

RESPONSE SURFACE AND NEURO FUZZY  
METHODOLOGY FOR ROTATING MAGNETIC  
FIELD AND GMR ARRAY SENSOR FOR  
CRACK DETECTION IN FERROMAGNETIC  
PIPE

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Doctor of Philosophy

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## **SUPERVISOR'S DECLARATION**

We hereby declare that we have checked this thesis and in our opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Doctor of Philosophy in Electrical Engineering.

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## **STUDENT'S DECLARATION**

I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

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MAGNETIC FIELD AND GMR ARRAY SENSOR FOR CRACK DETECTION IN  
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## TABLE OF CONTENT

<b>DECLARATION</b>	
<b>TITLE PAGE</b>	
<b>ACKNOWLEDGEMENTS</b>	<b>ii</b>
<b>ABSTRAK</b>	<b>iii</b>
<b>ABSTRACT</b>	<b>iv</b>
<b>TABLE OF CONTENT</b>	<b>v</b>
<b>LIST OF TABLES</b>	<b>x</b>
<b>LIST OF FIGURES</b>	<b>xi</b>
<b>LIST OF SYMBOLS</b>	<b>xiv</b>
<b>LIST OF ABBREVIATIONS</b>	<b>xv</b>
<b>CHAPTER 1 INTRODUCTION</b>	<b>1</b>
1.1 Introduction	1
1.2 Research Background	5
1.2.1 NDT Needs for Pipeline Inspection	6
1.2.2 Factors Causing Degradation of a Pipeline	11
1.3 Problem Statement	12
1.4 Research Objectives	13
1.5 Research Scopes	13
1.6 Thesis Organization	14
<b>CHAPTER 2 LITERATURE REVIEW</b>	<b>13</b>
2.1 Introduction	13

2.2	Non-Destructive Testing	13
2.3	Non-Destructive Eddy Current Testing Principles	18
2.4	Eddy Current Testing Equivalent Circuit	20
2.5	Factors Affecting the Eddy Current Testing Inspection	20
2.5.1	Exciting Coil Frequency and skin Depth Effect	21
2.5.2	Material Magnetic Permeability	23
2.5.3	Lift-off	23
2.5.4	Conductivity of Material	24
2.6	Limitations of Coil Sensor in Eddy Current Probe	25
2.7	Types of Eddy Current Testing Probe for Pipe Assessment	26
2.7.1	Bobbin Probe	27
2.7.2	Full Saturation Probe	27
2.7.3	Rotating Bobbin Probe	28
2.7.4	Array Probe	29
2.7.5	C-Probe	30
2.7.6	X-Probe	31
2.7.7	Smart Array Probe	33
2.7.8	Rotational Magnetic Flux Sensor	34
2.7.9	Rotating Magnetic Field Probe	35
2.8	Overview of Giant Magnetoresistance (GMR) Sensors	37
2.9	Giant Magnetoresistance (GMR) Spin Valve Sensor	40
2.10	Giant Magnetoresistance Multilayer Sensor	43
2.11	The Influence of Various Parameters on the GMR Measurement	45
2.11.1	Structural Quality of Giant Magnetoresistance Sensor	45
2.11.2	Thickness Structure Layers of Giant Magnetoresistance Sensor	45
2.11.3	Temperature	47

2.12	Compensation Techniques in Eddy Current Testing Probes	49
2.13	Application of GMR Sensors in Hybrid Eddy Current Testing Probes	51
2.14	Optimization of Eddy Current Testing Probes Design	59
2.15	Response Surface Methodology	62
2.16	Multiple Response Surface Optimization Methods	64
	2.16.1 Experimental Design Techniques	64
	2.16.2 Search Methods	65
	2.16.3 Contour Plots	66
	2.16.4 Robust Parameter Design	66
	2.16.5 Dual Response	67
	2.16.6 Desirability Functions	67
	2.16.7 Generalized Distance Measure	68
	2.16.8 Loss Functions	68
	2.16.9 Minimal Satisfaction	69
2.17	Neuro-Fuzzy Systems	69
	2.17.1 Types of Neuro-Fuzzy Systems	70
	2.17.2 Adaptive Neuro-Fuzzy Inference Systems Structure	73
2.18	Summary	76
<b>CHAPTER 3 METHODOLOGY</b>		<b>78</b>
3.1	Introduction	78
3.2	Architecture of the Distributed System for Eddy Current Testing (DSECT) inspection	78
3.3	Design and operational principles of the DSECT probe	80
3.4	Simulation Model of Axial and Circumference Defect	84
3.5	Proposed Rotating Magnetic Field	90



3.6	Proposed GMR array sensor	92
3.7	Optimization of DSCET Probe Design using Response Surface Methodology	93
3.8	Design of Experiment	94
3.9	Multi-objective Optimization	96
3.10	System Validation	97
3.11	ANFIS Model	97
3.12	Development of DSECT System.	98
3.13	Excitation Source Circuit designs	101
	3.13.1 Phase Shift Circuit	101
3.14	Data acquisition system	105
3.15	Pneumatic Pusher system	106
<b>CHAPTER 4 RESULTS AND DISCUSSION</b>		<b>109</b>
4.1	Introduction	109
4.2	Distributed System for Eddy Current Testing (DSECT)	109
4.3	Simulation of the Axial and Circumference Defect for Carbon Steel Pipe	110
	4.3.1 Effect of Defect Depth	114
	4.3.2 Effect of Defect Length	116
4.4	Analysis of Response Surface Methodology Models for ECT Probe Designed	118
	4.4.1 Axial defect	119
	4.4.2 Circumference Defect	123
4.5	Optimization of the Probe Design	127
4.6	ANFIS Simulation Results	132
4.7	Experimental Results for Axial and Circumference Defect	137
4.8	Comparison the Accuracy of Axial and Circumference Defect Inspection	143

<b>CHAPTER 5 CONCLUSION AND SUGGESTION</b>	<b>144</b>
5.1 Conclusion	144
5.2 Contribution	145
5.3 Future Work	146
<b>REFERENCES</b>	<b>147</b>
<b>PUBLICATIONS</b>	<b>161</b>
<b>APPENDIX A RSM</b>	<b>162</b>
<b>APPENDIX B GMR SENSOR DATASHEET</b>	<b>180</b>
<b>APPENDIX C MATLAB SOURCE CODE</b>	<b>185</b>

## LIST OF TABLES

Table 1.1	Example of pipe dimension standard	5
Table 2.1	Major NDT Methods- A Comprehensive Overview	16
Table 2.2	Typical Depths of penetration	23
Table 2.3	Conductivity and resistivity of conductive materials.	25
Table 2.4	Compensation techniques used in eddy current testing.	51
Table 2.5	Summary of previous studies on application of GMR sensor in eddy current testing.	54
Table 3.1	Simulation parameters with COMSOL Multiphysics.	84
Table 3.2	DSECT probe design parameter and its level for central composite design	94
Table 3.3	Target value and limit for optimization of DSCET probe design	95
Table 4.1	Defect simulation dimension	110
Table 4.2	Experimental design and results (Uncoded factors).	117
Table 4.3	ANOVA table for axial defect detection response surface quadratic model.	118
Table 4.4	ANOVA for the circumference defect detection response surface quadratic model.	123
Table 4.5	Goals and limits for optimization of axial and circumference defect detection in 3 inc pipe inspection.	127
Table 4.6	Training and testing data	132
Table 4.7	Comparison between the numerical result and ANFIS models for testing data.	134
Table 4.8	Comparison of the predicted and experimental results	142

## LIST OF FIGURES

Figure 2.1	Principle diagram for eddy current testing	17
Figure 2.2	Equivalent Circuit for eddy current testing	18
Figure 2.3	Skin depth effect in eddy current testing for copper	21
Figure 2.4	A peak amplitude as a function of lift-off distance between probe and specimen surface	22
Figure 2.5	Hybrid probe: ECT coil with magnetic field sensor	24
Figure 2.6.	Axial and circumferential channels of array probe	28
Figure 2.7	General setting for a C-3 probe	29
Figure 2.8	Axial and circumferential channels of array probes	30
Figure 2.9	Smart array probe	32
Figure 2.10	Rotating magnetic flux sensor for pipe and tube inspection	33
Figure 2.11	Two phase rotating field eddy current probe described by Birring	34
Figure 2.12	Inner rotating field eddy current transducer	35
Figure 2.13	Hysteresis loops for several Fe/Cr for different thickness of Cr and with the presence of magnetic field.	37
Figure 2.14	Magnetoresistance of three Fe/Cr super lattices at 4.2 K with different thickness	38
Figure 2.15	Schematic diagram of the spin valve configuration of FM/AFM	40
Figure 2.16	Schematic of a spin valve sensor element.	40
Figure 2.17	Schematic representation of the basic mechanism of the GMR	42
Figure 2.18	Magnetoresistance versus Cu spacer thickness for Co/Cu GMR multilayers at room temperature	44
Figure 2.19	Variation of the MR ratio as a function of the Cu thickness	44
Figure 2.20	GMR sensitivity in as-deposited (ASD) and annealed (ANN) states as a function of the NiFeCo layer thickness.	45
Figure 2.21	The annealed GMR multilayer in a vacuum at 300°C, 325°C and 350° C.	46
Figure 2.22	Annealed GMR multilayer in flowing argon	46
Figure 2.23	Cooperative neuro-fuzzy systems	65
Figure 2.24	Concurrent neuro-fuzzy systems	66
Figure 2.25	Tagaki-Sugeno hybrid neuro-fuzzy system	67
Figure 2.26	The architecture of ANFIS with 2 inputs and a single output	70
Figure 3.1	Architecture of the realized Distributed System for Eddy current Testing (DSECT)	78
Figure 3.2	Principle of the rotating field	80
Figure 3.3	Rotating field windings and bobbin pickup coil	82
Figure 3.4	ECT probe for DSECT system	83
Figure 3.5	Carbon steel pipe model with axial and circumference defect	85
Figure 3.6	Meshing using COMSOL Multipysics	86
Figure 3.7	Pipe defect simulation steps using COMSOL	89
Figure 3.8	Magnetic flux density decay along diameter direction	90
Figure 3.9	Amplitude contour of magnetic field component on the xy plane	90
Figure 3.10	Array of GMR sensor	91

Figure 3.11	Array GMR sensor located at the ECT probe for pipe inspection	92
Figure 3.12	Prototype of ECT probe design for pipe inspection	94
Figure 3.13	ANFIS model	96
Figure 3.14	Design of Distributed System for Eddy current Testing (DSECT)	98
Figure 3.15	DSECT Pusher system	99
Figure 3.16	Phase lag shift circuit: a) Circuit b) Simulation result	101
Figure 3.17	Phase lead shift circuit: a) Circuit b) Simulation result	102
Figure 3.18	Circuit diagram for phase shift circuits	104
Figure 3.19	High-speed DAQ card (DT 9844) for DSECT system	105
Figure 3.20	Schematic diagram of the whole pneumatic system	106
Figure 3.21	Ladder diagram for the pneumatic pusher system	107
Figure 4.1	Distributed system for eddy current testing	109
Figure 4.2	Axial magnetic flux density due to different defect with 100% depth measure by GMR sensors for axial defect (a) 2D, (b) 3D	111
Figure 4.3	Axial magnetic flux density due to different defect with 100% depth measure by GMR sensors	112
Figure 4.4	Simulation result of circumferential defect (13.5 mm X 1.5 mm) with different depth	113
Figure 4.5	Simulation results of circumferential defect with different depths: Amplitude of ECT probe signal vs. circular distance along the circumferential direction	114
Figure 4.6	Simulation results circumferential defect with different depths: Lissajous Pattern seen of real and imaginary component along the circumferential direction	114
Figure 4.7	Simulation result of 50% pipe wall circumferential defect with length (a) 10.5 mm, (b) 11.5mm, (c) 12.5mm.	115
Figure 4.8	Simulation results of 50% pipe wall circumferential defect with width 1.5 mm and different length. Amplitude of ECT probe signal vs. circular distance along the circumferential direction.	116
Figure 4.9	Simulation results of 50% pipe wall circumferential defect with width 1.5 mm and different length. Lissajous Pattern seen of real and imaginary component along the circumferential direction	116
Figure 4.10	Normal probability plot for axial defect detection	119
Figure 4.11	Axial defect detection Box-Cox Plot for power transforms	120
Figure 4.12	Interaction of probe design factors between probe diameter and the number of GMR sensor	121
Figure 4.13	Influence of number GMR sensor and ECT probe diameter in axial defect detection.	122
Figure 4.14	Normal probability plot for circumferential defect detection	125
Figure 4.15	Interaction of probe design factors	125
Figure 4.16	Influence of number GMR sensor and ECT probe diameter in circumferential defect detection.	126
Figure 4.17	Optimization solution for ECT probe design	128
Figure 4.18	Contour graph prediction of defect detection under optimum ECT probe design.	129

Figure 4.19	3-D graph prediction of defect detection under optimum ECT probe design.	130
Figure 4.20	ECT probe design for DSECT system based on optimum parameter design	131
Figure 4.21	ANFIS training	132
Figure 4.22	The percentage error of ANFIS models for training data	133
Figure 4.23	The comparison among the experimental and predicted values of average AD and CD using ANFIS models	135
Figure 4.24	Geometry dimension of circumference defect on carbon steel pipe	136
Figure 4.25	Geometry dimension of axial defect on carbon steel pipe	137
Figure 4.26	GMR sensor output for circumference defect inspection	139
Figure 4.27	GMR sensor output for axial defect inspection	141

## LIST OF SYMBOLS

$C_i$	Centre of the Gaussian Membership Functions
$\sigma_i$	Width of the Gaussian Membership Functions
$^{\circ}C$	Degree Celsius
$\mu$	Conducting Material Permeability
$\text{Å}$	Angstrom
$a$	Tuning Parameter
$B$	Vector of Tuning Parameters
$I$	Current
$K$	Kelvin
$L$	Inductance
$R$	Resistance
$V$	Voltage
$X$	Value of Design Variable
$x_i$	Design Parameter
$Y$	Vector of Observations
$\theta$	Angle
$\sigma$	Conducting Material Conductivity
$\omega$	Angular Frequency
$B_{\theta}$	Azimuth Magnetic Field
$B_r$	Radial Magnetic Field

## LIST OF ABBREVIATIONS

VT	Visual testing
AE	Acoustic emission
ANFIS	Adaptive neuro-fuzzy inference system
ANN	Artificial neural network
CNC	Computer numerical control
Cr	Cuprum
CTS	Copper tubing size
DAQ	Data acquisition
DC	Direct current
DSECT	Distributed System for Eddy Current Testing
ECT	Eddy current testing
Fe	Ferum
FEM	Finite element model
GMR	giant magneto resistance
MBE	Minimum bias estimator
MFL	Magnetic flux leakage
MRPC	Motorized rotating probe coil
MRPC	Motorized rotating probe coil
MSE	Mean squared error
MT	Magnetic particle testing
NDT	Destructive testing
NDT	Non-destructive testing
PT	Penetrant testing
PVC	Poly vinyl chloride
RPC	Rotating pancake coil
RSM	Response surface methodology
RT	Radiographic testing
RT	Radiographic testing
USB	Universal serial bus
UT	Ultrasonic testing