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Signature : …….

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Date : 24.06.2015

MULTI-CONTINGENCY CASCADING ANALYSIS OF SMART GRID BASED ON SELF ORGANIZING MAP (SOM)

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A report submitted in partial fulfilment of the requirements for the degree of Bachelor of Electrical Engineering (Industrial Power)

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2015

I declare that this report entitle “Multi-Contingency Cascading Analysis Of Smart Grid Based On Self Organizing Map (SOM)” is the result of my own research except as cited in the references. The report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : …….

Name : MUHAMMAD ASYRAF BIN MAT YUSOF

Date : 24.06. 2015

To my beloved mother and father

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ABSTRACT

In the investigation of power grid security, the cascading failure in multi-contingency situations has been a test because of its topological unpredictability and computational expense. Both system investigations and burden positioning routines have their limits. In this project, in view of sorting toward Self Organizing Maps (SOM), incorporated methodology consolidating spatial feature (distance)-based grouping with electrical attributes (load) to evaluate the vulnerability and cascading impact of various part sets in the force lattice. Utilizing the grouping result from SOM, sets of overwhelming stacked beginning victimized people to perform assault conspires and asses the consequent falling impact of their failures, and this SOM-based approach viably distinguishes the more powerless sets of substations than those from the conventional burden positioning and other bunching strategies. As an issue, this new approach gives a productive and solid method to study the force framework failure conduct in falling impact of basic segment failure.

ABSTRAK

Dalam penyiasatan keselamatan grid kuasa, kegagalan melata dalam situasi berbilang luar jangka telah ujian kerana ketidaktentuan topologi dan perbelanjaan pengkomputeran. Kedua-dua penyiasatan sistem dan beban rutin kedudukan mempunyai had mereka. Dalam projek ini, memandangkan jenis arah Penganjur Peta sendiri (SOM), metodologi menyatukan ciri spatial (jarak) -berdasarkan kumpulan dengan sifat-sifat elektrik (beban) untuk menilai kelemahan dan melata kesan pelbagai set bahagian dalam kekisi daya diperbadankan. Dengan menggunakan keputusan kumpulan yang SOM, set hangat disusun awal mangsa orang untuk melakukan serangan berkomplot dan kesan jatuh yang berbangkit daripada kegagalan mereka, dan pendekatan berasaskan SOM-ini maju malah membezakan set lebih berdaya pencawang daripada yang dari kedudukan beban konvensional dan strategi pencawang lain. Sebagai satu isu, pendekatan baru ini memberikan satu kaedah yang produktif dan pepejal untuk mengkaji rangka kerja kuasa kegagalan kelakuan yang jatuh kesan kegagalan segmen asas.

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SOM – Self Organizing Map

PI - Performance Index

ANN - Artificial Neural Network

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CHAPTER 1

INTRODUCTION

1.1 Research Background

Power system are worked with the goal that over-burdens don't happen either progressively or under any measurably likely contingency. This is regularly called keeping up framework " security". Test system is outfitted with devices for dissecting possibilities in a programmed manner. Contingency can comprise of a few activities or components that is straightforward case for blackout of a solitary transmission line and intricate for blackout of single of a few lines, various generators, and the conclusion of typically open transmission line. The Power grid security is one of the huge perspectives, where the correct move needs to be made by the operational specialists for the unseen contingency. In this way the contingency investigation is key for the power grid security. The contingency positioning utilizing the execution list is a strategy for the line blackouts in a power grid, which positions the most noteworthy execution record line first and returns in a plummeting way focused around the computed PI for all the line blackouts. This serves to make the former move to keep the grid secure. In the present work the Newton Raphson burden stream strategy is utilized for the power grid contingency positioning for the line blackout focused around the active power and voltage performance index [1]. The positioning is given by considering the general execution record, which is the summation of Active power and voltage performance index.

The self organizing map is a standout between the most mainstream neural network models. A self organizing map (SOM) is a sort of artificial neural network (ANN) that is prepared utilizing unsupervised figuring out how to create a low-dimensional (ordinarily two-dimensional), discretized representation of the information space of the preparation

examples, called a map. "Self Organizing" is on the grounds that no supervision is needed. SOMs learn all alone through unsupervised aggressive learning. "Maps" is because they attempt to map their weights to conform to the given input data [2] . The nodes in SOM network attempt to become like the inputs presented to them. Holding guideline "Features Maps" of the info information is a crucial standard of SOMs, and one of the things that makes them so important. Particularly, the topological connections between data information are saved when mapped to a SOM system. "Training" forms the guide utilizing info samples (a focused procedure, likewise called vector quantization), while "mapping" naturally orders another data vector.

Smart grid is system made through the blend of data engineering, correspondence innovation and electrical power framework. Smart grid is conveys electrical power to the shoppers utilizing two way computerized engineering. Monitors is the supply to the customers and estimations. Numerous nations and power markets are taking a gander at Smart Grid as progressive arrangements in conveying blend of upgraded qualities going from higher security, dependability and power quality, lower expense of conveyance, interest streamlining and vitality productivity. Smart grid arrangements empower utilities to build vitality profit and power dependability while permitting the clients to deal with the use and expenses through on going data trade. It affects all the parts of the power grid like generation, transmission and distribution [3].

A self organizing map is portrayed by the arrangement of a topographic map of the info designs in which the spatial areas (i.e. directions) of the neurons in the cross section are characteristic of inherent factual features contained in the info designs. The inspiration for the improvement of this model is because of the presence of topologically requested computational maps in the human mind. A computational map is characterized by an exhibit of neurons speaking to somewhat diversely tuned processors, which work on the tangible data motions in parallel. Hence, the neurons change information signals into a spot coded likelihood dispersion that speaks to the figured estimations of parameters by locales of most extreme relative movement inside the guide. The objective of adapting in the self organizing map is to cause distinctive parts of the system to react correspondingly to certain information designs. This is somewhat spurred by how visual, sound-related or other tangible data is taken care of in divided parts of the cerebral cortex in the human mind [4]. Schematically the Kohonen models are shown below:

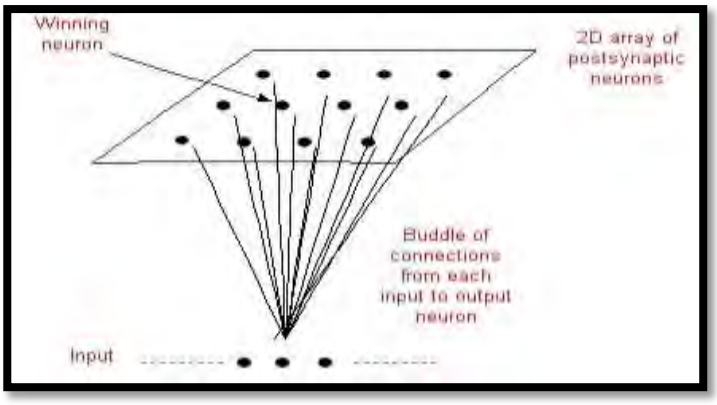

Figure 1.1 : Schematically of the Kohonen model [4].

1.2 Motivation

Nowadays, the power grid is a standout amongst the most basic base in cutting edge society. With a great many substations and transmission lines, the power grid is currently a complex grid comprises of numerous levels of territorial power sub grid whose group examples differ significantly crosswise over distinctive ranges. With this complex structure worked at diverse levels and by distinctive managers, the power grid are inexorably helpless against failures and face numerous security challenges. Among the difficulties to the power grid, vindictive assaults are attracting becoming consideration because of the expanding multifaceted nature of helplessness to shield. As the industry is moving towards the redesign of customary power grid to the most recent era of smart grid with more canny control from the communication system, it is additionally confronting the expanding dangers to keen smart grid security because of the heft of data and access looked for by the potential aggressors.

1.3 Problem Statement

Nowadays, there are many researchers study about design and concepts of self organizing maps in smart grid. The analysis also focus on the cascading failure analysis in multi-contingency scenarios has been a challenge due to its topological complexity and computational cost. The contingencies are chosen by computing a sort of seriousness indices known as Performance Indices (PI). These indices are ascertained utilizing the conventional power flow algorithms for individual possibilities in a logged off mode. In view of the qualities acquired the contingencies are positioned in a way where the most noteworthy estimation of PI is positioned first. The analysis is carried out beginning from the contingency that is positioned one and is proceeded till no severe contingencies are found. There are two sort of performance index which are of extraordinary utilize, these are active power performance index (PI_p) and reactive power performance index (PI_v). Hence, modern computers are furnished with possibility investigation programs which show the power system and are utilized to study blackout occasions and alarm the administrators of potential over-burdens and voltage infringement. The most troublesome methodological issue to adapt inside contingency investigation is the exactness of the strategy and the rate of arrangement of the model used.

1.4 Objectives

The objectives of this research are :

1) Define contingency cascading analysis for power system.
2) Utilize of ability Self Organizing Map (SOM) method using smaller and bigger data.
3) Apply Self Organizing Map (SOM) to contingency analysis.

1.5 Scope of work

Scope of these projects is only focus on multi-contingency cascading analysis of smart grid based on Self-Organizing Map (SOM). In this project, analysis and simulation there were using MATLAB software based SOM Toolbox to determine the analysis. The data mining from IEEE 14 Bus System and IEEE 57 Bus System will used for this project. U-matrix algorithm were used in order to find cluster in the nodes of the SOM.

CHAPTER 2

LITERATURE REVIEW

2.1 Theory and Basic Principles

2.1.1 Load Contingency Analysis

Contingency analysis is the investigation of the blackout of components, for example, transmission lines, transformers and generators, and examination of the ensuing impacts on line force streams and transport voltages of the remaining framework. It speaks to a vital device to study the impact of components blackouts in power framework security amid operation and arranging. Contingency alluding to unsettling influences, for example, transmission component blackouts or generator blackouts may cause sudden and expansive changes in both the setup and the condition of the framework [5]. Contingencies may bring about extreme infringement of the working imperatives. Thusly, getting ready for contingencies structures an essential part of secure operation.

Contingency investigation permits the framework to be worked protectively. The administrator normally needs to know whether the present operation of the framework is secure and what will happen if a specific blackout happens. Inexact models can be utilized as the DC burden stream as for megawatt streams. At the point when voltage is concern, full AC burden stream investigation is needed. The writing audits in contingency investigation gave data about numerous strategies that can be utilized to perform the contingency investigation. For look for of exactness, full AC burden stream examination is performed post every blackout utilizing the blackout reenactment to get post-blackout line streams and transport voltages. Operations staff must perceive which line or generator

blackouts will result in force streams or voltages to go out of their breaking points. So as to anticipate the impacts of blackouts, contingency investigation system is utilized. Contingency investigation strategies demonstrate a solitary gear disappointment occasion, that is one line or one generator blackout, or various supplies disappointment occasions, that is two transmission lines, a transmission line and a generator, one after an alternate in arrangement until all dependable blackouts have been examined. For every blackout tried, the contingency examination system checks all force streams and voltage levels in the system against their individual breaking points [6].

Electric power designers utilize their judgment and past experience for selecting and examining extreme contingency. Thusly, the change of a contingency situating figuring which would rank contingencies based upon their relative reality is alluring. The possibilities can be situated based upon their trappings in light of line stacking or transport voltages. A blended pack of figuring are created which can be gathered into two social occasions. One is the execution file (PI) based framework which utilizes a wide system scalar execution rundown to assess the earnestness of every one case by finding out their PI values and situating them properly. The other is the screening framework which is concentrated around vague force stream answer for discard those non-basic contingencies. With the progress of modernized thinking, expert structures and cushy theory are proposed to gage the reality of distinctive contingency. In like manner reenacted neural frameworks procedures execution record (PI) have been proposed for contingency determination [7]. In this study contingencies are situated using a PI based system. Framework execution records are not special and obtain differing structures depending upon the parameters that are of most basics to the specialist. The most generally perceived sort of structure execution records give a measure of the deviation from assessed estimations of system variables, for instance, line streams, bus voltages and bus power infusions. The ranking method used in this paper is a fast and accurate method to rank the contingencies according to their severity on the power system. The ranking technique utilizes a system wide scalar PI to quantify the severity of each contingency with actually calculating the post contingency line flows and bus voltages using full AC load flow analysis. Contingencies are ranked in the order of their performance index values and processed starting with the most severe contingency at the top of the list proceeding down the ranking to the less severe ones [8]. The performance indices are calculated for contingency cases with real flow violations and voltage violations. The masking problem is

successfully addressed by changing the exponent of the performance index from 2 to higher values. The post contingency line flows and bus voltages are obtained from the load flow solution after the application of the outage simulation. The exponent (m) of the performance index is changed in the range from 2 to 30 to avoid masking errors. Outages are then ranked on the basis of their corresponding performance indices. In this study the contingencies are ranked on the basis of line loading in equation 2.1 :

$$APLPI = \sum_{t=1}^{NL} W_{pi} \left(\frac{P_{tpc}}{P_{tLim}}\right)^{2\,m} \tag{2.1}$$

Where:

P_{tpc} :The post-contingency active power flow on line (i).

P_{tLim} :The active power flow limit on line (i).

W_{pi} :The weight factor of active power flow on line (i).

NL :Number of transmission lines.

m :Is a positive integer.

2.1.2 Smart Grid Network

The Smart Grid is the mix of electrical and digital technologies, information and communication which offices coordination methodology and framework to yield genuine measurable esteem over the power conveyance chain. It is a savvy future power grid that unites all supply, network and interest components through a correspondence grid. Brilliant network conveys power to purchasers utilizing two-way advanced innovation that empower the effective administration of shoppers, productive utilization of the grid to distinguish and remedy supply that is interest awkward nature [22]. Keen matrix arrangements empower utilities to expand vitality benefit and force dependability while permitting the clients to deal with the utilization and expenses through constant data trade. It affects all the segments of the power grid like generation, transmission and dispersion [9].

2.1.3 Self Organizing Maps (SOM)

The Self-Organizing Map is a standout between the most mainstream neural system models. A sorting toward oneself out guide (SOM) is a sort of simulated neural system (ANN) that is prepared utilizing unsupervised figuring out how to create a low-dimensional (ordinarily two-dimensional), discretized representation of the information space of the preparation examples, called a map. "Self Organizing" is on the grounds that no supervision is needed. SOMs learn all alone through unsupervised aggressive learning. "Maps" is on the grounds that they endeavor to guide their weights to fit in with the given info information. The hubs in a SOM system endeavor to wind up like the inputs displayed to them. Holding guideline "Features Maps" of the info information is a crucial standard of SOMs, and one of the things that makes them so important. Particularly, the topological connections between data information are saved when mapped to a SOM system. "Training" forms the guide utilizing info samples (a focused procedure, likewise called vector quantization), while "mapping" naturally orders another data vector [10]. A self-organizing map consists of components called nodes or neurons. Associated with each node is a weight vector of the same dimension as the input data vectors and a position in the map space. The usual arrangement of nodes is a two-dimensional regular spacing in a hexagonal or rectangular grid. The self-organizing map describes a mapping from a higher-dimensional input space to a lower-dimensional map space.

The structure of a SOM is genuinely basic, and is best comprehended with the utilization of an outline in figure 1 is a 4x4 SOM organize (4 hubs down, 4 hubs over). It is not entirely obvious this structure as being trifling, however there are a couple of key things to take note. In the first place, each one guide hub is joined with each one info hub. For this little 4x4 hub organize, that is 4x4x3=48 associations. Also, perceive that guide hubs are not joined with one another. The hubs are composed in this way, as a 2- D network makes it simple to picture the results. This representation is additionally valuable when the SOM calculation is utilized. In this setup, each one guide hub has an exceptional direction. This makes it simple to reference a hub in the system, and to compute the separations between hubs. Due to the associations just to the information hubs, the guide hubs are unaware in respect to what values their neighbors have. A guide hub will just redesign its weights (clarified next) focused around what the data vector lets it know [11].