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Detecting interaction/complexity within crowd movements using braid entropy

Key words: Crowd behavior; Motion segmentation; Motion entropy; Crowd scene analysis; Complexity detection; Braid entropy

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Motivation

1. The purpose of this study is to better understand crowd behavior by locally measuring the degree of interaction/complexity within the segment.

2. The degree of interaction/complexity is locally determined within a high-density moving group, which proceeds in the same direction as shown in the resulting complexity map, although this is expressed as a cluster in many other studies.

3. When the whole image is taken into consideration, complex-smooth behaviors in moving areas can be classified, and a general understanding of the flow of the movement can be reached.

Main idea

The image is divided into hexagonal cells. A braid is formed with trajectories corresponding to each cell. To create the braid, trajectories are tracked over time according to an angle value. The braid is defined as a spiral pattern occurring when three or more trajectories changed locations with each other over time. Trajectories are given symbolic counterparts for the swaps they made with each other.

The complexity of the braid is calculated depending on its symbolic counterparts. Then the interaction/complexity flow value in each cell of the image, separated by uniform hexagons, is calculated using finite time braid entropy (FTBE). In this way, a complexity map is created to show the crowd behavior.

Main idea

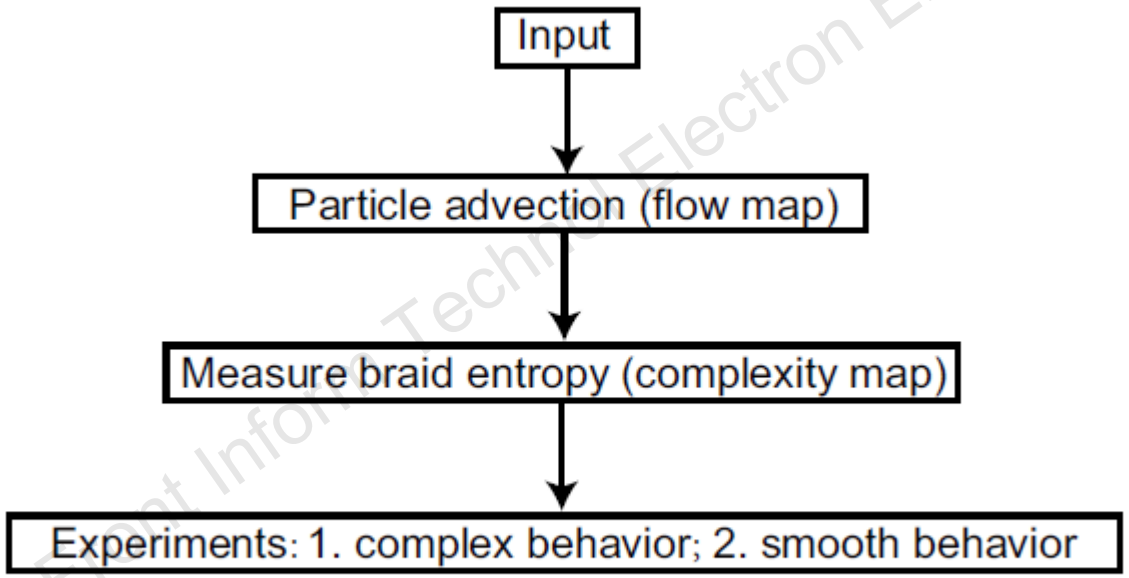

Fig. 1 Steps of the study

Method

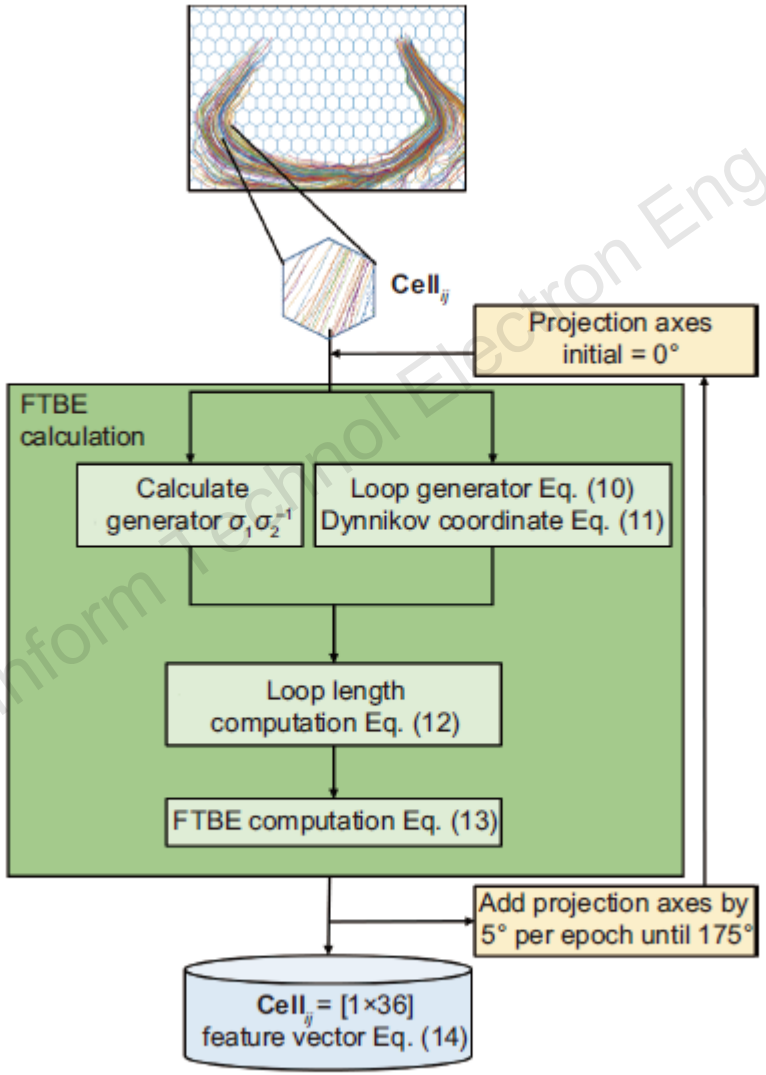

Fig. 5 Calculating the feature vector for each cell using braid entropy

Major results

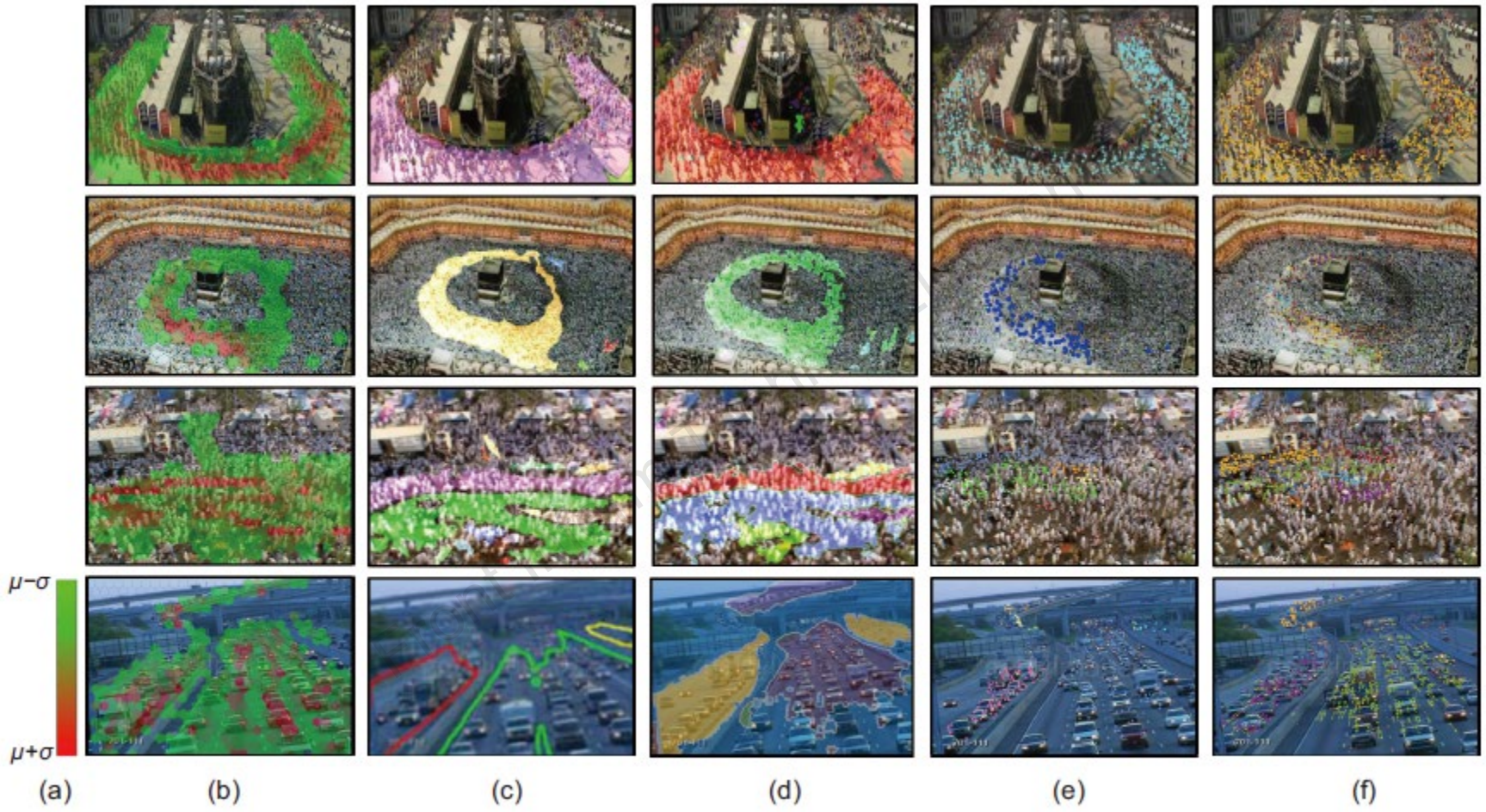

Fig. 7 The present study results compared with those of studies from the literature: (a) color scale; (b) our results; (c) Ali and Shah (2007); (d) Mehran et al. (2010); (e) Zhou et al. (2012a); (f) Zhou et al. (2013)

References to color refer to the online version of this figure

Major results

The complexity map we created revealed that, unlike in other studies, the flowing motion of a crowd going in the same direction does not show the same behavior in each region. In other words, there were regions with more or less complexity in the interactions of the flow of crowd moving in the same direction.

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Conclusions

1. We have examined the interactions among people in crowd movements. The motion information in the video sequences has been represented by trajectories. The spiral pattern formed by the trajectories has been locally investigated and the degree of complexity in the region has been determined using the FTBE value calculated from 36 different directions at an interval of 5°.

2. Ultimately, by interpreting the behavior of the crowd using the generated complexity map, we identified the regions in which the movement was proceeding smoothly and those in which the interactions among the individuals increased. We also demonstrated that braid theory can be a useful method for interpreting trajectories.

3. In this study, the degree of interaction and complexity were determined locally within a high-density moving group proceeding in the same direction and were shown as the resulting complexity map. This is expressed as a cluster in many studies. When the whole image was taken into consideration, the complex and smooth behaviors in the moving areas can be classified and a general understanding of the flow of the movement can be reached.