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**Three Dimensional Vortex Wake Structure of Flapping Wings in Hovering Flight** BO CHENG, YUN LIU, XINYAN DENG, School of Mechanical Engineering, Purdue University, BIO-ROBOTICS LAB TEAM — Flapping wings create complex vortex structures in the wake, as the vortices of one wing stroke shed periodically and travel downwards with the induced flow. However, the detailed three-dimensional vorticity distribution and evolution in the far wake are scarcely understood experimentally. In this study, the three-dimensional vortex wake structure in both the near and far field of a dynamically-scaled flapping wing was investigated experimentally, using volumetric three component velocimetry. Summarily, the overall result of the wing action is to create a coherent vortex structure consisting of a tip vortex (TV), trailing-edge shear layer (TESL) and leading-edge vortex (LEV). The shed TESL rolls up into a root vortex (RV); together with the TV in the wake, they contracts radially but stretch tangentially in the wake. Concurrently, the downwash is distributed in an arc-shaped region enclosed by the stretched tangential vorticity of TVs and RVs. Overall, a closed vortex ring structure is not observed in the current study, because there is no well-established starting and stopping vortex structures that smoothly connect to TV and RV. Finally, evaluation of the vorticity transport equation shows that both TV and RV, while convected downwards, undergo vortex stretching, a three-dimensional phenomenon in rotating flows. It also confirms that the vorticity evolution is dominated by convection with secondary tilting/stretch effects, while the magnitude of vorticity dissipation is negligible.

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