

**AUTOMATIC FAULT ANALYSIS IN POWER SYSTEMS
VIA APPLICATION SERVICE PROVIDER**

A Dissertation

by

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Abstract

Automatic Fault Analysis in Power Systems via Application Service Provider

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This dissertation presents a new approach to automated fault analysis in electrical power systems. New contributions to the fault and disturbance investigation topic are automated fault analysis service (AFAS) via application service provider (ASP) and remote relay testing service (RRTS). The implementation of AFAS complies with the new international standard of communication network and system in substations (IEC-61850).

The signal processing approaches in an automated fault analysis service are based on the wavelet transform and empirical mode decomposition methods. Several case studies have been carried out to test the performance of the signal segmentation technique. The data for analyses are from simulated fault data and from real disturbance records obtained from the intelligent electronic devices (IEDs) in substations.

The implementation of AFAS and RRTS was developed using C# with .NET technologies, MATLAB and open source software. Signal segmentation, signal modelling, fault type classification, fault location service, a web-based COMTRADE viewer and remote relay test service have been developed in this dissertation. Such services are designed to enhance manual investigations performed by engineers. The services have been tested extensively using disturbance records from power utilities and a power system simulation model.

Statement of Originality

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.

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List of Abbreviations

ACSI	Abstract Communication Service Interface
AFAS	Automated Fault and disturbance Analysis Service
ANN	Annunciator elements
API	Application Program Interfaces
ASP	Application Service Provider
ATP	Alternative Transient Program
CB	Circuit Breaker
CBMA	Circuit Breaker Monitor Analysis
CFG	Configuration elements
COMTRADE	Common format for Transient Data Exchange
CON	Control elements
CT	Current Transformer
CWT	Continuous Wavelet Transform
DFRs	Digital Fault Recorders
DFRA	Digital Fault Recorders Analysis
DPRA	Digital Protective Relay Analysis
DFT	Discrete Fourier Transform
DPRs	Digital Protective Relays
DWT	Discrete Wavelet Transform
EJS	Easy Java Simulation
EMD	Empirical Mode Decomposition
EMS	Energy Management System
FAFL	Fault Analysis with Fault Location
FFT	Fast Fourier Transform
FTP	File Transfer Protocol
GOOSE	Generic Object Oriented Substation Event
GUI	Graphical User Interface

HPF	High Pass Filter
ICA	Independent Computing Architecture
IEDs	Intelligent Electronic Devices
ISP	Internet Service Providers
ISVs	Independent Software Vendors
IA	Instantaneous Amplitude
IMFs	Intrinsic Mode Functions
IT	Information Technology
JIM	Java Internet Matlab
LAN	Local Area Network
LD	Logical Devices
LN	Logical Nodes
LPF	Low Pass Filter
MET	Metering and measurement elements
MMI	Man Machine Interface
MMS	Manufacturing Message Specification
MSD	Multi-resolution Signal Decomposition
OLE	Object Linking and Embedding
OPC	Ole for Process Control
PHP	PHP Hypertext Pre-processor
PRO	Protection elements
PSCAD	Power System Computer Aided Design
QMF	Quadrature Mirror Filter
RDP	Remote Desktop Protocol
RF	Fault Resistance
RMS	Root Mean Square
RPC	Remote Procedure Calls
RRTS	Remote Relay Testing Service
RTS	Relay Test System
SAS	Substation Automation System
SCADA	Supervisory Control and Data Acquisition

SD	Standard Deviation
SEL	Schweitzer Engineering Laboratories
SER	Sequence of Event Recorder
SOA	Service Oriented Architecture
SOAP	Simple Object Access Protocol
TimeSeg	Time Segment
TLI	Test Laboratories International
UDDI	Universal Description and Discovery Interface
VNC	Virtual Network Computing
VT	Voltage Transformer
WAN	Wide Area Network
WAP	Wireless Application Protocol
WCF	Windows Communication Foundation
XML	eXtensible Markup Language
WS-AFA	Web Services for Fault Analysis
WSDL	Web Services Description Language

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2. M. Musaruddin & R. Zivanovic, "Web Services for Automated Fault Analysis in Electrical Power Systems," *International Journal of Advances in Information Sciences and Service Sciences, AISS* Volume 2, Number 3, September 2010, Seoul, Korea.

Conference Papers:

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2. M. Musaruddin , M. Zaporoshenko & R. Zivanovic, "Remote Protective Relay Testing," in *Proceedings IEEE Australasian Universities Power Engineering Conference (AUPEC 2008)*, Sydney, Australia.
3. M. Musaruddin & R. Zivanovic, "Web Services for Automated Fault Analysis in Electrical Power System," in *Proceedings IEEE International Conference on Networked Computing and Advanced Information Management and Services (NCM 2009)*, Seoul, Korea.
4. M. Musaruddin & R. Zivanovic, "Automated Fault Analysis in the Indonesian Power Utility: A Case Study of South Sulawesi Transmission System," in *Proceedings IEEE Australasian Universities Power Engineering Conference (AUPEC 2009)*, Adelaide, Australia.
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