Design, Development and Operation of UAVs for Remote Sensing

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Why fly UAVs?

• Fly where human flight is “too dangerous”
• Fly at a reduced expense w.r.t. crewed flight
• Fly more stealthily than crewed flight

What can you do with UAVs?

• Remote sensing—military recon, crop/soil health, natural disaster damage, environmental change, spying (government, industry, individual)
• Airborne communications hub
• Delivery—weapons, fertilizers, fire suppressants, medical supplies, mail, NetFlix
KU UAS program: Core Competencies

• Mission-driven system development
  – Pick the right UAV for the mission
  – Design/Build custom airframe/avionics as needed

• UAV flight control
  – Upset-tolerant control algorithms
  – Obstacle/air traffic avoidance
    • Vision & Radar data integration
    • Cognitive algorithms for avoidance
  – Cooperative flight

• UAV Avionics development
KU UAS Program: Facilities & UAVs

• Garrison Flight Research Center
  ➢ 2500 sq ft fabrication space
  ➢ Avionics development lab
  ➢ Structural load frame
  ➢ Mal Harned Propulsion Test Lab
  ➢ *AST 4000 fixed base simulator*

• Structural Composites Lab
  ➢ Carbon fiber airframes
  ➢ Glass fiber radar apertures

• RF Anechoic Chamber
  ➢ Fits UAVs to 20-ft wingspan

• Meridian (NSF)
  ➢ Unique design
  ➢ Ice-sounding platform
  ➢ Multiple arctic deployments
  ➢ Custom ground station

• G1X
  ➢ Modified kit UAV: extended wing
  ➢ Ice-sounding radar
  ➢ Dual-frequency radar
  ➢ En route to Antarctica

• MSTs
  ➢ Meridian surrogate trainers
Meridian UAS on final approach
NEEM Camp, Greenland ice sheet
Meridian UAS Overview

weights
- takeoff weight: 1082 lb
- empty weight: 753 lb
- payload weight: 165 lb
- fuel weight: 164 lb

performance
- cruise speed: 110 kts
- range: 600 nm
- endurance: 12 hrs
- L/D (cruise): 12.5

powerplant
- engine: TAE Centurion 2.0
- power: 160 hp

For more information, contact:
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The desired, “mission-driven” spot in design space

Design Space sweet spot

Crewed Aircraft

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Meridian UAV Ice-sounding: NEEM Drill Site, Greenland

Radar Returns (time domain)

Ice surface
Internal layers
Ice-bed echo

Meridian at the NEEM Camp

Echo-gram thru Greenland ice sheet:
note the bedrock at ~2.5 km down

Internal layers
Ice-bed returns
Trace number
Meridian Ground Station and Health Monitoring System GUIs
Meridian Training System (33% scale YAK 54) on final approach at Pegasus Field, Antarctica
G1X UAS Overview

weights
- takeoff weight: 85 lb
- empty weight: 65 lb
- payload weight: 10 lb
- fuel weight: 10 lb

performance
- cruise speed: 70 kts
- range: 57 nm
- endurance: 1 hr
- L/D (cruise): 13

powerplant
- engine: DA 100
- power: 9.8 hp

G1X during installation of 14MHZ and 35MHz sounding antennas in the Structural Composites Laboratory

For more information, contact:
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KU UAS Program: People

• Faculty
  – Shawn Keshmiri—control law development
  – Rick Hale—airframe & radar aperture design/build
  – Dongkyu Choi—artificial intelligence, situational awareness
  – Haiyang Chao—cooperative flight, vision systems
  – Chris Allen—radar for obstacle/traffic identification
  – Mark Ewing—avionics development

• Staff
  – Andy Pritchard—A&P mechanic
  – Wes Ellison—electronics technician, avionics development
  – George Blake—electronics technician, comm systems
KU UAS Program: Partners

- NSF/Center for Remote Sensing of Ice Sheets (CReSIS)
  - 10-year, $20M grant
  - Underwrote Meridian, G1X and AFS autopilot development
- NASA Langley
  - Aircraft/UAV aerodynamic upset conditions identification
- NASA Ames
  - UAV dynamics & control
  - Cooperative/formation flight
- DARPA
  - Cognitive algorithms for control
- Ft Riley
  - Access to Ft. Riley restricted airspace
- Kansas State University
  - Access to Smoky Hills restricted airspace
KU UAS Program: Current Priorities

• Making flight in the NAS safer
  – Non-linear control laws for low, slow UAVs
    • Upset-proof
    • Precision trajectories
  – See/sense/avoid technology
    • Integration of vision and radar data
    • Cognitive architectures to insure avoidance
  – Spin-off technology to GA community (workload reduction)

• Remote sensing... *in Kansas if airspace is cleared*
  – Precision flight line technology—spinoff from ice-sounding
  – Robust systems meeting emerging certification standards
  – Formation flight, creating synthetic apertures

• Re-purposing existing UASs to new partners/customers