



AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
Computer Engineering and Systems

Machine Learning Techniques for mitigating voltage collapse

A Thesis submitted in partial fulfilment of the requirements of the
degree of

Master of Science In Electrical Engineering
(Computer Engineering and Systems)

By

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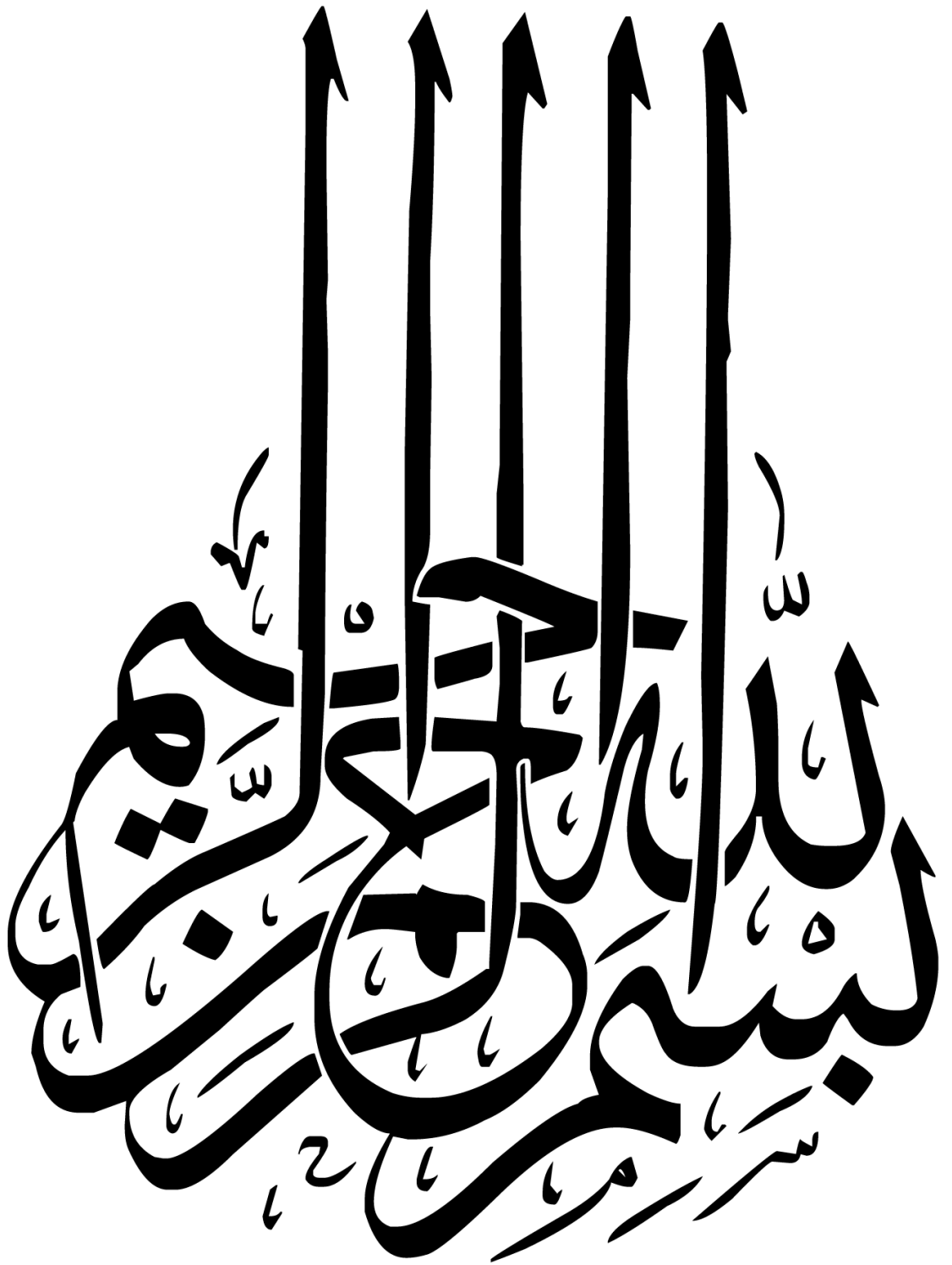
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Statement

This thesis is submitted as a partial fulfillment of Master of Science in Electrical Engineering Engineering, Faculty of Engineering, Ain shams University.

The author carried out the work included in this thesis, and no part of it has been submitted for a degree or a qualification at any other scientific entity.

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“I dedicate this work to my little princes Layan Mohamed”

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25 February 2018

Abstract

In the power system, the instantaneous and permanent stability is a major requirement that cannot be overlooked. Because of the power grid large-scale systems, any disturbance anywhere on the power grid could pose a reason of an overall dynamic imbalance. Major consequences could be occurred to the electricity feeding across wide areas of country which is called partial blackout, even entire country which is called overall blackout. It is perhaps for this reason that the existence voltage stability indices which indicate the power grid system stability level is very essential. knowing the voltage stability level of the transmission lines that involves the power grid in real time (online operation) , the voltage stability of the entire power grid could be obtained easily . There are several mathematical base voltage indices. But in this proposal, another voltage stability index will be build based on the machine learning techniques to mitigate the voltage collapse phenomenon. This predictor is proposed in transient stability analysis based on machine learning techniques such as (Linear regression, neural network, and Decision tree). This predictor is built after a comparison was made between the impacts of various machine learning algorithms using different datasets. Three different mathematical voltage stability indices (FVSI, Lmn, and NLSI) had been used to prepare datasets for the training purpose. An early warning system had been built based on the proposed predictor. This early warning system could be used to inform the system operator with the hazards of voltage instability issues in the electric power grid and visualize these hazards. The E.W.M (Early warning module) had then been used as a kernel to build V.S.A.M.A (Voltage Stability Automatic Maneuver Algorithm) that can handle the voltage instability issue.

Several tools had been used to obtain and implement the V.S.A.M.A .The Power World Simulation tool had been used as a simulator of the electric power grid (IEEE 9-Bus system). The RapidMiner Studio had been used to build the predictors that can evaluate the stability of transmission lines of the electric power grid. Finally, the Matlab had been used to implement the visualizer, the voltage instability predictor and the proposed algorithm (V.S.A.M.A).

Key Words: Decision tree, Early warning, Line stability index, Linear regression, Maneuver algorithm, Neural network, Predictive analysis , Predictive modeling , Predictors , RapidMiner programming, Voltage stability.

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Contents

Statement	4
Acknowledgments	6
Abstract.....	7
List of Figures	11
List of Tables.....	13
List of Abbreviations.....	14
List of Symbols	16
Chapter 1 : Introduction	2
1.1 The Impact and Importance of Electric power system	2
1.2 Electric power system Structure.....	2
1.3 The control center and the operators Duty	3
1.4 Electric power system Blackout Definition and Impact.....	4
1.5 Scope.....	4
1.6 Problem Statement.....	5
1.7 Objectives.....	4
1.8 Thesis Organization	6
Chapter 2 : Background and Literature Review.....	8
2.1. Introduction	8
2.2. Power System Stability	8
2.2.1. Definitions	8
2.2.2. Classification.....	8
2.2.2.1. Rotor Angle Stability	9
2.2.2.2. Voltage stability.....	10
2.2.2.3. Frequency stability.....	11
2.2.3. Two Bus System Model.....	11
2.2.4. Voltage Stability Indices	12
2.2.4.1. Fast voltage stability index (FVSI)	15
2.2.4.2. Line stability index (Lmn).....	15

2.2.4.3. Novel line stability index (NLSI)	15
2.2.4.4. Line Stability Factor (LQP)	16
2.2.4.5. Line Voltage Stability Index (LVSI)	16
2.2.4.6. Novel Voltage Stability Index (NVSI)	17
2.2.4.7. Line Stability Index (Lp)	17
2.2.4.8. Power Transfer Stability Index (PTSI).....	18
2.2.4.9. Voltage Stability Index (VSI_1).....	18
2.2.4.10. Voltage Stability Load Index (VSLI)	19
2.3. IEEE 9-Bus System	19
2.4. Load Flow analysis.....	20
2.5. Machine Learning	21
2.5.1. Introduction	21
2.5.2. Classification of Machine Learning	22
2.5.3. Machine Learning Algorithms.....	25
2.5.3.1. Multiple Linear Regression algorithm.....	25
2.5.3.2. Decision Tree algorithm	25
2.5.3.3. Artificial Neural Network (A.N.N) algorithm	27
2.5.4. Applied Machine Learning Process.....	29
2.5.4.1. Define the Problem	30
2.5.4.2. Prepare Data.....	30
2.5.4.3. Spot Check Algorithms.....	30
2.5.4.4. Improve Results	30
2.5.4.5. Present Results	31
2.5.5. Prediction in machine learning	31
2.5.6. Model evaluation criteria.....	31
2.6. Visualization	32
2.7. Related Works	33
Chapter 3 : Tools and Simulators	37
3.1. Introduction	37
3.2. MATLAB	37
3.3. Power World.....	38
3.4. RapidMiner Studio	43
Chapter 4. Methodology.....	47

4.1.Introduction.....	47
4.2.Proposed System Block Diagram.....	47
4.3.Case Study Selection.....	48
4.4.The Power Grid Simulation.....	52
4.5.Datasets Preparation.....	55
4.6.Building the predictors.....	56
4.7.Load Flow Module.....	60
4.8.Visualizer and Early warning Module (E.W.M).....	68
4.9.Voltage Stability Automatic Maneuver Algorithm (V.S.A.M.A).....	70
Chapter 5. Results.....	74
5.2.1. Multiple Linear Regression.....	74
5.2.2. Decision Tree.....	76
5.2.3. Artificial Neural Network (A.N.N).....	78
5.2.4. Other machine learning algorithms.....	78
5.2.5. Case study.....	81
Chapter 6. Conclusions and Future Work.....	84
References.....	88

List of Figures

Figure 1.1: Electric power system configuration and structure.....	3
Figure 2.1: Classification of the power system stability	9
Figure 2.2: The two bus representation of a power system	11
Figure 2.3: The IEEE 9-Bus system structure	19
Figure 2.4: Load Flow Block Diagram.....	21
Figure 2.5: Applying a model based on field data	22
Figure 2.6: Three types of Machine Learning techniques	22
Figure 2.7: Methodology of the human's solving exercise problems	23
Figure 2.8: Supervised Learning Algorithms	24
Figure 2.9: Unsupervised Learning	24
Figure 2.10: Semi-supervised Learning.....	24
Figure 2.11: M.L algorithms grouped by the Similarity	24
Figure 2.12: Decision Tree Example	26
Figure 2.13: The perceptron	27
Figure 2.14: CHAID flow chart.....	27
Figure 2.15: The Heaviside step activation function.....	28
Figure 2.16: The logistic sigmoid activation function.....	28
Figure 2.17: The multilayer perceptron	29
Figure 2.18: The machine learning process	29
Figure 2.19: The machine learning workflow	31
Figure 2.20: The process of generating a graphical representation.....	32
Figure 2.21: Examples of graphical elements	33
Figure 2.22: Examples of graphical properties.....	33
Figure 2.23: Accuracy for some graphical and spatial elements	33
Figure 2.24: Method to predict the voltage collapses based on VSIs.....	34
Figure 2.25: Voltage collapses prediction based on Wide-area measurement.....	35
Figure 3.1: Visualizer GUI	37
Figure 3.2: Example OF Electric Power Grid in Power World Simulator.....	38
Figure 3.3: Power World Modes	39
Figure 3.4: The Network Combo-box	39
Figure 3.5: Objects in Network Combo-box	39
Figure 3.6: Generator Information window	40
Figure 3.7: Bus Information window.....	40
Figure 3.8: Branch Information window	40
Figure 3.9: Load Information window.....	40
Figure 3.10: The Model Explorer Panel	41
Figure 3.11: Branches Input Report.....	41
Figure 3.12: Branches Status Report	42
Figure 3.13: Buses Report	42
Figure 3.14: RapidMiner perspectives Switch.....	43
Figure 3.15: The operators view	44

Figure 3.16: The repositories view	44
Figure 3.17: The Process view.....	45
Figure 3.18: The Parameters view	45
Figure 4.1: Proposed System Block Diagram in Run-Time.....	48
Figure 4.2: Proposed System Block Diagram in Simulation-Time.....	48
Figure 4.3: The electric power grid of the CRCC	49
Figure 4.4: The electric power grid of Cairo North.....	50
Figure 4.5: The electric power grid of Cairo East	51
Figure 4.6: The electric power grid of Cairo West.....	51
Figure 4.7: The electric power grid of Cairo South.....	52
Figure 4.8: Step-1: Draw the grid buses	53
Figure 4.9: Step-2: Draw the transmission lines.....	53
Figure 4.10: Step-3: Draw the generators.....	54
Figure 4.11: Step-4: Draw the loads	54
Figure 4.12: Step-5: Customize the bus report	54
Figure 4.13: Step-6: Customize the transmission lines report.....	55
Figure 4.14: Loads and Generators power control slides	55
Figure 4.15: Collected data in Excel Sheet.....	56
Figure 4.16: Step1: Brows for the Excel or CSV file	57
Figure 4.17: Step2: Specify the data format	57
Figure 4.18: Step2: Format the columns types	58
Figure 4.19: Step4: Imported data report.....	58
Figure 4.20: RapidMiner most common operators.....	59
Figure 4.21: Predictor model based on linear regression	59
Figure 4.22: Predictor model based on A.N.N	60
Figure 4.23: Predictor model based on decision tree.....	60
Figure 4.24: Gauss iterative method flowchart.....	61
Figure 4.25: V.S.A.M.A flow chart	71
Figure 5.1: Actual vs. Predicted for L.Reg Model	74
Figure 5.2: L.Reg model Accuracy.....	75
Figure 5.3: L.Reg Model.....	75
Figure 5.4: Discretization Steps.....	76
Figure 5.5: Decision tree model Accuracy	77
Figure 5.6: Graphical representation of the decision tree model.....	77
Figure 5.7: Graphical representation of the A.N.N model	78
Figure 5.9: The A.N.N model Accuracy.....	79
Figure 5.8: The weighting arrays for the A.N.N model	79
Figure 5.8: Proposed System Block Diagram in Simulation-Time.....	80
Figure 5.12: Visualizer for the case study	81

List of Tables

Table2.1: Comparison of Voltage Stability Index	13
Table2.2: Taxonomy of Voltage Stability Indices	14
Table2.3: The IEEE 9-Bus system Bus data	20
Table2.4: The IEEE 9-Bus system Line data	20
Table2.5: Accuracy of the proposed model	35
Table4.1: The IEEE 9-Bus system Line data	69
Table5.1: Evaluation of the ten Scenarios in the case study	82
Table6.1: Predictors accuracy Comparison	84
Table6.1: Related Works Comparison	85

List of Abbreviations

SCADA	Supervisory Control And Data Acquisition
NCC	National Control Center
RCC	Regional Control Center
VSAMA	Voltage Stability Automatic Maneuver Algorithm
VSIS	Voltage Stability Indices
CPF	Continuation Power flow
FVSI	Fast Voltage Stability Indices
LMN	Line Stability Index
NLSI	Novel Line Stability Index
LQP	Line Stability Factor
LVSI	Line Voltage Stability Index
NVSI	Novel Voltage Stability Index
LP	Line Stability Index
PTSI	Power Transfer Stability Index
VSI_1	Voltage Stability Index
VSLI	Voltage Stability Load Index
WSCC	Western System Coordinating Council
LF	Load Flow
ML	Machine Learning
MLR	Multiple Linear Regression
KDD	Knowledge Discovery In Databases
OPF	Optimal Power Flow
SQL	Structured Query Language
RTU	Remote Terminal Unit
CRCC	Regional Control Center
CAN-RCC	Canal Regional Control Center
ARCC	Alexandria Regional Control Center
WRCC	West Delta Regional Control Center
SRCC	South Upper Egypt Regional Control Center
CN	Cairo North

CE	Cairo East
CW	Cairo West
CS	Cairo South
PU	Per-Unit System
EWM	Visualizer And Early Warning Module