UNIVERSITI TEKNOLOGI MARA

A NOVEL TECHNIQUE TO IDENTIFY SOURCE OF THE NEUTRAL TO EARTH VOLTAGE (NTEV) USING SUPPORT VECTOR MACHINE (SVM) BASED ON TIME-FREQUENCY ANALYSIS

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

Faculty of Electrical Engineering

February 2019

CONFIRMATION BY PANEL OF EXAMINERS

I certify that a Panel of Examiners has met on 18 December 2018 to conduct the final examination of Mohd Abdul Talib Bin Mat Yusoh in his **Doctor of Philosophy** thesis entitled "A Novel Technique to Identify Source of the Neutral to Earth Voltage (NTEV) Using Support Vector Machine (SVM) Based on Time-Frequency Analysis" in accordance with Universiti Teknologi MARA Act 1976 (Akta 173). The Panel of Examiner recommends that the student be awarded the relevant degree. The Panel of Examiners was as follows:

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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 results 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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ABSTRACT

Neutral to Earth Voltage (NTEV) rise in the commercial building has been categorised as one of the major Power Quality problems. Based on the IEEE Std 1695 and Hydro-Québec standards, the tolerable limit for the NTEV rise should be below 10V. However, its magnitude tends to exceed the tolerable threshold value due to several factors, such as nonlinear load, heavy neutral current load, lightning strikes, and improper wiring connection. Based on the corresponding problems, the NTEV rise contributes to the heating, incorrect operation and malfunctions of equipment, frequent tripping, and electromagnetic interference to the system. Therefore, the development of a comprehensive technique is required to identify the NTEV rise in the commercial building, where the conservative effort to solve the standing problems can be minimised. The objectives of this research are to identify the source that contributes the NTEV rise in the commercial building. Thus, the initial work carried out in this study focuses on the derivation of the grounding system modelling, which is related to NTEV in the commercial building during multi-frequency variation. The RLC grounding system is proposed in this derivation model, where its performance is compared with the conventional grounding system to produce the profile of the NTEV in normal condition, similar to the profile of an actual data measurement. Furthermore, the mathematical models of NTEV rise are also developed according to problems caused by loose termination, open conductor and lightning strike. In relation to the NTEV models, a classification technique is developed by employing the combination of S-transform (ST) and several types of classifier tools. The classifier tools utilised in this study comprised the Probabilistic Neural Network (PNN), General Regression Neural Network (GRNN), Support Vector Machine (SVM), and K-Nearest Neighbor (K-NN). Moreover, a novel technique is developed to identify the source location of NTEV rise in the commercial building. In this state, the identification techniques are concentrated on the problems due to loose termination and open conductor. To illustrate the effectiveness of the proposed technique, the simulations are carried out on the 7-feeder distribution system and 13-node distribution system using MATLAB/Simulink software. Fourier Transform (FT) with respect to DC component analysis is utilised in a novel technique to identify the standing problems that occur either on the upstream or downstream location. The results showed that the RLC model of the grounding system outperformed the conventional grounding system in terms of percentage error, mean squared error (MSE) and Pearson correlation coefficient. The result of the percentage error, MSE and Pearson correlation coefficient using the RLC model are 2.5473, 0.0165 and 0.9503, respectively. In addition, the results of the NTEV rise have also been successfully derived in the mathematical model. The results of the classification have shown that the SVM classifier outperformed the other classifiers in terms of accuracy value. The overall accuracy results of PNN, GRNN, K-NN, and SVM are 94.7%, 97.7%, 97.7%, and 98.3%, respectively. Finally, the results of a novel technique could identify the source location of the NTEV rise when the problems occur either on the upstream or downstream location with respect to the measurement points. The upstream and downstream locations are seen identified based on the negative and positive polarities of the proposed technique.

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