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Learning to Cloak Swimming Objects in Viscous Environments using a Flock of Artificially Intelligent micro-Robots MEHDI MIRZAKHANLOO, University of California, Berkeley, SOHEIL ESMAEILZADEH, Stanford University, MOHAMMAD-REZA ALAM, University of California, Berkeley — Here, we present a systematic methodology to actively cloak swimming objects within any arbitrarily crowded suspension of micro-swimmers. Our approach is to conceal the target swimmer throughout its motion using an interacting flock of swimming agents equipped with adaptive decision-making intelligence. Through a reinforcement learning algorithm, the cloaking agents experientially learn optimal behavioral policy in the presence of flow-mediated interactions. This artificial intelligence enables them to dynamically adjust their swimming actions, so as to optimally form and robustly retain any desired arrangement around the moving object without disturbing it from its original path. Therefore, the presented active cloaking approach is both robust against disturbances and non-invasive to the motion of cloaked objects. We then demonstrate how the trained cloaking agents can be readily used, in any region of interest, to realize hydrodynamic invisibility cloaks around any number of arbitrary intruders. Our findings provide a clear road-map toward realizing hydrodynamic invisibility cloaks for externally or internally controlled artificial swimming micro-robots, which paves the path toward non-invasive intrusion of swimming micro-robots with a broad range of biomedical applications.

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