Analyzing pedestrian density at football stadium entrances

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Abstract: Massive events require a precise management of pedestrian crowds in order to control high-density scenarios and avoid the accidents that have dramatically increased over the last decades.The simulation of the access of fans to stadiums is an important area that needs to be addressed, as certain crowd-related tragedies have occurred during this process. In this contribution, we study the access of football fans to San Mamés stadium in Bilbao using empirical data provided by the Athletic Club.

We introduce a novel technique to define the desired velocity fields for pedestrians both outside and inside the stadium using OpenFOAM, a tool frequently employed in computational fluid dynamics. By introducing a single additional parameter to control the inflow of people through turnstiles, we reproduce the empirical access rate of people in 15 matches and calculate the time evolution of the maximum local density. We use our macroscopically calibrated version of the Social Force Model for pedestrian simulations and consider three different settings of the agents, varying in them their initial position in the geometry and their sizes. Finally, we evaluate the impact of the total number of attendees and the time distribution of their arrival on maximum local densities. We create multiple virtual scenarios in which a varying number of agents N arrive at the stadium at different rates characterized by logistic distributions with standard deviations σ [1].

References:

[1] A. García, D. Hernández-Delfin, B. González, G. Garitaonaindia, D.-J. Lee, M. Ellero, Analysis of local density during football stadium access: Integrating pedestrian flow simulations and empirical data, Physica A 638, 129635 (2024).