OPTIMAL VOLTAGE STABILITY ASSESSMENT BASED ON VOLTAGE STABILITY INDICES AND ARTIFICIAL NEURAL NETWORK

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I dedicate this thesis to my beloved parents, supervisors, sisters, family and friends

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ABSTRACT

The evaluation of voltage stability assessment experiences sizeable anxiety in the safe operation of power systems, due to the complications of a strain power system. With the snowballing of power demand by the consumers and also the restricted amount of power sources, therefore, the system has to perform at its maximum proficiency. The noteworthy to discover the maximum ability boundary prior to voltage collapse should be undertaken. A preliminary warning can be perceived to evade the interruption of power system's capacity. This research considered the implementation of static and time-step system monitoring methods that able to provide a timely warning in the power system. Numerous types of line voltage stability indices (LVSI) are differentiated in this research to resolve their effectuality to determine the weakest lines for the power systems. The main motivation of these indices is used to predict and forecast the proximity towards voltage instability in the power system control and security applications. The indices are also able to decide the weakest load buses which are close to voltage collapse in the power system. Therefore, the static and time-step simulation (TSS) results are used to calculate the line stability indices and to ratify with voltage stability indices theory. The line voltage stability indices are assessed using the IEEE 9-Bus system, IEEE 14-Bus System and IEEE 30-Bus system to validate their practicability. The results are used to calculate the line stability indices by using Matlab software. This research also introduced the implementation of voltage stability monitoring by using Artificial Neural Network (ANN). Results demonstrated that the calculated indices and the estimated indices by using ANN are practically relevant in predicting the manifestation of voltage collapse in the system. Overall, VCPI(Power) index is able to detect the voltage collapse point precisely due to its accuracy in forecasting. This index successfully showed the capability to forecast the voltage collapse point either in small or a larger power system network. Therefore, essential actions can be taken by the operators in order to dodge voltage collapse incident from arising.

ABSTRAK

Penilaian taksiran kestabilan voltan mengalami pertimbangan yang kritikal dari segi aspek keselamantan dalam sistem kuasa elektrik. Dengan permintaan kuasa elektrik yang semakin meningkat daripada pihak pengguna dan jumlah penjanaan elektrik kuasa yang terhad. Maka, faktor-faktor ini menyebabkan sistem kuasa sentiasa beroperasi pada keadaan maksimum. Langkah perlaksanaan perlu ditekankan untuk mencari batas kemampuan maksimum sebelum keruntuhan voltan terjadi. Satu amaran awal mampu diperhatikan bagi mengelakkan gangguan kapasiti pada sistem kuasa elektrik. Kajian ini merangkumi pelaksanaan kaedah statik dan masa nyata dalam pemantauan sistem yang mampu memberikan amaran yang berkesan dalam sistem kuasa elektrik sebelum keruntuhan voltan terjadi. Pelbagai jenis indeks kestabilan voltan pada talian diaplikasikan dalam kajian ini untuk memantau keberkesanan mereka untuk menentukan talian yang tidak stabil pada sistem kuasa elektrik. Motivasi utama indeks digunapakaikan untuk meramalkan jarak ke arah ketidakstabilan voltan demi untuk mengawal sistem kuasa elektrik dalam aplikasi keselamatan. Sebaliknya, indeks juga mampu membuat keputusan untuk mengetahui beban *bus* yang paling lemah di mana dekat dengan kejatuhan voltan dalam sistem kuasa. Keputusan statik dan masa langkah simulasi telah digunakan untuk mengesahkan dengan teori kestabilan voltan yang sedia ada. Indeks kestabilan voltan talian dinilai menggunakan *IEEE 9-Bus*, *IEEE 14-Bus* dan *IEEE 30-Bus* untuk mengesahkan keberkesanan mereka. Kajian ini juga memperkenalkan pelaksanaan pemantauan kestabilan voltan dengan menggunakan *Artificial Neural Network (ANN)*. Keputusan menunjukkan bahawa indeks yang dikira dan indeks yang dianggarkan dengan menggunakan *ANN* adalah relevan untuk meramalkan keruntuhan voltan dalam sistem. Secara keseluruhan, indeks VCPI(Kuasa) mampu mengesan titik keruntuhan voltan dengan tepat kerana ketepatannya dalam ramalan. Oleh itu, tindakan-tindakan awal mampu dilaksanakan oleh pengendali untuk mengelak keruntuhan voltan insiden daripada mengambil tempat.

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LIST OF SYMBOLS AND ABBREVIATIONS

b	Bias for ANN
kV	Kilo Volts
I_L	Load Current
Z_L	Load Impedance
V_L	Load Voltage
J_R	Reduced Jacobian Matrix
θ	Teta
E_{TH}	Thevenin Voltage
w	Weight for ANN
Z_{TH}	Thevenin Impedance
AC	Alternating Current
ANN	Artificial Neural Networks
B	Shunt Charging
Degree	Bus Angle
FACTS	Flexible Alternating Current Transmission System
FFBPNN	Feed Forward Back Propagation Neural Network
FVSI	Fast Voltage Stability Index
GA	Genetic Algorithm

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