Advanced Optimization of HAWT Rotor Blades

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Source: https://www.emaze.com
Research team at the Department of the Built Environment

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Introduction

• Fossil energy reserves are limited.
• Wind energy is a promising alternative.
• Rotor blade geometry has a large effect on the performance of Horizontal-Axis Wind Turbines (HAWTs).

Methodology

• Shape optimization
• Topology optimization
• Computational Fluid Dynamics (CFD)

[Flowchart diagram]

Goal: Developing a multi-disciplinary optimization strategy of the blade structure to improve the performance of HAWTs.

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First year progress

- Shape optimization (SO)
  - To find an optimal **boundary shape** of a structure with given constraints.

- Topology optimization (TO)
  - To determine the optimal **distribution of material** within a fixed domain.

An element with 0 density is void, and that with unit density is solid.

Minimizing the strain energy of the cantilever beam with given area.

Minimizing the strain energy of the cantilever beam with given material.

Cantilever beam optimization problem

Density

0.001 0.112 0.223 0.334 0.445 0.556 0.667 0.778 0.889 1
Current work

- A hybrid structural design method
  - A new method is proposed and implemented by integrating shape and topology optimization in a sequential manner.

Flowchart of the hybrid structural design method
Conclusions

• The variation of the shape of the design domain has a big influence on the final results of topology optimization.
• The sequence of shape and topology optimization in the new method does not have a crucial impact on the final optimization results.

Future work

• Predicting aerodynamic performance of turbine blades using CFD.
• Implementing the hybrid optimization method in blade structural design.
Thank you for your attention!
Questions?