Activities at Lone Star UAS Test Site and TAMUCC

An update
Scientific Committee for Oceanographic Aircraft Research
August 16, 2017

Presenter:
Michael Starek
Assistant Professor
School of Engineering and Computing Sciences
## LSUASC Recent Highlights (since August 2016)

<table>
<thead>
<tr>
<th>Event</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>NASA Unmanned Traffic Management (UTM) Technical Capability Level 2 Demonstration Flights</td>
<td>2016-10</td>
</tr>
<tr>
<td>Counter UAS Missions at DFW Airport for the FAA</td>
<td>2017-04</td>
</tr>
<tr>
<td>Second Annual Texas UAS Summit and first Student Poster Competition in Dallas, Texas</td>
<td>2017-05</td>
</tr>
<tr>
<td>Second Space Act Agreement with NASA signed for work on autonomous software architectures for small UAS</td>
<td>2017-05</td>
</tr>
<tr>
<td>Memorandum of Agreement signed with Quebec UAS Centre of Excellence and Texas A&amp;M Engineering Extension Service</td>
<td>2017-05</td>
</tr>
<tr>
<td>NASA UTM: Air-to-air detection of sUAS by a radar on a sUAS</td>
<td>2017-06</td>
</tr>
</tbody>
</table>
UAS Detection Mission at DFW Airport (April 2017)

- UAS detection operations for FAA’s Pathfinder 4 project
- Flights occurred at Dallas/Fort Worth International Airport using multiple drones
- LSUASC’s first operation in Class B airspace
UAS Detection Mission at DFW Airport

List of Partners:
Gryphon Sensors * FAA * DHS * DoD * FBI * FCC * CBP * DOI * DOE * NASA * DOJ * BOP * USS * USCP * DOT
NASA EVAA: Autonomous Architectures
Expandable Variable Autonomy Architecture (EVAA)

• Need for ‘trustworthy’ autonomous systems
  – Package delivery
  – Surveying
  – Inspection
  – BVLOS/BRLOS

• Challenge of verification & certification of autonomous systems

• Multi-monitor run-time assurance (MM-RTA)
At this stage, we do not know all requirements (Phase 1-2)
  • Rapid prototyping
• We are doing proof-of-concepts before building a safety case
• Non-traditional; goes against current attitudes
  • EVAA can override pilot inputs
  • **Full autonomy** (minimal user input)
• Not using current rigorous aviation software/hardware standards (DO-178C, RTOS, etc.)
NASA EVAA: Autonomous Architectures

Inputs
- Terrain Database
- Obstacle Database
- Terrain Sensors
- Obstacle Sensors
- ABSAA Sensors
- Air traffic feeds
- NASA UTM
- AP status
- Sensor status
- Flight system status
- Risk Map Database
- Land command
- Emergency status
- Geofence Database
- WX Services
- WX Radar

Monitor
- GCAS
- ACAS
- Health Monitor
- FLS
- Geofence
- Weather Monitor

Prevents
- e.g. Ground Collision Avoidance System

Bad Things
- Airplane crash
- Car accident
- Emergency signal
NASA EVAA: Autonomous Architectures
Autonomy Testbed

VTOL/Flying-Wing
5ft wingspan
< 10 lbs
COTS < $2,500
20-45min endurance
15min turnaround

“Elissa,” a COTS FireFLY6 VTOL UAV
NASA UTM Detect and Avoid (small UAS)
NASA UTM Detect and Avoid (small UAS)

- Use of a low cost, size, weight, and power radar (the Echodyne MESA-DAA ~ 2 lbs)
- Integration onboard a small UAS (the AirRobot AR180)
- Detection of other small UAS by the radar when airborne (air-to-air)
- Display of detected targets in LSUASC’s Cirrus software to allow the PIC to avoid targets
Echodyne MESA-DAA Radar

- compact high-performance radar that can be mounted on small to medium-sized UAVs to safely and reliably Detect And Avoid obstacles for beyond line of sight flight operations.

- operates like a phased array radar with true beam scanning in both azimuth and elevation

*Phantom 4 detected @ 750 m range*
Cirrus Air-to-Air Radar Target Display, June 2017 Test
Cirrus Air-to-Air Radar Target Display, June 2017 Test
Activities at TAMUCC
College of Science & Engineering
sUAS Coastal Surveying

adaptive.
sUAS sensor integration

Reflected Solar Energy

- UV
- Visible
- NIR
- SWIR
- MWIR

Emitted Thermal Energy

- LWIR

0.4 µm
1.0 µm
1.7 µm
3.0 µm
5.0 µm
8.0 µm
14.0 µm

SWIR
MWIR
LWIR

Emitted Thermal Energy
NSF MRI Grant: Development of an Integrated Gas Monitoring and Source Identification UAS for Exploration, Compliance and Assessment

Payload

Sony A7Rii (42.4 MP)

5.8 kg

Microportable Greenhouse Gas Analyzer (CH$_4$, CO$_2$, H$_2$O)

Penguin B UAV

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MTOW</td>
<td>21.5 kg</td>
</tr>
<tr>
<td>Empty Weight (excl fuel and payload)$^1$</td>
<td>10 kg</td>
</tr>
<tr>
<td>Wing Span</td>
<td>3.3 m</td>
</tr>
<tr>
<td>Length</td>
<td>2.27 m</td>
</tr>
<tr>
<td>Wing Area</td>
<td>0.70 m$^2$</td>
</tr>
<tr>
<td>Powerplant</td>
<td>2.5 hp</td>
</tr>
<tr>
<td>Max Payload</td>
<td>10 kg</td>
</tr>
<tr>
<td>Takeoff method</td>
<td>Catapult, Runway or car top launch</td>
</tr>
</tbody>
</table>

Performance:

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Endurance$^2$</td>
<td>20+ hours</td>
</tr>
<tr>
<td>Cruise Speed</td>
<td>22 m/s</td>
</tr>
</tbody>
</table>

source: image from maker of the gas analyzer
Topographic Light Detection and Ranging (Lidar)

1. Pulse a laser from an airborne platform to the surface and records reflected energy

   Laser \rightarrow \text{(Laser Receiver)} \rightarrow \text{(Reflectors)}

2. Measure Time of Travel ($T_t$)

   $T_t/2 \times c = \text{range}$
UAS Lidar

Riegl VUX-LR

- Up to 1350 m range @ 60% reflectivity
- Multi-echo detection, waveform processing

Pulse Aerospace Vapor 55

LITEF mems uIMU

SPECIFICATIONS

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross Weight</td>
<td>55 lbs</td>
</tr>
<tr>
<td>Useful Load - (Battery + Payload)</td>
<td>34 lbs</td>
</tr>
<tr>
<td>Allowable Payload - With Full Endurance*</td>
<td>&lt; 11 lbs</td>
</tr>
<tr>
<td>Max Cruise Endurance - With Full Payload</td>
<td>60 Minutes</td>
</tr>
</tbody>
</table>
UAS Lidar
projects
Education
Erosion Monitoring
Packery Channel, TX
Coastal Survey of Little St. George Island, FL (10 km)
NOAA Apalachicola NERR

Dense, textured 3D point cloud, > 1000 pts/m², March 2017
Thank you SCOAR!

Contact:
Michael J. Starek
School of Engineering and Computing Sciences
Michael.Starek@tamucc.edu