Flock Fragmentation: The Dispersal of Saturated Flocks in a System of Self-Propelled Particles

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Collective motion is a phenomenon of ordered motion that attracts much scientific interest because of its presence in a wide variety of applications such as the flocking behavior of birds or self-assembling nanoparticles. This study examines the nature of flock fragmentation, a specific behavior in which, though collective behavior and aligned movement is not disrupted, a flock of collectively moving particles loses cohesion and splits into smaller sub-flocks. Though there is plenty of literature that establishes the basis for collective motion and the stability of flocking behavior, there has been no literature thus far that examines factors that enhance the fragmentation of flocks. This study proposes a new model to analyze this splitting behavior and its properties. In order to quantify the extent of flock fragmentation, three measurements are used: the order parameter, number of unique flocks, and influence density, a measurement of effective concentration. Using an examination of saturated flocking structures as well as an incorporation of various factors and system parameters, the study finds the system can be effectively influenced towards optimal flocking behavior with regards to flock cohesion. Further analysis was conducted on the nature of the sub-flocks formed from fragmentation as well as the difference between high and low density initial conditions. The results of the study provide insight into the observation of natural systems like schools of fish and are of particular interest to design optimization of artificial systems such as drug delivery or drone systems.

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