INTERNSHIP REPORT

Weather-Based Prediction of Wind Turbine Energy Output

A Next-Generation Approach to Renewable Energy Management

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1. Introduction

Renewable energy plays a major role in modern power systems. Wind energy is one of the most widely used renewable energy sources. However, electricity generated by wind turbines depends on weather conditions such as wind speed, wind direction, and temperature. Since weather conditions change frequently, wind energy production also varies. This project develops a machine learning-based system that predicts wind turbine electricity output using weather data.

2. Problem Statement

Wind turbines generate electricity based on weather conditions. Because weather is unpredictable, electricity production changes continuously. This creates challenges in forecasting power generation, planning maintenance, and managing power supply and demand. Inaccurate predictions may lead to power shortages and increased costs. Therefore, a predictive system is required to estimate wind turbine energy output accurately.

3. Objectives

- Collect historical weather and wind turbine data.
- Clean and preprocess the dataset.
- Build a machine learning model for prediction.
- Evaluate model performance using MAE, RMSE, and R^2 score.
- Develop a web-based interface for real-time prediction.

4. Requirement Analysis

Functional Requirements

- Users can enter weather details such as wind speed and direction.
- System automatically processes the input data.
- Machine learning model predicts wind turbine power output.
- Predicted result is displayed on the screen.
- Model can be saved and loaded for future use.

Non-Functional Requirements

- Accurate and reliable predictions.
- Fast response time.
- User-friendly interface.
- Secure data handling.

5. Project Planning

Historical wind farm data was collected and used for training. Data cleaning included removing invalid records, handling missing values using interpolation, and scaling features. Random Forest Regressor was selected due to its ability to handle non-linear relationships and reduce overfitting.

6. System Design

The system includes data collection, preprocessing, machine learning model training, and a Flask-based web application. The trained model is saved and integrated into the web application for real-time prediction.

7. Project Development

An 80/20 train-test split was used for validation. Performance metrics such as R^2, MAE, and RMSE were used to evaluate accuracy. The Flask web application allows users to input weather parameters and receive predicted energy output instantly.

8. Results and Testing

The Random Forest model achieved good prediction accuracy. User testing confirmed that the system provides quick and reliable predictions.

9. Conclusion

The project successfully developed a machine learning-based wind energy prediction system. The system supports better renewable energy management and efficient power planning.

10. Future Scope

- Integration with real-time weather API.
- Use of advanced models like LSTM.
- Cloud deployment.
- Development of maintenance alert system.