Improvement of small wind turbines and advancement of design optimization method

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Research Outline

Vertical axis wind turbine

As the latest emergency power sources, small wind turbines are watched with keen interest. Wind turbines can be broadly classified into horizontal- and vertical-axis wind turbines, depending on the direction of the rotor's axis of rotation. The most famous type of horizontal axis wind turbine is the propeller type wind turbine, which has high power generation efficiency. On the other hand, vertical-axis wind turbines include Darius-type wind turbines and Savonius-type wind turbines. These wind turbines have several advantages over propeller-type wind turbines, such as flexibility in a wind direction, low noise, and easy maintenance. However, their disadvantage is that their power generation efficiency is lower than that of propeller-type wind turbines.

In this laboratory, we are working to improve the performance of small vertical-axis wind turbines by improving the blade geometry and other features.

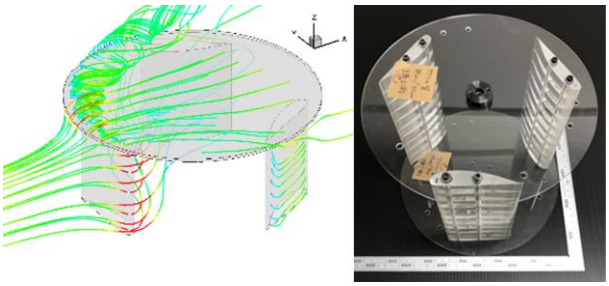

Figure 1 A small vertical axis wind turbine

Design optimization

In product development, there is a required to design higher-performance products within a limited time frame. One approach to this problem is a design optimization method. Design optimization methods, combined with automatic performance evaluation methods, propose higher-performance designs in less time than human trial-and-error.

Our laboratory uses the kriging response surface method, one of the global optimization methods, as a design optimization method. This method is more suitable for the design of fluid machinery such as wind turbines than the design optimization method using sensitivity analysis. However, the Kriging response surface method is not good for complex design problems (problems with a high degree of design freedom). Our laboratory is working to advance design optimization methods in order to apply them to more complex design problems and reduce computational costs.

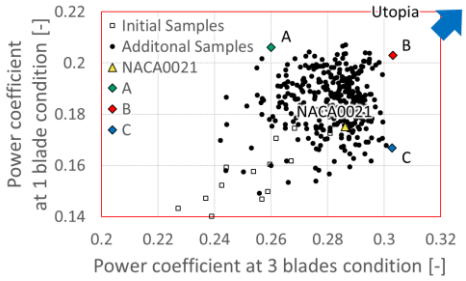

Figure 2 Trade-off relationship

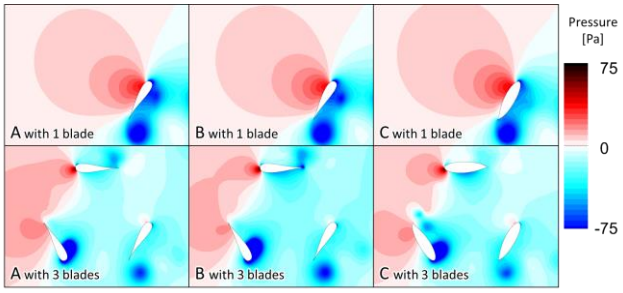

Figure 3 Pressure distribution