



The Influence of Individual Characteristics on Crowd Dynamics

Paul Georg

IAS Series

Band / Volume 46

ISBN 978-3-95806-561-1

Mitglied der Helmholtz-Gemeinschaft

Forschungszentrum Jülich GmbH
Institute for Advanced Simulation (IAS)
Civil Safety Research (IAS-7)

The Influence of Individual Characteristics on Crowd Dynamics

Paul Geoerg

Schriften des Forschungszentrums Jülich
IAS Series

Band / Volume 46

ISSN 1868-8489

ISBN 978-3-95806-561-1

Contents

List of Figures	xii
List of Tables	xv
1 Introduction	1
1.1 Motivation and Scope	1
1.2 Outline of the Thesis	3
2 State of Research	5
2.1 Engineering Data for the Pre-movement Phase	6
2.2 Engineering Data for the Movement Phase	10
2.3 Importance of Empirical Relations	14
3 Data Collection	19
3.1 Studies on Preparation and Low Density Movement	21
3.1.1 Participants	21
3.1.2 Study Setup	22
3.2 Studies on Movement in Groups and Toward Dense Crowds	23
3.2.1 Participants	23
3.2.2 Study Setup	31
3.2.3 Data Capture	33
3.2.4 Data Availability	34
4 Methodology	36
4.1 Starting Position and Measurement Area	36
4.2 Delaunay Triangulation and Voronoi Tessellation	37
4.3 Space-time-mean	42
4.4 Specific Flow Concept	44
4.5 Description of visible disabilities	45
4.6 Indicating the Impact of Heterogeneity	47

5	Data Analysis	49
5.1	Objectives	49
5.2	Pre-movement Phase	50
5.3	Unimpeded Speed	52
5.4	Stationarity	56
5.5	Individual Time Gap	62
5.6	Adaptation of Speed	67
5.7	Capacity Analysis for Corridors Depending on Population	72
5.8	Capacity Analysis for Bottlenecks Depending on Population	77
5.9	Validity of Specific Flow Concept	82
5.10	Summary	84
6	Performance of Heterogeneous Crowds	85
6.1	Extended Pre-movement Phase	85
6.2	Variation of the Empirical Relations	86
6.3	Variation of Individual Speed in a Crowd	89
6.4	Parametrisation of Movement in Heterogeneous Crowds	93
6.5	Application in Engineering Egress Calculation	94
7	Summary and Conclusions	96
7.1	Summary	96
7.2	Outlook	99
A	Study Documentation	127
A.1	Research involving human participants	127
A.2	Studies on Preparation and Low Density Movement	128
A.2.1	Assistive devices	128
A.2.2	Trial Sequence	131
A.2.3	Unimpeded Assisted Speed on the Horizontal	132
A.3	Studies on Movement in Groups and Toward Dense Crowds	134
A.3.1	Scoring the Basic Population Towards Participation	134
A.3.2	Population Characteristics	134
A.3.3	Data Capture and Trajectories Quality	145
A.3.4	Starting Position	149
A.3.5	Time Series Analysis	152
B	Fundamental Diagrams Depending on Populations	163
B.1	Fundamental Diagrams for Corridor Studies	163
B.1.1	Cor_old	164
B.1.2	Cor_cog	166
B.1.3	Cor_whe	168

B.1.4	Cor_wal	170
B.1.5	Cor_mix	172
B.1.6	Cor_het	174
B.1.7	Cor_ref	176
B.2	Fundamental Diagrams for Bottleneck Studies	178
B.2.1	Bot_old	178
B.2.2	Bot_cog	180
B.2.3	Bot_whe	182
B.2.4	Bot_wal	184
B.2.5	Bot_mix	186
B.2.6	Bot_het	188
B.2.7	Bot_ref	190
B.3	Fitting Results	192
C	Individual Distances and Time Gaps	193
C.1	Time Gaps	193
C.2	Distances between Neighbours	199
D	Publications	204
E	Curriculum Vitae	209
F	Digital Appendix	211

IAS Series
Band / Volume 46
ISBN 978-3-95806-561-1