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JSC News Special Issue: Civil Security and Traffic

The JSC division "Civil Security and Traffic (CST)" was established in 2012. Headed by Prof. Armin Seyfried, it currently has about 20 scientists. CST works closely with the "Department of Computer Simulation for Fire Safety and Pedestrian Traffic" at the University of Wuppertal, where several members of the division give lectures and supervise students. The main research fields cover pedestrian dynamics, traffic and fire simulations.

Pedestrian and Traffic Modelling

Pedestrian and road traffic is simulated to predict the efficiency of circulation areas in buildings and road networks. Road traffic simulations are mainly driven by economic and environmental questions. In the case of pedestrian flows, safety aspects such as evacuation times or crowd management dominate. The dynamics of pedestrians and vehicles show similar characteristics and are microscopically modelled by an agent-based representation. Each agent locally regulates its movement according to the local density, based on either a system of differential equations or a stochastic process. At a global scale, collective phenomena like stop-and-go waves and congestions can be observed.

In addition to modelling the underlying pedestrian motion, the route finding and choice is of special interest. The modelling of these processes is essential for model validation in complex scenarios. Based on several existing psychological approaches describing human choice behaviour, algorithms are being developed for pedestrian routing in complex buildings.

All innovations are integrated in the Jülich Pedestrian Simulator (JuPedSim), a freely available open source tool for pedestrian traffic simulation and analysis.

Laboratory Experiments

The understanding and modelling of crowd dynamics relies on empirical data for analysis and validation. Laboratory experiments allow for selective parameter analysis in a controlled environment. Over the last decade, CST members have performed experiments with increasing numbers of participants and complexity. Recent experiments, as part of the BaSiGo project, with a total of 2000 participants were the largest of their type worldwide. Systems for the automatic extraction of walking paths and enhanced data analysis methods were developed, which provide density and velocity maps with a high spatial and temporal resolution.

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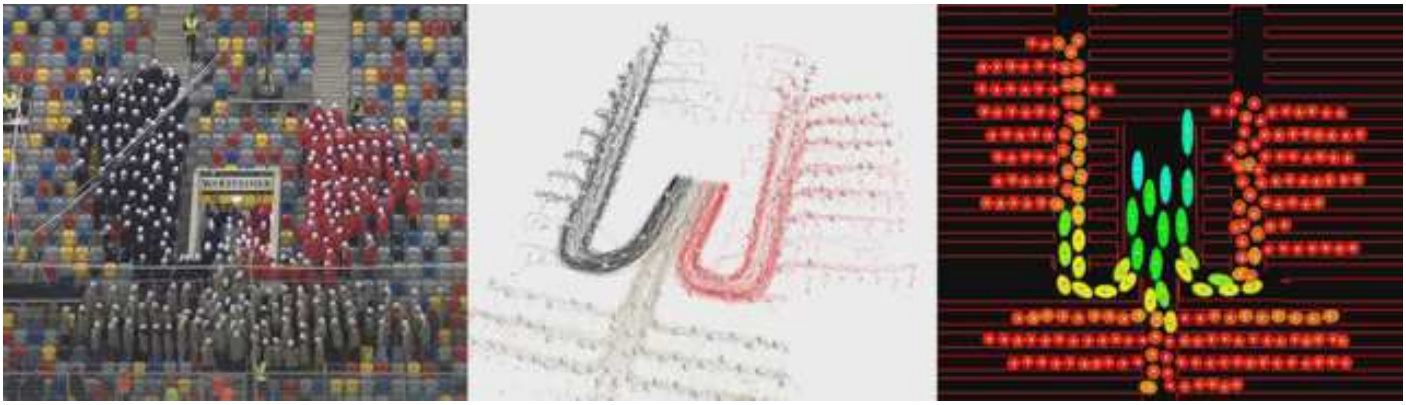

Laboratory experiments | Trajectory extraction | Modelling

In addition to new complex scenarios, unique markers for each pedestrian have been used to extract individual trajectories. This technique allows personal attributes, e.g. gender and age, to be related to the local and global dynamics.

The complexity of real crowds can only be examined in field studies. For this purpose, we are developing methods to capture individual trajectories in natural environments without artificial markers.

Traffic Simulation

The complex dynamics of transport systems has been a research topic for many years. Beginning with simple origin-destination assignments, the focus has shifted to more challenging scenarios, like the dynamics in multimodal mixed traffic. One of the division's research topics is the microscopic simulation of those scenarios. It focuses on the hybrid combination of simulation models of varying fidelity. Some situations require a microscopic view of the dynamics, while for others a coarser view is sufficient. This enables a simulation to capture the complex dynamics while reducing its computational cost.

Fields of application are integrated planning tools for large-scale events, transport systems in urban areas, and multimodal evacuation scenarios. Future research will focus on real-time simulations and decision support systems for large events.

Fire Safety Research

A research goal in fire safety is to understand the physical and chemical processes and phenomena of fires. Based on this understanding, sophisticated fire protection methods can be engineered to make existing and new buildings safer.

Fires involve many processes, like turbulent air dynamics, combustion and radiation. The numerical methods used in this group to model fires are based on computational fluid dynamics. Taking into account large and complex geometries, multiple species and chemical reactions, fire simulations necessitate the use of HPC systems.

Current software engineering activities cover massively parallel, adaptive mesh refinement techniques and real-time simulations on GPUs. The safety engineering applications concentrate on the spread of smoke and fire in underground stations and coupling this to pedestrian dynamics simulations.

Scientific Community and Outreach

Last year's conference "Traffic and Granular Flow '13", organized by CST, brought together 105 international researchers. For its tenth edition, the conference returned to the location of its very first appearance in 1995 at Forschungszentrum Jülich. In addition to the classical topics of granular flow and highway traffic, its scope included digital data transport, pedestrian and evacuation dynamics, intercellular transport, swarm behaviour and collective dynamics of other biological systems. The most prominent topic this year was pedestrian dynamics with 47 contributions.

The scientific community working on pedestrian dynamics, crowds, traffic and other systems of self-driven particles, such as molecular motors, animal groups or agents, is growing. Publications in this research field are topically widespread and have no dedicated journals. With support of the Central Library in Jülich, CST has initiated a peer-reviewed, open access journal to create an open and focused forum for this community.

On the occasion of the Science Year 2014, the exhibition vessel "MS Wissenschaft", will be making a port call in over 30 German cities located on German waterways. On board the floating science centre is an annually changing exhibition. This year, CST is contributing an exhibit that demonstrates the ship's evacuation simulation. Visitors also learn about CST's current research activities.

Further Information and Contact

More information about current activities and projects is available at *http://www.fz-juelich.de/ias/jsc/cst*.

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