Flying High
MicroUAV (Unmanned Air Vehicles)
Applications for Public Works

APWA National Congress
San Antonio, Texas
September 2007

Mike Harrell, P.E.
Senior Engineer
mharrell@ara.com
www.ara.com
(p) 217-356-4500

Flight Plan
+ Traditional Aerial Video/Photography
+ Background on UAVs/MUAVs
+ Sample Applications of this Technology
+ Georeferenced Aerial Photographs and your GIS system

Flight Plan – Traditional Aerial Video/Photography
+ Typical methods
  - Tasked satellite (special circumstances)
  - NASA Space Shuttle
  - Full-size aircraft
Traditional Aerial Video/Photography

Typical methods

- Helicopter
- TerraServer (Microsoft)
- Google Earth

Disadvantages

- Expensive!
- Time Sensitive
  - Slow to schedule often requires flight plan
  - Slow to deliver results once mission is complete
- Not reactionary

Typical Aerial Image from Full-size Aircraft
(Image property of Skylight Photographic, June 2005, taken with Canon EOS 20D)
Flight Plan – The Unmanned Air Vehicle (UAV)

+ Unmanned – duh!
+ Remote-controlled
+ Can be large
+ Often needs catapult or runway for launch
+ Likely requires at least 2 people to operate

Flight Plan – The Unmanned Air Vehicle (UAV)

+ Some examples of UAVs
  ➢ US Naval Research Lab - Sender
  ➢ MLB’s BAT3

+ Original concepts began with the military

Flight Plan – The Micro Unmanned Air Vehicle (MUAV)

+ Small
+ Lightweight – a pound or less
+ Similar functionality
+ Typically lower image resolution – a result of lighter payload
Flight Plan –
The Micro Unmanned Air Vehicle (MUAV)

- Some examples of MUAVs
  - ARA’s Nighthawk
  - Aerovironment’s WASP

- Most developed for the war fighter in theatre

Flight Plan –
Advantages of the MUAV Approach

- Portable
- One-Man Operation
- Robust, Field-Tough

Flight Plan –
MUAV Portability

- Current Model of ARA Nighthawk®
Flight Plan – Advantages of the MUAV Approach

- No Flight Plan Required
- Safe for Operator and General Public
- No humans put at risk! (pilots)

Flight Plan – Flight Controls

- GPS waypoints
- Manual – with joystick
- “Follow-me”

Flight Plan – Camera Payloads

- Digital color video/photography
- Infrared
  (color infrared image courtesy of NASA)
- Coming soon
  - Heat-Sensitive
  - Gimbal mount
Flight Plan – Camera Payloads

+ Gimbal Camera
  - 360° of viewing capability

(play video clip from desktop)

Flight Plan – Camera Payloads

+ Gimbal Camera
  - 360° of viewing capability

Applications – Where do we use this?

+ Flood Management

(Aerial Photograph courtesy of NOAA)
Flight Plan – Applications – Where do we use this?

- Traffic/Intersection Monitoring
- Parking Lot Utilization
  - “Surface Transportation Surveillance from Unmanned Aerial Vehicles” (Coifman et al., Ohio State University, 2004.)
  - Research sponsored by the National Consortium for Remote Sensing in Transportation – Flows (NCRST-F)

Flight Plan – Applications – Where do we use this?

- Traffic/Intersection Monitoring
  (Image courtesy of Coifman, MLB)

Flight Plan – Applications – Where do we use this?

- Parking Lot/ Parking Space Utilization Monitoring
  (Image courtesy of Acclaim Images)
Flight Plan – Applications – Where do we use this?

+ Roof/Facility Inspections
  - Annual or systematic
  - In response to event

(Image courtesy of TodaysFacilityManager.com)

Flight Plan – Applications – Where do we use this?

+ Pavement/Bridge Inspections
  - In response to event
  - Likely not detailed enough to perform annual inspections

Flight Plan – Applications – Where do we use this?

+ Emergency Response
  - Fire response and strategic placement of equipment
  - Live intel without putting people at risk
Flight Plan – Applications – Where do we use this?
+ Under Development – Aerial Asset Management

The Sky is the Limit!

Flight Plan – Applications – Where do we use this?
+ The Sky is the Limit!

Flight Plan – UND UAV COE
+ Center of Excellence for Economic Development in Unmanned Aerial Systems and UAV Simulation Applications (whew!)
+ University of North Dakota – 2006
+ three central research questions integrating UAS into the national airspace:
  ➢ navigating and controlling UAVs,
  ➢ airspace management,
  ➢ homeland security and related technology
Sense-and-avoid technology

“...designing a payload with the instruments and sensors needed to see — and avoid — any type of moving target, such as a parachutist, a small airplane, anything that isn’t equipped with a transponder or other device signaling its presence.”
Example Actual Mosaic
High Altitude (500-ft)/Low Resolution

- Automatically created from Nighthawk video using software process
- Altitude flown is ~500 ft
- Lower altitude proposed (e.g., 75') will produce finer resolution (1/pixel)

Achievable Ground Resolution

- Plot of lens field of vision (FOV) angle vs altitude to achieve desired ground resolution of 1 inch/pixel
- 5" spall will be 5 pixels wide
- Feature size resolution: ±20% at 5", ±4% at 2".

Post-Processing/Analysis

- One-man portability
- Software-based path planning
- Flight operations to include
  - Hand launch capability
  - Autonomous waypoint navigation
  - Video streaming at 640 x 480 pixel resolution, 30 frames per second (EO) and 320 x 240, 30 fps (thermal IR)
- AV landing and recovery
- Video stabilization and mosaic construction features using stand-alone software

Image courtesy of ARA, Inc.
Example Road EO Flight Data

- E-W Run
- W-E Run

Images courtesy of ARA, Inc.

Example Composite Road EO Flight Data

Image courtesy of ARA, Inc.

Example Composite Road Thermal Flight Data

Image courtesy of ARA, Inc.
Example Composite Road Thermal Flight Data

Image courtesy of ARA, Inc.

Flight Plan – Inclusion into Existing GIS

- Easier than you would think!
- Still images are georeferenced (geospatial imagery)
- Upload like any aerial image

Image courtesy of Geo-3D, Inc.

Flight Plan – Inclusion into Existing GIS

- COTS Software available to identify assets in images
- User can categorize, measure, and assess condition of assets
- OCR may automate this process
Nighthawk Sample Video