

## Proposal for Research Cluster

*Joint Research and Education Program "Palestinian-German Science Bridge PGSB"  
Forschungszentrum Jülich GmbH & Palestine Academy for Science and Technology*

### Topic of research cluster

Intelligent Pedestrian Dynamics - Special Interest Group (IPD-SIG): Computational Modelling and Experimental Investigation of Heterogeneous Crowd Compositions

### Proposed participants

#### Cluster representative at Forschungszentrum Jülich (if applicable)

Title	Degree	First name	Surname
Mr.	Dr.	Mohcine	Chraibi
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Institute		Job title	
Institute for Advanced Simulation, Civil Safety Research (IAS-7)		Group Leader	
University affiliation			
Bergische Universität Wuppertal - Computer Simulation for Fire Safety and Pedestrian Traffic			

#### Cluster representative at Palestinian university (if applicable)

Title	Degree	First name	Surname
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Home university and faculty/department		Job title	
The Arab American University, Palestine		Professor	

#### Proposed cluster participants in Jülich/German universities:

- Armin Seyfried, Prof., Computer Simulation for Fire Safety and Pedestrian Traffic, Bergische Universität Wuppertal, Supervision of topics related to experimental investigation of pedestrian dynamics.
- Antoine Tordeux, Jun. Prof., Fachgebiet Verkehrssicherheit/Zuverlässigkeit, Bergische Universität Wuppertal, Supervision of topics related to traffic dynamics and shared spaces.

#### Proposed cluster participants at Palestinian universities

- Ahmad Alia, Research and Teaching Assistant, Department of Information Technology, An-Najah National University, Development of Cross-platform pedestrian trajectories prediction and simulation tools



## Scientific content of proposal (max. 5 pages)

### Which fields/research topics can/should be included in this cluster, how do they fit together?

The proposed research cluster aims at exploring a number of interrelated topics that fall under the “Pedestrian Dynamics and Heterogeneous Crowd Compositions” domain. These topics are:

- Identification and analysis of both micro and macro factors that affect pedestrian compositions in real-world application scenarios. Our goal in this context is to quantify and measure the level of impact of each factor on pedestrians’ movement decisions and behaviour.
- Incorporating various factors for predicting pedestrians’ future movement characteristics and trajectory points. The successful implementation of this step is tightly-coupled with the previous task as not all factors have the same weight and impact on shaping the movement characteristics of various pedestrian compositions.
- Experimental Simulation of Various Crowd Compositions under Different Environmental and Experimental Setups and Conditions. On one hand, investigation of pedestrian behaviour by means of experiments and simulations is a fundamental part of this cluster and should form a solid basis for all ongoing activities. On the other hand, shared spaces, where pedestrians interact with other transport objects like cars are becoming increasingly important and critical for the safety of pedestrians. Therefore, an important part of this cluster is the investigation of various interaction forms between different traffic participants.
- Exploiting a Variety of Modelling Techniques to replicate and simulate crowd movement features. The goal of this research task is to create 3D modelling scenarios that can serve as a reference for exploring various human movement activities under different conditions. The proposed simulation results in this context will be in the form of 3D short movies that can be shared across multiple communities that are involved in understanding crowd dynamics.

### Current activities in this field / results achieved from already existing cooperation projects

In the framework of the PGSP project, we investigated occupant behaviour in buildings and developed a prediction model of observed data from self-made experiments performed at the university of Wuppertal. Hereby, we investigated the accuracy of two commercial shading control devices (SOLEXA and WAREMA). Furthermore, we empirically study occupant interaction and satisfaction with respect to thermal and visual comfort under various solar shading control strategies to find out the optimal shading control set points. This *ongoing* work is part of a PhD thesis in collaboration with the Department of Civil Engineering at An-Najah National University. Preliminary results of this work are a paper entitled “A comprehensive review of human-building interfaces: Behaviour, energy use impacts and occupant comfort” in the Building and environment Journal. Data analysis of the experiments performed in summer 2019 are ongoing and planned to be published as a journal paper. Furthermore, in cooperation with the Arab American University, Palestine, we performed an experiment in the facilities of the university with 47 participants. The aim of the experiments was to investigate the alleged gender-differences in pedestrian dynamics. Moreover, we developed a neuronal-based model to replicate the results of the experiments and predict other aspects of the behaviour of pedestrians like age and culture. The results of this study were published in the IEEE Access journal under the title “Experimental Investigation on the Alleged Gender-differences in Pedestrian Dynamics: A Study Reveals No Gender Differences in Pedestrian Movement Behaviour”. Parts of the results were presented as an oral contribution in the international scientific conference for research in the field of Computational Collective Intelligence, France (2019).

### Please prepare a sketch/model of how this cluster would help toward creating a scientific infrastructure in Palestine, as well as lasting cooperation between researchers in Jülich and

**Palestine. Please address all points in the call text. If possible, please include a graphic representing your idea.**

This cluster is guided by the following research question: How can we gain standardized cross-cultural and empirical insights into the behavior of pedestrians in open and shared spaces?

This question is addressed through a research design that weaves together three streams: mathematical model development, empirical fieldwork, and software engineering. In this way, the cluster aims for deep interdisciplinary research. The project's empirical focus is Palestine, Germany and China, where different cultural and social variations can be exploited empirically and open questions regarding the influence of culture, age and gender can be addressed.

In the long-term different products for prediction and evaluation of crowd dynamics are to be developed on basis of different open-source projects to guarantee a sustainability and continuation of development. In this regard, the already existing projects JuPedSim<sup>1</sup> and PeTrack<sup>2</sup>, both active open-source software mainly developed by researchers from Forschungszentrum Jülich, will serve as starting platforms for investigating new scientific questions related to modelling of pedestrian dynamics and tracking of crowd movement in controlled experiments as well as developing new solutions for real-time assessment and visualization of crowd densities in open and shared spaces. These developments will serve in different ways:

First, bachelor, master and PhD students are provided with numerical frameworks to focus on research, i.e. development and validation of new models. Their research results are not only published in written form but will be made public in form of software pieces integrated in the offered framework (e.g. JuPedSim). In this manner, we can guarantee continuity of research and strengthen reproducibility of scientific results even after the end of the supervised theses.

Second, our experimental work will contribute to develop consistent and sustainable data on mixed traffic research. This is especially helpful and extremely important for data comparison, since one of our scientific endeavors are cross-cultural research in the field of pedestrian dynamics.

Last but not least, we aim to bundle our theoretical and empirical findings in form of a real-time assessment and prediction tool that can be used to gain instant insights on the dynamics of crowd in open spaces and hence preventively avoid potentially dangerous situations e.g. high densities as well as temporal and spatial bottlenecks.

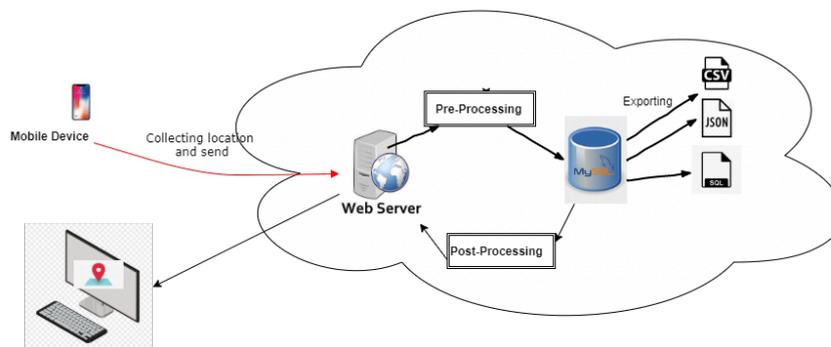


Figure 1: Proposed detection system to assess and predict crowd dynamics in open spaces.

<sup>1</sup> <http://www.jupedsim.org>

<sup>2</sup> <http://bit.ly/2leJB7e>

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**Please share any ideas for possible funding sources for the cluster, including any joint funding proposals that are being planned/submitted.**

For promoting mobility between countries, especially to perform experiments in place, there is possibility to apply for the “International Visiting Professor Program”<sup>3</sup>. This program offers the possibility to stay in China for at least 2 months for research reasons. Mohcine Chraibi participated in this program in 2018 and 2019.  
 Furthermore, application for computing time is possible<sup>4</sup>, which can be crucial for our planned real-time assistance system.

## Signatures

### Representative of research cluster in Jülich (if applicable)

Date	Name	Signature
03.03.2020	Dr. Mohcine Chraibi	

### Representative of research cluster at Palestinian University (if applicable)

Date	Name	Signature
03.03.2020	Dr. Mohammed Maree	

<sup>3</sup> <https://employment.ustc.edu.cn/cn/enindexnews.aspx?infoID=636234679190252190>

<sup>4</sup> <https://www.fz->

[juelich.de/ias/jsc/EN/Expertise/Supercomputers/ComputingTime/computingTime\\_node.html](https://www.fz-juelich.de/ias/jsc/EN/Expertise/Supercomputers/ComputingTime/computingTime_node.html)

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