J-FLiC UAS Flights for Acoustic Testing Research

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Automated Flight Control Lab
1) Altitude at center microphone = 100 +/- 20 ft AGL
2) Centerline deviation = 0 +/- 10 ft
3) Nominal cruise speed for J-FLiC testing: 60 – 130 kts

- PI determined each pass to be Good or Bad
- visual observation of centerline offset
- airspeed/altitude callout
- expressed preference for repeatability
Remotely Piloted Vehicles for Experimental Flight Control Testing

**FLy**ing Controls Testbed (FLiC)

**J-FLiC**

**Operational Concept**

- External pilot (EP) executes manual takeoff
  - EP alternately monitors auto-takeoff
- EP engages autopilot in local area if manual
- Autopilot transitions to designated test area
- Ground station operator (GSO) engages experimental controls
- Induce unanticipated disturbances
  - Landing gear / flaps
- Experimental controller compensates
- Discontinue disturbances
- GSO disengages experimental controller
- GSO engages autopilot Return to HOME
- EP executes manual landing
- Alternately monitors auto-landing
- 12-15 minutes total flight time
J-FLiC

- Wingspan: 80 inches
- Length: 94 inches
- Weight: 40 lbs
- Wing area: 1600 sq in
- Wing loading: 58 oz/sq ft
- Thrust: 34 lbs
- Speed range: 35 – 200 kts
- Flight time: 14 minutes
- Radio gear: Futaba 14MZ // 2.4 GHz
- Futaba R6014HS receiver with failsafe
- Micropilot 2128g autopilot installed
- 900 MHz radio modem for telemetry// GCS

- First flight: 17 Aug 2004
- Recent flight: 03 Sep 2015
- Total flights: 276
- Autopilot engaged: 170
- AUVSI UAV Demo 2007
Test Configurations

- Landing gear down, full flaps

- 60 / 80 / 95 kts

- Clean

- 80 / 130 kts
J-FLiC Flight Test Team

- James W. High, ESB – Ground Control Station operator
- Jeff Hill, RSD – Range safety Officer (RSO) / Observer
- Robert McSwain, AESB – Test coordinator / FDAS/photos
- Zak Johns, NIA – Observer / runway alignment coach
- Jeff Werner, AESB – model servicing and support
- Michael Logan, AESB – Range Officer in Charge (OIC)
- Mark Motter – Pilot in Command (PIC), autopilot
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Challenges

- J-FLiC last operated on 11 Sep 2012 at beginning of program
- Preliminary flights scheduled for 12 May
  - Limited flights (8) due to winds and mechanical problems
    - Engine startup, landing gear air system leaks
  - Only three autopilot flights
    - Lost link - return to HOME waypoint, climb to 800’, 80 kts
    - Good speed regulation for both clean and landing config
    - AP climb/descent configured for 65 kts, clean only
    - No flights to check AP ground tracking performance
- PI reviewed data from manual flights, deemed acceptable
  - Airspeed
  - Altitude
  - Vertical profile
  - Centerline offset
- Research scheduled for Aug 24 – Sep 4
- Microphone array setup and calibration 24-26 Aug
- Initial J-FLiC flights 27 Aug, no data taking flights
  - Simulated engine out approaches, lost link response
- 28 AUG
  - One “practice” data taking flight – 6 of 24 passes good
    - 80 kts, landing configuration, manual
  - Two autopilot development flights late in the day
    - Ground tracking for runway alignment
- 29 AUG
  - Three data taking flights - 18 of 35 passes good
    - 60 / 80 / 95 knots landing configuration, manual (10/22)
    - 80 / 130 clean, manual (8/13)
  - Three autopilot development flights late in the day
    - 800 to 500’, 600 to 300’, 400 to 100’, good runway alignment
manual flight path, 60/80/95 kts, landing configuration, 29 Aug 15
manual flight path, 80/130 kts, clean configuration, 29 Aug 15
30 AUG (Rest day)

31 AUG

- Three data taking flights - 21 of 32 passes good
  - 80 knots clean, autopilot (6/6)
  - 80 knots landing config, manual (7/13)
  - 95 knots, landing config, manual (8/13)

- Three autopilot development flights late in the day
  - Determined throttle settings for climb and descend in landing configuration
  - Check runway alignment in landing config, 80 kts
  - Climb/descend from 800’ to 500’

01 SEP

- Ready for 80 kts, landing config, 400’ - 100’, autopilot
- No flights that day
02 SEP

Three data taking flights - 17 of 21 passes good

- 80 knots landing config, autopilot (6/6)
- 80 knots clean, autopilot (3/4)
- 60 knots, landing config, manual (8/11)

03 SEP

Three data taking flights - 17 of 20 passes good

- 80 knots landing config, autopilot (6/6)
- 80 knots clean, autopilot (6/6)
- 80 / 130 knots, clean, manual (5/8)

Overall

- 73 / 108 passes good
  - Manual - 46/80 58%
  - Autopilot – 27/28 96%
Autopilot flight path, 80 kts, landing configuration, 02 Sep 15
Autopilot flight path, 80 kts, landing configuration, 03 Sep 15
Typical auto and manual flight paths
Lost Link recovery 02 SEP 15 Flight #2
Potential improvements/ Future Work

- Data-driven decision making for “good / no-good”
- Real-time adjustment of waypoints for better runway alignment (from one pass to the next)
- Operation with RC link de-energized except during landing and takeoff abort
- Lost link response triggered by loss of ground control station command and data telemetry link
- Operation beyond visual range in restricted airspace
- Fully automated flight – autoland and takeoff
  - Data-driven decision making for go around and takeoff abort