myCopter
newsletter #2

This is the second newsletter for the project myCopter, funded by the European Union under the 7th Framework Program.

First progress meeting

The first progress meeting for the project was held in the Foresight Centre at The University of Liverpool, in Liverpool, United Kingdom. Apart from representatives of all project partners, our project officer from the European Union also attended the meeting. On two consecutive days we discussed the progress of the project and presented the future goals of each individual work package.

Project members in Liverpool

HELIFLIGHT-R at The University of Liverpool

Being in Liverpool provided us with the opportunity to evaluate the first version of a model for the dynamics of a generic, highly-augmented Personal Aerial Vehicle (PAV) on the HELIFLIGHT-R simulator. A swarm flight scenario had been set up on this research simulator and all participants could experience the dynamic PAV behavior that is considered to be required for an average user.

Scientific progress

We have achieved significant progress in the first year of the project. Several tasks that we already completed are highlighted below.

Updated vehicle model

The dynamic vehicle model for a generic representation of PAV-like flight behavior was upgraded to include additional response types. Now it is possible to command the translational rate for the vehicle longitudinal and lateral axes and also provide a sideslip command in the directional axis. Additionally, a 'hybrid' mode has been introduced that features multiple response types in different regions of the flight envelope.

Fixed-base flight simulator

We implemented the generic PAV model in a fixed-based flight simulator that is equipped to measure explicit and implicit behavioral responses, such as control stick inputs as well as eye-tracking and physiological measures. The simulator affords a large field of view of 105° x 100°. A preliminary experiment has been performed with an expert helicopter pilot to evaluate gaze and motor control in a manual flying task. A range of tasks for basic flight was defined together with the pilot and a protocol for testing was established. This protocol will be used in experiments with flight-naïve participants.

Assessment of self-localization algorithms

We performed a survey on localization algorithms based on the consideration that the available power, weight and computational budget on-board of a small air vehicle are restricted. This survey lead to the conclusion that current technology can support the use of sensor feeds from a camera, inertial measurement units, GPS receivers, magnetometers and air-pressure sensors. Following preliminary tests, we propose a versatile framework to tackle pose estimation for real-time operation under general conditions. Challenges like operation in GPS-denied environments, high motion dynamics and highly unsynchronized sensor inputs are taken into consideration. This framework will be developed for tasks such as take-off, navigation, landing and obstacle avoidance. In the next steps, GPS signals will be integrated into the system and we will undertake migration from a traditional pinhole camera model to a wide-angle camera.

Fixed-base flight simulator at the Max Planck Institute for Biological Cybernetics

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Review of collision avoidance sensing technologies

We completed a review of collision avoidance sensing technologies, which led us to propose a sensor package using RADAR, vision, GPS and a reliable ad-hoc communication system. Evaluations with very small and low-cost Doppler radar modules, dielectric lenses and signal processing provide promising results that will allow the design of a multi-beam radar system that is suitable for the deployment on a small flying vehicle. Furthermore, we developed an algorithm in order to detect possible collision risks and the extrapolated separation distance for approaching objects from Doppler velocity data obtained from simple radar sensors.

Concept drawing of a multi-beam radar system using a single spherical microwave lens and multiple radar modules

In parallel to the sensor evaluations, we developed a real-time simulation program for large-scale 3D swarms. This allows the simulation of thousands of PAVs, using a simplified physics model, for experimenting with collective behavior, multi-vehicle coordination and collision avoidance. The generic PAV model is currently being integrated into the simulaton program.

Operational system components for PAVs

We analyzed the operational components of PAVs such that design features and options for PAVs and the supporting infrastructure can be established. PAVs are foreseen to be commuter vehicles and they shall provide point-to-point connections for typical commuting distances and should also be competitive to existing ground based transportation methods. We expect that a future PAV must exhibit 'super Level 1' handling qualities, which can be characterized by decoupled axes and a lack of compensatory control inputs. Conventional response types like rate or attitude command might not suffice for these demands, but higher-order response types like translational rate command or new, unconventional response types will need to be developed for PAVs.

In order to choose appropriate flight controls, we identified existing aircraft and car controls that are imaginable for future PAVs. Among them are conventional helicopter controls, side sticks, car-like controls, tilt-rotor power levers and combinations of these. Features like haptic cues and pilot displays for flight guidance are foreseen to contribute towards the applicability of these flight controls in a PAV scenario. All these options will contribute to a list of desirable features and options for PAVs and the supporting system.

Exploring the socio-technological environment

We identified the key issues that relate to the implementation of PAVs into the current transport system. The potential obstacles, challenges and opportunities of PAVs were described after an extensive literature research, which was performed on related research, regulations concerning light air vehicles, the use of automation, air safety, air traffic management, and unmanned aerial vehicles. Furthermore, we performed interviews with several experts from academia and industry on their views on a personal air transport system. Some of the issues that were identified included availability of a personal aerial vehicle due to weather and the legal aspects in terms of certification, qualification of the user, airspace regulations, and insurance. Future work will focus on several issues in more detail.

Conferences

HELI World 2011

Frank Nieuwenhuizen presented the myCopter project at HELI World 2011, a conference on helicopter technologies and operations. The conference was held during the AIRTEC exhibitions in Frankfurt, Germany. During the conference stakeholders from science and industry, as well as operators came together to present and discuss state-of-the-art structures, systems, sensors and services related to helicopter technologies and operations.

Abu Dhabi Air Expo

Heinrich Bülthoff was invited to present a keynote lecture on the myCopter project at the first and General Aviation Exhibition at Al Bateen Executive Airport, Abu Dhabi, UAE. He discussed ongoing research in our project such as the technologies needed to adapt helicopters for urban commuting. After the presentation, industry experts, manufacturers, and civil aviation experts joined Prof. Bülthoff for further discussions.

In the press

The myCopter project has featured in more than 35 news articles, such as in Der Spiegel. An overview is given on our website. And the number of subscribers to our newsletter has surpassed 160 people, ranging from private persons to industry representatives.

References

[1] Nieuwenhuizen, F. M., Jump, M., Perfect, P., White, M. D., Padfield, G. D., Floreano, D., Schill, F., Zufferey, J.-C., Fua, P., Bouabdallah, S., Siegwart, R., Meyer, S., Schippl, J., Decker, M., Gursky, B., Höfinger, M. and Bülthoff H.H. (2011) myCopter – Enabling Technologies for Personal Aerial Transportation Systems. Third International HELI World Conference 2011, Frankfurt, Germany.

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