Estimating contact forces in a dense crowd

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Mots-clés : Crowd modeling, Macroscopic/Microscopic approach, Non-local interactions, Contact forces/Pressure, Panic situation, Non-smooth dynamics, Simultaneous collisions, Measure differential inclusion.

This work deals with the estimation of pressure during the movement of a dense crowd. Based on the non-smooth approach of contact dynamics for both rigid and deformable solids, proposed by Michel Frémond, we propose the definition of percussion/force of contacts generated through congestion or panic situation, when pedestrians stay tight against each other. First, we use a second-order microscopic model, in which crowd is treated as a system of rigid solids (discrete medium). Contact forces are rigorously defined taking into account multiple, simultaneous contacts, non overlapping condition between pedestrians. Second, a continuous "equivalent" approach is used where the crowd is assimilated to a deformable solid (continuous medium), and pressure is calculated according to volume and surface constraints. This approach makes it possible to keep an admissible right-velocity (after impact), including both, the non local interactions (at a distance interactions) between non neighbor pedestrians and the choice of displacement strategy for each pedestrian.
Finally, two applications are presented: a one-dimensional simulation of an aligned pedestrians chain crashing into an obstacle, and a two-dimensional simulation corresponding to the evacuation of a room.

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