Weighted-averaging model of crowd motion generalizes to different turn angles and crowd sizes

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Journal of Vision, October 2020, *20* (11), 923.
doi:https://doi.org/10.1167/jov.20.11.923

Abstract

From schools of fish to pedestrians on a busy street, it appears that collective motion emerges from local interactions between individuals. The crux of the problem is to understand these local interactions, including the rules of engagement and the neighborhood of interaction over which they operate. In Rio, Dachner & Warren's (2018) behavioral model, a pedestrian aligns their heading with a weighted average of the heading directions of all neighbors in the field of view (the rule), whose weights decay exponentially with distance (the neighborhood). The model was based on and fit to data with neighbors turning only ±10°. Here we test how the model generalizes to moderate turn angles of ±0-20° with fixed parameters (for large angles, see Wirth & Warren, VSS, 2017, 2019). In the first experiment, a participant (N=12) was instructed to "walk with" a virtual crowd of 12 virtual humans presented in a Samsung Odyssey HMD. On each trial, the crowd began walking forward; after 2-3s, a subset of neighbors (0, 3, 6, 9, or 12) turned left or right by 5°, 10°, 15°, or 20°. The participant's heading and speed were recorded. Mean final heading increased with subset turn angle ($p < .001$), as well as subset size ($p < .001$), confirming a proportional influence over this turn range. Mean final speed showed no main effects of turn angle or subset size, although there was a significant interaction ($p = 0.05$), indicating a slight slowing with a ±20˚ turn as subset size increases to maintain stability (Hicheur, et al. 2005). Next we plan to manipulate the size of the crowd to test whether neighbor influence is averaged or additive. The results indicate that the weighted-averaging model generalizes over a moderate range of turn angles.

Acknowledgements: Funding: NIH R01EY029745, NSF BCS-1849446