Title: An Experimental and Theoretical Study of Autorotation: Application to Airborne Wind Energy Harvesting

The growing demand for energy and the push to decrease greenhouse emissions has brought about a rise in the popularity of renewable energy systems. One of the most popular renewable energy systems is the wind turbine. However, the wind turbine has several inherent limitations, namely that it only generates power in the presence of sufficiently high and consistent wind speeds. As a result, wind farms are typically built in areas with a high probability of the required wind speeds, which are located in limited parts of the globe. One way of overcoming this drawback is to tap into the energy available in winds at high altitudes which are not only consistent and of sufficient magnitude, but also globally pervasive. An airborne wind energy device based upon the phenomenon could potentially be used to exploit the vast quantities of energy present at high altitudes.

The work in this thesis first presents our study of a tethered-airfoil system as a candidate AWE system. A mathematical model was used to show the feasibility of energy capture and the stability of the device in a wind field. Subsequently, the research identified an autogyro to be better suited for high altitude energy harvesting. To this end, the thesis first presents a theoretical basis of the principle of autorotation, which is developed from existing models in literature. The model was adapted to predict aerodynamic conditions when used for harvesting energy. Encouraging simulation results prompted the main emphasis of this thesis, namely design of experiments to corroborate theory. Several experiments were devised to determine basic performance characteristics of an autogyro rotor and the data from each experiment is presented. Finally, we provide some conclusions and make comments on improvements which can be made for future experimentation.

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The public is welcome to attend.