UNIVERSITI TEKNOLOGI MARA

IMMUNE-BASED TECHNIQUE FOR ONLINE SECURITY EVALUATION IN POWER SYSTEM

SAIFUL IZWAN SULIMAN

Thesis submitted in fulfilment of the requirements for the degree of Master of Science

Faculty of Electrical Engineering

December 2006

ABSTRACT

Voltage instability has recently become a challenging problem for many power system operators. This phenomenon could lead to the occurrence of voltage collapse or blackout to the whole system. Voltage stability monitoring in power system operation is a suggested solution for this problem so that the occurrence of voltage collapse due to voltage instability could be avoided. This thesis presents the application of Artificial Immune Systems (AIS) for online voltage stability evaluation which could be used as an early warning system to the power system operator so that necessary action could be taken in order to avoid the occurrence of voltage collapse. Based on the literature review, it has been found that no research has yet been conducted in analyzing voltage stability condition of a power system using AIS, indirectly showing that this new technique provides an alternative way in solving this problem based on voltage stability index evaluation. Key features of the proposed method are the implementation of clonal selection principle that has the capability in performing pattern recognition task and the implementation of multistage programming concept which has steered the developed system to complete the computation at a rate faster and enhanced the efficiency of the training process in terms of the accuracy of the prediction. The proposed method was developed using C++ programming language and was tested on the IEEE 6-bus and 30-bus power system. Fast performance with accurate prediction for voltage stability index has been obtained. A comparative study also had been conducted with another Artificial Neural Network-based system developed for the similar purpose. The results obtained have shown the potential of AIS as an alternative method in solving pattern recognition-related task and in this case recognizing the voltage stability condition based on the loading condition of a system. This new technique promises many advantages in producing good solutions and has the potential to be a valuable tool for fast real-time voltage stability assessment in a power system.

ACKNOWLEDGEMENT

Alhamdulillah, praise be Allah for His Almighty and Graciousness. With His utmost blessings, I was able to finish this study within the time duration given.

My success will not be easily achieved if it was not for the thoughtfulness of several individuals. Firstly, my appreciation goes to my supervisor; Assoc. Prof. Dr. Titik Khawa who has guided and effortlessly enriched me with ideas and opinions in order for me to complete this study successfully. Her kindness for helping me in many ways during this study will not be forgotten. Her suggestions in carrying out this study has also has enabled me to acquire new knowledge and harness my skills.

I will always remember my parents' words of wisdom and the ongoing support they have continuously provided. With their much love and devotion, I was able to stand tall holding to my roots, being proud of who I am and not be afraid of being the best I can be. Thank you so much for waiting patiently for me to complete this study and understanding all my needs. I love you both so much.

This study would not be possible if not for the financial support given. Therefore, a lot of appreciations to UiTM for the financial support provided to me in completing this study.

To all my friends, thank you for all your support and motivations.

Saiful Izwan bin Suliman
Faculty of Electrical Engineering
Universiti Teknologi MARA (UiTM)
Shah Alam

TABLE OF CONTENTS

CHAPTER 1

INTRODUCTION

1.0 Introduction

Voltage stability is the ability of a power system to maintain voltage so that when load is increased, both power and voltage are controllable. Voltage security on the other hand is the ability of a power system not only to operate in a stable condition, but also to remain stable (as far as the maintenance of system voltage is concerned) following any reasonable credible contingency or adverse system change.

Security evaluation involves evaluating the power system's ability to face various contingencies, and proposing ways to counter its main weaknesses when necessary [1]. Normally, power system operates in a condition that is considered secure. It means the system will remain in a secure operating state if any single event or failure were to occur. In a secure state, all system parameters are operating as desired with all voltages within their specified limits [2]. Hence, security evaluation is one of the main procedures in the planning and operation of an electrical power system.

Modern power systems are often operated near capacity. During the peak demand periods, power lines may be loaded to near capacity limit. A power system operating near to its capacity limit requires quick response by operators in the event of contingencies and hence rapid security evaluation is needed in order for the system to continue to operate normally.

Over the past few decades there has been a growing interests in the use of biological process as a source of inspiration for solving computational problems. This research area is often referred to as Biologically Inspired Computing. The primary motivation of this