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Experimental analysis of self-organizing patterns in crossing flows of pedestrians: Detection of stripes

Pratik Mullick[1]*, Sylvain Fontaine[2], Cecile A.-Roland[2], Anne H.- Olivier[3], William H. Warren[4], Julien Pettre[1]

[1]INRIA Rennes - Bretagne Atlantique, Campus de Beaulieu, Rennes, France
[2]Université Paris-Saclay, CNRS/IN2P3, IJCLab, Orsay, France
[3]Université Rennes, INRIA, CNRS, IRISA, M2S, France
[4]Department of Cognitive, Linguistic and Psychological Sciences, Brown University, Providence, Rhode Island, USA
*pratik.mullick@inria.fr

Pedestrians in a crosswalk often form multiple lanes of traffic, moving in opposite directions (180°). Such spontaneous pattern formation is an example of self-organized collective behavior, a topic of intense interdisciplinary interest. When two groups of pedestrians cross at an intersection (90°), similar diagonal stripes appear. Naka [1] conjectured that the stripes are perpendicular to the mean walking direction of the two groups. This facilitates the forward motion of each group and reduces collisions.

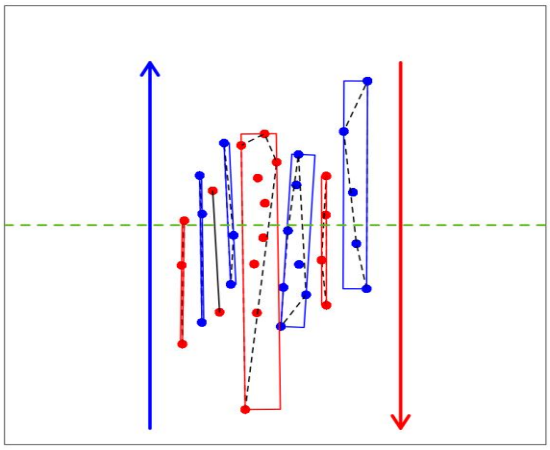

Figure 1: Stripes for a typical trial of counter flow (crossing angle = 180°)

We present the first empirical test of the hypothesis by studying two groups of participants crossing at seven different angles (30° intervals). To analyze the striped patterns, we introduce two computational methods, a local Edge-cutting algorithm and a global Pattern-matching technique.

We find that stripes are indeed perpendicular to the mean walking direction at all crossing angles, consistent with the hypothesis. But other properties depend on the crossing angle: the number of stripes increases with crossing angle, whereas the spacing of stripes, the number of pedestrians per stripe, and the crossing time all decrease. Moreover, the width of individual stripes is “squeezed” in the middle of the crossing. Future models of crowd dynamics will need to capture these properties.

References

[1] Y. Naka. *Mechanism of cross passenger flow - Study on Complicated Passenger Flow in Railway Station* (Part I) (in Japanese). Trans Arch Inst Jpn 258: 93-102 (1977)