MESSY GENETIC ALGORITHMS FOR OPTIMISATION OF WATER DISTRIBUTION SYSTEMS INCLUDING WATER HAMMER

BY

ZHENG YI WU

B.Sc., Civil Engineering, Guizhou Institute of Technology, Guizhou, China, 1983

M.SC., Structural Engineering, Guizhou Institute of Technology, Guizhou, China, 1986

M.Sc., Hydroinformatics, International Institute for Infrastructural, Hydraulic & Environmental Engineering, Delft, The Netherlands, 1994

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ABSTRACT

A standard and/or improved GA, using a fixed-length genotype and crossover operation, have been widely used in science and engineering disciplines. It is well-known that the GA is robust in searching for the optimal combination of diameter and rehabilitation actions of water distribution systems but requires a large number of evaluations. A characteristic, which has been observed from the studies, is that the optimal solution of the design and rehabilitation of water distribution systems is located at the boundary of the feasible and infeasible regions of the search space. Previous research has not considered the sizing of pipe wall thicknesses and water hammer protection measures, which are always required in reality. In this research, first of all, the original messy genetic algorithm is applied to the optimisation of design and rehabilitation of water distribution systems. It has been found that the messy GA is more efficient and effective than the standard and improved GAs at solving the optimisation of water distribution systems, but it requires a huge initial population size. This has been overcome by introducing the fast messy GA. Secondly, a scheme of co-evolutionary and self-adaptive penalty has been proposed for the GA solving a constrained boundary optimisation problem. It is purposely designed to guide the GA to search the boundary of the feasible and infeasible regions of the search space. It has been shown that this approach is very effective and efficient for the optimisation of water distribution systems. Finally, the hydraulic network solver (EPANET) for steady state simulation has been incorporated into a transient model for simulation of water hammer in water distribution systems. A methodology for comprehensive optimisation of pipe diameters, pipe classes and surge tanks of the water distribution systems has been developed by carefully integrating the steady state hydraulic solver, the water hammer simulation model, the fast messy GA and the boundary search strategy.

CONTENTS

DECLARATION ii

ABSTRACT iii

ACKNOWLEDGMENT iv

LIST OF FIGURES xi

LIST OF TABLES xiv

LIST OF NOTATION xvii

1. INTRODUCTION 1

1.1 The Need for Robust and Efficient Optimisation 3

1.2 Objectives and Thesis Overview 5

2. LITERATURE REVIEW 7

2.1 Traditional Optimisation Approaches 7
2.1.1 Optimisation methods without using a network solver 7
2.1.2 Optimisation methods using a network solver 11

2.2 Evolutionary Optimisation Techniques 15
2.2.1 Standard genetic algorithms: a brief overview 15
2.2.2 A standard GA based approach 16
2.2.3 Lessons from the GA based approach 18
2.2.4 Motivation for using messy genetic algorithms 19

2.3 Simulation Models 20
2.3.1 Steady state model 21
2.3.2 Transient model 22

2.4 Scope of This Research 24

3. MESSY GENETIC ALGORITHM FOR OPTIMAL DESIGN OF WATER DISTRIBUTION SYSTEMS 27

3.1 Problem Description 27

3.2 Discrete Model Formulation 28

3.3 A General Optimisation Procedure 31

3.4 Why Messy Genetic Algorithms? 31

3.5 Genotype Representation and Fitness 33

3.6 Mapping From Genotype to Phenotype 36

3.7 Messy GA Components 38
3.7.1 Messy genotype 39
3.7.2 Thresholding selection 39
3.7.3 Messy operators 41

3.8 Two-Phase Evolution 43

3.9 Implementation of the Messy Genetic Algorithm for Optimisation of Pipe Networks 45
3.9.1 The messy genetic algorithm 46

3.9.2 Hydraulic solver 47
3.9.3 The Interface program 48
3.9.4 The structure of mGANET 49

3.10 Application and Results 53
3.10.1 Case study I: the two reservoir network 53
3.10.2 Case study II New York city water supply tunnels 61

3.11 Summary 74

4. SPLIT PIPE FORMULATION FOR GENETIC ALGORITHM OPTIMISATION OF WATER NETWORKS 75

4.1 Introduction 75

4.2 Analysis of a Continuous Model 77

4.3 Formulation of a Split Pipe Model 85

4.4 Genetic Algorithm Mapping Scheme for Split Pipe Model 87

4.5 Integrating the Split Pipe Model into Messy Genetic Algorithm 88

4.6 Case Study I: The Two Reservoir Network 90
4.6.1 Genetic algorithm coding and parameters 90
4.6.2 Results and comparison for the two reservoir network 91

4.7 Case Study II: New York City Water Supply Tunnels 94
4.7.1 Results and comparison for the New York city tunnels problem 94

4.8 Summary 98

5. OPTIMAL REHABILITATION OF WATER DISTRIBUTION SYSTEMS USING A MESSY GENETIC ALGORITHM 99

5.1 Introduction 99

5.2 An Overview of Rehabilitation 99

5.3 Problem Formulation 101
5.3.1 Pipeline rehabilitation 101
5.3.2 Pump rehabilitation 103

5.4 A Case Study 104
5.4.1 Messy genetic algorithm coding and decoding 107
5.4.2 Results and a comparison 110

5.5 Summary 112

6. FAST MESSY GENETIC ALGORITHM FOR OPTIMAL REHABILITATION OF LARGE-SCALE WATER DISTRIBUTION SYSTEMS 114

6.1 Introduction 114

6.2 Lessons From Genetic Algorithm Paradigms 116
6.2.1 An overview of messy genetic algorithms 116
6.2.2 Why a standard GA sometime fails 117
6.2.3 Why messy genetic algorithm works 118
6.2.4 Bottleneck of original messy genetic algorithm 120

6.3 The Structured Messy Genetic Algorithm of Hahal et al. (1997) ... 121
6.3.1 Structured messy genotypes ... 121
6.3.2 Structured messy evolution ... 122

6.4 Fast Messy Genetic Algorithm ... 124
6.4.1 Components of fast messy genetic algorithm ... 124
6.4.2 A framework for the fast messy genetic algorithm ... 127

6.5 An Enhanced mGANET ... 129

6.6 A Comparison Study—The Two Reservoir Network ... 130
6.6.1 Fast messy GA coding, decoding and parameters ... 130
6.6.2 Results and comparison ... 131

6.7 Optimal Rehabilitation of Large-scale Network ... 134
6.7.1 A Moroccan network ... 135
6.7.2 Optimal rehabilitation criteria ... 136
6.7.3 Fast messy GA parameters ... 143
6.7.4 Results ... 143

6.8 Summary ... 149

7. BOUNDARY SEARCH OF GENETIC ALGORITHMS BY SELF-ADAPTIVE PENALTY ... 151

7.1 Introduction ... 151

7.2 Constrained Optimisation Problems ... 152

7.3 Conventional Method for NLP ... 154
7.3.1 Traditional penalty methods ... 155

7.4 Methods in Evolutionary Algorithms for NLP ... 157
7.4.1 Penalty methods ... 157
7.4.2 Search for feasible solutions ... 159
7.4.3 Hybrid methods ... 161

7.5 Boundary Search GA by a Self-adaptive Penalty ... 162
7.5.1 Boundary optimisation problem ... 162
7.5.2 Boundary search ... 162
7.5.3 Self-adaptive penalty ... 164

7.6 Boundary fmGA Optimisation of Water Distribution Systems ... 166
7.6.1 Results for a case study ... 167
7.6.2 Convergence behaviour ... 172

7.7 Summary ... 177

8. MODELLING HYDRAULIC TRANSIENTS IN WATER DISTRIBUTION NETWORKS ... 179

8.1 An Introduction ... 179

8.2 Necessity of Comprehensive Transient Analysis ... 180

8.3 Governing Equations ... 181

8.4 Characterisation of Pipeline Systems ... 183
8.4.1 Interior section ... 184

8.4.2 Boundary conditions 186

8.5 Modelling System Implementation 187

8.6 A Low Head Irrigation System 190
8.6.1 System description 190
8.6.2 Transient events and boundary conditions 191
8.6.3 Transient evaluation 192
8.6.4 Simulation results 192

8.7 Verification of the Transient Model 201
8.7.1 Verification without a surge tank 201
8.7.2 Verification with a surge tank 202

8.8 Summary 210

9. OPTIMAL TRANSIENT DESIGN OF WATER DISTRIBUTION NETWORKS 212

9.1 Introduction 212

9.2 Design for Transient or Water Hammer Events 213

9.3 A Model for Optimal Transient Design 214

9.4 Incorporation of HAMMER into fmGANET 216

9.5 A Simple Pipeline Case Study 219
9.5.1 Critical transient loading 221
9.5.2 Optimal solution 222

9.6 A Real System Case Study — Loveday Irrigation Network 226
9.6.1 Stage-one optimisation 227
9.6.2 Stage-two optimisation 233

9.7 Sensitivity of Optimal Transient Solution 238

9.8 Summary 245

10. CONCLUSIONS AND RECOMMENDATIONS 247

10.1 Introduction 247

10.2 Conclusions 248

10.3 Recommendations 254

11. BIBLIOGRAPHY 256

Appendix A OPTIMAL SOLUTIONS FOR REHABILITATION OF THE MOROCCAN NETWORK 268

A.1 Optimal Solution of fmGA5 268

A.2 Optimal Solution of fmGA6 272

A.3 Optimal Solution of fmGA7 275

A.4 Optimal Solution of fmGA8 279

Appendix B OPTIMAL SOLUTIONS OF NEW YORK TUNNELS PROBLEM BY BOUNDARY GA OPTIMISATION 284

B.1 Optimal Solution with Fixed Penalty Factor γ = 5,000,000 284
B.2 Optimal Solution with Fixed Penalty Factor = 7,000,000 284
B.3 Optimal Solution with Fixed Penalty Factor γ = 11,000,000 285
B.4 Optimal Solution with Fixed Penalty Factor γ = 2,000,000 286
Appendix C DATA FOR TRANSIENT ANALYSIS OF LOVEDAY IRRIGATION SYSTEM 288
C.1 Node Data 288
C.2 Tank Data 288
C.3 Pipe Data 288
C.4 Concrete Pipe Data for Transient Simulation 289
C.5 Hobas Pipe Data for Transient Simulation 290
Appendix D STAGE-ONE OPTIMAL SOLUTIONS FOR DESIGN OF LOVEDAY NETWORK USING CLASS II PIPES 292
D.1 Output of Solution 1 292
D.2 Output of Solution 2 294
D.3 Output of Solution 3 296
D.4 Output of Solution 4 298
D.5 Output of Solution 5 301
D.6 Output of Solution 6 303
D.7 Output of Solution 7 305