Model Wind Turbine

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COLLEGIATE WIND COMPETITION
U.S. DEPARTMENT OF ENERGY

Project Description

Department of Energy Collegiate Wind Competition
- Provide experience in wind energy to new engineers

Optimize UWYO 2024-2025 design
- Redesign blades using new airfoils better suited for the Reynolds number
- Upgrade mechanical components to reduce friction and ensure smoother, more reliable operation
- Design a new control system to operate the generator at optimal efficiency
- Develop software for autonomous operation of wind turbine and control system

Design Requirements

Key Project Goals
- Generate electrical power across integer wind speeds ranging 5–11 m/s
- Incorporate a control system capable of monitoring conditions and initiating emergency shutdown procedures
- Implement an electrical load system to determine and adjust optimal load resistance for varying wind speeds
- Enable data acquisition and performance measurement, including voltage, RPM, and power output for analysis and validation

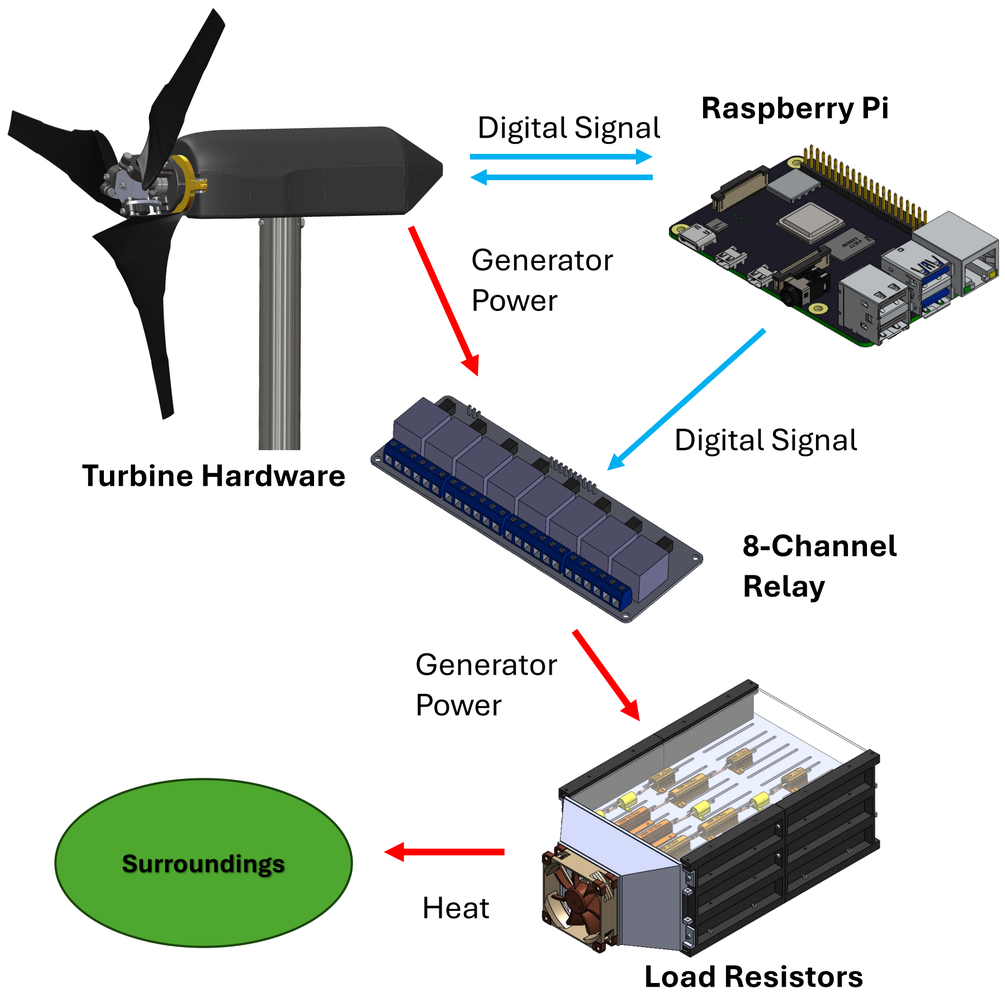

Figure 1: Schematic depicting the design of the control system.

Fabrication

Methods Used:
- 3D printing: Blades, turbine components and control system enclosure
- Waterjet: Control system aluminum plates
- Laser Cutting: Control system acrylic face sheets
- Hydraulic Press: Bearing housings

Control System:
- Complete redesign
- Forced convection for efficient cooling
- Tiered resistor bank for efficient space usage

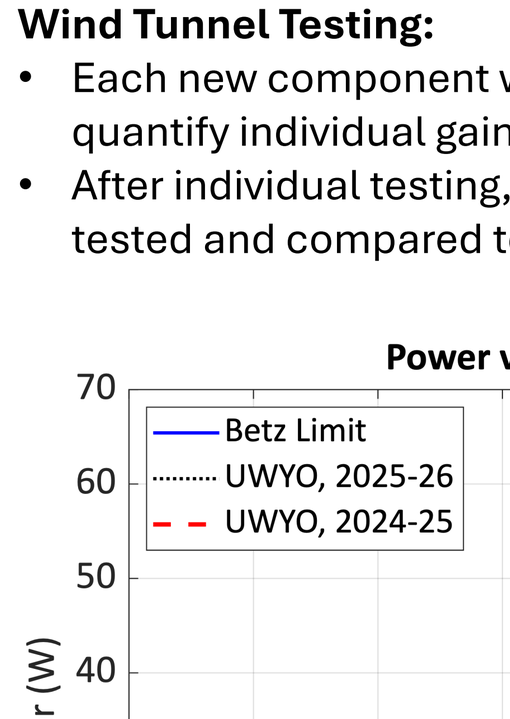

Figure 2: Load resistors and heat sink

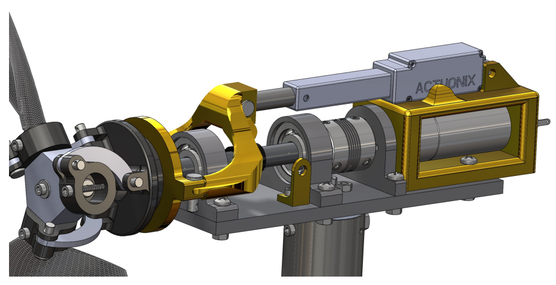

Figure 3: Highlighting of newly designed components

Testing and Analysis

Wind Tunnel Testing:
- Each new component will be isolated and tested to quantify individual gains
- After individual testing, the current iteration will be tested and compared to the previous design

Figure 4: Plot depicting power production vs. wind speed for UW 2024-25 and 2025-26 prototypes