myCopter – Enabling Technologies for Personal Aerial Transportation Systems

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http://www.mycopter.eu
The dream of a flying car

Technology exists to build aircraft for individual transport

- Many concepts have already been developed

Drawbacks of current designs

- Needs for a pilot license
- Focus on single vehicles
The challenges of personal aviation

Our goal is not to design a specific Personal Aerial Vehicle (PAV)
“Designing the air vehicle is only a relative small part of overcoming the challenges... The other challenges remain...” [EC, 2007]

We want to address the challenges of building a Personal Aerial Transportation System (PATS)

[EC, 2007] European Commission,
Out of the box - Ideas about the future of air transport, 2007
EU-project myCopter

- Duration: Jan 2011 - Dec 2014
- Project cost: €4,287,529
- Project funding: €3,424,534
Enabling technologies for a short distance commute

- Exploring the socio-technological environment
- Human-Machine Interaction and training issues
- Control and navigation of a single PAV
- Navigation of multiple PAVs, swarm-technology

Institutions involved:

- KIT (Karlsruhe Institute of Technology)
- Max-Planck-Institut für biologische Kybernetik
- DLR
- University of Liverpool
- ETH (Eidgenössische Technische Hochschule Zürich)
- EPFL (Ecole Polytechnique Fédérale de Lausanne)
Explorations of social and economic impact

The biggest hurdle is acceptance by society
- Safety concerns
- Legal issues
- Ecological aspects
- Noise

Perceptions, expectations and concerns
- Subjective judgements of technologies shape its development
- Expectations legitimise decisions and guide actions
- Concerns shape risk assessment and management
Which challenges are we addressing?

- 90% of commuting trips to work is shorter than 25 km and do not take longer than 30 minutes
- Peak hour delays in most European cities are generally about 15 to 20 minutes
- Weather may limit availability and reliability
- Key factors for transportation choice are availability, cost, reliability and door-to-door travel times
Training for “ab-initio” PAV users

Develop training requirements for PAV users

- Develop a model that provides very good handling qualities for easy flying
- Determine the level of training with non-pilots / car drivers
- Investigate emergency situations and the implications for training
Multi-sensory human-machine interfaces

Novel HMI: haptic shared control

- Combining the advantages of manual control and automatic control
- The pilot remains in control and can overrule the automatic control system
- Admittance measurements show how pilots are affected by the guidance forces
Objective measures for workload using EEG

Mental workload

- Function between resources demanded by the task and the resources available to the operator
- Measured traditionally with questionnaires, such as NASA-TLX
- Alternative: psychophysiological measures, particularly EEG to measure workload in piloted control tasks through ERPs

Event-related potentials (ERPs)
The response of the brain to a certain event (such as a sound)
Novel human-machine interfaces

Novel HMIs are needed for safe and efficient operation of PAVs

- Assess the perceptual and cognitive capabilities of average PAV users
- Novel inceptors: steering wheel
- Testing HMI technologies in a Flying Helicopter Simulator

Novel inceptors in the Flying Helicopter Simulator, DLR
A novel approach to control

Develop robust novel algorithms for vision-based control and navigation

Vision-aided localisation and navigation
- Estimate position in dynamic environments
- Build a 3D map for autonomous operation

Markus W. Achtelik, ETH Zürich
Vision-aided automatic take-off and landing

No ground based landing guidance, everything on board

- Proper landing place assessment and selection are paramount for safe PAV operations
- Onboard surface reconstruction to recover 3D surface information using a single camera
- Autonomous landing with visual cues
Decentralised air traffic control

Formation flying along flight corridors
- Global traffic control strategies require swarming behaviour
- Develop flocking algorithms with UAVs

Collision avoidance strategies: Take inspiration from crowd behaviour
- Distributed, collaborative, reactive, individual goals

Flocking behaviour, EPFL

Guy et al., Eurographics Symposium on Computer animation, 2010
UAVs flying in a swarm

- Low-cost, light-weight and easy to repair
- Evaluate collision avoidance strategies
  - Determine range and bearing of surrounding vehicles
  - Active (laser, sonar, radar) vs. passive sensors (vision, acoustic)
- Outdoor capable for realistic evaluations
Experimental validation of proposed technologies

Verify selected developed technologies in flight

Flying Helicopter Simulator

- Fly-by-wire / fly-by-light experimental helicopter
- Equipped with many sensors, reconfigurable pilot controls and displays
- Validate HMI concepts, novel display systems and automation technologies
PATS: a solution to congestion?

Volume of road transportation continues to increase

- Average occupancy rate: 1.5 persons per car
- For commuting: 1.2 persons per car!
- Severe congestion: 100 Billion € lost to European economy yearly

1.5 persons per car

Occupancy rates of passenger vehicles, eea.europa.eu
Strategic impacts of a PATS on the longer term

1. Potentially environmental benefits
   - Spending less time and thus energy in traffic
   - Energy efficiency with future engine technologies

2. Use developed technologies for general aviation
   - Automation, navigation, collision avoidance

3. Enhanced flexibility in urban planning
   - Fewer roads, bridges and less maintenance
   - Less conflicts in land usage
Thank you for your attention

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