REVIEW ON EXPERT POWER SYSTEM AND ITS CATEGORIZATION

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Abstract: This paper is based on review on working culture and performance of Expert System and on the communication from sensors and an analysis and solution based decisions/issuing concept. The Artificial Neural Networks (ANN) shall be used for obtaining the solutions. Electricity is one of the key infrastructural inputs in the development of Nations economy. Modern economies are dependent on reliable and secure electricity services. Electricity makes an essential contribution to economic performance, international competitiveness and community prosperity of a country. 'Transmission' and 'Grid Management' are essential functions for smooth evacuation of power from generating stations to the consumers. Grid management in India is carried out on a regional basis. The country is geographically divided in five regions namely, Northern, Eastern, Western, North Eastern and Southernt. Performances Concept of Grid Hierarchy, Smart Grid Structure its structure

Keywords: Expert System, Smart Grid; Artificial Neural Network(ANN.)

I. INTRODUCTION

Electricity is one of the key infrastructural input in the development of Nations economy. Modern economies are dependent on reliable and secure electricity services. Electricity makes an essential contribution to economic performance, international competitiveness and community prosperity of a country. 'Transmission' and 'Grid Management' are essential functions for smooth evacuation of power from generating stations to the consumers. Grid management in India is carried out on a regional basis.

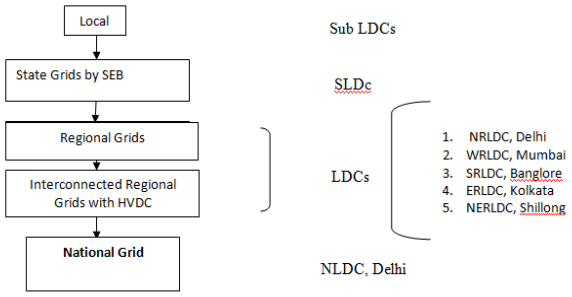

Fig.1.1: Grid Hierarchy

The Functions of grid management can be Ex-Ante, Real Time and Post Facto. Ex-Ante function involves estimating the future scenarios, evaluating options and making elaborate plans to meet the anticipated as well as unforeseen events. Real Time functions primarily comprise of balancing the dynamically varying supply and demand of electrical energy in interconnected system. All this requires extensive coordination with the operating personnel positioned at switching stations, generator control rooms and other load dispatch centres. Critical decisions have to be taken at the spur of the moment.

Post Facto functions involve grid performance reporting, post-mortem of events, settlement of accounts, documentation of experience and interaction with stake holders. In order to enhance the power system visibility and improve the quality of supervision in real time power grid operation in the country, the grid control rooms at the regional and state level have been equipped with a state of the art communication and data acquisition system (SCADA).[1]

Under the system the vital system variables are measured by transducers installed at all the important locations. The recorded data is transmitted through communication channels and ultimately displayed in the operator consoles in the load dispatch centres. Smart grid can be considered as the next generation power grid, which provides bi-directional flow of electricity and information, with improving the power grid reliability, security, and efficiency of electrical system from generation to transmission and to distribution .[2] A smart grid enables the

(i) Integration of renewable energy resources at distribution network.

(ii) Supervisory control and real-time status monitoring on the power network.

(iii) Self-monitoring

(iv) Self-healing feature, adaptive response to fault in country.

II. POWER SYSTEM INTERCONNECTION

The interconnections are mostly realized by synchronous links where such solutions are technically feasible and economically justified. On the other hand HVDC links often offer technically better and more economical solutions. A large number of examples worldwide shows, that HVDC is a quite suitable solution. However, in many situations, hybrid solutions for interconnection are more advantageous: a synchronous high voltage AC link, supported by an additional HVDC link.[3] In cases where the synchronous interconnection is technically at the limit, HVDC can support the operation of the interconnected systems and thus makes the synchronous AC link more reliable.

The development of power systems takes into account locations of expected load demands on one hand and the suitable location of power stations on the other hand, to transport the energy from generation to consumers.

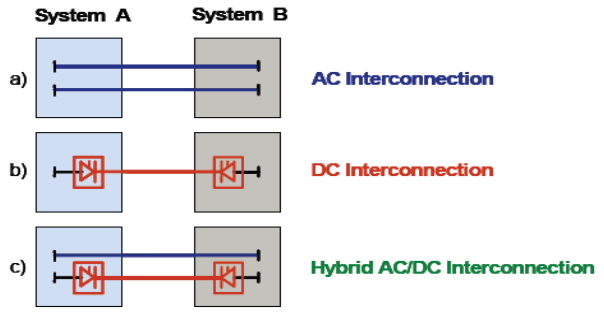

Fig. 2.1: Alternatives of Power System Interconnections

Advantages of System Interconnection:

- Increase in service reliability
- Addition and replacement of transmission facilities.
- Installed Capacity savings
- Decrease in spinning reserve requirements
- Operating savings
- Possibility to use larger and more economical Power Plants
- Reduction of the necessary Reserve Capacity in the System
- Utilization of most favorable Energy Resources
- Flexibility of building new Power Plants at favorable Locations
- Reduction of Losses by an optimized System Operation

AGC problem.

The continuing growth of this nation has been and will continue to be achieved at the expense of an enormous consumption of electrical energy, thus causing a demand for more efficient use of generation facilities. Careful usage of generating facilities reduces the ecological impact through reduction in fuel consumption and discharge problems. The trend is toward larger and larger units, which increases the problems of system stability. Controlling the frequency has always been a major subject in electrical power system operation and is becoming much more significant recently with increasing size, changing structure and complexity in interconnected power systems. Global studies show that power consumption in the world follows closely the increase of Population.

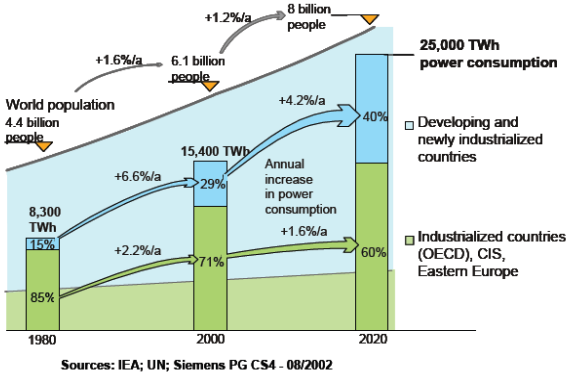

Fig. 2.2: Development of World Population and Power Consumption, 1980 to 2020

III. EXPERT SYSTEM

An expert system is a computer program which captures the knowledge of a human expert on a given problem, and uses this knowledge to solve problems in a fashion similar to the expert. The system can assist the expert during problem-solving, or act in the place of the expert in those situations where the expertise is lacking. Expert systems have been developed in such diverse areas as science, engineering, business, and medicine. In these areas, they have increased the quality, efficiency, and competitive leverage of the organizations employing the technology.[4]

The program models the following characteristics of the human expert:

- Knowledge
- Reasoning
- Conclusions
- Explanations

The expert system models the knowledge of the human expert, both in terms of content and structure. Reasoning is modelled by using procedures and control structures which process the knowledge in a manner similar to the expert.

A. Expert system structure

The structure and operation of an expert system are modelled after the human expert. Experts use their knowledge about a given domain coupled with specific information about the current problem to arrive at a solution.

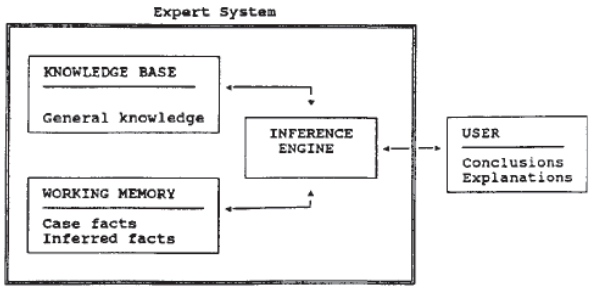

Fig 3.1: Expert system structure.

The knowledge base contains specialized knowledge on a given subject that makes the human a true expert on the subject. This knowledge is obtained from the human expert and encoded in the knowledge base using one of several knowledge representation techniques. One of the most common techniques used today for representing the knowledge in an expert system is rules.

Specific information on a current problem is represented as case facts and entered in the expert system's working memory. The 'working memory contains both the facts entered by the user from questions asked by the expert system, and facts inferred by the system. The working memory could also acquire information from databases, spreadsheets, or sensors, and be used by the expert system to conclude additional information about the problem by using the general knowledge contained in the knowledge base.

The analogy of human reasoning is performed in the expert system with the inference engine. The role of the inference engine is to work with the available information contained in the working memory and the general knowledge contained in the knowledge base to derive new information about the

problem. This process is similar to the way a human reasons with available information to arrive at a conclusion.
Several general reasons for employing an expert system such as:

- Replacement of human expert
- Assistant to human expert
- Transfer of expertise to novice

Neural networks, with their remarkable ability to derive meaning from complicated or imprecise data, can be used to extract patterns and detect trends that are too complex to be noticed by either humans or other computer techniques. A trained neural network can be thought of as an "expert" in the category of information it has been given to analyse. Neural networks process information in a similar way the human brain does. The network is composed of a large number of highly interconnected processing elements (neurons) working in parallel to solve a specific problem. Neural networks learn by example. They cannot be programmed to perform a specific task. Neural networks and conventional algorithmic computers are not in competition but complement each other. There are tasks are more suited to an algorithmic approach like arithmetic operations and tasks that are more suited to neural networks.

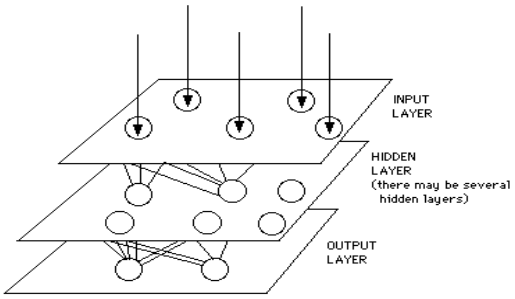

Fig 3.2: A Simple Neural Network Diagram.

An artificial neural network (ANN) is a model that emulates a biological neural network. This concept is used to implement software simulations for the massively parallel processes that involve processing elements interconnected in network architecture. The artificial neuron receives inputs that are analogous to the electrochemical impulses that the dendrites of biological neurons receive from other neurons. The output of the artificial neuron corresponds to signals sent out from biological neuron over its axon. These artificial signals can be changed similarly to the physical changes occurring at neural synapse. Artificial neural networks (ANN) have been developed as generalizations of mathematical models of biological nervous system.[5]

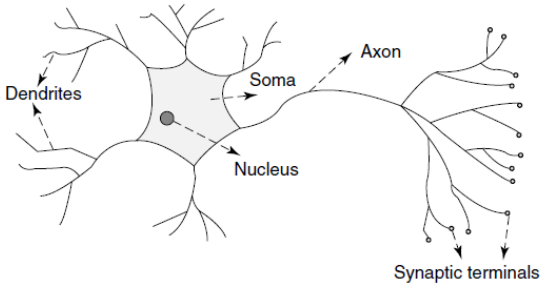

Fig 3.3: Mammalian Neuron

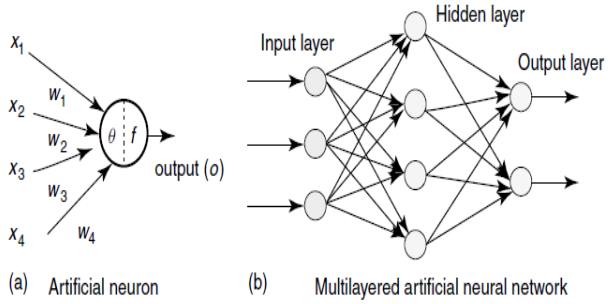

Fig 3.4: Architecture of an Artificial Neuron and a Multilayered Neural Network

The neuron output signal O is given by the following relationship:

$$O = f(net) = f\left(\sum_{j=1}^{n} wjxj\right) \quad \text{.....equation 3.1}$$

Where, net = wTx = w1x1+.....+wnxn and θ is called the threshold level.As most of the information in the real world is imprecise, and one of humans' greatest abilities is to effectively process imprecise and "'fuzzy" information. Fuzzy systems are knowledge based or rule based systems. The heart of a fuzzy system is a knowledge base consisting of the so called fuzzy IF-THEN rules. A fuzzy IF-THEN rule is an IF-THEN statement in which some words are characterized by continuous membership functions. Once a network has been structured for a particular application, that network is ready to be trained. To start this process the initial weights are chosen randomly. Then, the training, or learning, begins. There are two approaches to training - supervised and unsupervised. Supervised training involves a mechanism of providing the network with the desired output. Unsupervised training is where the network has to make sense of the inputs without outside help. [6] ANNs provide an analytical alternative to conventional techniques which are often limited by strict assumptions of normality, linearity, variable independence etc. Because an ANN can capture many kinds of relationships it allows the user to quickly and relatively easily model phenomena which otherwise may have been very difficult or impossible to explain otherwise

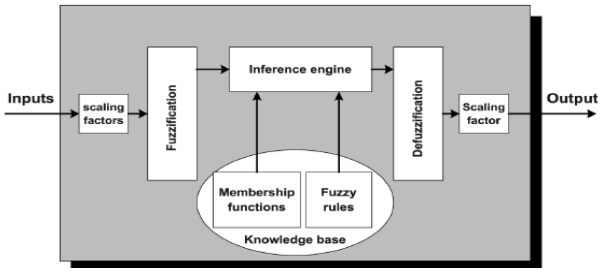

Fig 3.5: Components of a Fuzzy Logic System

IV. CLASSIFICATION OF BUSES

For load flow studies it is assumed that the loads are constant and they are defined by their real and reactive power consumption. It is further assumed that the generator terminal voltages are tightly regulated and therefore are constant. The main objective of the load flow is to find the voltage magnitude of each bus and its angle when the powers generated and loads are pre-specified.

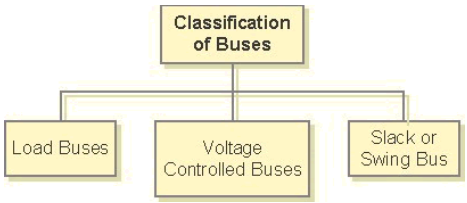

Fig 4.1:Classification of buses

Load Buses: In these buses no generators are connected and hence the generated real power PGi and reactive power QGi are taken as zero. The load drawn by these buses are defined by real power -PLi and reactive power -QLi in which the negative sign accommodates for the power flowing out of the bus. This is why these buses are sometimes referred to as P-Q bus. The objective of the load flow is to find the bus voltage magnitude |Vi| and its angle δi.

Voltage Controlled Buses : These are the buses where generators are connected. Therefore the power generation in such buses is controlled through a prime mover while the terminal voltage is controlled through the generator excitation. Keeping the input power constant through turbine-governor control and keeping the bus voltage constant using automatic voltage regulator, we can specify constant PGi and | Vi | for these buses. This is why such buses are also referred to as P-V buses. It is to be noted that the reactive power supplied by the generator QGi depends on the system configuration and cannot be specified in advance. Furthermore we have to find the unknown angle δi of the bus voltage.

Slack or Swing Bus: Usually this bus is numbered 1 for the load flow studies. This bus sets the angular reference for all the other buses. Since it is the angle difference between two voltage sources that dictates the real and reactive power flow between them, the particular angle of the slack bus is not important. However it sets the reference against which angles of all the other bus voltages are measured. For this reason the angle of this bus is usually chosen as 0°

V. CONCLUSION

Various aspects of Load flow control and Expert systems are reviewed and discussed. In present scenario to make grids smarter and to make the efficient load distribution along with optimized use of resources ANN can be use to design Expert system for control. According to the need of the grid customized expert system using ANN , Fuzzy etc. can be designed.

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