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A holistic guiding system for pedestrians: a proof of concept

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Abstract Crowds could be made safer and flow more efficient by guiding pedestrians through an automatic system. Yet, no such system is being employed anywhere in the world. In former work we tackled obstacles to this goal: sensing and distribution of congestion information through a direct communication network, resolving congestion when facing limited compliance, and collecting data on compliance behavior. Here, we combine all into one socio-technical system and demonstrate through simulation how congestion at metro station Münchner Freiheit is resolved.

Keywords Socio-technical system, Guiding strategies, Compliance, Pedestrian modeling, Direct mobile communication, Survey

Building and investigating a system for crowd guidance

Whether at large events or in everyday traffic, crowds could be made safer and flow more efficient if one succeeded in guiding pedestrians towards better routes, as one does with cars. Ideally this would happen through an automatic system without involving human crowd managers. An app could make information available to anyone with a smartphone. Such a system is illustrated in Figure 1.

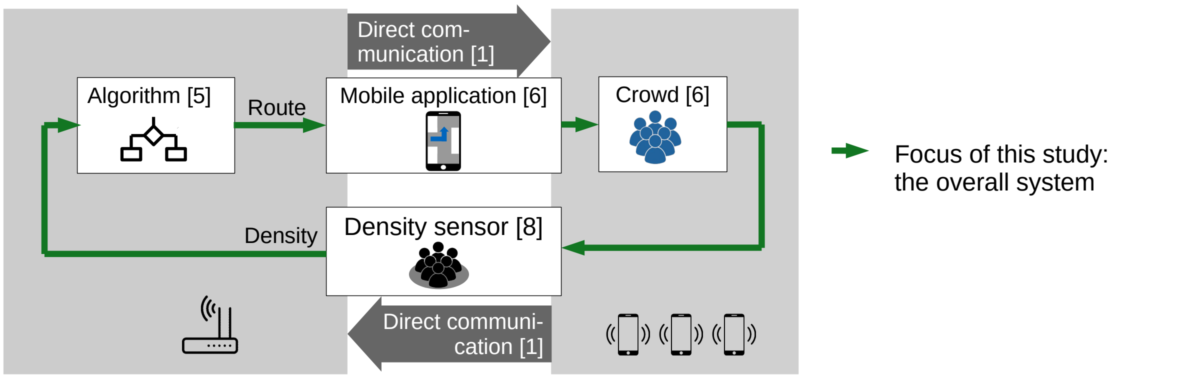

Figure 1: Components of a crowd guidance system that have been already analyzed in [1, 2, 3, 4]. The focus of this study is on the overall system. We integrate componontes into an overall concept and test it for a real life use case.

Yet, while the idea may seem obvious, as of today no such system is being employed anywhere in the world. A number of factors make the task more challenging than for car traffic. One is that we need a way to sense congestion in crowds that are often distributed over an area that may be hard to survey, even by cameras. Another issue is that instructions need to be distributed within the crowd. In preceding publications, e. g. Ref. [1], we suggested using direct mobile communication to do both, sense and transmit congestion information in a crowd, and showed that it is technically feasible.

However, most issues are non-technical. In particular, pedestrians need to perceive and understand instructions. Also information must be identical for all members of a group traveling together. Most importantly, unlike water molecules, people need to be convinced to comply. Even in the best of circumstances, compliance will be nowhere near 100% as often assumed in former concepts of control systems for pedestrian traffic, e.g. in Ref. [5, 6, 7]. The good news is that, compliance as low as 30 percent may suffice to resolve congestion as we demonstrated in an abstracted scenario with three routes in Ref. [2].

But will it work for real people in a real world scenario? In a survey with almost 1000 soccer fans we compiled realistic compliance distributions with respect to app designs that conveyed directional

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suggestions. We saw that, when congestion information was added, compliance with route suggestions among soccer fans sufficed to significantly reduce jams [3].

All three aspects—information gathering and transmission, a robust guiding algorithm capable of handling low compliance, and mechanisms to foster compliance—are essential building blocks of a functional system. However, considering these elements in isolation is insufficient, as they interact. To assess whether the overall system is effective, it must be conceptualized and tested as an integrated whole. Therefore, in this contribution, we compose an overall concept—namely, a complex socio-technical system—and evaluate it through simulations.

We demonstrate, through a simulation study, how severe congestion on a preferred route at metro station Münchner Freiheit is relieved. Congestion is reduced on the preferred route to the trains during the rush before a Bayern München soccer match. A percentage of counterflow is estimated from a field study in 2020 Ref. [8]. In addition, we assume that only 40% of the people consult their smart phones for instructions. Compliance among these smart phone users is modeled after the survey data in Ref. [8]. See Figure 2.

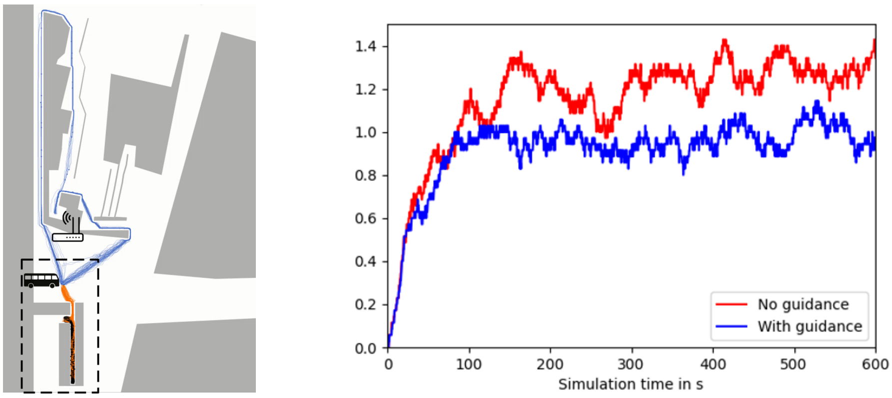

Figure 2: Left: Bird's eye schematic of three routes from the bus station to the train level. The shortest (orange) route is the preferred route for most. There is counterflow on that route. The guidance system points new arrivals to the least congested route. Right: Red: density without guidance system in persons/m^2 on the preferred route to trains. Blue: density with guidance, 40% app usage assumed, compliance among app users as in survey (about 40%), same counterflow as in unguided case.

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