Diplomand	Martin Schön
Dozent	Dipl. Ing. ETH Dejan Romancuk
Projektpartner	Aurora Swiss Aerospace
Experte	Dipl. Ing. ETH Andreas Fleckenstein
Themengebiet	Produktentwicklung & Mechatronik

Folding Propeller Design Concept

Introduction

Urban air mobility (UAM) is about extending the current passenger transport in urban environments into airspace. The population of urban areas is constantly increasing. The UAM is intended to counteract the resulting increase in urban transport on the ground. Autonomous air taxis will be used as transport components in the future. Aurora Swiss Aerospace is a development company affiliated to the Boeing Group. In connection with UAM, they are working on a concept study for an air taxi / passenger air vehicle (PAV, Fig.1). The PAV successfully made its maiden flight on 22 January 2019 in Manassas, Virginia, USA.

This autonomous flight system is a combination between an octa copter and an aircraft. During the flight phase, the eight unused engines and their propellers create high air resistances. The aim of this bachelor thesis is to define a concept for a folding propeller mechanism that minimizes this aerodynamic drag during the flight phase.

Fig. 1: Aurora's Passenger Air Vehicle

Procedure

After the task has been discussed in detail with the client, a requirement list is defined. This requirement list is compiled using a mission definition of the PAV. On the one hand, Aurora's inputs are used for the definition of the requirements review. On the other hand, the EASA certification specifications CS-23 (normal, utility, aerobatic, and commuter category aeroplanes) & CS-27 (small rotorcraft) are also considered. After considerable research, a morphological box is used to work out possible solutions for the subfunctions and to evaluate them with predefined weighted evaluation criteria. This evaluation provides the foundation for the subsequent concept development.

A calculation tool was used to approximate the loads on a propeller mount (Fig. 2). The preliminary sizing of the mounting support of the six propeller blades was performed with these loads.

Subsequently, a digital model was set-up by CAD (Fig. 3). Since the mechanism included a locking mechanism for the extended state, a multi-body simulation was carried out in Siemens NX Motion to examine the kinematics for the extension and retraction processes and to check their feasibility.

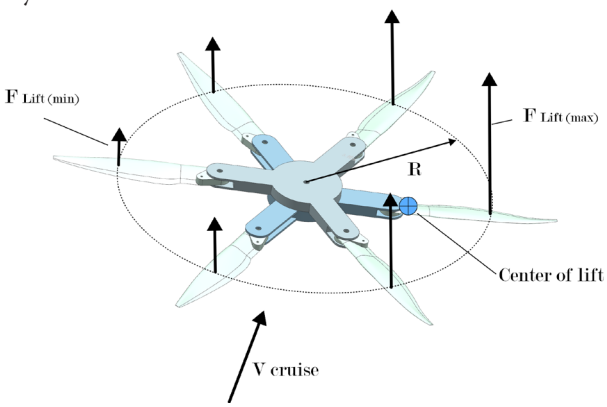

Fig. 2: Qualitative representation of the lift forces on the propeller blades

Results

The multibody simulation shows that the mechanism with its locking mechanism works. A further simulation shows, that the aerodynamic drag could be reduced by 34 % compared to a comparable five blade propeller at a cruise speed of 50 m/s. For the possible further examination of the project, the individual upcoming project steps are shown as well.

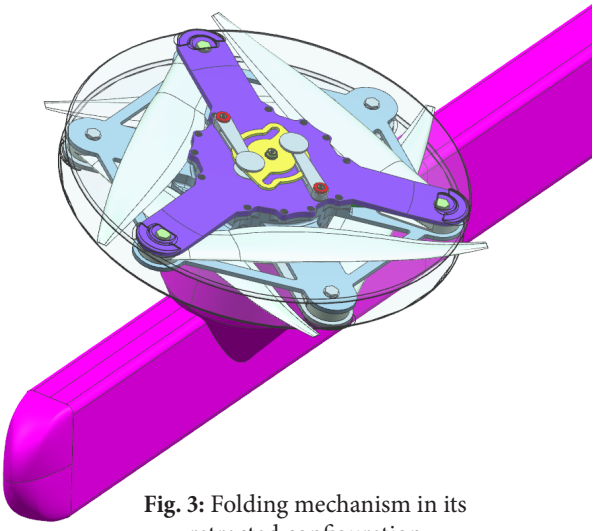

Fig. 3: Folding mechanism in its retracted configuration