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#### Achieving GA FDM -Application of a lightweight recording system

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### Outline

- Background information
- Recorder chosen and test setup
- Results
  - Recording data validation
  - Image and audio qualities
  - Image identification, why?
- Instrumental image identification
  - Implication to FDM
- Concluding remarks

# Why GA FDM?

- Civil air transport becomes safer today
- Dealing with GA investigation most of time
- Challenges in GA investigation
  - 1. Accident scene in remote/ mountainous area
  - 2. Lack of data from navigation aids
  - 3. Lack of weather data
  - 4. Lack of terrain database
  - 5. Usually no mean of onboard recording device available
- Mostly loss of control in-flight (LOC-I) occurrences







#### Solution to enhance safety?





### Justification of LRS

- In Taiwan, most of aircraft under 5,700 kg / rotorcraft under 3,180 kg are not equipped with flight recorders.
- Availability, Affordability, and Applicability
- ED-155 (LRS min. performance specs) compliance?
- Investigative benefits: reduce time/cost, no need to entirely rely on witness interview, site survey, traditional investigation... etc.
- Operators/Owners' benefit: operation review, training, FOQA, FDM and SMS program



#### Recorder Chosen

- Compact size: 4" x 2.5" x 2"
- 8.8 oz (0.55 lbs) ~ 250 grams
- Self-contained data acquisition
- Supply Voltage 14 32V DC
- Crash hardened internal memory
- Removable memory (SD card):
- 16GB, 4 hrs of video, 200+ hrs of inertial data
- Internal memory: 8 GB (2 hrs of video)
- TC on AS350 / EC 135/145/175 / AW139 etc.
- STC on AS350 / AS365 / Bell 206 / AW109/ Cessna 172







## Recorder Chosen

Recorded parameters (4 Hz):

- GPS Location (Lat./Long./Alt.)
- Ground speed
- Vertical Speed
- Heading
- Pitch / Roll Attitude
- Pitch/ Roll/ Yaw rate
- Lat. / Long./ Normal acceleration
- Cockpit images (4 Hz), ambient audio and ATC communication





### Test Setup

- Three aircraft types: Bell206 / AS365 STOL CH-701 (ultra-light)
- Handheld GPS for data validation







#### Recording data validation





### Audio/Image qualities

- Images exported in 4 Hz and audio in pieces of 0.5 secs in 4 Hz.
- Image resolution 1600x1200 pixels
- Powerplant / rotor data collected from images and audio
- Audio needs stitching or direct re-recording before use
- AS365 main rotor frequency matches that in ASC database



# Why analyze images?

- An advantage over advanced integrated avionic system
- Images contain information not recorded as parameters
- Powerplant related data particularly important for V1000
- Area of interest:
  - Main rotor / tail rotor RPM
  - Torque
  - Warning panel
  - Exterior environment
  - Crew interaction (if dual pilots)
- A mean to confirm if LRS is correctly calibrated







#### However...

- Real in-flight images are different from simulation images
- Many occasions we have to deal with irregular images







Pilot obstruction

Sunlight luminosity

**Needles overlapping** 

# Identifying the instrument reading

- 12000+ images from Bell 206 analyzed
- 50 min of flight data
- Use airspeed indicator and altimeter as benchmarks
- Image binarization required
- Two algorithms, same accuracy
  - Static binarization and needles matching
  - Dynamic binarization and Eigen analysis
- Efficiency improvement







#### Automatic, fast, and accurate

- Both algorithms provided satisfying results on both altitude and airspeed comparison
- Further efficiency improvement through Eigen analysis can reduce computation time by 5 times





# Implication of LRS to GA FDM

- Flight data storage with easy access for retrieval
- Understand aircraft states and handling qualities
- Event detection & FDM program for GA operators
- Lightweight Recording System vs. Modern Advanced Integrated Avionic System
- Superior crash survivability
- Understand flight instrument status and cockpit environment thru recorded images and audio
- Elevate efficiency of accident investigation



### To wrap up...

- A study on lightweight recording system for GA conducted
- Flight tests on three types of aircraft: AS365, Bell 206, and ultra-light
- Basic flight parameters / data recorded with satisfying accuracy
- An automatic process developed to identify flight instrument reading from 12,000+ recorded images with accuracy and efficiency
- Image identification on flight instrument provided efficient and quick access to data that originally may not be available
- Lightweight recording system elevates efficiency of investigation and safety level of GA



#### Conclusions

What role should the Foundation consider in terms to further the state of understanding, awareness or implementation of the themes of this presentation?

- 1. Partner with GA advocate organization (e.g. AOPA) to reach out GA owners/pilots to promote use of recording device(s).
- 2. Organize regional workshops for GA operators to promote use of LRS and safety awareness.
- 3. Assemble promotional material on social media to highlight benefits of LRS and its recorded data for FDM



