JuPedSim: Framework for simulating and analyzing the Dynamics of Pedestrians

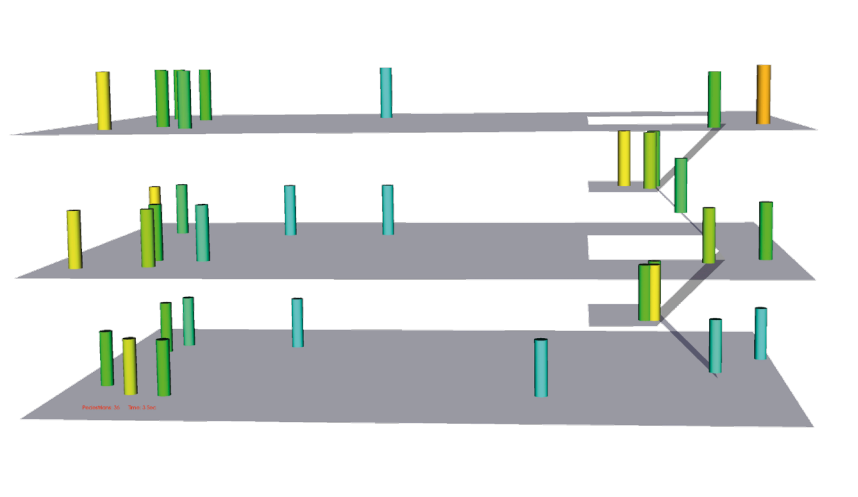

Figure 1: Screenshot of the simulation of a building evacuation with three floors connected with two staircases. Pedestrians are represented with cylinders and their velocities is color coded (red for slow and green for fast (ca. 1.34m/s)). After 4 seconds, there are still 36 pedestrians in the building.

The growing complexity of modern buildings and pedestrians' outdoor facilities make the use of simulation software inescapable. Simulations are used not only in the design phase of new structures but also later in the preparation or monitoring of large-scale events. To obtain reliable results, it is paramount to understand and reproduce the underlying phenomena which rule the dynamics of the pedestrians. There exist numerous software tools, mostly commercial (or with proprietary licenses), for simulating pedestrians. They usually implement a single model and are only of limited use for academic purposes, where the aim is generally a rapid prototyping framework for implementing and testing new concepts or models. There exist open source tools as well. But they are mainly designed for applications and do not offer easy access for model testing or extension. In addition the state of the art in the modeling of pedestrians is characterized by a high dynamic and the zoo of models is still growing. However, it lacks a common basis for model comparison and benchmarking. From the scientific and academic point of view, it is often crucial to understand how a model has been implemented since the mathematical description and the computer implementation sometimes differ. This also raises issues about the validation of the models, especially against empirical data, which is often neglected in many software systems.

The Jülich Pedestrian Simulator, JuPedSim, is an extensible framework for simulating and analyzing pedestrians' motion at a microscopic level. It consists at the moment of three modules which are loosely coupled and can be used independently. JuPedSim implements state of the art models and analysis methods.

The module JPScore computes the trajectories of the pedestrians given a geometry and an initial configuration. The start configuration includes the desired destinations, speeds, route choices and other demographic parameters about the pedestrians. Three-dimensional geometries are also supported. Two models at the operational level (locomotion system, collision avoidance) and three models at the tactical level (route choice, short term decisions) are actually implemented in the framework [1,2]. Other models are in the process of being integrated. Further models can be incorporated by third parties without much effort. Other behavioral

parameters are implemented such the possibility to share information about closed doors with other agents and the ability to explore an unknown environment looking for an exit.

The second module JPSvis visualizes the geometry and the trajectories, either from files or streamed from a network connection. High resolution videos can also be recorded directly from the module interface.

The module JPSreport analyses the results from the simulation or any other source for instance experiments and generates different type of plots. The reporting tool integrates four different, measurement methods [3]. Possible analyses include densities, velocities, flows and profiles of pedestrians in a given geometry.

Planned features for the framework include a graphical user interface for editing the geometry, which will also include import capabilities for various CAD formats and the connection of the pedestrian simulation with a fire simulator. In contrast to other simulation packages, an emphasis is set on the validation of the implemented models. The empirical data used for the validation come from numerous experiments that have been conducted in different geometries during the past years. All inputs and output files are XML based. JuPedSim is platform independent, released under the LGPL License and written in C++. All information including documentation, source code and experimental data are available at www.jupedsim.org. JuPedSim has been used for instance in a real time evacuation assistant for arenas [1] and will be used to simulate the Berlin underground station Osloer Straße in the ORPHEUS project [5].

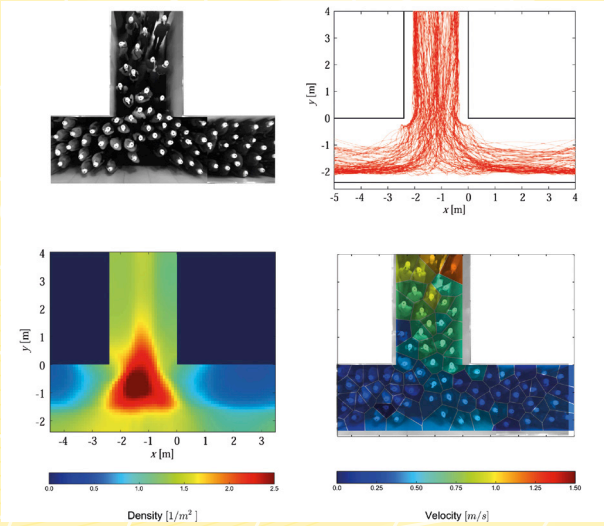

Figure 2: Workflow for analyzing trajectories using JPSreport. Top left: experiment involving two pedestrian streams coming from left and right and merging in a T-Junction. Top right: automatically extracted trajectories using PeTrack [4]. Bottom left: density profiles computed with JPSreport using the Voronoi method [3]. Bottom right: instantaneous velocities of the pedestrians using the Voronoi method [3].

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ORPHEUS - Fire Safety in the Underground, inside Spring 2015.

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