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Mixed reality framework for collective motion patterns of swarms with delay coupling[1] KLEMENTYNA SZWAYKOWSKA, IRA SCHWARTZ, Naval Research Lab — The formation of coherent patterns in swarms of interacting self-propelled autonomous agents is an important subject for many applications within the field of distributed robotic systems. However, there are significant logistical challenges associated with testing fully distributed systems in real-world settings. In this paper, we provide a rigorous theoretical justification for the use of mixed-reality experiments as a stepping stone to fully physical testing of distributed robotic systems. We also model and experimentally realize a mixed-reality large-scale swarm of delay-coupled agents. Our analyses, assuming agents communicating over an Erdos-Renyi network, demonstrate the existence of stable coherent patterns that can be achieved only with delay coupling and that are robust to decreasing network connectivity and heterogeneity in agent dynamics. We show how the bifurcation structure for emergence of different patterns changes with heterogeneity in agent acceleration capabilities and limited connectivity in the network as a function of coupling strength and delay. Our results are verified through simulation as well as preliminary experimental results of delay-induced pattern formation in a mixed-reality swarm.

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