DESIGN AND OPTIMIZATION STUDY OF A WIND VERTICAL SYSTEM

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1st Semester 2021/2022 (GP1)

ABSTRACT

The aim of this project is design and optimization of Vertical axis wind turbine with vibration analysis that can be mounted to any structure in order to supply sufficient energy. The project involved a comprehensive literature review on different types of renewable energy systems, comparison between VAWT and HAWT systems and wind resource assessment. Different methodologies of optimization were performed. Two methodologies selected for this study were Particle Swarm Optimization (PSO) and Genetic Algorithm (GA). Mechanical vibration models for VAWT systems were reviewed. The proposed design of VAWT selected for development in Project 2 was modified H-Darrieus wind turbine based on literature reviewed.

OBJECTIVES

The objectives of this project are:

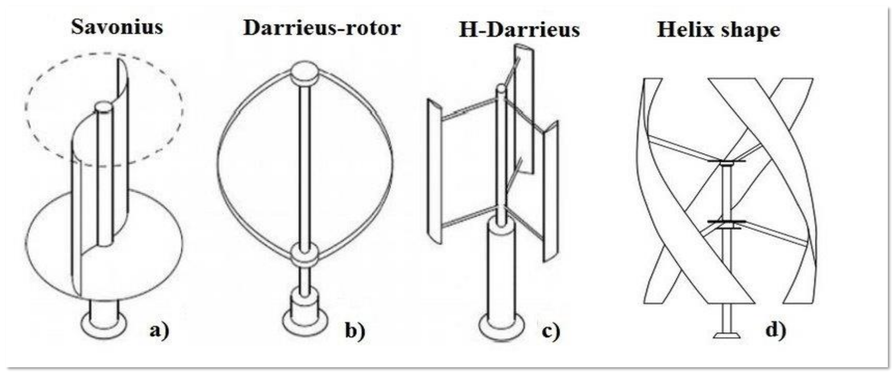
- Bibliographic study on renewable energy and different wind energy systems.
- Bibliographic study on different types of vertical axis wind turbines.
- Optimization methods used in design.
- Vibration problems in vertical axis wind turbines.

DESCRIPTION

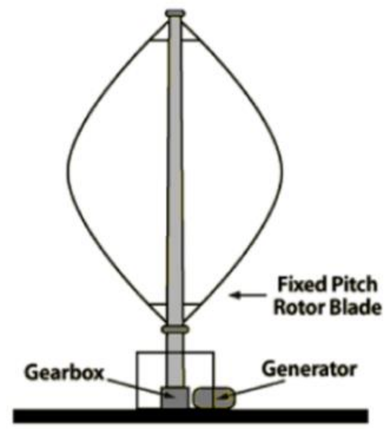
Renewable energy is any form of energy that does not produce emissions and does not need the action of burning of nonrenewable resources like coal, oil or wood to produce power, rather, it receives energy from the sun, geothermal heat, wind, sea tides and waves.

The main components of a wind energy system consist of turbine blades, generator, gearbox, bearings, and tower.

COMMON TYPES OF VAWT



Common types of vertical axis wind turbines.



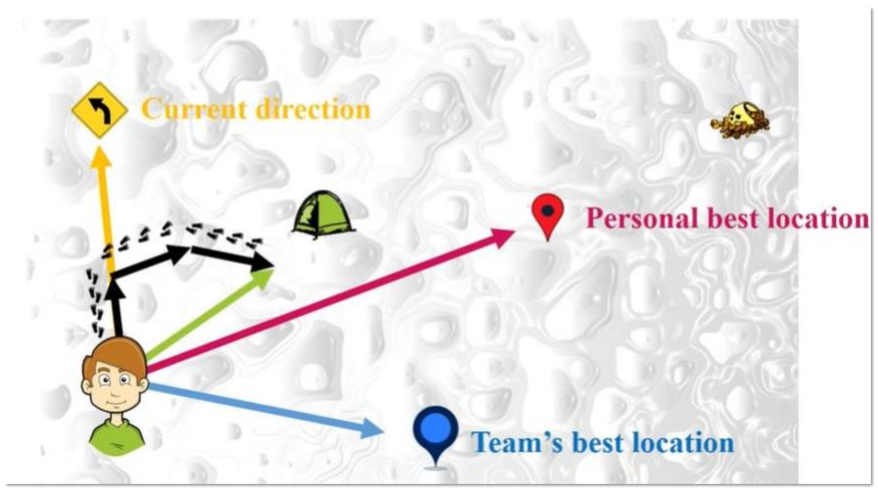
Common parts of vertical axis wind turbines.

PARTICLE SWARM OPTIMIZATION

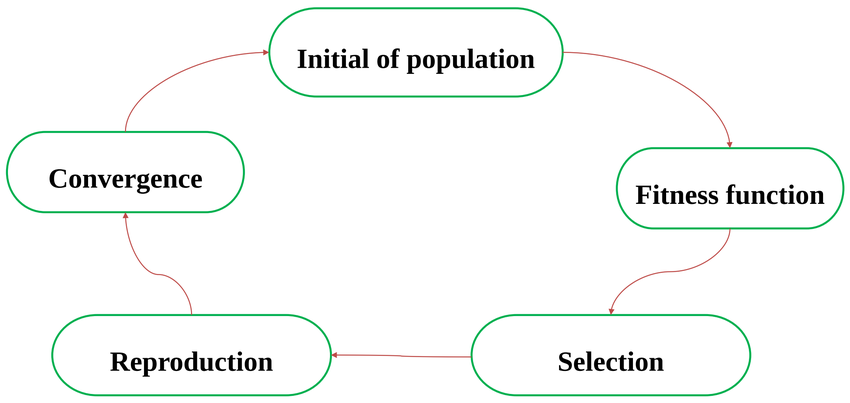
$$\overrightarrow{V_i^{d+1}} = 2r_1\overrightarrow{V_i^d} + 2r_2\left(\overrightarrow{P_i^d} - \overrightarrow{X_i^d}\right) + 2r_3\left(\overrightarrow{G^d} - \overrightarrow{X_i^d}\right)$$

Next velocity (tomorrow) | Current velocity (today) | Personal best solution | Global best solution | Distance to the personal best | Distance to the global best

Mathematical model of PSO.



PSO Search Strategy.

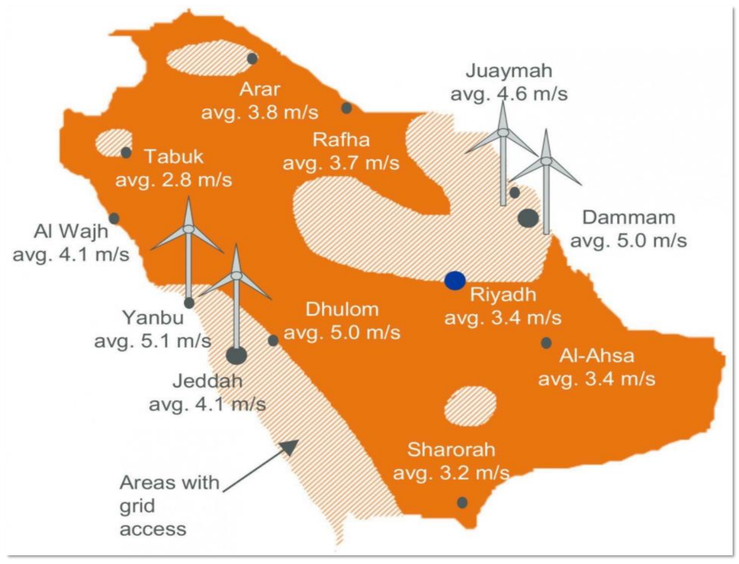


Genetic algorithm cycle.

ADVANTAGES OF VAWT

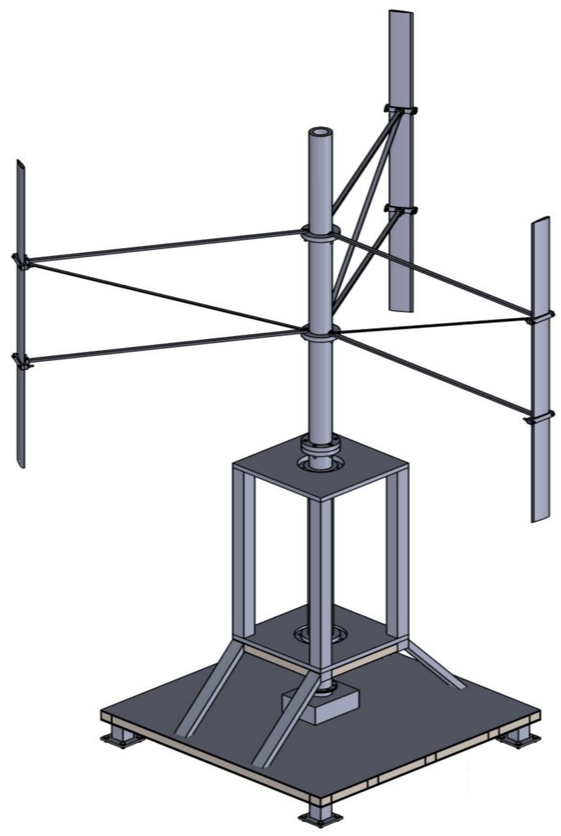
- VAWT work in all wind directions
- Does not need more area for installation
- Small tower sway
- Less noise

WIND RESOURCE IN KSA



Wind speeds of KSA measured at 10 m height.

PROPOSAL DESIGN



Modified H-Darrieus VAWT design.

CONCLUSION

VAWT was selected for this project. They are ideal for homes and small farms. The most common VAWTs were Savonius, Darrieus, H-Darrieus, and Helix wind turbines. The selected concept of VAWT is H-darrieus to be modified in future work.