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RESEARCH ARTICLE OPEN ACCESS

Design of distribution system based on Multi Agent Systems

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Abstract:

As the revolutionary change in electric power industry begins with the latest communication infrastructure it is on the verge of a revolutionary transformation to develop a smart grid to meet the requirements. The objective of this paper is to discuss the design and simulation of the distributed smart grid based multi agent system. A multi agent application development will be discussed that involves agent specification and application design. The smart grid system has designed and simulated using MATLAB Simulink for fault identification and restoration of the data.

Keywords--- **distribution system; smart grid; multi-agent;matlab.**

I INTRODUCTION

The multi agent system (MAS) is one of the most popular distribution control solutions. Advantages of MAS include the ability to survive single-point-failures and decentralized data processing, which leads to efficient task distributions eventually causing faster operation and decision-making process. In artificial intelligence, agent-based technology has been hailed as a promising paradigm for conceptualizing, designing, and implementing software systems. Multi-agent technologies can be applied in a variety of applications, such as to perform power system disturbance diagnosis, power system restoration, power system secondary voltage control and power system visualization. Some of the most recent work has implemented a multi-agent system to control the operation of a micro grid.

Recently, Power System makes progress many studies based on agent technology. It manages distribution network converting Feeder, Bus and Switch into agents. After that performs restoration and operates distribution network. Distribution network based on the Ethernet communication converting switch into agents performs restoration using the information exchange. Also, there are studies used Artificial Intelligence (AI) algorithms which is similar to Agent technology for Distribution System Operation and restoration. Then, many Studies have been progressing not only studying distribution network but also operating and protecting power system based on Multi-Agent.

In this paper, the work is discussed the design of distributed restoration system based on Multi-Agent system. Followed with introduction, this paper consists of seven sections. Section II describes the multi agent technique and multi agent architecture is discussed in Section III. The distribution automation system structure and function are presented in section IV. Section V introduces the design considerations of the proposed restoration system. Section VI shows the simulation results of faults and finally conclusions are given in Section VII.

II. MULTI-AGENT ARCHITECTURE

The idea behind any multi-agent system is to break down a complex problem handled by a single entity a centralized system into smaller simpler problems handled by several entities a distributed system. The architecture of a multi-agent system is presented in Figure. 1. It consists of four agents which are control agent, a DER agent, a user agent and a database agent defined as follows.

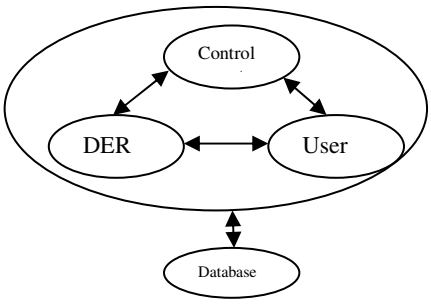

Figure 1. Architecture of multi agent system

1. ***Control agent***puts forth responsibilities that include monitoring system voltage and frequency to detect contingency situations or grid failures, and sending signals to circuit breaker to isolate the micro grid from the utility when an upstream outage is detected. The responsibilities also include receiving electricity price ($/kWh) signal from the main grid, which may be obtained from advanced metering infrastructure, and publishing them to the rest of entities.

2.***DER agent***is responsible for storing associated DER information, as well as monitoring and controlling DER power levels and it does connect/disconnect status. DER information to be stored may include DER identification number, type (solar cells, micro turbines, fuel cells, etc), power rating (kW), local fuel availability, cost function or price at which users agree to sell, as well as DER availability, i.e. planned maintenance schedule.

3***. User agent*** acts as a customer gateway that makes features of a micro grid accessible to users. It includes responsibility of providing users with real-time information of entities residing in the system. A user agent also monitors electricity consumption by each critical and non- critical load. A user agent also allows users to control the status of loads based on priority predefined by a user.

4.***Database agent*** is responsible for storing system information, as well as recording the messages and data shared among agents. Database agent also serves as a data access point for other agents, as well as users.

III DESIGN CONSIDERATION

An agent can be defined as an intelligent entity, which performs given tasks by using its knowledge and information gleaned from the working environment. It can act in a suitable manner toward achieving the given tasks successfully based on the following common properties, particularly in power grid systems.

- ***Autonomy***. An agent has some level of self-control ability. It can exist and execute tasks in an environment without external directions. In power grid systems, it is necessary for each node to make decisions autonomously in order to achieve quick response when there are some faults occurring. In addition, autonomy could take the pressure of system operators who form the last line of defense.
- ***Adaptivity.*** An agent has the ability to learn and improve its performance with previous experience. In power grid systems, a node should be able to make precise decisions based on its previous experience and current states.
- ***Reactivity.*** An agent can perceive its environment and respond in a timely fashion to changes that occur in the environment. In power grid systems, a node should have the ability to perceive the change of its environment and act in real time in order to reduce the loss when a fault happens.
- ***Sociality.*** An agent has the ability to interact, communicate and work with other agents. When a fault occurs in a power grid system, it might be inevitable for some nodes to cooperate together to deal with the fault. Therefore, the nodes in the power grid system should be able to communicate and negotiate to each other

In order to implement the proposed multi-agent system, a simulation test bed is developed in Matlab/Simulink, shown in Figure.2 as a simplified distribution circuit that comprises: a 50kW distributed generator, grid interface (inverter, pulse width modulation or PWM controller, low-pass filter and isolation transformer), loads (including 50kW critical loads and 12.5kW non-critical loads) and load circuit breakers which are IP- enabled, a distribution transformer (12.47kV/240V), the main circuit breaker and the utility grid at 12.47kV. A fault is applied to the upstream circuit at 0.1 second after the simulation starts.

Measurements are voltage and current waveforms at bus B2, which represent Voltage and current outputs produced from the distributed generator

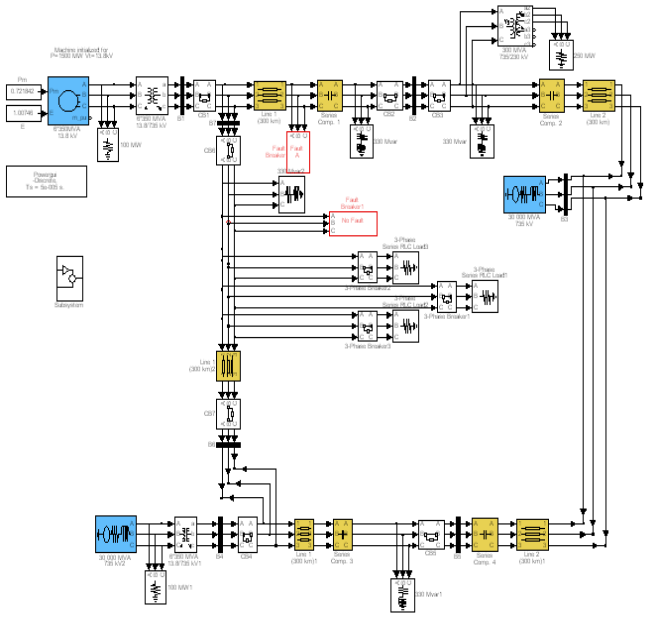

Fig.2 Simulink model of 8 bus multi agent system

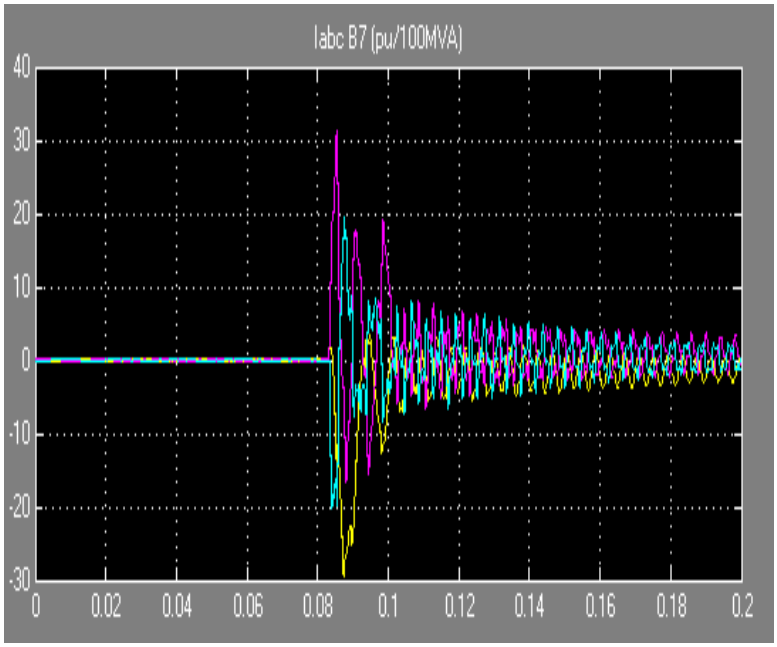

Fig.4.Average net power of 8 bus system

IV SIMULATION RESULTS

The objective of this simulation is to demonstrate that the proposed multi agent system can facilitate the seamless transition of the system. Figure.3 (a), (b), & (c) are show separately the start of fault and load triping in all lines one by one which are obtained from the simulation of multi agent system design using MATLAB SIMULINK

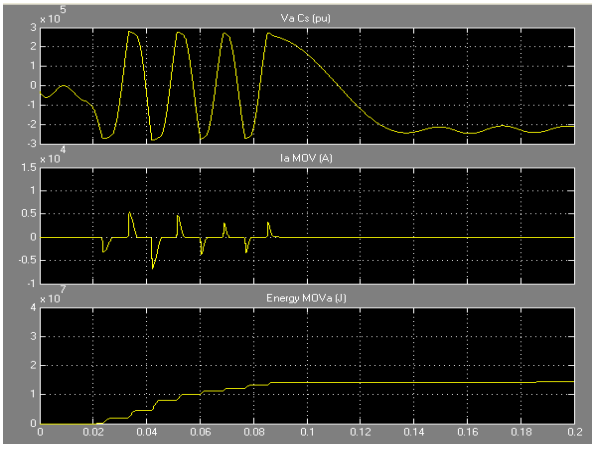

Fig.3.Fault occurrence in single line

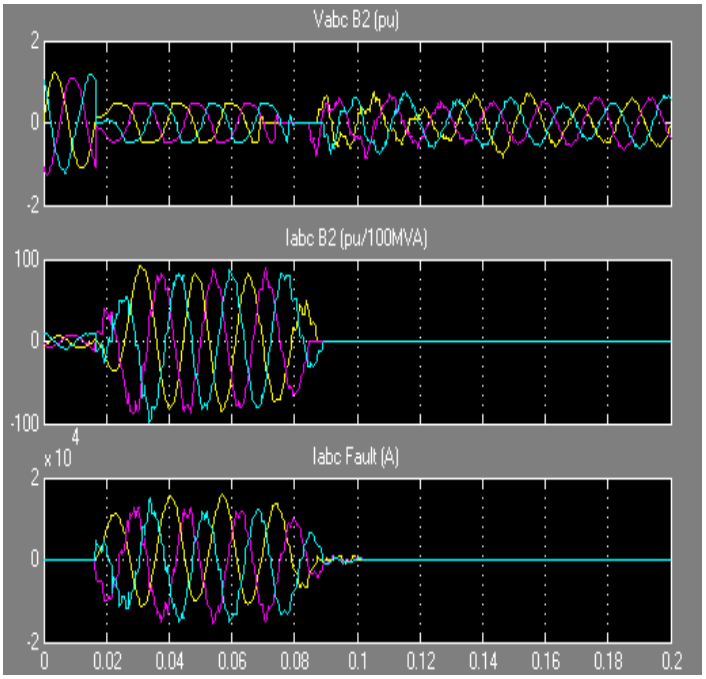

Fig.5.Fault occur at 0.1 sec for three line

V CONCLUSION

In this paper, the design and simulation of the multi-agent system are proposed. The proposed multi-agent system consists of a control agent, a DER agent, a user agent and a database agent. This demonstrates that the agent's capability can be considered as a software alternative to a traditional hardware-based zonal protection system for isolating a micro grid. Therefore, the multi-agent system provides a more flexible and updatable layout, which will allow the redefinition of the micro grid zonal boundary on the fly. In addition to serving as a flexible protection alternative, the multi-agent system also sheds non-critical loads according to a predefined prioritized list while stabilizing the micro grid after its isolation from the main grid.

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