myCopter: Enabling Technologies for Personal Aerial Transportation Systems

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The dream of Personal Aerial Vehicles

Technology exists to build aircraft for individual transport
• many concepts have already been developed

Drawbacks of current designs
• Need for of a pilot license
• Need for infrastructure (e.g., landing strip)
• Focus on vehicle design instead of transport system
Motivation for Personal Aviation

100 Billion Euro is lost yearly in the EU due to congestion

Motivation for Personal Aviation

20x more fuel is wasted in the USA in traffic jams than is used by the entire General Aviation fleet.

Motivation for Personal Aviation

In large European cities, car drivers spend more than 50 hours per year in traffic jams.

“Roadmap to a Single European Transport Area,” 2011
Challenges for Personal Aviation

“Designing the air vehicle is only a relative small part of overcoming the challenges… The other challenges remain…” [EC, 2007]

- How many?
- Who can fly?
- What about safety, noise, … ?
- How are PAVs integrated into existing transport systems?
EU-project: myCopter

- Duration: Jan 2011 – Dec 2014
- Project cost: €4,287,529
- Project funding: €3,424,534
Enabling Technologies for Personal Aviation

**mycOpter**

**Automation (vision-based)**
- Navigation
- Landing place assessment
- Sensor-fusion for collision avoidance

**Piloting PAVs**
- Shared control between human and automation
- Situational awareness

**Human-machine interfaces**
- Control interfaces and displays
- Multi-sensory feedback

**Exploring the socio-technological environment**
- Acceptance: noise, safety, fuel, cars in the sky
- Integration into current transport systems

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Novel Approaches to Automation

**Goal:** Develop robust novel algorithms for vision-based control and navigation

**Challenges**

- Emulate VFR pilots
  - Recognize obstacles and other traffic
  - Recognize landing areas
  - In all season and in adverse weather conditions
Framework for Vision-Based Navigation
Collision Avoidance Strategies

50 vehicles at the same altitude fly from a point on a circle to a point on the opposite side
Demonstration of Swarm Technology
Piloting PAVs

**Goal:** Develop augmentation for PAVs

**Challenges**

- Flying a helicopter is difficult and requires lots of training
- It is not clear which skills prospective pilots should have
Augmented PAV Dynamics

Develop and assess new response types for VTOL vehicles

Basic helicopter rate control with cyclic
::
  Attitude control (pitch and roll)
::
  Translation control (forward/lateral velocity)
  Turn coordination, heave augmentation
::
  Car-like steering
Human-Machine Interfaces

Goal: Develop human-machine interfaces that make flying as easy as driving a car

Challenges

• Current flight controls and displays are not intuitive
• Multisensory perception is not taken into account
• No reliable objective measurements of pilot workload
Intuitive Displays and Controls

• Highway-in-the-Sky display
• Active sidestick to feel the highway (spring-like guidance forces)
Multi-sensory Human-Machine Interfaces

Novel HMI: haptic shared control

- Combining the advantages of manual and automatic control
- The pilot remains in control and can overrule the automatic control system
Objective Measures for Workload using EEG

Novel mental workload measures

- Traditionally with questionnaires, such as NASA-TLX
- Alternative: psychophysiological measures, EEG, heart-rate variability, skin conductance
Human-Machine Interfaces

Exchange helicopter flight controls with a steering wheel and pedals
HMI Demonstration in DLR Simulator
The Socio-Technological Environment

**Goal:** Generate knowledge on the demands and preferences of society towards PAVs

**Challenges**
- Identifying hurdles for introducing PAVs
- User expectations and objections
- Investigating where PAVs could have an impact
How do people see Personal Air Transport?

Focus group interviews in 3 European countries to determine user perceptions and expectations

1. Discussion on mobility patterns and behaviour as well as perceived promises and actual expectations on PAV / PATS
2. Demonstration of a PAV ride in a simulator
3. Discussion on PAV-specific aspects such as design, operational environment, autonomy, usability, etc.
Where do we go from here?

Developing PAV handling with MPI’s high fidelity motion simulator

CableRobot Simulator: https://youtu.be/cJCsomGwdk0
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