AERIAL INSPECTIONS USING UNMANNED AERIAL VEHICLES

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Research Motivation

- Construction related environmental impacts
  - Produce 20 to 1,000 times more sediment discharge
  - 80 million T/yr of construction generated sediment
  - Water quality & aquatic ecosystem degradation

- 2012 NPDES Construction General Permit (CGP)
  - Regulations limit NPS pollution from construction sites ≥ 1 acre
  - Requirements for erosion & sediment control practices, inspections, and maintenance
ESC INSPECTION REQUIREMENTS

- Formal inspection
- Conducted by Qualified Credential Inspector (QCI)
- Weekly or after ≥0.25 in. storm events
- Time consuming & arduous site walkthrough inspections
- Reports to be retained for three years from permit expiration
- Need for more effective/efficient methods
UNMANNED AERIAL VEHICLES - UAVs

- Initially developed for military sector
- Autonomous or remotely guided
- Rapidly increasing civilian / research applications
- Availability / affordability
- Low altitude, high resolution spatial and sensing data collection
- High flexibility in data collection and platforms
EMERGING UAV APPLICATIONS

- Agriculture
- Archeology
- Delivery Services
- Emergency Management
- Inspections
- Law Enforcement
- Mapping
- Meteorology
- Photography
- Search & Rescue
- Wildlife Monitoring
TRANSPORTATION & CONSTRUCTION INSPECTION APPLICATIONS

BRIDGE & OVERHEAD TRAFFIC SIGNS

REVERSE-LANING OPERATIONS

DAM & LEVEE SAFETY

EROSION & SEDIMENT

NATURAL RESOURCES
UTILITY INSPECTION APPLICATIONS

- Power Generation
- Transmission Lines & Towers
- Overhead Lighting
- Pipeline
- Waste Management
PHOTOGRAMMETRY & MAPPING APPLICATIONS

2D: ROADWAY DESIGN

DEM: STOCKPILE & EARTHWORK

3D: BRIDGE & STRUCTURES
**UAV TYPES**

**ROTARY**
- Easily deployable - VTOL
- Agile maneuverability
- Ability to hover, stare
- Payload precision
- Confined & vertical operation

**FIXED WING**
- Higher cruising speeds
- Low energy consumption
- Longer duration / range
- Simpler structure
- Longer range
UNMANNED AERIAL SYSTEM ELEMENTS

GPS

RC

PC

USER?
PROJECT OBJECTIVES

- Identify UAV applications
  - Erosion & sediment control site inspections
  - Project management & documentation
- Conduct case study on active construction site
- Investigate photogrammetric applications
- Identify advantages in UAV based inspections
DJI PHANTOM 2 VISION

- UAV Quadcopter
  - 13.8 in. length / 2.6 lb. weight
  - 25 min. / 984 ft. flight range
  - 34 mph max. flight speed

- Sensor
  - 14 MP photographs / 1080/30P video
  - 0-60 deg. gimbal tilt

- Operation
  - First person real-time view
  - GPS flight control enabled
  - Autonomous flight plan application
CASE STUDY

- Selected site study
  - 25 acre residential subdivision (Auburn, AL)
  - Six total inspections over 16 weeks
  - 18 rain events ≥ 0.25” (21.8” total)

- Flight plan
  - 150’ flight altitude / 70% image overlap
  - Followed traditional on-foot inspections
SEDIMENT BASIN

STEEP SLOPE

STREAM
GULLY EROSION – GROUND PERSPECTIVE
GULLY EROSION – GROUND PERSPECTIVE
CORRECTIVE ACTION (5/1/14)
EROSION AND FLOW PATH IDENTIFICATION
SEDIMENT BASIN
INEFFECTIVE E&S CONTROLS
E&S CONTROL IMPROVEMENTS
PHOTOGRAMMETRY

- Obtaining reliable measurements from overlapping photographs
- Scaled three-dimensional reconstruction through triangulation
- Common applications
  - Large-scale topographic surveys, land-use maps, forestry covers
- Image resolution
  - Airplane / satellite: 7.9 to 19.7 in./pixel
  - Low altitude UAV: 0.40 in./pixel
PHOTOGRAMMETRIC DEM GENERATION
VOLUME ESTIMATION

STOCKPILES

- Haul & transport estimation
- Efficient material storage / handling

SEDIMENT BASINS

- Available storage volume
- Identification of dredging / maintenance needs
EROSIVITY: ASSESSMENT, RISK, & PREDICTION

- DEM surface comparisons
  - Soil migration volumes

- Risk & prediction
  - Topographic feature characterizations
  - Delineation of drainage sub-basins, runoff flow reaches / paths
  - GIS risk indicator models for runoff

- Tools for ESC selection / sizing
VEGETATIVE ESTABLISHMENT

- Temporary or permanent vegetation
- Effective erosion control
  - Used to stabilize disturbed areas
  - Required within 14 days
  - Provide 70% of pre-construction cover
- Normalized Difference Vegetation Index (NDVI)
  - Measures infrared reflectance of vegetation
- Identification of areas in need of seeding, nourishment
- Construction industry is burdened with legal disputes
- Assessment of pre-development conditions
  - Identification of natural resources
- Project progression
  - Evaluation of progress
  - Contractor claims / disputes
- Material management
  - Pavement sub-base thickness
  - Stock-pile volumes
- Project communication
  - Public meetings
  - Design engineers / contractors
CONCLUSIONS

- Affordability / low cost
- Efficient & flexible to landscape
- UAV site inspection advantages
  - Bird’s eye perspective
  - Identification of flow paths
- Bridges the gap scale and resolution
  - Low altitude data collection
  - High resolution DEM generation
CONTINUING RESEARCH GOALS

- Further conduct aerial erosion and sediment control inspections
- Comparatively analyze UAVs / photogrammetry software platforms
- Access the accuracy of developed volumetric estimation methods
- Develop UAV inspection recommendations / guidelines
Current “ban” on commercial operations

Regulation proposal released 2/15/15

- Small drones ≥ 55 lbs
- 500 ft commercial operation ceiling
- 100 mph restriction
- Visual contact w/ UAV
- Ban on nighttime operation
- Aerospace knowledge exam
- TSA background security check
- No requirements for pilots license

Final regulations expected September 2015 – delays likely
Auburn University receives nation's first FAA authorization to operate Unmanned Aircraft Systems Flight School

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By: Charles Martin

AUBURN UNIVERSITY -- Auburn University has received the nation's first FAA approval to operate a new Unmanned Aircraft Systems Flight School as part of the Auburn University Aviation Center.

"This is an honor for Auburn University," said Bill Hutto, director of the Auburn University Aviation Center. "We will conduct commercial flight training in this new flight school and will also make the new flight school available to our Department of Transportation for training military-ready pilots for the U.S. military."
UAV OPERATION SAFETY CONSIDERATIONS

- **Public Awareness**
  - Be courteous, polite, professional

- **Area & Environment**
  - Overhead obstructions: wires/cables, towers
  - Animals, bystanders, property
  - Buffer zones, alternate landing area
  - Topography
  - Inclement weather: wind, visibility, temperature, precipitation
  - Avoid controlled airspace

- **Flight Plan**
  - Use a co-pilot / spotter
  - Notify bystanders, property owners
  - Contingency plan
  - Emergency preparedness

- **Equipment**
  - Pre-flight inspection
  - Check for and address any damage
  - Battery status: RC & UAV

- **Safety & Common Sense!**
QUESTIONS?

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