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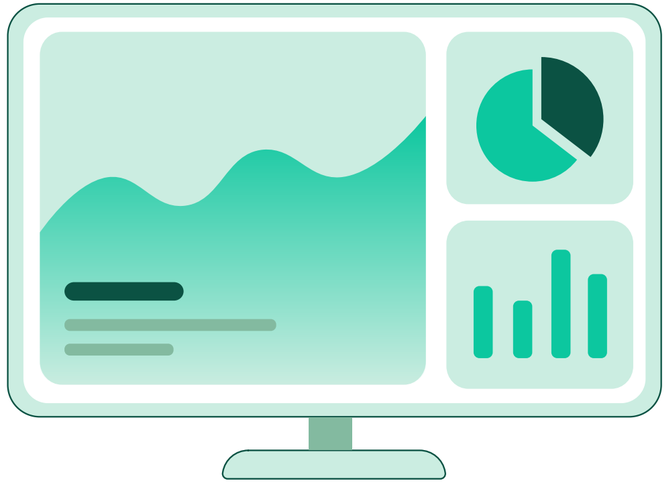
WINDMILL DASHBOARD PROJECT



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MY UNDERSTANDING OF PROBLEM STATEMENT

- **Data Overload and Real-Time Analysis:** The project involves handling and visualizing large volumes of real-time data generated by wind turbines. The goal is to develop a dashboard to efficiently process and display this data to aid monitoring and decision-making.

- **Operational Efficiency and Predictive Maintenance:** A key objective is to enhance the operational efficiency of wind farms by implementing predictive maintenance features. This involves analyzing data to predict potential equipment failures and schedule maintenance proactively, thereby reducing downtime and maintenance costs.

- **User-Friendly and Interactive Interface:** The project requires creating an intuitive and interactive dashboard that simplifies complex data. The interface should be user-friendly, providing clear and actionable insights to operators for better decision-making and overall management of the wind farm operations.

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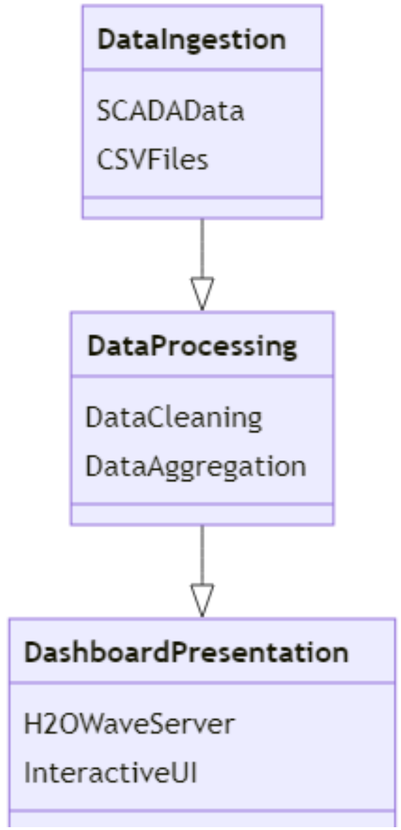
HIGH LEVEL DESIGN (HLD)

01 **Data Ingestion** starts by pulling data from **SCADA** systems and **CSV** files.

02 The ingested data is then passed to the **Data Processing** module, which undergoes cleaning and aggregation.

03 Processed data is then sent to the **Dashboard Presentation** layer, handled by the H2O Wave Server.

04 The **H2O Wave Server** renders the data on the **Interactive UI**, which is accessible to the users.



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FEATURES AND TECH STACK

Detailed Performance Metrics:

- Displays key performance indicators like mean, median, standard deviation, and coefficient of variation.
- Summary cards and statistical analysis for quick insights.

Multiple Data Views:

- Includes various pages for different aspects of the data, such as quarterly summaries, turbine coordinates, yearly production changes, and failure analysis.

Predictive Maintenance Insights:

- Predictive analytics to identify potential equipment failures and schedule maintenance proactively.

Tech Stack:

- **H2O Wave**: Framework for building real-time, interactive dashboards.
- **Python, Pandas, Plotly:** Programming Language and libraries used to build the dashboard.
- **SCADA Systems, CSV Files:** Data Sources
- **Jupyter Notebooks**: Used for initial data exploration and prototyping of data processing steps.

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CHALLENGES

Real-time Data Integration:

- Integrating real-time **SCADA** data with historical **CSV** files posed a significant challenge in terms of **data synchronization and consistency.**

Data Cleaning and Processing:

- Handling **missing values, inconsistent data formats, and outliers** required robust data cleaning and preprocessing techniques.

Interactive Visualization:

- Ensuring **smooth, real-time interactivity** within the **H2O Wave** framework while maintaining **performance** was complex.

Rendering Issues:

- Initial attempts to **render charts and graphs** on the dashboard encountered multiple issues, such as incorrect rendering and **high payload sizes**, which led to **server errors**.

User Interface Design:

- Designing an **intuitive and responsive user interface** that caters to various user needs was challenging.

Predictive Analytics Integration:

- Incorporating **predictive maintenance** insights into the dashboard required advanced machine learning models and seamless integration with the existing system.

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POTENTIAL ACHIEVEMENTS WITH EXTENDED TIME AND SUPPORT

What I Achieved in 3 Days:

Initial Dashboard Setup:

- Successfully set up the initial framework for the dashboard using H2O Wave, including integrating SCADA data and CSV files.

Basic Data Processing and Visualization:

- Implemented basic data processing and cleaning workflows. Created initial visualizations and integrated them into the dashboard, although rendering issues persisted.

Attempted Various Visualization Libraries:

- Explored multiple libraries like Plotly, Matplotlib, and others to find the best fit for interactive visualizations. Despite challenges, gained valuable insights into their capabilities and limitations.

Initial LLM Integration Attempts:

- Started integrating LLMs (e.g., GPT-4) to assist with code generation for the dashboard. Encountered challenges with accurate and functional code generation but laid the groundwork for future improvements.

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FUTURE VISION

Automated Dashboard Generation Using LLMs:

- Given time and opportunity, I envision developing an application where LLMs can be trained to understand the requirements and generate dashboards automatically. This involves defining parameters, providing situational examples, and allowing the LLMs to create various dashboards using H2O Wave.

Customizable and Dynamic Dashboards:

- Users can specify their requirements through a user-friendly interface, and the LLM-powered backend will generate tailored dashboards. This approach will significantly reduce the time and effort required to create complex, data-driven visualizations.

Enhanced Analytical Capabilities:

- Integrating advanced analytics and machine learning capabilities directly into the dashboard to provide actionable insights and predictive maintenance recommendations.


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