

Cairo University
Institute Of Statistical Studies & Research
Department Of Operations Research

Distance Recognition and Resources Assignment for The Targets Using Neural Networks Approach

**A Thesis
Submitted in Partial Fulfillment
For The Requirement of The Degree of
M.Sc. in Operations Research.**

By:
Taher Taha Zaki

Supervised by

Prof. Dr Hegazy Zaher

Institute Of Statistical Studies & Research
Cairo University

Dr . Mohamed A. Ewees
Institute Of Statistical Studies & Research
Cairo University
2010

Certification

I certify that this work has not been accepted in substance of any academic degree and is not being submitted in candidature of any other degree to solve this problem.

Any portion of this thesis in which I am indebted to other sources are mentioned and explicit references are given

Student name : Taher Taha Zaki

Signature :

Dedication

My mother and my wife
For their love and their support

List of Figures

Figure		Page
2.1	Fourier transform	6
2.2	Wavelet analysis	7
2.3	Constituent waves of different scales and position	8
2.4	Scaling wavelet	9
2.5	Shifting wavelet	9
2.6	Magnitude of wavelet coefficient	11
2.7	One-Stage filtering: approximations and details	13
2.8	One-Stage filtering decomposition	14
2.9	Downsampling coefficient	14
2.10	Multiple-level decomposition tree	15
2.11	Multiple-level decomposition	15
2.12	Haar wavelet	16
2.13	Daubechies wavelet	16
2.14	Biorthogonal wavelet	17
2.15	Human nervous system	20
2.16	The McCulloch-pitts neuron	21
2.17	Sgn function	22
2.18	Sigmoid function	22
2.19	The perceptron	24
2.20	Simple neuron model	24
2.21	Feedforward network	25
2.22	Multilayer feedforward network	26
2.23	A Kohonen Feature Map.	27
2.24	The topological forming of the feature clusters during a training session	30
2.25	Learning vector quantization networks	31
4.1	Wavelet Shape	46
4.2	System for signal processing based on Wavelet	47
4.3	The wavelet decomposition tree	48
4.4	The designed backpropagation neural Network	51
4.5	The designed earning vector quantization networks	53
4.6	The membership functions of input variable target distance	62
4.7	The membership functions of input variable target velocity	64

4.8	The membership functions of input variable target altitude	65
4.9	The membership functions of input variable target size	68
4.10	The membership functions of output variable dangerous value	68
5.1	Training with Backpropagation	74
5.2	Training with SON	75
5.3	Predicted output (A) and actual output (T) Using Fourier analysis	76
5.4	Predicted output (A) and actual output (T) using wavelet analysis	77
5.5	Predicted output (A) and actual output (T) using backpropagation N.N.	78
5.6	The difference between assigning number of weapons (T) and predicted values using N.N. (A)	79

List of Tables

Table		Page
4.1	The range and dimension of the input variables	61
4.2	Constants of fuzzy membership functions for target distance	63
4.3	Constants of fuzzy membership functions for target velocity	65
4.4	Constants of fuzzy membership functions for target altitude	66
4.5	Constants of fuzzy membership functions for target size.	67
5.1	Average errors using backpropagation N.N.	73
5.2	Average errors using Self Organization N.N.	74
5.3	Average errors using Fourier analysis	76
5.4	Average errors using Wavelet Analysis	77
5.5	Rustles of using backpropagation N.N.	78

List of Abbreviations

AI	Artificial Intelligent
ANN	Artificial Neural Network
CWT	Continuous Wave Transform
COG	Centre of gravity
DWT	Discrete Wavelet Transform
FFT	Fast Fourier Transform
FL	Fuzzy Logic
GLHN	Generalized Linear Hopfield Network
LVQ	Learning Vector Quantization
MLP	Multilayer Perceptron
NLP	Non Linear Programming
PNN	Probabilistic Neural Network
SON	Self Organizing Neural Network
WTA	Weapon Target Assignment

Acknowledgements

I would like to thank my great supervisor Professor Hegazy Zaher for his expert advice and excellent guidance.

My deepest thanks and gratitude are due to Prof. Dr. Mohamed Osman .

Summary

Distance recognition and resources assignment for the targets are fundamental problems due to related applications of operations research in different domains. In this thesis, we describe both distance recognition and resource target assignment for the model we built as a representation of the actual system. The research consists of two parts. The first part is to determine the distance of vehicles (target) based on sound emitted by them. The sound is preprocessed using both wavelet method and Fourier transform method to obtain feature vectors to be used by a neural classifier. We design both backpropagation neural network and Self Organizing Neural Network (SON) to determine the distance of the targets, due to the change of wave propagation at day morning and night because of the noise, we detect the sound produced by vehicles using microphone to determine the distance at different times of day. The second part is to assign the minimum number of weapons in n sites to defense m targets, we do not have sufficient information related to dangerous values of the enemy targets and the data are typically fuzzy in nature, so we use Fuzzy Logic to calculate the dangerous values of the targets. The dangerous value of enemy target reflects the degree of significant of this target, the dangerous value of target depends on the following parameters: The distance, velocity, altitude and capacity of the targets. A new

nonlinear mixed integer programming representation of weapon target assignment (WTA) problem is formulated. We use Matlab programming and backpropagation neural networks to solve this problem.

This thesis consists of 6 chapters:

-Chapter one , Introduction of the thesis.

-Chapter Two, The basic concepts of signal analysis, fuzzy logic, neural networks, nonlinear programming.

-Chapter Three, Survey of pervious work of "artificial Neural networks for pattern recognition" , "solution of linear and non linear programming" and "artificial neural networks for constrained optimization problem" .

-Chapter Four, The proposed model which consists of the backpropagation neural networks and the self organizing neural networks to solve distance target recognition problem , the mathematical programming to formulate and solve resources target assignment problem and the backpropagation neural networks to solve the resources target assignment problem.

Chapter Five, Experiments and results of the research model using back propagation neural networks, self-organization neural networks.

Chapter Six, Conclusion and Further Research.

Contents

List of Figures	..iv
List of Tables	..vi
List of Abbreviations	..vii
Acknowledgments	..viii
Summary	..ix
Chapter 1 : Introduction	
1.1 Introduction.....	1
1.2 Research Problem	4
1.3 Research Objective	4
Chapter 2: Fundamental Concepts	
2.1 Distance Definition	5
2.2 The Data Processing and Features Extracting.....	5
2.2.1 Fourier Transform	5
2.2.2 Wavelet Analysis	6
2.2.2.1 The Continuous Wavelet Transform...	...8

2.2.2.1.1 Scaling	9
2.2.2.1.2 Shifting	9
2.2.2.1.3 Five Easy Step to Continuous Wavelet	9
2.2.2.2 The Discrete Wavelet Transform.....	11
2.2.2.2.1 One stage Filtering Approximation and Details	12
2.2.2.2.2 Multiple Level Decomposition ...	14
2.2.2.3 Wavelet Families.....	16
2.3 Fuzzy Systems	17
2.3.1 Fuzzy Logic	18
2.3.2 Fuzzy Set.....	18
2.4 Neural Networks.....	19
2.4.1 Introduction to Neural Network	19
2.4.1.1 The Nervus System.....	19
2.4.1.2 Brain Versus Computers.....	20
2.4.1.3 The McCulloch Pitts Neuron	21
2.4.1.4 Some Useful Functions.....	22

2.4.1.5 The McCulloch Pitts Neuron Equation.....	22
2.4.1.6 The perceptron	23
2.4.2 The Backpropagation	23
2.4.2.1 Neuron Model	22
2.4.2.2 Feedforward Network.....	24
2.4.2.3 Backpropagation Algorithm.....	25
2.4.3 Self Organization Networks.....	26
2.4.3.1 The Kohonen Algorithm	27
2.4.3.2 Kohonen Network Algorithm	29
2.4.3.3 Neighborhoods	30
2.4.4 Learning Vector Quantization Networks	31
2.4.4.1 Architecture	31
2.5. Nonlinear Programming.....	32
2.5.1 Convex Set.....	32
2.5.2 convex Hull.....	33
2.5.3 polytope.....	33

2.5.4 Closure S and Interior S.....	33
2.5.5 Convex Function.....	34
2.5.6 Differentiable Function	34
2.5.7 Kuhn Tucker conditions.....	34
2.6 Analysis of Basic Notions in Convex Programming	35
Chapter 3: Survey and Pervious work.....	
3.1 Introduction	37
3.2 Artificial Neural Networks for pattern recognition	38
3.3 Artificial Neural Networks for Solving Constrained Optimization Problems	40
3.4 Resource Assignment Problem Using Mathematical Programming”	41
Chapter 4: The Proposed Model	
4.1 Introduction	...44
4.2. Distance Target Recognition Using Neural Networks.....	...44
4.2.1 The Feature Extraction	...45

4.2.1.1 The Fourier Transform	...45
4.2.1.2 Wavelet Transform	...46
4.2.1.3 Signal Processing	...47
4.2.1.3.1 Discrete Wavelet Transform	...47
4.2.1.3.2 Matlab code using Fourier Transform	...49
4.2.2 Neural Network	...50
4.2.1.1 Backpropagation Neural Network	...50
4.2.1.1.1 Recognizer	...51
4.2.1.1.2 Preprocessing and postprocessing ...	...51
4.2.1.1.3 Principal Component Analysis	...52
4.2.1.1.4 Post Training	...53
4.2.2.2 Learning Vector Quantization	...53
4.3 Resources Target Assignment Using Mathematical Programming	...55
4.3.1 Model Assumptions	...55
4.3.2 The Mathematical Model	...55