

# ERDC

Engineer Research and  
Development Center

## Microbotic Infrastructure Inspection Navigation Systems 2014 IPR

**Jennifer Wozencraft**

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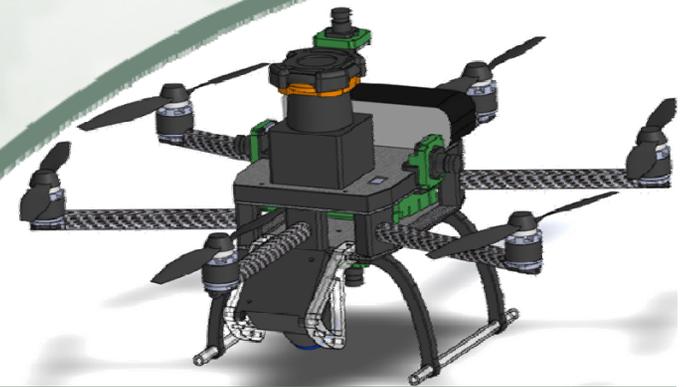
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28 October 2014

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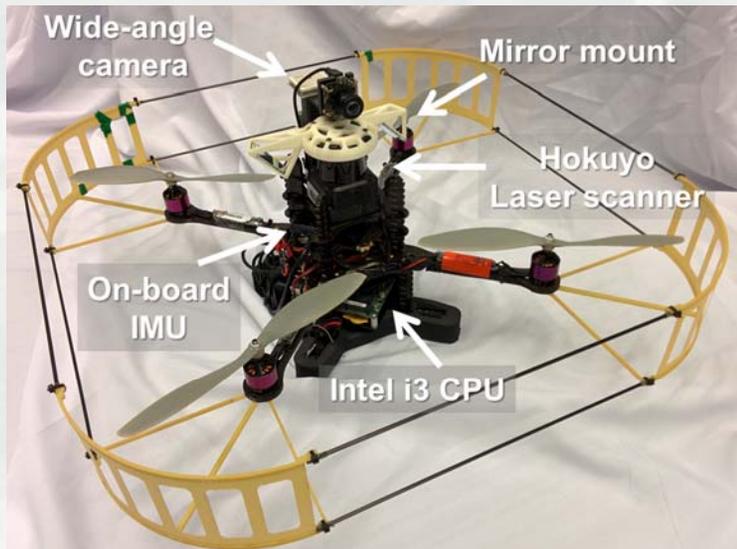
# Microbotic Infrastructure Inspection

- PI: Jennifer Wozencraft
- Problem: Inspection of some infrastructure components is high-risk and resource-intensive.
- Collaborators
  - ▶ Army Research Lab
  - ▶ University of Pennsylvania
    - General Robotics, Automation, Sensing and Perception Lab
  - ▶ Carter's Lake and Lake Allatoona and Operations Managers
    - Ricky Wilson and Wayne Vandenburg
  - ▶ US Bureau of Reclamation
  - ▶ Tennessee Valley Authority
- Development of micro UAVs for inspection of infrastructure
- Multi-sensor fusion for simultaneous mapping of the environment and autonomous microbot navigation
- Works outdoors and indoors
- Research focuses on autonomous navigation vision in featureless, tunnel-like environments



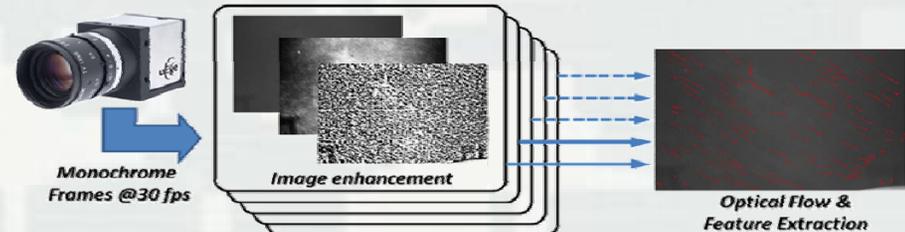
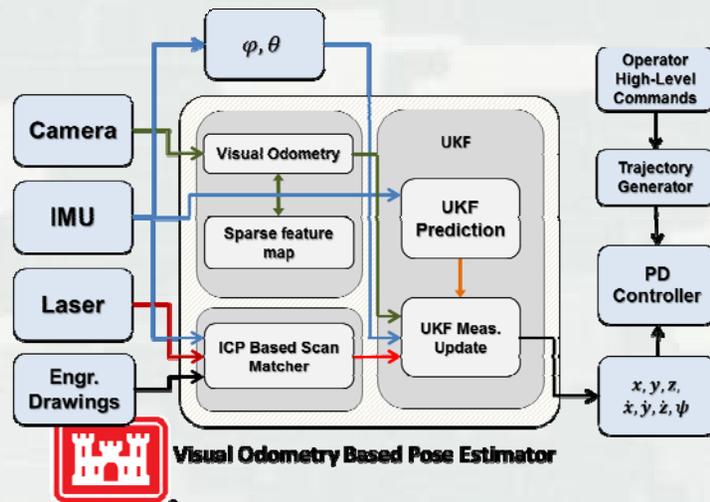
# FY14 Product Development

Inspection of Penstocks and Featureless Tunnel-like Environments using Micro UAVs



## Autonomous Inspection of Penstocks with Micro UAVs

Tolga Ozaslan, Shaojie Shen, Yash Mulgaonkar, James Keller, Vijay Kumar



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# FY14 Product Development

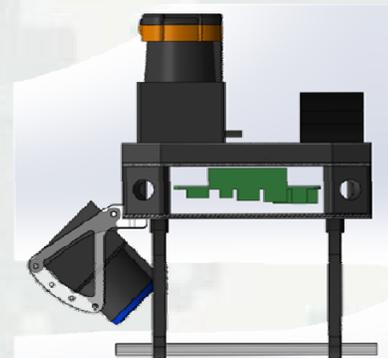


Penstock Inspection Hexrotor



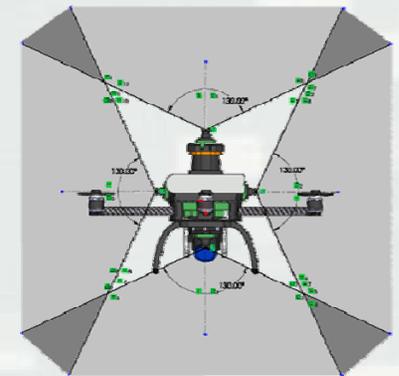
LIDAR

Camera Overlay



Top Forward-facing LIDAR

Bottom Downward-facing LIDAR – adjustable to different angles



Specification	Value
Core (Plates, Booms, Autopilot)	750 g
Battery (Thunder Power 4 cell 4400mAh)	415 g
Landing Gear	65 g
CPU (GIGABYTE dual core i7 mini PC)	195 g
Top LIDAR (Hokuyo UTM-30LX)	248 g
Bottom LIDAR (Hokuyo UST-20LX)	130 g
Cameras (mvBlueFOX) x4	16 g x4 = 56 g
Misc. Mounting Hardware / Cables	~ 170 g
<b>Total Weight</b>	<b>~2030 g</b>
<b>Max Thrust</b>	<b>6 x 600 g = 3600 g</b>
<b>Thrust to Weight Ratio</b>	<b>~ 1.77</b>
<b>Flight Time</b>	<b>10+ minutes</b>

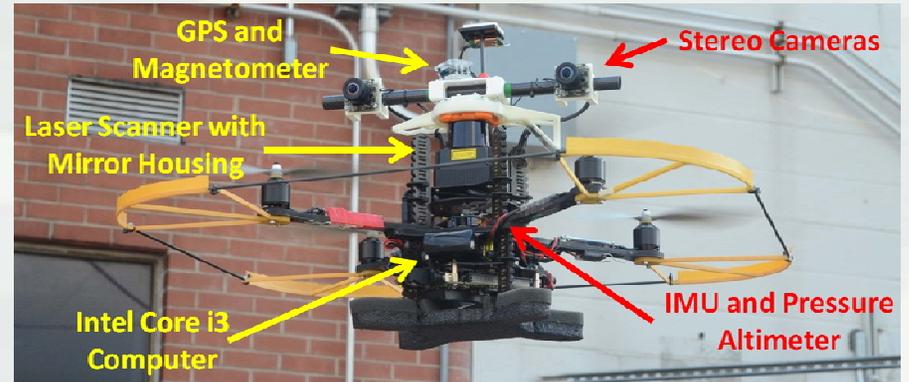
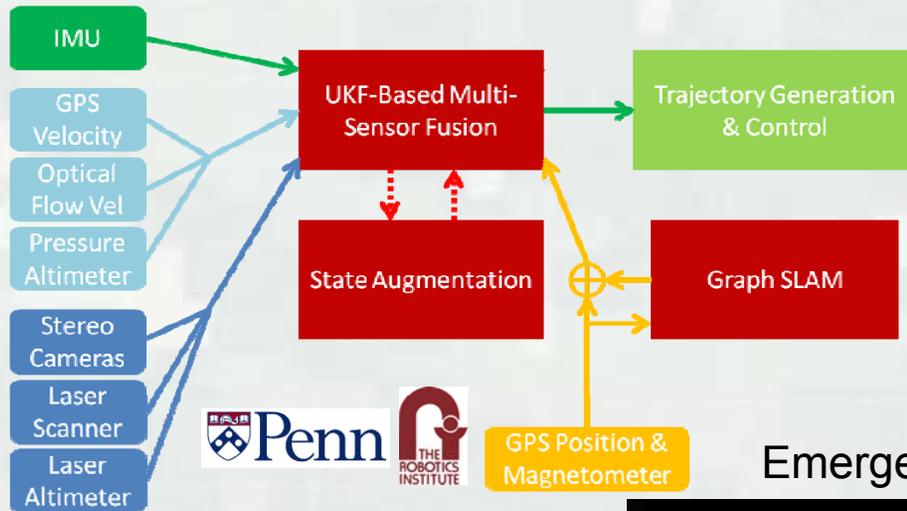
\*Booms are not shown  
KMeI Robotics



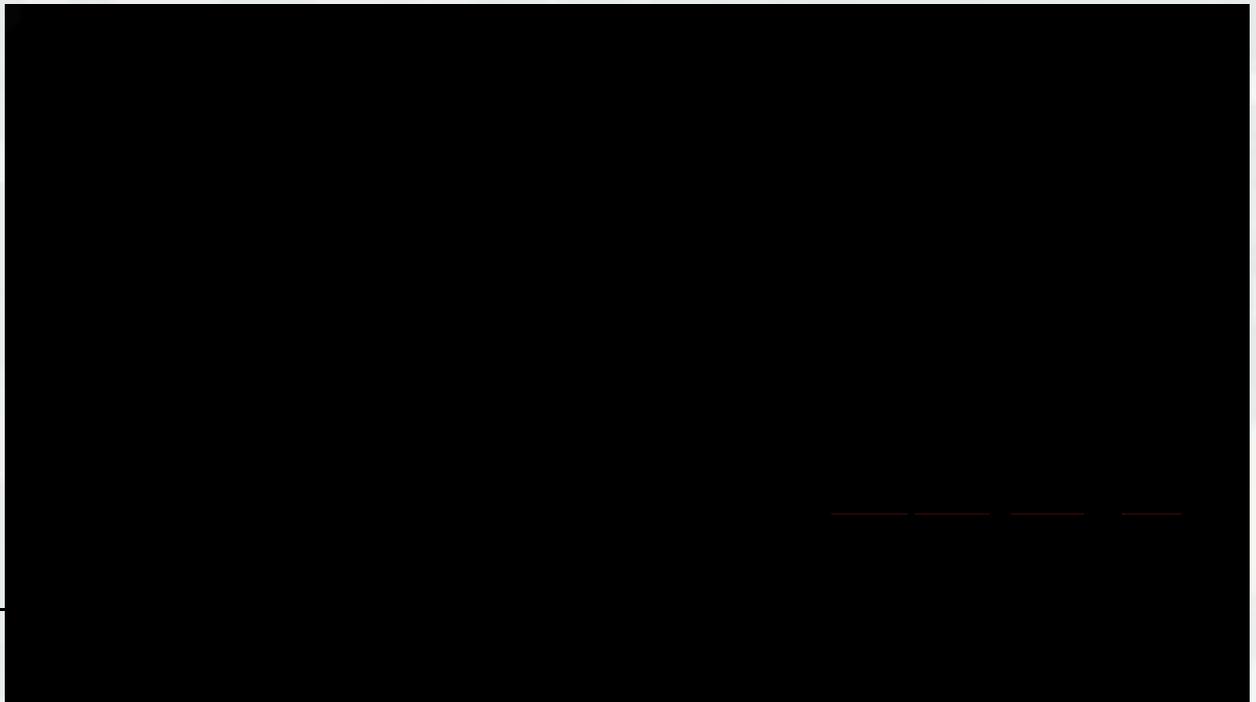
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# FY14 Product Development

Multi-Sensor Fusion for Robust Autonomous Flight in Indoor and Outdoor Environments



Emergency spillway tainter gates, Carter's Dam, GA



# FY15 Proposed Activities

- Milestone 1: Test prototype in a penstock (Q1)
- Milestone 2: Evaluate results of prototype test (Q1-2)
- Milestone 3: Modify on-board algorithms and sensors to enable more microbot autonomy (Q1-3)
- Milestone 4: Develop user interface (Q1-3)
- Milestone 5: Final demonstrations (Q3)
- Milestone 6: Develop capability to build 3D reconstructions of lidar points and imagery (Q1-4)
  
- Product 1: Alpha prototype microbot for penstock and tainter gate inspection with user interface, training, and user manual (Q4)
- Product 2: Draft journal paper describing capability (Q4)

**Basic Functions**

- Google Maps Integration
- Control Inputs
  - Auto Takeoff
  - Waypoint Control
  - Hover-In-Place
  - Return-To-Home
  - Emergency Land
- Video Feedback
- Configure Basic Settings
- Data Logging
- Hardware-In-Loop Flight Simulator



<http://www.dji.com/product/ipad-ground-station>

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