault is cleared this will maintain the stability of the system. In conventional centralized structure it becomes difficult for protection devices to perform better and fast operation.
Agent based intelligent and decentralized is used to solve the above problem of transient stability. In [13] agent based system with two layers i.e. bottom layer and top layer was

proposed. At bottom layer agents can take care of reliable data processing (CCT information) by sensing the power system environment and at the top layer agents can perform basic control tasks (trip the circuit breakers before CCT) by agents autonomous decisions. Agents can perform their individual tasks within their environment is shown in fig. 3.

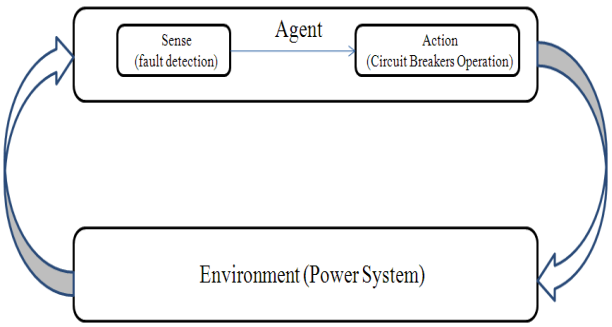


Fig. 3. Agent activity in the power system environment

In [14] Multi-Agent fault diagnosis system is designed using agent based platform for testing power system. Fig. 4 shows an example of two bus test power system this consist of a generator, a load three switches. Each switch in power system layer represents an equivalent switching agent in Multi-Agent layer.

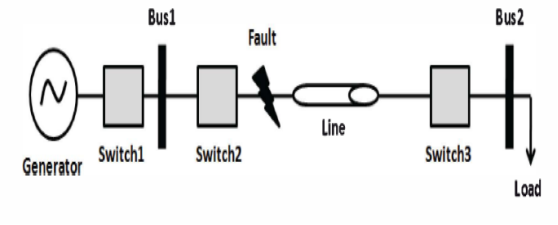


Fig. 4. A Simple 2-bus test power system

To perform switching control action switching agent (SAs) uses a switching algorithm. By this algorithm system status is sensed to continuously monitor and measure the current; if any abnormal condition (faults) is detected by SAs the decision to trip the breaker is taken otherwise perform normal operation. At the same time inter agent communication takes place this means that SAs communicates with other SAs in Multi-Agent layer to find out whether any abnormal condition(faults) is detected or not. If any abnormal condition (faults) occur then take decision to trip breaker otherwise perform normal operation. Decision taken by SAs to trip breakers can isolate whole system from fault. When the fault is cleared again reclose the breakers by sensing the power system environment. The flowchart of switching algorithm is shown in fig. 5.

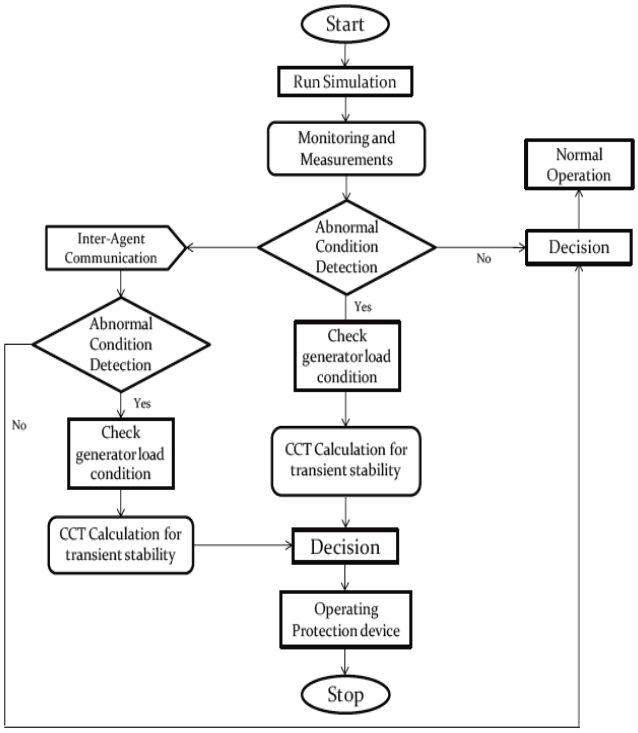


Fig. 5. Flowchart of switching algorithm

Above reviewed cases was designed and simulate by using Matlab/Simulink and Multi-Agent System platform was developed by using Java Agent Developing Environment (JADE) a fully JAVA platform. Matlab S-Function is used as a middleware between Matlab/Simulink and Java. Agents in Multi-Agent System are controlled by its external Java programs through Matlab S-function and Matlab server.

5. Related work

In [15] the authors use set of stability agents to design a real time closed-loop wide area decentralized power system stabilizers. This design is based on reinforcement learning. In [16] the authors designed a system having two type of agents i.e., Prediction Agent, Control Agent Prediction Agent predicts the stability of the system. Control Agent increases the generating power of the generating unit. In [17] the authors an Auto-reclosing algorithm with reference to power system stability based on MAS.

In [18] the author presents a parallel implementation of the transient stability problem on basis of clusters of workstations. In [19] authors used a Multi-Agent technology with two types of agents first one is tracking agents, these agents track the generator rotor angle to determine the instability. Second one is control agents it perform control action by fast valuing.

6. Conclusion and future work

In this paper Multi-Agent based system are reviewed for transient stability enhancement during faulty conditions. Here the agents are used to analyze and understand abnormal condition like faults. Agents cooperate and communicate among the other agents within the system to predict fault and operate the protective devices to isolate faulty section by tripping breaker before the critical clearing time and auto-reclose the breaker as soon as fault is cleared. Agents are flexible enough to adapt dynamic changes in the power system and make decision accordingly. The future approach of this work will focus on intelligent Multi-Agent based transient stability analysis for multi-machine system during faulty conditions of a power system network while maintaining minimum power losses and good voltage profile.

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