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Power system restoring based on Artificial Neural Network

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Abstract: Power companies now days are using different techniques for restoration of Power. There are many laid down procedures to be followed for Power restoration. Computer aided system can find more effective ways for power restoration. There are many challenges for power restoration. This paper briefly proves the idea behind the Artificial Neural Network in power restoration. It also describes the types of the Artificial Neural Network, their structures, different learning methods and power restoration methods. The power restoration plans are made by the Artificial Neural Network with the help of the power system restoration plan.

Keywords: Artificial, Neural, Network, Power, Restoration

I. INTRODUCTION

In today’s world, constant power supply is necessary for different companies to run properly. So the need of power restoration arises here. Ensuring the continuous supply of the power is also difficult task. When there is power outage the continuity of the power supply is disrupted. These have far-reaching implications for commerce industries and in our daily living. Power utility companies have some drastic measures to mitigate the social and economic costs of blackouts. Some protocols used previously are inefficient and time consuming. So the necessity of more efficient and consistent methods i.e. electrical equipment arises.

Because of the energy demands and the expansion of existing power transmission networks and lines, most of the recent power systems are being operated at near-capacity. The result of this is - the state of the power systems should be continuously controlled in a comprehensive manner than was required resulting in less conservative power system function and control operation. With the help of advent of smart computer tools complex power problems that originate from the area of power system planning, diagnosis, operation and network can be solved easily (Nath and Balaji, 2014). One of the tool is the ARTIFICIAL NEURAL NETWORK SYSTEM. Hundreds of models had been created and classified as artificial neural networks, but they are distinguished by the functions, topology, agreed values, or learning algorithms (Gershenson, 2012)

II. WHAT IS THE NEURAL NETWORK

Neural networks are there to reflect the behaviour of the human brain. It allows computer programs to recognize patterns of problems and solve the common problems in the fields of Artificial Intelligence, machine learning and deep learning.

III. WHAT IS ARTIFICIAL NEURAL NETWORK

The term "Artificial Neural Network" which is derived from Biological neural networks that can develop the structure of a human brain. The human brain that has neurons interconnected to one another, similarly artificial neural networks also have neurons that are interconnected to one another in various layers of the networks. Here neurons are known as nodes.

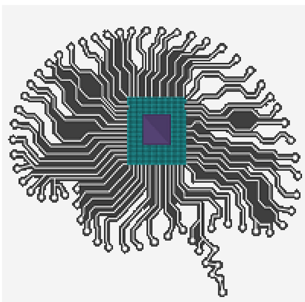

Fig. 1 Artificial Neural Network

IV. POWER RESTORATION

A. SYSTEM RESTORATION PLANS

To avoid a power system blackout, the system operator proposes the system defence plan (SDP), i.e., a real-time analysis and communication between the main components of the power system. There are two basic issues in the planning of system restoration. The first challenge concerns the generality of restoration plans after faults. Plans should be uniform and transferable from system to system regarding the basic procedures. However, a review of the available literature reveals that differences in methods of restoration plans are closely related to differences in the characteristics of individual power systems. Another challenge to establishing effective plans is a common unavailability of effective optimization tools. The optimization problems belong to the class of combinatorial optimization problems. According to the general procedures of system restoration above and the available literature, the restoration strategies can be classified into five general types "bottom–up", "top–down", "outside–inside", "inside–outside" and "joint restoration.

Bottom–Up: This strategy is based on predefined islands within the power system with the possibility of a black start (BS) of production units within the island
Top–Down: This strategy restores the transmission network by activating the black start generating units and afterward engaging other non-black-start generating units.
Build-Inward: This strategy can be applied to power systems with additional (reserve) connection to other available interconnections. By switching to auxiliary transmission lines, connections are established with an external system to restart the production
Build-Outward: To re-establish supply of an outer ring of the transmission network without using the interconnections, the system restoration must go from the ring to the external network.
Build-Together: In this strategy, the transmission network is restored in stages to provide sufficient power to fit the load.

To implement system restoration plans, it is necessary to check their technical feasibility both under the normal operating condition and under the disturbed operating conditions. Technical feasibility of system restoration plans includes the following:

- Active Power and Frequency Regulation Balancing During the system restoration process

It is necessary to maintain the system frequency and voltage within the allowed limits using the inertia of the generating units (especially turbines) and protection equipment

- Reactive Power and Voltage Regulation Balancing

Restoration of power supply of high-voltage lines to a voltage lower than nominal, operation of the generator at the minimum allowed voltage levels, disconnection of static capacitors, switching of shunt and series reactors and capacitors, setting up regulation transformers and activating loads with inductive power factors.

- Transient Over voltages

During a black start, over voltages can occur in certain parts of the system. Transient over voltages can also occur as a result of circuit breakers switching, load switching causing risk of damaging the loads' insulation

- Self-Excitation

If the excitation current is relatively large in relation to the power of the generation unit. This can result in an uncontrolled increase in voltage and can result in damage to the primary protection equipment within the generation unit. Self-excitation can also occur on the load side due to a sudden loss of power supply

- Switching on the Load

in Cold State If the load power supply is switched off for several hours or longer, the current when restoring the power supply to the consumer can be 8 to 10 times higher than the nominal value

- System Stability

During the system restoration procedure, voltage and load angle must maintain stability. In general, angular stability is checked when multiple generation units are used

- Relay Protection Setting and Load Monitoring

During the system restoration, a constant change in the power system configuration and operating conditions can lead to an unwanted tripping of the relay protection

- Organizing Power System into Islands

In order for the entire interconnection to restore power as quickly as possible, it is necessary to divide the system into islands, but the following criteria must be met: -
each island should have enough power for a black start; -
each island should have sufficient connections between generation units, with the possibility of a black start of generation units that are not able to do so in order to be able to restore them; -

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each island should be able to regulate frequency of generation units and loads within the prescribed limits; -each island should have adequate real-time voltage monitoring and regulation in order to maintain an appropriate voltage profile; -all nods in the island bordering with nearby islands should be equipped with synchronization devices

B. SYSTEM PROTECTION TOOLS

DC Supply

Since the protection system is supposed to remove all the faults from the system, this function must never be compromised during a fault. For the correct action of the protective equipment dc supply is provided.

Measuring Transformers

The voltage and current values in a power system are so high that they cannot be directly connected to relays protective equipment and measuring instruments. Therefore, the connection of these instruments is made through measuring transformers - that is, current and voltage transformers.

Switch Gear

Switchgear is the apparatus used for switching, controlling and protecting electrical circuits and equipment during the fault. Switch gear equipment include switches, circuit breakers (CBs), fuses and relays. Typically, a low voltage CB is anticipated to operate in 1 to 3 cycles, that is 20ms to 60ms for a 50Hz system. While the medium voltage CB is expected to operate in 3 to 5 cycles, that is 60ms to 100ms for a 50Hz system.

Communication

Protection relays are distantly located from each other. Therefore, to effectuate protection services, communication between these elements is essential. There are different communication link types used for protection signalling.

D. SPECIAL TECHNIQUES BASED PROTECTION SCHEMES

1. Setting-less Protection Schemes

The concept of setting-less protection also referred to as dynamic state estimation-based protection (DSEBP), is derived from the differential protection. DSEBP utilizes the voltage and current measurements from inside and the terminals of the protection zone, speed and torque measurements in case of rotating devices, or other internal measurements such as thermal measurements.

2. Synchro phasor Assisted Protection Schemes

The integrated impedance angle-based protection. The scheme is robust in distinguishing the critical issues from the faults, and thus it could be a potential candidate for developing centralized protection schemes for system. The method detects the faults by monitoring the absolute value of the rate of angle difference of the phase voltage between the PCC and the bus closest to the faulted line by using PMUs

3. Travelling Wave based Protection Schemes

The method determines the fault direction by comparing the polarities of current and voltage travelling waves. The proposed scheme is based on the mathematical morphology, technology and a simplified polarity detection method. The neural network-based classifiers are used to distinguish between the internal and external faults. This approach only requires local measurements of current. Information exchange is not required as frequently as compared to other protection schemes.

4. Machine Learning based Protection Schemes

The scheme first uses Pearson correlation coefficients from data-mining to analyse uncertain elements and then a hybrid artificial neural network and support vector machine (SVM) model for state recognition based on big data streams. Finally, the proposed scheme determines the adaptive protection settings and network reconfigurations. A new method based on a Hilbert–Huang transform (HHT) and ML techniques. The scheme initially extracts the differential features from specific current signals using HHT, which are then fed as input to the three different ML models, i.e., Naive Bayes classifier, SVM, and extreme learning machine, for the detection and classification of faults. The work shows that relay measurements could be used to obtain detection features for ML-based prediction models to detect the faults accurately. A supervised ML method using principal component analysis to extract features is proposed for fault detection. A MG protection scheme based on wavelet transform (WT) and deep neural networks. The scheme samples and prepossesses the current signals using discrete WT for the extraction of statistical features. The fault detection is done by giving these features as inputs to deep neural networks for training and testing.

V. CONCLUSION

Now days restoration of Power system is an area that is becoming popular. Artificial intelligence is able to generalize and process data quickly, many techniques based of that can be proposed to enhance power system restoration. Apart from using some predefined operating procedures for restoration, these methods suggested using the machine as an operator aid. With Artificial Intelligence Machine Learning also helps for the same. Finally, Island Restoration Scheme is one of the most effective power restoration schemes especially when dealing with large network.

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