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Shape optimizations of fluid flow around a circular cylinder by using PINNs

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Abstract

Physics-informed neural networks (PINNs) have recently attracted much attention in the field of thermo-fluids engineering as a unified framework for solving forward and inverse problems. In this study, we develop and assess a new shape optimization framework based on PINNs combining with a level-set function and volume penalization method to solve fluid flow and associated heat transfer around an arbitrary complex geometry. We consider a steady laminar flow around a circular cylinder as one of the most common benchmark problems to verify the proposed scheme. It is demonstrated that the optimal shape for minimizing the drag obtained in the present study agrees well with that reported in a previous study of using conventional numerical methods. Furthermore, we extend it to a heat transfer enhancement problem, and improvement of a heat transfer performance is confirmed. Based on the present results and its ease of implementation, PINNs can be considered as a promising tool for shape optimization in thermos-fluids problems.

Keywords: PINNs, Shape optimizations, Circular cylinder flow, Volume penalization method, Level-set function