Moving Humans Out of the Loop

Achieving True Autonomy in Aerial Robotics

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Overview

- Current commercial UAV market
- RC vs. UAV
- The human factor in UAV operations
- Considerations for airspace integration
- Required layers of autonomy
- COTS components for affordable enhanced autonomy
- UAVs as aerial robots
- Functional improvements – true autonomy
- Summary & Conclusions

Overview – Current Market

- Low cost, low quality systems prevail
- Poor airspace integration
- Room for operator error = risk of incidents
- Skilled operators required (insufficient automation)
- Operators use the cheapest systems available
- No quality control, no true engineering

Unmanned? …RC vs. UAV

- Current state of the art commercial drones:
  - Remote-controlled
  - Some can perform automated flight, but
    - No sense & avoid capability
    - No true autonomy (decision-making, etc.)
  - Poor safety/reliability track-record
  - Often not truly "engineered" products
  - Difficult to integrate into airspace

- ✓ Note: terminology varies slightly, e.g. UAV, UAS, RPAS. (also commercial vs. hobby/RC)

- ✓ In fact, many of present day commercial UAVs are modified hobby RC models

Aerial Robotics

- What makes Unmanned Aircraft Systems into aerial robots?
  - Automation
  - Sensing capabilities
  - Interaction with environment (sense & avoid, swarm operations, automated navigation, target tracking and following, etc.)
  - Complex operations
  - Collaboration with other systems (e.g. ground, marine)

Human Factor in UAS Operation

- Cheap systems affordable to virtually anyone
- Safety procedures often inadequate
- Skilled operators often required
- Handling, operation, accidents, distractions…
- Too much to know… not streamlined
- Communication key to safe operation
  - See and avoid
  - Payload operation
- Systems often built by nontechnical personnel

✓ Getting the human operator out of the loop can minimize incidents borne of the human factor

– GCS "cockpit" design/ergonomics, product maintainability, error-handling, safe launch & recovery,

http://helifreak.com/

http://www.theblaze.com/

http://safeflightcopters.com/

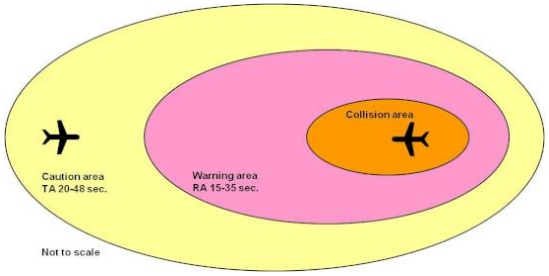
http://www.droneport.com/

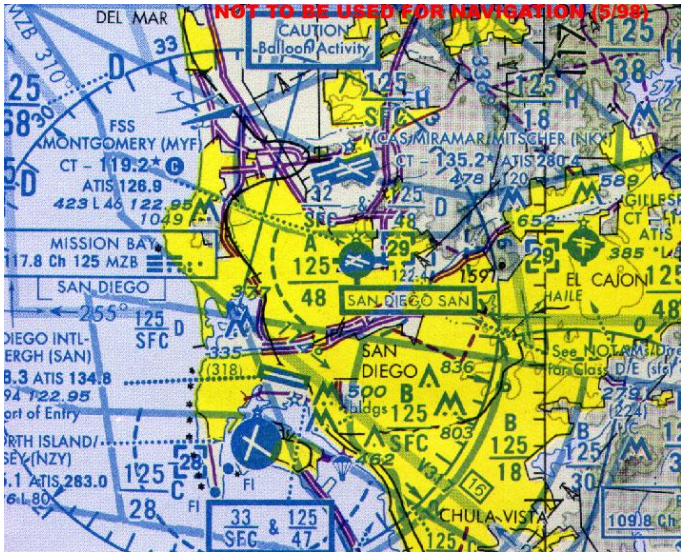
http://groundtruthexploration.com/

https://facwiki.cs.byu.edu/

Airspace Integration

- Operators are often not aviators
- Enhanced automation (and autonomy) is needed to eliminate operator error
- Higher reliability/robustness needed
- Additional failsafe modes needed

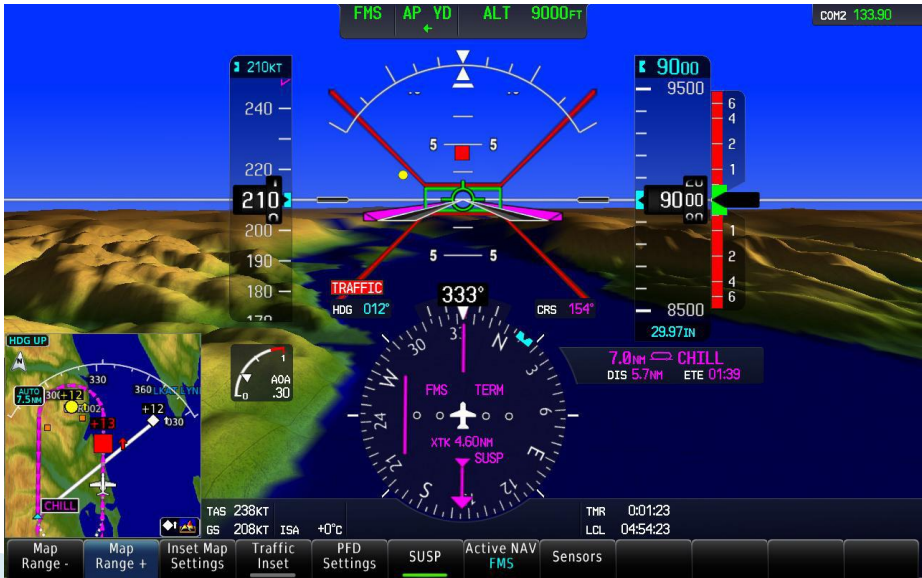




Need for Enhanced Automation

- Ground control stations that facilitate operation (beyond just flight data)
- Sense & avoid, traffic awareness and collision avoidance
- Interaction with ATC and air traffic
- Decisions-making (Autonomy!)

http://sarasotaavionics.com/



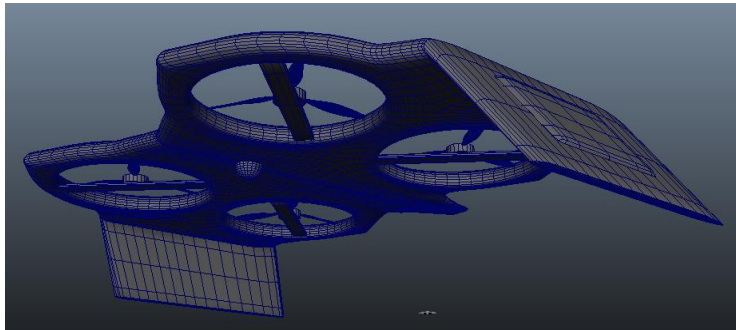
Support for Autonomy

- Multiple equipment types exist that can support autonomy. Some examples:
  - LiDAR (e.g. Flash LiDAR)
  - IR sensors
  - Ultrasonic sensors
  - EO Cameras (for use of machine vision)
  - Transponders
  - Radars (as small as 2kg)
- Flight controllers need little weight increase for added capability. Weight is the primary consideration!



Truly Autonomous UAS

- Pilot out of the loop: can monitor, approve launch or termination, take over
- Minimal mission-planning requirements
- System knows its surroundings and can interact with it
  - Implement a GIS database
  - Situational awareness, decision-making
  - Mission planning interface extremely simplified
- Examples?
  - Still under development… e.g. AerialX HummingBird



Summary & Conclusions

- Current state of the art in commercial UAS is not truly autonomous but rather remotely piloted
- Automation and efforts toward autonomy make UAS count as aerial robots
- Enhanced automation is important for safe airspace integration!