Using crowd simulation to encourage social distancing

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As Europe faces a resurgence of coronavirus, having loosened strict lockdowns, one of the most important policy questions is how people can safely social distance in crowded places. Our ability to accommodate maximum safety and capacity has been greatly reduced during the pandemic, raising concerns about the future layout of public spaces.

My research and development

group at Utrecht University along with start-up

uCrowds have deployed a crowd simulation framework to help manage groups of people in this new world of public space under coronavirus.

The software allows users to create and run models for simulating realistic crowd behaviour, including how people move around a space and how they avoid collisions within environments. Simulations are run in realistic environments to study the effectiveness of their methods.

How does the software work?

Simulated pedestrians in the software do not move around randomly; they have one or more destinations. They can either be alone or in groups.

One relatively recent addition we have made is that a certain percentage of the simulated people take up more space, for example those who are travelling in small, social groups. The pedestrians then walk to their destinations in a realistic manner, avoiding other people and obstacles.

We modelled the way people move in the simulations using 13 years of data on how real people move. We collected some of this from students who carried trackers while walking across hallways and other spaces. We also conducted experiments with groups of students at festivals, where much larger groups of people moved alongside each other.

Since our model is based around individuals and social groups, we have now been able to add effects of social distancing. All their interactions lead to the kinds of emergent behaviours we are observing in real crowds. Examples include lane formation (pedestrians following the

people who walk in front of them when crowds got too busy), pressure waves, and more anticipation because individuals are trying to keep a greater social distance between one another.

Practical applications

How do we use this information to help with coronavirus planning? Crowd simulation models can be scaled up immensely. If you have a sufficiently fast computer, our simulation engine can simulate up to 550,000 people in real time.

The software can also make projections: for example, if you simulate 20,000 people, you can fast forward the simulation to 35 times the actual speed. That means that the software can also look into the future and warn officials to close off access routes in areas that are becoming too busy.

If governments use this kind of software, they can send text messages to people's mobile phones to direct pedestrians to take other route options to their destinations. A pilot project is running at St Pancras railway station in the UK which demonstrates this technology.

The software has been previously used for the Grand Départ of the Tour de France in 2015, which brought 800,000 spectators to Utrecht. Simulations in a virtual Utrecht supported the municipal government in planning the surroundings of the cycling course and testing the prognoses for the flows of the spectators. One of the scenarios included computing the maximum number of individuals that would safely fit on a square. When this number was reached in reality, the entrance to this square could be safely closed in time.

Simulating social distance

We have recently updated the simulation to reflect the social distancing measures in place in the Netherlands which require people to stay 1.5 metres apart.

The simulation does not simply set the minimum distance between simulated people to 1.5 metres, but takes into account the fact that people make imperfect estimations. Even the fact that people are becoming tired of coronavirus measures and are hence paying less attention to distancing is considered. The software also simulates groups containing members of the same household, which are moving closer together.

As the pandemic unfolds, this model can be used to get insights in the daily operation of train stations, airports, high streets or even festivals in this new 1.5-metre world. By simulating crowds at this distance, we hope to contribute to helping open up the economy in these bizarre times.

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