Numerical methods for crowds

Student projects Applied Mathematics

Annually, there are many events which attract thousands or even millions of people, such as Lowland and the Hajj pilgrimage. Daily, millions of people use public transport hubs or shopping malls. They make up huge crowds that have to be managed, such that the infrastructure is used efficiently and safely. Models are used to predict crowd dynamics fast and accurately. For an overview of the models, have a look at Duives et al (2013, TR-C) State-of-the-art crowd motion simulation models.

We have developed a new model and numerical methods for efficient simulations. Computations can be done fast because the flow is approximated as a continuum flow, so there is no need to model individual pedestrians. Numerical methods are based on a fixed (Eulerian) grid with pedestrians travelling from one grid cell to the other. As an alternative, a novel method uses a moving (Lagrangian) grid which travels with the pedestrians. Both methods need further development, some of the questions that remain to be answered:

- When using a fixed coordinate system, is it a good idea to use a Corner Transport Upwind Method?
- When using the moving coordinate system, is it best to use a hexagonal or a triangular grid?
- How to deal with boundaries such as walls, especially when using moving coordinates?
- How can we include different types of pedestrians, and pedestrians with different destination, and their interactions, within one simulation?
- What are the stability conditions for the numerical methods?
- Is it possible to use a meshless method to simulate crowd flows?

If you want to contribute to an answer to any of those questions, or if you want to find out more about the projects, please contact:
Dr. ir. Femke van Wageningen-Kessels (f.l.m.vanwageningen-kessels@tudelft.nl); or
Prof. dr. ir. Kees Vuik (c.vuik@tudelft.nl)

Key words: crowd dynamics; pedestrian flows; modelling; simulation; numerical methods; finite difference methods; finite volume methods