EXPERIMENTAL STUDY ON THE FLOW CHARACTERISTICS WITH BIOMIMETIC STRUCTURE OF A FISH CAUDAL FIN

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Visualization method(s): particle tracking
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ABSTRACT: In the past decade, researchers pay lots of attentions on the development of biomimetic structure for robots. Some researchers focus on creatures in water and the others focus on creatures in the air. In this study, a novel structure has been developed to simulate the movement of a fish caudal fin. A motor driven grooved cam and a flapper with linkage are the components of this mechanism. Almost all of the biomimetic structures in present time produce sinusoidal angular velocity profile. However, the optimal angular velocity profile may not be in the sinusoidal form. Fig. 1 shows the design of this novel structure and the experimental setup. The flapper is attached to a pole inserted in a bearing. A strut links the flapper pole and the cam with another bearing. The second bearing was inserted in a trough machined on the cam. When the motor drives the cam, the bearing slides in the trough and the strut transforms the rotary motion into flapping of the foil. The feature of present novel mechanism is to produce a faster motion from the side to the center and slower motion from the center to the other side.

In this study, the flapper is driven by the grooved cam and generates air flow. The trough trajectory was designed so that the foil can flap with specified angular velocity variation. The flow is affected by the rotational speed of the cam, the angular velocity variation, and the material of the flapper. In the experiment, the rotational speed of the cam varies from 1 Hz to 6Hz, the angular velocity variation is 1 and 2, and the material of the flapper includes aluminum and PVC. The flow is visualized through a smoke line with laser sheet. The flow rate is also measured with hot-wire anemometer. Only the points in a quarter of the cross section were measured due to symmetric condition. Results show that the flow velocity is increase with the increase of rotational speed and the angular velocity variation. The flow shows inverse von Karman vortex street to downstream of the flapper. Vortices are induced with flapper motion. Figure 2 and 3 show the flow was induced by the flapper and vortices were produced due to flapper motion with 1Hz of rotational speed.

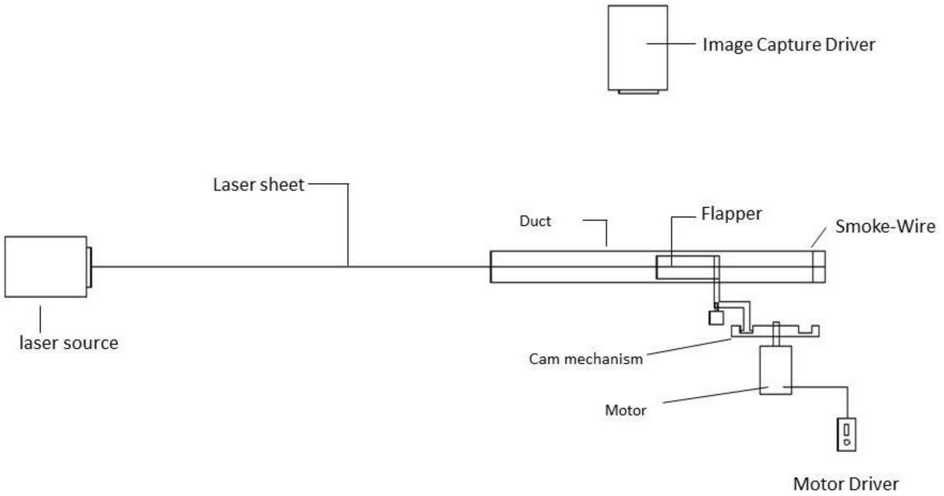

Fig. 1 Biomimetic structure and experimental setup

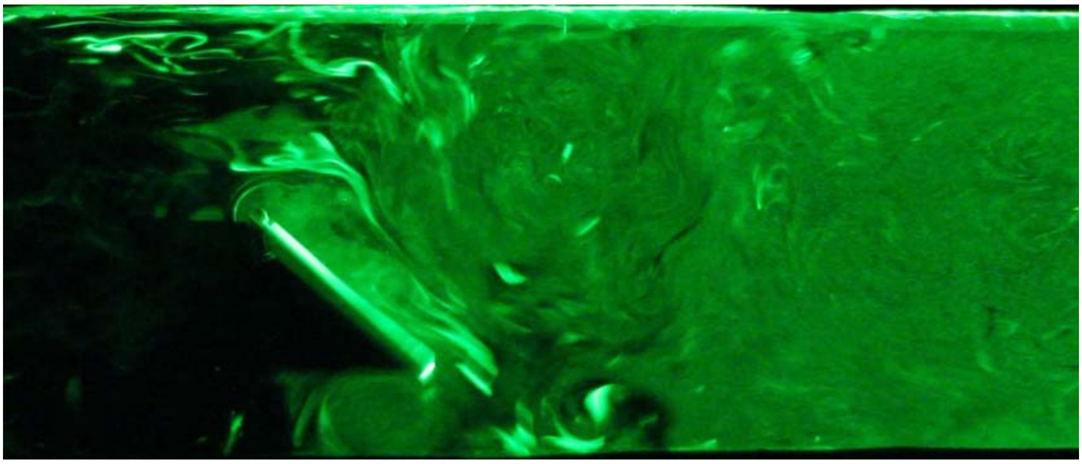

Fig. 2 Top view of duct flow with flapper towards the side

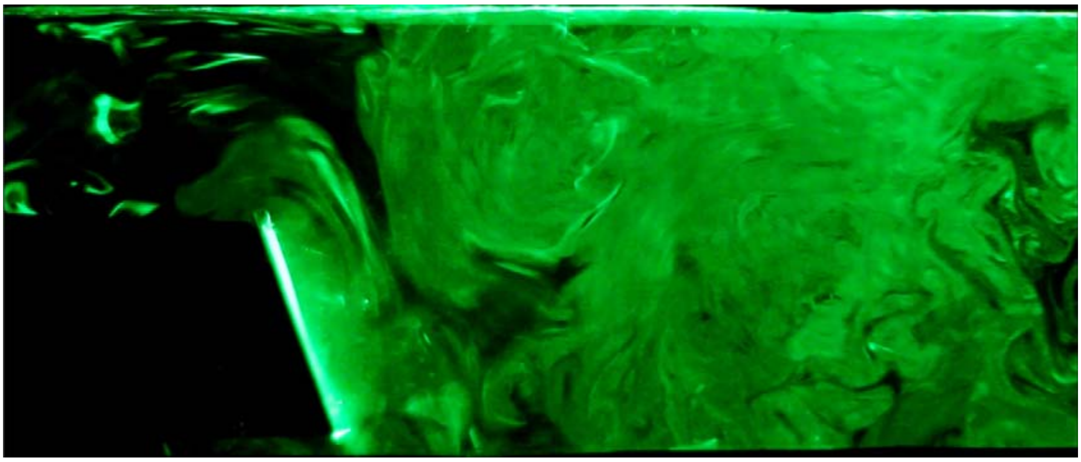

Fig. 3 Top view of duct flow with flapper on the side