

myCopter

Enabling Technologies for Personal Aerial Transportation Systems

Project status after 2.5 years

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Current means of transportation for daily commuting are reaching their limits during peak travel times, which results in environmental issues due to wasted fuel and loss of time and money. A study commissioned by the European Union entitled 'Out of the Box' considers a personal aerial transportation system (PATS) as a viable alternative for transportation to and from work. The study also acknowledges that developing such a transportation system should not focus on designing a new flying vehicle for personal use. Countless inventions have already been studied in previous decades and some have even been built, but these vehicles never evolved into a PATS that is ready for large-scale commuting purposes.

Instead of focusing on the technical requirements and construction of a vehicle itself, the *myCopter* project investigates the necessary requirements for establishing a personal aerial transportation system. In this project we aim to determine the social and technological aspects needed to set up a transportation system based on personal aerial vehicles (PAVs). The *myCopter* project focuses on three research areas: social acceptance, automation technologies, and human-machine interfaces and training.

Acceptance by society

In order for a PATS to be a viable transportation alternative, it will have to integrate seamlessly in the existing transportation environment. PAVs will have to be safe, cost-effective and socially acceptable. Thus, we employ technology assessment methodologies to assess how a PATS can become part of the current transportation systems. In 90% of the cases, commuting trips are shorter than 25 km and rarely exceed 30 minutes. Peak hour delays on such trips are generally about 15 to 20 minutes. These figures provide a clear framework in which PAVs will have to operate if they are to provide a solution to congestion problems. Furthermore, in order to be accepted by society, PAVs will have to deal with various safety concerns, legal issues, ecological aspects and noise.

In tandem, we rely extensively on focus group interviews to determine expectations of the potential user; a PATS will never take off without societal acceptance. These methodologies are rarely jointly used, which makes the *myCopter* project a pioneering effort in the area of personal transportation. We are conducting these interviews in different European countries and discuss mobility patterns as well as perceived

promises and actual expectations for a personal air transport system. Interviewees will also experience a PAV ride on a simulator, such that PAV-specific aspects such as design, the operational environment, autonomy, usability, and more can be discussed. This will give us novel insights into the critical user expectations that should need to be fulfilled prior to public acceptance of a PATS.

Automation technologies for PAVs

We consider vehicle automation to be a primary technological requirement for PAVs. Contrary to cars, PAVs with vertical take-off capabilities are not inherently stable. A pilot would need to continuously control the vehicle to keep it comfortably aloft. Automation technologies can enhance the stability of vehicle response such that laypersons can fly PAVs without taking a comprehensive pilot's training course.

Automation technologies also will be needed to perform safety-critical tasks such as collision avoidance and automatic take-off and landing. This requires the use of many novel sensor capabilities. Within *myCopter*, we are integrating vision-based sensors and corresponding computer vision algorithms in unmanned flying vehicles. By fusing vision sensors with others such as low-cost radar modules, we can fly the vehicles autonomously. We take inspiration from nature by developing algorithms that let PAVs fly in swarms and that use collision avoidance strategies based on vision. In this way, PAVs can fly in groups along highways to minimise their impact on urban areas.

In the first 2.5 years of the *myCopter* project we have achieved autonomous flight with an unmanned flying vehicle based on camera vision. Currently, we are extending this approach by implementing path planning capabilities to perform navigation at low altitudes in dynamic environments. This includes generating maps of unknown spaces, circumventing featureless areas to avoid mislocalisation and optimising paths around obstacles. Furthermore, we have developed vision-aided automatic take-off and landing algorithms that recover 3D surface information from a single camera image. These algorithms can be used to autonomously select an appropriate landing site.

Intuitive control of PAVs

It is crucial for PAV control interfaces to be designed in an intuitive way, because PAV users can be expected to have only limited flight training. Within *myCopter* we investigate the necessary degree of automation and the extent to which people can be trained to fly PAVs effectively. Novel human-machine interfaces, such as Highway-in-the-Sky displays, provide an intuitive visual display of the flight trajectory. Additional haptic guidance forces on the control stick allow the pilot to "feel" the prescribed tunnel trajectory and can provide alerting cues when the pilot deviates from the desired flight path. These technologies are tested in various flight simulators and the most promising ones are implemented and evaluated in real flight on an experimental helicopter.

We have implemented an augmented PAV dynamic model that can simulate various vehicle dynamics. The most basic response types reflect helicopter rate responses, which are augmented to reflect, e.g., translational rate commands, turn coordination,

heave augmentation, or car-like steering. With this model we are able to evaluate the use of novel control inceptors (e.g., steering wheel or active sidesticks) in operating a PAV. In addition, we are developing multi-sensory human-machine interfaces that use haptic cues to provide PAV pilots with guidance cues that are felt as forces on the control inceptor. Last but not least, we are investigating the use of psycho-physiological measures to objectively determine the workload of PAV users, such that workload can be determined continuously and directly during execution of the task, without interfering with the task or the pilot.

The final year of the project

In the final year of the *myCopter* project, which runs until the end of 2014, we will focus our efforts on implementing the developed technologies and demonstrating them to stakeholders at a public workshop at the German Aerospace Center DLR in Braunschweig, Germany. This will include demonstrating our developed automation technologies in flight on unmanned aerial vehicles. We will use multiple vehicles to evaluate swarm behaviour and collision avoidance strategies. Furthermore, we will verify selected enabling technologies in flight with the DLR Flying Helicopter Simulator. This experimental helicopter is equipped with many sensors, reconfigurable pilot controls and displays such that we can validate HMI concepts, novel display systems and automation technologies in an environment that most resembles an actual PAV in flight.

More information on the *myCopter* project can be found at <http://www.mycopter.eu>.