Multi-Agent modelling of Dense cRowd dynAmicS (MADRAS): Application to the Festival of Lights (Lyon)

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Trustworthy models for the dynamics of dense crowds are crucial for the prediction of pedestrian flow and the management of large crowds. However, current models suffer from some severe deficiencies, especially at high density. In this context, the MADRAS project aims to develop innovative agent-based models to predict and understand dense crowd dynamics (from 2 to 8 ped/m2) and to apply these models in a large-scale case study. Three complementary modelling approaches are being pursued: (i) neural networks (NN) that will be trained on available data to predict pedestrian motion as a function of their local environment and trajectory [1], (ii) a physics-based model coupling a decisional layer, where a desired velocity is selected according to an empirically validated collision-anticipation strategy, and a mechanical layer, which takes care of collisions and contacts, (iii) an agent-based model providing a versatile behavior allowing agents to switch dynamically between a library of models on operational, tactical and strategical levels depending on the density.

These approaches will be confronted with novel validation methods, using data from controlled experiments. The models will then be exploited at larger scale to simulate the flows on crowded streets at a real mass gathering, the Festival of Lights in Lyon. To this end, empirical data have been collected during the Festival of Lights 2022 (cf. Fig. 1): it combines filming some streets and squares from above, gathering GPS tracks and contacts data while crossing the square.

The objective of this contribution is twofold. First it will present the dataset gathered during the Festival of Lights 2022 and cleaned using a combination of various approaches. Second, it will introduce the overall approach developed in the MADRAS project allowing modelers to combine data-driven, physical-based and agent-based models in order to simulate this evacuation phenomenon, at different scales.

Figure 1: Place de Terreaux at the Festival of Lights in 2022

Bibliography

[1] Korbmacher, R., and Tordeux, A., *Review of pedestrian trajectory prediction methods: Comparing deep learning and knowledge-based approaches*, IEEE Transactions on Intelligent Transportation Systems, 2022.