

AGENT-BASED MODELLING: INTEGRATING AGENT PERCEPTION AND PEER PRESSURE TO REDUCE HERDING EFFECT



By

MUZNA ZAFAR

01-244142-017

A thesis submitted to the Department of Software Engineering,
Bahria University, Islamabad in the partial fulfillment for the
requirements of a Masters degree in Software Engineering

OCTOBER 2016

ABSTRACT

Many crowd evacuation models have been proposed with different aspects of interests. This research is an attempt to integrate multiple aspects to study their collective effect on crowd dynamics. The agent-based model uses perception map for routing decision using personal observation in comparison to the information perceived from distant communication with interactive agents. Information sharing has been incorporated to provide updated information to agents regarding the perception map. This model is combined with the game-theoretic model resolving the consequences of influence on agents exhibiting two types of behaviours; emotional and rational. Overall this work aims at minimizing the effect of herding as well as reducing the evacuation time. A hypothetical space has been designed to evaluate the execution of the model on different environment settings. Multiple exit strategies have been simulated based on combination of aspects. The work has been evaluated using parameters such as time, panic and agents' distribution across two exits. The results indicate that proposed model can help to achieve both evacuation efficiency as well as minimal panic population. Moreover, it can be concluded that having a symmetric placement of exit can help to achieve desired results.

CERTIFICATE OF ORIGINALITY

No portion of the work referred to in the thesis has been submitted in support of an application for another degree or qualification of this or any other university or other institution of learning.

COPYRIGHT STATEMENT

1. The author of this thesis (including any appendices and/or schedules to this thesis) owns any copyright in it (the "Copyright") and she has given Bahria University, Islamabad the right to use such Copyright for any administrative, promotional, educational and/or teaching purposes.
2. Copies of this thesis, either in full or in extracts, may be made only in accordance with the regulations of the Bahria University Library. Details of these regulations may be obtained from the Librarian. This page must form part of any such copies made.
3. The ownership of any patents, designs, trademarks and any and all other intellectual property rights except for the Copyright (the "Intellectual Property Rights") and any reproductions of copyright works, for example graphs and tables ("Reproductions"), which may be described in this thesis, may not be owned by the author and may be owned by third parties. Such Intellectual Property Rights and Reproductions cannot and must not be made available for use without the prior written permission of the owner(s) of the relevant Intellectual Property Rights and/or Reproductions.
4. Further information on the conditions under which disclosure, publication and exploitation of this thesis, the Copyright and any Intellectual Property Rights and/or Reproductions described in it may take place is available from the Head of Department of Software Engineering, Bahria University, Islamabad.

ACKNOWLEDGEMENTS

First and foremost, all praise is to the Almighty Allah for blessing me with the strength and patience needed to complete this research. No word is scripted, and no author may dare, if not by His sacred will.

I take this opportunity to express my sincere gratitude to my supervisor, Dr. Kashif Zia, for his continued guidance and help, to which these few lines can hardly do justice. I could not have imagined a better mentor for my research study.

One of the most important acknowledgements is to my parents, for facilitating me in this endeavour. This accomplishment would not have been possible without them.

Finally, a very special thanks to my friend, Zufshan Zareen, For providing me with moral support and continuous appreciation throughout the process of research.

DEDICATION

To my Parents & Friends...

TABLE OF CONTENTS

ABSTRACT	i
CERTIFICATE OF ORIGINALITY	ii
COPYRIGHT STATEMENT	iii
ACKNOWLEDGEMENTS	iv
DEDICATION	v
LIST OF FIGURES	viii
LIST OF TABLES	x
1 INTRODUCTION	1
1.1 Motivation	1
1.2 Problem Definition	2
1.3 Purpose	3
1.4 Background	4
1.5 Thesis Outline	6
2 LITERATURE REVIEW	8
2.1 Models Based On Physical Laws	9
2.2 Behavioural Models	10
2.3 Social Cognitive Models	12
2.4 Crowd Behaviour in AmI Environment	13
2.5 Game-Theoretic Approaches	15
2.6 Proposed Model	16
3 MODELS	18
3.1 Perception Model of Routing Decision	18
3.1.1 Agent Mobility	18

3.1.2	Perception Map	19
3.1.3	Interaction with Peers	20
3.1.4	Trust Model	20
3.2	Game Theoretic Model of Peer Pressure	20
3.2.1	Next Cell Selection Criteria	21
3.2.2	The Game	21
3.3	Integrated Model	22
4	IMPLEMENTATION	24
4.1	Simulation	24
4.1.1	Simulation Space	24
4.1.2	Environment Type	24
4.1.3	Agent Population	25
4.2	Exit Strategies	26
4.2.1	Strategy 1: Nearest Exit	26
4.2.2	Strategy 2: Least Congested Route	26
4.2.3	Strategy 3: Least Congested Route through Interaction	27
4.2.4	Strategy 4: Route Based on Peer Pressure	28
4.2.5	Strategy 4 Plus: Route Based on Peer Pressure	28
4.2.6	Strategy 5: Route Based on Interaction & Trust	28
4.2.7	Strategy 6: Route Based on Combined Model	28
4.2.8	Strategy 6 Plus: Route Based on Combined Model	28
5	RESULTS & ANALYSIS	29
5.1	Results	29
5.2	Analysis	29
5.2.1	Analysis Parameters	29
5.2.2	Findings & Discussions	30
6	CONCLUSION & RECOMMENDATIONS	41
6.1	Contributions	41
6.2	Conclusion	42
6.3	Recommendations	43
	BIBLIOGRAPHY	43
	APPENDIX A	50

LIST OF FIGURES

3.1	Physical space divided into sectors with agent population shown in blue dots. (a) The white streets represent the walkable areas. (b) Point of Attractions are shown in red	19
3.2	Next Cell Selection Criteria Strategy Explained	21
3.3	Activity Diagram of Combined Model	23
4.1	Space divided into 25 equally-sectioned sectors	25
4.2	Geometrical Variation of two exit shown in red. (a) Symmetric. (b) Asymmetric. (c) Hidden.	25
4.3	The Space with variable agents population and varied environment types. 10% agents are Rational represented by circles, whereas 50% are interactive represented in yellow color. Rest of them are emotional agents. (a) 500 agents in symmetric environment. (b) 1000 agents in asymmetric environment. (c) 1500 agents in hidden environment. . .	27
5.1	Initial Setting with 1500 agents, 10% rational and 25% interactive agents. 30	30
5.2	Simulation time for each strategy	31
5.3	Graphs relating to two exits of agent population 1500 with 10% rational agents and 25% interactive agents across different strategies. (a)Utilization of left and right exits by agents. (b)Agents distribution across two exit.	32
5.4	Graphs relating to panic in agent population 1500 with 10% rational agents and 25% interactive agents across different strategies. (a)Maximum number of agents in panic. (b)Maximum Panic index Value.	33
5.5	The Space with population of 1500 agents in environment E3. 10% agents are Rational represented by circles, whereas 25% are interactive represented in yellow color. Rest of them are emotional agents. The agents in Blue are in waiting mode whereas agents in Red represent agents in Panic at 45th iteration.	34

5.6	Simulation time across three environment settings	35
5.7	Graphs relating to two exits of agent population 1000 with 10% rational agents and 50% interactive agents. (a)Utilization of left and right exits by agents in three environment settings. (b)Agents distribution across two exit in three environment settings	36
5.8	Graphs relating to panic in agent population 1000 with 10% rational agents and 50% interactive agents. (a)Maximum number of agents in panic across three environment settings. (b)Maximum Panic index Value across three environment settings	37
5.9	Population of 1000 agents in asymmetric environment type with varying percent of rational agents(in circles) and fixed 50% interactive agents(yellow circles). (a) 10% Rational Agents. (b) 25% Rational Agents.	38
5.10	Effect of Rational Agent population on Evacuation Time	38
5.11	Effect of Rational Agent population on Number of agents in Panic . .	39
5.12	Population of 1000 agents in environment type E3 with 10% Rational agents and varying percent of Interactive agents(yellow circles) (a) 50% Interactive Agents. (b) 100% Interactive Agents.	39
5.13	Effect of Interactive Agents population on Evacuation Time	40
5.14	Effect of Interactive Agent population on Number of agents in Panic .	40

LIST OF TABLES

3.1	The Game Explained	22
6.1	Simulation Cases run on Agent population 1500 with 10% rational agents and 25% interactive agents on Environment setting E3	50
6.2	Simulation Cases run on Agent population 1000 with 10% rational agents and 50% interactive agents	50
6.3	Simulation Cases run on Agent population 1000 with 50% interactive agents on Environment setting E2	51
6.4	Simulation Cases run on Agent population 1000 with 10% rational agents on Environment setting E3	51