UNIVERSITI TEKNOLOGI MARA

COMPUTATIONAL INTELLIGENCE BASED POWER TRACING FOR NON DISCRIMINATORY LOSSES CHARGE ALLOCATION AND VOLTAGE STABILITY IMPROVEMENT

ZULKIFFLI BIN ABDUL HAMID

Thesis submitted in fulfillment
of the requirements for the degree of
Doctor of Philosophy

Faculty of Electrical Engineering

August 2013

AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the result of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

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Name of Student	:	Zulkiffli Bin Abdul Hamid
Student I.D. No.	:	2010284032
Programme	:	PhD in Electrical Engineering (EE990)
Faculty	:	Faculty of Electrical Engineering
Thesis Title	:	Computational Intelligence based Power Tracing for Non Discriminatory Losses Charge Allocation and Voltage Stability Improvement
Signature of Student	:	....
Date	:	August 2013

ABSTRACT

This thesis proposes a new power tracing technique using computational intelligence approach for non discriminatory losses charge allocation and voltage stability improvement. Contrary to conventional techniques which mainly rely on matrix operation, the proposed algorithm implements optimization technique as an alternative for performing the tracing process. At first, in producing a good optimization algorithm, a hybridization technique was proposed for adopting the finest features of two different algorithms; namely the Genetic Algorithm (GA) and continuous domain Ant Colony Optimization (ACO_R). The hybrid algorithm is termed as the Blended Crossover Continuous Ant Colony Optimization (BX-CACO). It was found that performing power tracing via BX-CACO produced reliable tracing results as it is free from assumption like proportional sharing principle (PSP). Without treating the power system to be lossless, the tracing results are based on actual system condition; which means that they are consistent. Despite BX-CACO required computation time during optimization process, it is still within tolerable range. In addition, the proposed technique was able to promote fair losses charge allocation by involving imaginary consumers other than generation companies (GENCOs) and distribution companies (DISCOs); where, not all conventional tracing techniques include such consideration in their pricing scheme. Subsequently, the developed tracing algorithm was modified in the context of stability index tracing. At this stage, the limited application of power tracing in the field of power system economics was enhanced for the purpose of voltage stability improvement. By utilizing the Fast Voltage Stability Index (*FVSI*) as the index to be traced, the proposed stability index tracing is called *FVSI*-Tracing (*FVSI*-T); which consists of two schemes namely *FVSI*-Generation Tracing (*FVSI*-GT) and *FVSI*-Load Tracing (*FVSI*-LT). From both schemes of *FVSI*-T, a ranking list indicating the priority of buses to be performed any countermeasures against voltage instability was derived. Contrary to conventional techniques such as sensitivity analysis and stability index approach, the derived ranking list consists of two types of locations ranked based on their priority; which are bus and line. In addition, the ranking list derived from BX-CACO-based-*FVSI*-T is available at any system conditions and includes all possible sources and sinks that also participate in the system. This highlights its merit over conventional ranking techniques. After experiment and comparative studies, it was justified that the derived ranking list gave reliable signal for satisfactory and consistent voltage stability improvement in the problem of generation power dispatch, placement of compensating devices, and load shedding. Regardless of the change in system condition, the derived ranking list from *FVSI*-T resulted in steady trend of voltage magnitude and consistent losses reduction as compared to convetional methods. Eventually, in providing an effective load shedding scheme with reliable amount of load power to be shed, an intuitive Fuzzy Inference System (FIS) was designed using *FVSI* as the criterion when designing its membership functions and rules. Through experiment, the proposed method resulted in the most consistent voltage stability improvement over other methods as both FIS and the derived ranking list are based on *FVSI*.

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CHAPTER THREE: DEVELOPMENT OF POWER TRACING ALGORITHM VIA COMPUTATIONAL INTELLIGENCE TECHNIQUE