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2016 SATU Joint Research Scheme Program

Host Application Form

Date: 2016 / 04 / 22 (year /month/day)

1. Host University

University of Malaya (Kuala Lumpur, Malaysia)

2. Host Unit

Department of Mechanical Engineering, Faculty of Engineering

3. Joint Research Project Title

Design, Fabrication and Testing of the Novel Cross Axis Wind Turbine

4. Principal Investigator

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6. Project Details

Project Description

Wind turbines can be categorized into two basic types determined by which way the turbine spins/ They are vertical axis wind turbine (VAWT) and horizontal axis wind turbine (HAWT). There are various disadvantages of both of the VAWT and the HAWT. This project aims to overcome the drawbacks of these two different types of wind turbines by proposing a novel cross axis wind turbine (CAWT) that can overcome the disadvantages of each wind turbine type while being capable of a maximum exploitation of wind power irrespective of the direction of the wind blowing, without necessitating any type of orientation mechanism and furthermore provides a better self-starting capabilities. To further illustrate the disadvantages in terms of on-coming wind directions for the HAWT and VAWT, Figure 1 shows that these conventional wind turbines rely heavily on one horizontal wind direction. Moreover, the HAWT requires a yaw mechanism to rotate its rotor to face the oncoming wind. Although the VAWT is an omni-directional wind energy device, it is just limited to one direction only with winds coming from the horizontal direction. The VAWT also have a poor starting behavior especially for low wind speeds region. On top of that, the wind conditions in urban areas require specially designed wind turbine to maximize the potentials of wind energy, hence the novel cross axis wind turbine is proposed.

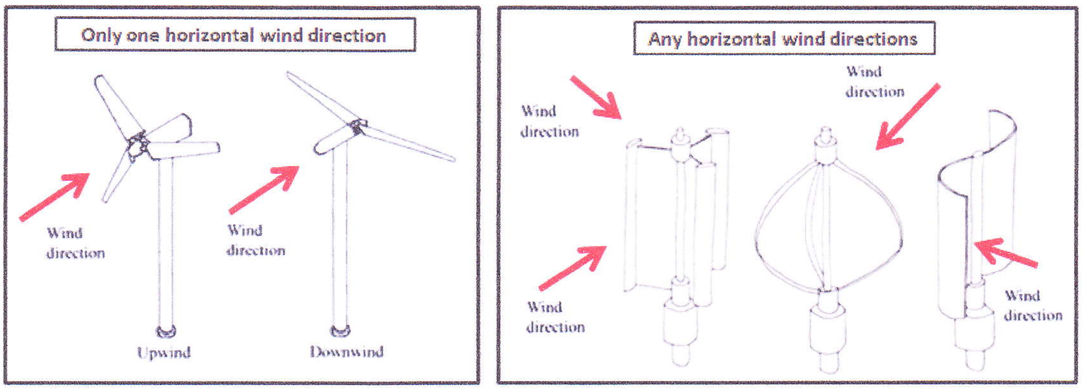

Figure 1. Comparison between wind direction for horizontal axis wind turbine and vertical axis wind turbine

The cross axis wind turbine (CAWT) comprises of a supportive frame, a turbine rotor assembly mounted on the supportive frame and rotates on its vertical axis. For converting kinetic energy caused by the movement of the turbine rotor assembly to electrical energy and mechanical energy; an electric generator is connected to the turbine assembly. The CAWT has three main vertical blades that are connected to the six horizontal blades via specially designed connectors. This arrangement forms the cross axis wind turbine. The significant advantage of the CAWT is that it can function

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with air flow that is omni-directional from the sides for the vertical axis wind turbine, and from the bottom of the turbine through the horizontal axis blade (see Fig. 2). The horizontal blades act as the radial arms of the CAWT, connecting the hub to the vertical blades. The vertical wind flow, either created by a building or a structure called the deflector, interacts with the aerofoil-shaped arms (Figure 3). These radial arms act as a HAWT to create a lift force which in turn produces an aero-levitation force. The force reduces the bearing frictions in the generator, hence extending the lifespan of the wind turbine. Furthermore, the aerofoil-shaped arms enhance the self-starting ability of the CAWT, and improve the performance of the entire wind turbine by maximizing the utilization of energy from the wind. The novel design of the CAWT is aimed to build a compact wind turbine system that can operate in an area having complex wind pattern and low wind speed, and moreover can overcome the disadvantages of both the VAWT and the HAWT.

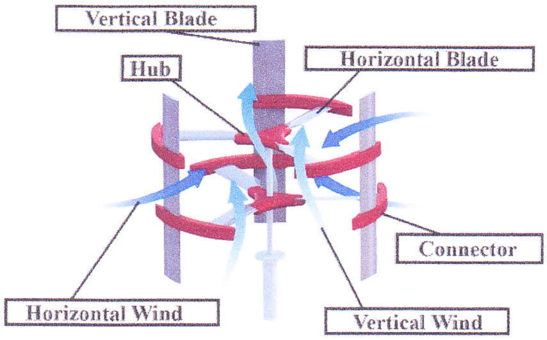
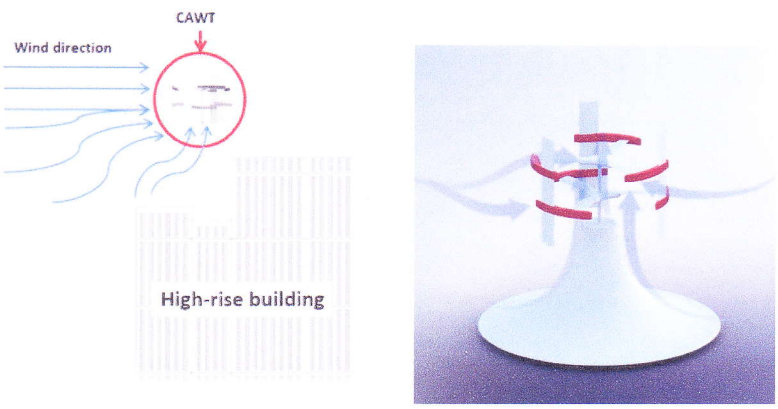


Figure 2. General arrangement of the CAWT (arrows show the vertical and horizontal wind directions)



(a) (b)

Figure 3. (a) The CAWT on a high-rise building with wind flow directions

(b) CAWT integrated with deflector

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	The CAWT will be fabricated and experiment will be conducted on a number of parameters, i.e. rotational speed and power performance in order to get an optimum design with higher efficiency, less material and cost effective. The design works are divided into three tasks; a) Design the shape and geometry of the CAWT and the test rig, b) Design the basic structure of the CAWT for field work implementation, and c) Design the arrangement and configuration of the generator for optimum integration with the CAWT. Then, simulation and experiment will be carried out in order to optimize the design and evaluate basic performances. With the CAWT prototype, testing and data collection will be conducted. In this stage, detailed analysis, troubleshooting and redesigning will be carried out. Wind tunnel testing for different configurations of CAWT models over a considerable range of velocities would be carried out; including flow characteristic visualization, wind velocities measurement, pressure measurement, start-up time, vibration, noise, stability and wind turbine power efficiency measurement. The wind tunnel test result will be correlated and validated with the computational fluid dynamics (CFD) simulation results for performance evaluation and to continue developing the CAWT. Completing the design and analyses stages, an actual size pilot prototype of the entire system will be fabricated. The integration of each sub-system and the functionality of the whole system will be examined.

7. Acknowledgement (Signed by the President or SATU representative to show recognition)

Name
title

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_______________(signature)

Date: 2016 / 04 / 25 (yyyy/mm/dd)

Please email satu@email.ncku.edu.tw before 2016.4. 29(Fri.) for application with the subject line: < 2016 SATU JRS host application –School Name>. Thank you.