Global Sensitivity Analysis of Fault Location Algorithms

by

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Contents

Abstract

Transmission lines of any voltage level are subject to faults. To speed up repairs and restoration of power, it is important to know where the fault is located. A fault location algorithm's result is influenced by a series of modeling equations, setting parameters and system factors reflected in voltage and current inputs. The factors mentioned are subject to sources of uncertainty including measurement and signal processing errors, setting errors and incomplete modeling of a system under fault conditions. These errors have affected the accuracy of the distance to fault calculation. Accurate fault location reduces operating costs by avoiding lengthy and expensive patrols. Accurate fault location speeds up repairs and restoration of lines, ultimately reducing revenue loss caused by outages. In this thesis, we have reviewed the fault location algorithms and also how the uncertainty affects the results of fault location.

Sensitivity analysis is able to analyze how the variation in the output of the fault location algorithms can be allocated to the variation of uncertain factors. In this research, we have used global sensitivity analysis to determine the most contributed uncertain factors and also the interaction of the uncertain factors. We have chosen Analysis of Variance (ANOVA) decomposition as our global sensitivity analysis. ANOVA decomposition shows us the insight of the fault location, such as relations between uncertain factors of the fault location.

Quasi regression technique has also been used to approximate a function. In this research, the transmission line fault location system is fitted into the ANOVA decomposition using quasi regression. From the approximate function, we are able to get the variance of the sensitivity of fault location to uncertain factors using Monte Carlo method. In this research, we have designed novel methodology to test the fault location algorithms and compare the fault location algorithms. In practice, such analysis not only helps in selecting the optimal locator for a specific application, it also helps in the calibration process.

Statement of Originality

I hereby declare that this is an original thesis and is entirely my own work under the guidance and advice of my supervisor Dr. Rastko Zivanovic. This work contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text.

I give consent to this copy of my thesis, when deposited in the Adelaide University Library, being made available for loan and photocopying, subject to the provisions of the Copyright Act 1968.

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Nomenclatures

SA	Sensitivity Analysis
FLA	Fault Location Algorithm
DFL	Distance-to-Fault Locator
GSA	Global Sensitivity Analysis
SRC	Standardized Regression Coefficients
PDF	Probability Density Function
FP	Factor Prioritization
FF	Factor Fixing
VC	Variance Cutting
FM	Factors Mapping
ANOVA	Analysis of Variance
MC	Monte Carlo
QMC	Quasi Monte Carlo
ISE	Integrated Square Error
MSE	Mean Squared Error
LOF	Lack of Fit