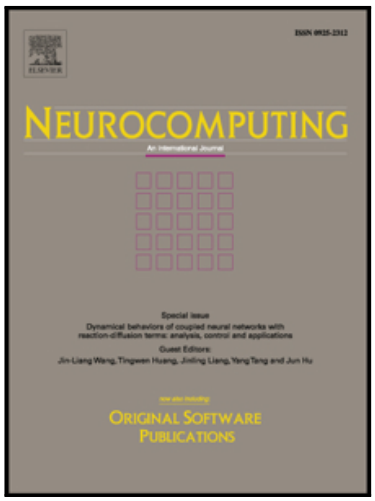

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Wei Lu , Xiang Wei , Weiwei Xing , Weibin Liu

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Trajectory-based Motion Pattern Analysis of Crowds

Wei Lu[a], Xiang Wei[a,*], Weiwei Xing[a], Weibin Liu[b]

[a]School of Software Engineering, Beijing Jiaotong University, Beijing 100044, China

[b]Institute of Information Science, Beijing Jiaotong University, Beijing 100044, China

Abstract

Various techniques have been developed in recent years to simulate crowds, and most of them focus on collision avoidance while ignoring basic statistical spatiotemporal properties that crowd should possess. In order to improve the quality of crowd simulations, in this paper, we investigate some statistical characteristics of pedestrians in unstructured scenes using captured motion trajectories. Each trajectory is first represented as a four-dimensional vector, following which trajectories with the same entrance/exit areas are clustered to form motion patterns using the fuzzy c-means (FCM) algorithm. Since errors arise during tracking, outliers are eliminated using the local outlier factor (LOF) algorithm, and the refined velocity field can then be obtained. Finally, for each motion pattern, we find and confirm the following three spatiotemporal statistical properties of pedestrians: 1. The distribution of path length obeys the power law. 2. Pedestrians' speeds follow a Gaussian distribution. 3. Pedestrians tend to maintain a lower speed in entrance/exit areas and a higher one in the middle of a given path.

Keywords:
crowd; pedestrian; motion pattern analysis; outlier detection; spatiotemporal; velocity field.

1. Introduction

With the rapid rise of urbanization worldwide, crowds of people have become ever more common. The phenomenon of the crowd has thus attracted a considerable amount of research interest in a large number of applications, such as crowd management, public space design, virtual environments, visual surveillance, and so on. Crowd motion pattern analysis, the cornerstone of these applications, has witnessed a surge in attention from researchers in sociology, psychology, physics, statistics, and computer science.

Crowds of pedestrians exhibit particular, subtle behaviors the complexity of which reflects the intricate nature of human beings. However, there are certain phenomena common to crowds that need to be investigated. In recent years, researchers have conducted analyses of trajectory data tracked by surveillance devices that capture the motion information of pedestrians [1-3]. However, most such work has focused on scene understanding and abnormal detection, and has ignored some basic statistical spatiotemporal characteristics exhibited by crowds in

* Corresponding author. E-mail address: 14112081@bjtu.edu.cn