A NUMERICAL METHOD FOR THE COMPUTATION OF HOPF BIFURCATION POINTS IN FLUID MECHANICS

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ABSTRACT

This work deals with the computation of Hopf bifurcation points in 2D fluid mechanics. These bifurcation points characterize the transition between a stationary flow and a time periodic flow. The proposed numerical method lies on the association of two methods. The first one is based on the computation of a bifurcation indicator [1] which has the property to be null at Hopf bifurcation points. This indicator is computed by using a perturbation method and the Padé approximants. This method is efficient but can demand long CPU times if precise critical values are requested. Moreover, this method is not an automatic ones and needs a great deal of post-analysis work for each computation (see [1] for more details). The second method [2] consists on solving an augmented nonlinear system whose solutions are Hopf bifurcation points. Nevertheless, the latter needs good initial values to ensure the convergence. These initial values can be difficult to determine. So, the main objective of this work is to couple the two previous methods. We propose to use the quantities coming from the bifurcation indicator proposed in [1] as initial approximations for the augmented system proposed by [2]. More precisely, the minimum value of the indicator is introduced in the Newton iterative scheme. This permits to define an automatic and efficient algorithm for the computation of Hopf bifurcation points.

Classical numerical tests, flow around a cylinder and the lid-driven cavity, show that the proposed method is efficient and permits to compute the critical values of the flow even for initial Reynolds numbers far from the Hopf bifurcation points.

REFERENCES

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