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Subject Area	Environmental Engineering	

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Flow regimes in vertical axis wind turbines

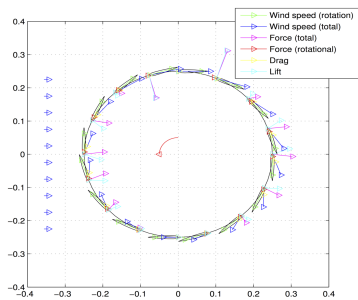## Exchange study at Nanyang Technological University in Singapore
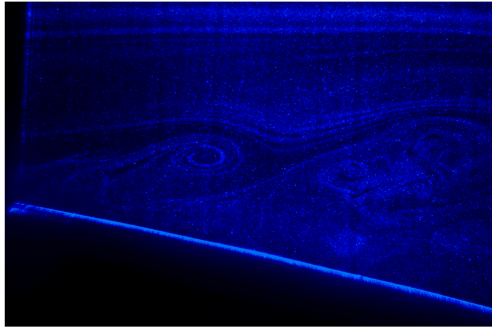
Particle image velocimetry picture of NACA 0012 profile in wind tunnel

Acting forces on blade with tip speed ratio 2.5 and 5 m/s wind speed

Introduction: This study examines flow regimes at an airfoil operating in a vertical axis wind turbine. It covers explanation of relation between determined drag and lift coefficients and their influences on operating parameters. First part is focused to figure out pressure distribution, drag and lift coefficients from blade. Simulation of generated power from wind turbine is implemented in a Matlab model.

Procedure/Result: XFOIL was used to deliver automated drag and lift coefficients. It provides a fast generation of further profiles coefficients from NACA 0015, NACA 0018, NACA 0021 and NACA 0024. For more detailed view were some CFD simulations with Ansys CFX done. Validation of determined coefficients was done with some references and wind tunnel measurements with NACA 0012 profile. Particle image velocimetry was used to provide better visualization of flow regime.

Task: The next step was the development of a vertical axis wind turbine model in Matlab. It determines energy output of operating wind turbine with 60 points evaluated during one rotation. The accuracy of results was improved with implementation of single stream tube model. Which considers the law of momentum conservation. With acquired knowledge from both parts of study. Consequences of determined coefficients to optimal operating point and resultant energy output is discussed. Furthermore are coefficients highly dependent on chosen operating point. Some approaches were evaluated to reduce drawback of stall. Solving of challenges was targeted without support of pitch adjustment. Since it increases operating and maintenance cost of turbine. All parts of thesis are focusing to improve overall energy output of vertical axis wind turbine.
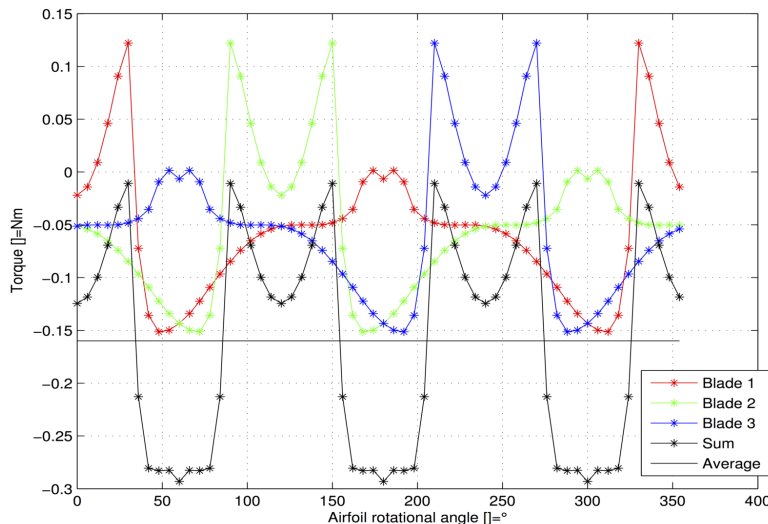
Resultant torque with 3 blade vertical axis wind turbine