A Concept Demonstration including Drone-Deployed Sensors for Critical Infrastructure Assessment and Protection

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Part of a proposed collaboration proposal with the World Federation of Scientists under ‘The New Manhattan Project’
What assets do we want to monitor?

• Nuclear facilities
• Electrical power conversion / distribution networks
• Natural gas pipelines
• Water systems
• Transportation and shipping systems
• Other critical infrastructure
Drone / UAV Sensor Sets

• Optical imaging / advanced pattern recognition
  – New ATRs, advanced situational awareness
• Thermal imaging
  – Cheap if good background contrast
  – Useful in many different applications
• Stand-off chemical / biochemical/aerosol detection
  – For example, Fast CARS, Marlon Scully, Texas A&M
  – Sandia National Labs
  – LANL
• Neutron and gamma sensing
  – Emphasis on easily-deployed neutron sensors
• Magnetic sensing / Power grid monitoring
  – Inductively-coupled, drop-deployable
  – Texas Synchrophasor Network, for example
• Vibration / environmental monitoring
Deployment Methods

- On-board sensing (air, water, land)
  - Ubiquitous imaging / automated image analysis
  - Thermal imaging

- Unattended sensor drop (air, water, land)
  - Nuclear (neutron / gamma) sensing
  - Powerline monitoring
  - ‘Help me’ beacons

- Low-power drop sensing, with ‘mothership’ communications
OpenROV Underwater Drones

- https://d17kynu4zpq5hy.cloudfront.net/igi/openrov/luOK4uNbs3F3Fua1.huge

This drone deploys over a 100-meter range underwater, using fiber optic for command / control. Useful for threat detection, hull inspection, channel obstruction monitoring, Cable integrity, mine detection, etc.

Thanks to Dick Lanza
Drone Thermal Imaging

From Workswell, see www.drone-thermal-camera.com

Detect and infer...
‘Hot Spots’ associated with damage, malfunction, decay, etc.
Production levels and characteristics from power plants
Power distribution levels in networks
New Neutron Sensors

• Solid-state hexagonal boron nitride development at Texas Tech’s Nanophotonics Center
  – \(^{10}\text{B} + \text{n} \rightarrow \alpha + ^{7}\text{Li}\)
  – Much more robust than scintillators, \(^{3}\text{He}\) and \(\text{BF}_3\) gas phase detectors – This one is ‘droppable’
  – Wide band-gap semiconductor, low leakage current, and direct electronic readout on a chip
  – Over 50% efficiency, typically 43 microns thick

• Applications in:
  – nuclear weapons detection in port shipping containers
  – reactor and nuclear fuel characterization, etc.
  – Many more
Surprise gamma-ray detection from thunderstorms

• Pair-production within thunderstorms!

Detected in 1992 using NASA’s orbiting Compton Gamma-Ray Observatory

Expanded capability on Fermi’s Gamma-ray Burst Monitor

—from Scientific American, August, 2012
Extensive design capacity and capability today

• Easy embedded / sensor electronics design and development
  – TechShop, NI MyRio, Raspberry PI, other FPGA-based products, etc.

• Ubiquitous multi-use platforms
  – Novel apps development
  – From nuclear detection to heart / blood monitoring

• Excellent opportunity for open-source grand engineering challenges

• Extensive new materials development
Conclusions

• Advances in technology and materials are accelerating ubiquitous sensing at a unprecedented pace
• Optical observations and infrared thermal measurements are most common, with emerging, easily deployed nuclear / bio-chem sensors
• Drones can both sense from their platforms, and deploy (i.e. ‘drop’) unintended, countermeasures or communications-supported sensors readily
• The ‘new normal’ is in rapid, flexible platform designs in small companies to address very specific concerns