MICROSCOPIC MODELING OF CROWDS INVOLVING INDIVIDUALS WITH PHYSICAL DISABILITY: EXPLORING SOCIAL FORCE INTERACTION

by

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Abstract

Microscopic Modeling of Crowds involving Individuals with Physical Disability: Exploring Social Force Interaction

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It has been shown that nearly one quarter of a population is affected by a disability which influences their interaction with the built environments, other individuals, and evacuation policies inhibiting their exit ability during an emergency evacuation. It is predicted that the number of individuals with a disability is on the rise. In the 21st century alone, there have been hundreds of events attributed to stampede or crowd crush, natural disaster, political revolt, terrorism, and other related emergencies. With an increase in the world's population, understanding emergency evacuations and how to best apply them is of growing importance. While research has investigated how crowds interact and evacuate, very little has been investigated in the impacts of how the disabled change an evacuation. While there are some beginnings to affect modeling with heterogeneous behaviors of disabled, little has been known in the analysis of crowds involving individuals with disabilities. There is a need to understand and model such interaction and how it impacts crowd movement. This dissertation implements and develops a novel video tracking system to study heterogeneous crowds with individuals with disabilities towards conducting a large-scale crowd experiment. A large-scale crowd experiment is conducted and the results are analyzed through a developed analysis graphical user interface for use with crowd dynamics experts. Preliminary

results of the large-scale crowd experiment demonstrate differences in the velocities and overtaking perception of various groups with disabilities composed of the visually impaired, individuals with motorized and non-motorized wheelchairs, individuals with roller walkers, and individuals with canes or other stamina impairments. This dissertation uses these results to present a hybrid Social Force model that can capture the overall overtake behavior of the empirical data from our crowd experiments. Finally future research goals are discussed in the eventual development of a Mass Pedestrian Evacuation system for crowds with individuals with disabilities. Lessons from this dissertation are discussed towards goals of crowd control.

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Public Abstract

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Nearly one quarter of a population is affected by a disability which influences crowd evacuation. Emergencies such as stampede or crowd crush can occur during evacuations. While research has investigated crowd evacuation, little has been researched involving individuals with disabilities. There is a need to understand and model individuals with disabilities in their interaction and how it impacts crowd movement. This dissertation creates a video tracking system to study heterogeneous crowds with individuals with disabilities towards conducting crowd experiments. A large-scale crowd experiment is conducted and the results are analyzed through a developed analysis graphical user interface. Preliminary results of the experiment demonstrate differences in the velocities and overtaking perception of various groups with physical disabilities. This dissertation uses these results to present a hybrid Social Force model that can capture the overall overtake behavior of the empirical data. Finally future research goals are discussed in the eventual development of a Mass Pedestrian Evacuation system for crowds with individuals with disabilities. Lessons from this dissertation are discussed towards goals of crowd control.

To the children of my youth.

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