UAV-based Risk Reduction and Rapid Response System

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Outline

1. Challenges to Risk Reduction & Rapid Response
2. UAV Solutions
3. An UAV-based Risk Reduction & Rapid Response Prototype System
4. Way Forward
5. Conclusions
Challenges to Risk Reduction & Rapid Response

Temporal Resolution

Very hard to be satisfied but it is a critical factor for risk reduction & rapid response. (satellite revisit time, the time to acquire the first image of the disaster, … …)

Uninterrupted Monitoring

Very difficult to be implemented in a period of days. (orbit limitation for satellite, tired or unbearable for Manned aircraft)

Extreme environments

Very dangerous. (poison gas, nuclear leakage, volcanic eruptions, … …)
UAV Solutions

- To work under extreme conditions
- Receiving & processing on site
- Long endurance (more than 40 hours)
- High-resolution
- Mobility & flexibility

Net working

To complete various complicated missions synergistically during a disaster;
To create an instant communication infrastructure following a disaster.

Risk Reduction & Rapid Response System
An UAV-based Risk Reduction & Rapid Response Prototype System — Components

- A-type UAV
- B-type UAV
- Comprehensive test vehicle
- Command car
- UAV carrier vehicle
- Primary mobile station
- Secondary mobile station
An UAV-based Risk Reduction & Rapid Response Prototype System -- *Emergency procedures*

- Flight platform & control system
- Data processing & analysis system
- Mission planning and management system
- High accuracy standard payload systems
- Disaster area
- Disaster assessment report & product
- Response & relief

*Disaster*
An UAV-based Risk Reduction & Rapid Response Prototype System – System capacity

**Function**

Synchronous acquisition of high resolution optical image, Pol-SAR or In-SAR image.

**Performance**

- **Cruise time:** >24h
- **Practical ceiling:** 7 km
- **Take-off conditions:** airport runway, road

**Hyperspectral imager**
- **Spectral range:** 400~1000nm
- **Spectral resolution:** 5nm
- **Bands:** 128
- **Spatial resolution:** 1.0m (H=5km)
- **Swath width:** 1.0km (H=5km)

**Wide-swath multi-spectral camera**
- **Spatial resolution:** 0.5m (Pan) / 1.0m (MS) (H=5km)
- **Bands:** 4
- **Swath width:** 6.0km (H=5km)

**Area array camera**
- **Spatial resolution:** 1.0m (H=5km)
- **Swath width:** 2.0km (H=5km)

**Interferometric SAR**
- **Frequency Band:** Ku
- **Spatial resolution:** 1m (H=5km)
- **Vertical accuracy:** 2m~4m
- **Horizontal accuracy:** 5m~10m
- **Swath width:** 2km
- **Working distance:** 12km (H=5km)

**Polarimetric SAR**
- **Frequency Band:** X
- **Spatial resolution/Swath width/working distance (H=5km):**
  - 0.3m/2.5km/12~15km
  - 1m/4km/15~20km
  - 3m/8km/20~30km
- **Polarization:** HH, VV, HV, VH
An UAV-based Risk Reduction & Rapid Response Prototype System — Example images

Image from wide-swath multi-spectral camera

- Flood
- Typhoon/Storm surge
- Earthquake
- Landslide & Mudslide
- Fire
- Snow
- ...
An UAV-based Risk Reduction & Rapid Response Prototype System -- **Example images**

- Hyperspectral data cube from hyperspectral imager
- Water pollution
- Diseases and insect pests, freeze injury

...
An UAV-based Risk Reduction & Rapid Response Prototype System -- Example images

Polarimetric SAR image

Flood

Landslide & Mudslide

...
An UAV-based Risk Reduction & Rapid Response Prototype System -- Example images

Intensity image from Ku-band In-SAR system

DEM extracted from Ku-band In-SAR images

Geological disasters

Urban Subsidence
Way Forward

UAV – Networking

Aerostat – To enhance the positioning and communication in disaster area
Conclusions

UAV-based Risk Reduction & Rapid Response System

- To meet time-sensitive and high-resolution needs of emergency response and disaster relief
- To monitor continuously
- To work under harsh environment

Risk reduction and rapid response is not just “Image” but a “reality”. UAV-based Risk Reduction & Rapid Response System shall be an effective technical means in our real life.
Thanks