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Deep Reinforcement Learning for Bluff Body Active Flow Control in Experiments and Simulations.[1] DIXIA FAN, Massachusetts Institute of Technology, LIU YANG, ZHICHENG WANG, Brown University, MICHAEL TRIANTAFYLLOU, Massachusetts Institute of Technology, GEORGE KARNIADAKIS, Brown University — We demonstrate in experimental environments the feasibility of applying deep reinforcement learning (DRL) in complex fluid applications automatically discovering active control strategies without any prior knowledge of flow physics. We demonstrate the methodology in the active control of the turbulent flow past a circular cylinder with the aim of reducing the drag force. We maximize the power gain efficiency by properly selecting the rotation of two small diameter cylinders located parallel to and downstream of the main cylinder. By properly defining rewards and noise reduction techniques and after an automatic sequence of tens of towing experiments the DRL agent is shown to discover a control strategy that is comparable to the optimal strategy found through lengthy planned control experiments. In addition, companion DRL-guided simulations illustrate the flow mechanism: the fast rotation of small cylinders reattach the flow in the main cylinder rear and hence significantly reduce the pressure drag. While DRL has been used effectively in recent flow simulation studies, this is the first time that its effectiveness is demonstrated experimentally, providing a potential paradigm shift in conducting fluid experiments and paving the way for exploring even more complex flow phenomena.

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