A Visual Model of Collective Motion in Human Crowds

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Collective motion in human crowds emerges from local interactions between individual pedestrians. Previously, we found that an individual in a crowd aligns their velocity vector with a weighted average of their neighbors' velocities, where the weight decays with distance (Rio, Dachner, & Warren, PRSB, 2018; Warren, CDPS, 2018). Here, we explain this "alignment rule" based solely on visual information. When following behind a neighbor, the follower controls speed by canceling the neighbor's optical expansion (Bai & Warren, VSS, 2018) and heading by canceling the neighbor's angular velocity. When walking beside a neighbor, these relations reverse: Speed is controlled by canceling angular velocity and heading by canceling optical expansion. These two variables trade off as sinusoidal functions of eccentricity (Dachner & Warren, VSS, 2018). We use this visual model to simulate the trajectories of participants walking in virtual (12 neighbors) and real (20 neighbors) crowds. The model accounts for the data with root mean square errors (.04–.05 m/s, 1.5°–2.0°) the distance decay as a consequence of comparable to those of our previous velocity-alignment model. Moreover, the model explains Euclid's law of perspective, without an explicit distance term. The visual model thus provides a better explanation of collective motion.