Czech Technical University in Prague
http://www.cvut.cz

Milan Rollo, Martin Selecký, Tomáš Meiser
{rollom, selecmar, meiset}@fel.cvut.cz

Agent Technology Center
Department of Computer Science
Faculty of Electrical Engineering
Czech Technical University in Prague

9th February 2012

Outline

- available UAVs
  - Procerus UAV
  - Mikrokopter
  - LinkQuad
  - * Light sports aircraft

- hardware related issues
  - hw integration
  - autopilots
  - data/video transmission

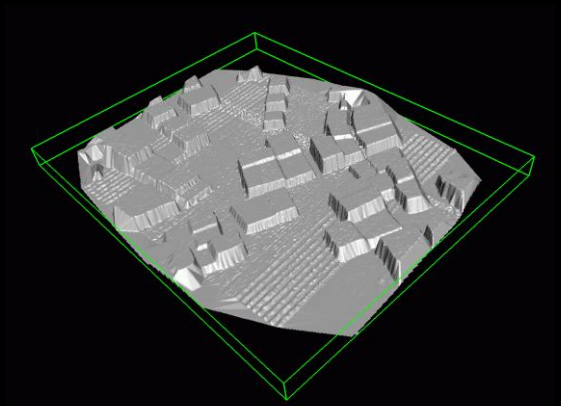
- research issues
  - trajectory planning (AA*, HexGrid, wind)
  - autonomous behavior of UAVs (team action planning)
  - collision avoidance
  - human-machine interface
  - mixed simulation

- legal issues
- videos

From Software to Hardware

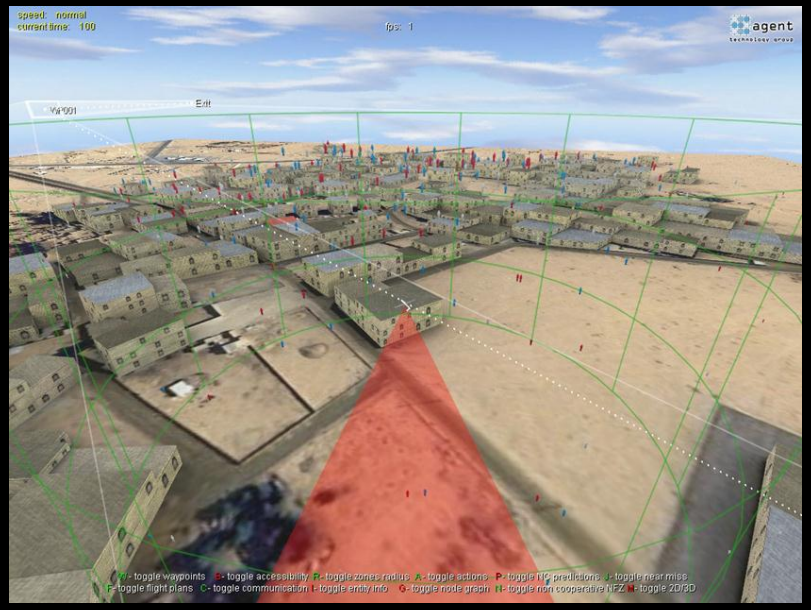
AgentFly multi-agent system for air-traffic control (both civilian and UAS oriented)

- autonomous agents for UAS collision avoidance
- AgentFly for tactical UAS control
- application for NextGen ATC
- human-machine interface design



- deployment of AgentFly to UAS platform
  - integration of imprecise flight execution
  - adaptation of parameters for current environment
  - flight execution monitoring

- information collection tasks
  - exploration
  - persistent surveillance
  - tracking
  - comm. network improvement



Procerus UAV

- Procerus UAS
  - made in US (export regulated by ITAR license)
  - fixed wing configuration EPP foam (wingspan 183 cm)
  - 4x 4Ah Li-Pol batteries for electronics and engine
  - on-board CPU modules – autopilot, image processing, AgentFly control
  - modems for data communication (869MHz) and video transmission (2.4GHz)
  - GPS unit, three-axis gyros, accelerometers, magnetometer, pressure-based airspeed and altimeter
  - gimbal color camera Sony, retractable system, motorized pan/tilt control, 10x zoom
  - ~40 minutes endurance, flight speed 50-100 km/h
  - take-off weight <7kg

- funded by Ministry of Defence of the Czech Republic, started July 2009

Mikrokopter

- Mikrokopter VTOL
  - modular multicopter system
  - aerial platform from 4 to 12 motors
  - capable of autonomous flight with NaviCtrl and GPS
  - optional control by cell phone (via Bluetooth)
  - flight behavior fully adjustable by MKTool

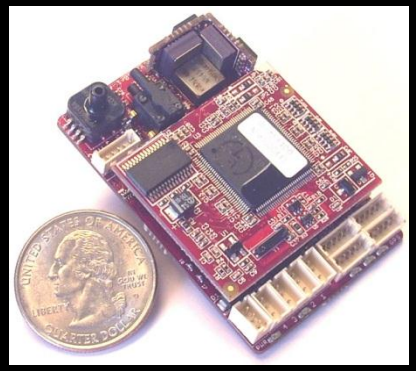
  - engine power 4 x 110 W
  - payload 300-700g (depends on battery)
  - 15-45 minutes endurance, flight speed ~35 km/h
  - 1x Li-Pol battery 11,1-14,6V
  - max. altitude 350 m
  - take-off weight <3kg

LinkQuad

- LinkQuad VTOL
  - similar to Mikrokopter
  - 4 engines, Li-Pol battery
  - 2x onboard Gumstix SOC
  - payload ~500g
  - 20 minutes endurance, flight speed ~35 km/h
  - take-off weight <3kg

Hardware

- autopilots
  - Kestrel
  - LinkBoard
  - Mikrokopter Flight Control



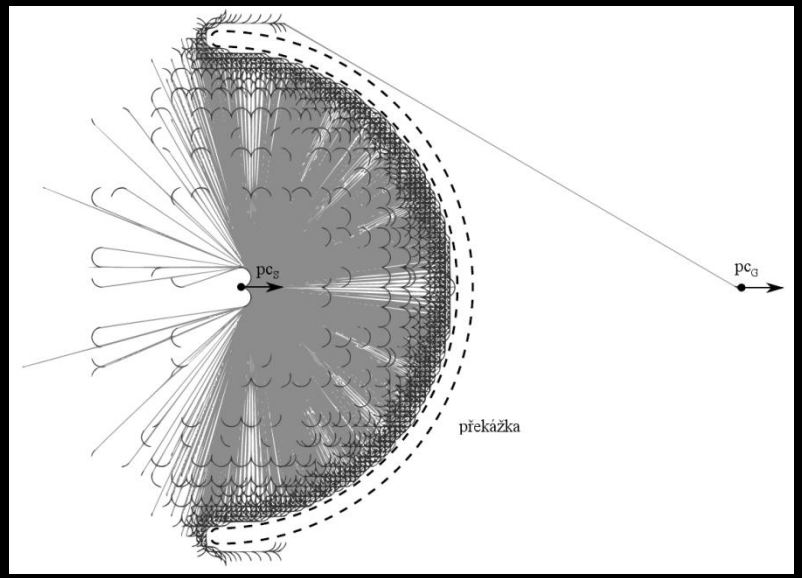
- communication
  - RC controllers (Futaba, Graupner)
  - ZigBee
  - data modem (Microhard Nano)
  - analog video
  - Gumstix wi-fi
  - blue tooth

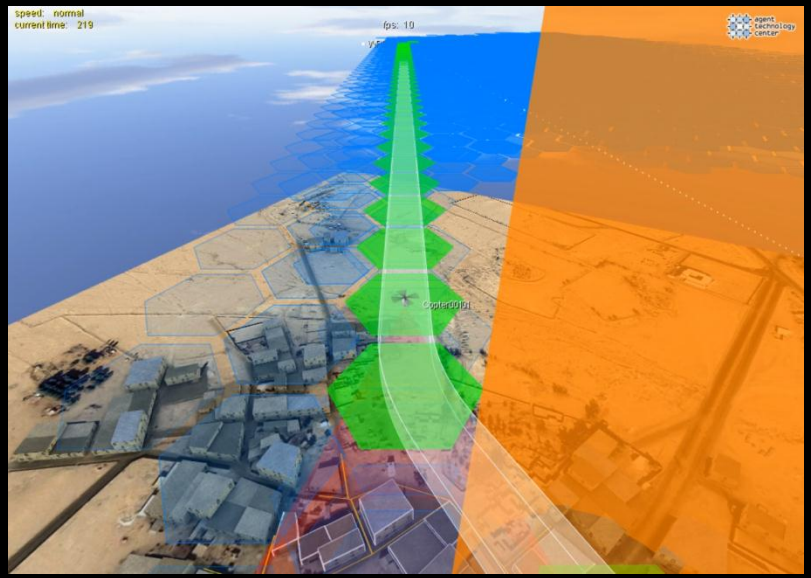
- onboard computers
  - Gumstix – ARM Cortex A8

- cameras
  - Sony BTC88R
  - DPX 201

Research Issues

- trajectory planning (AA*, HexGrid, wind)
  - limited computational resources
  - dynamic environment
    - no flight zones
    - terrain
    - other assets
    - replanning





Research Issues 2

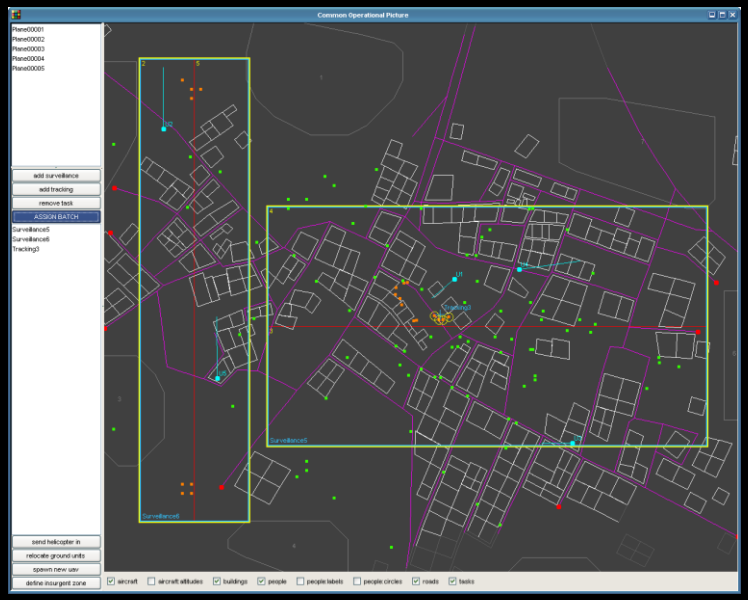
- autonomous behavior
  - combining surveillance, tracking, collision avoidance, etc.
  - multi-layered planning architecture
  - real-time coordination

- collision avoidance
  - cooperative/ * noncooperative
  - exchange of flight trajectories
  - conflict detection and resolution

- mixed simulation
  - combination of simulated and real units
  - rapid development of distributed algorithms
  - large-scale tests

Human – Machine Interface Design

- coordination of team of heterogeneous assets by one operator
  - information gathering and fusing
  - visualize common picture
  - collaboration with DCGI
  - deliver commands to units



- project D3CoS – Designing Dynamic Distributed Cooperative Human-Machine Systems
- application domains
  - aeronautics
  - automotive
  - maritime

- funded by Artemis Joint Undertaking since March 2011

Deployment on Light Sports Aircrafts

- project SAFEFLY
- advisory tool for cooperative and non-cooperative collision avoidance for domain of light sports aircrafts
- cooperation with industrial partners
  - TL elektronic (HW manufacturer)
  - F – AIR (flight school)
- integration of various HW devices
  - EFIS & EMS Integra
  - Zaon / FLARM
  - GPS, radio modems

- applied research, SW and HW prototype

- funded by Technology Agency of the Czech Rep. (TACR), started January 2011

Notes

- research funding
  - Czech Government (MoD, TACR)
  - European Commission
  - industry partners (both EU and US)
  - US defense agencies

- legal issues
  - Civil Aviation Authority (ÚCL)
  - regulation L2, annex X
  - insurance
  - accidents (UZPLN)

  - radio spectrum