Monitoring Natural Disasters with Small Satellites – Smart Satellite Based Geospatial System for Environmental Protection

Krištof Oštir, Space-SI, Slovenia
• Natural and technological disasters
• Current state in mapping
• System that connects all stakeholders
• Crowd sourcing
• Small satellite system
• Space and ground segment
• Data processing
• Data delivery
Disasters

- Natural and technological disasters are causing huge damage and loss of lives
- They are more and more frequent
Estimated damage (US$ billion) caused by reported natural disasters 1900 - 2011

Year

Estimated damage (US$ billion)

- Kobe earthquake
- Hurricane Katrina
- Honshu Tsunami
- Wenchuan earthquake

EM-DAT: The OFDA/CRED international Disaster Database - www.emdat.be - Université Catholique de Louvain, Brussels - Belgium
• There is a huge and diverse number of end users that need mapping data
  – public authorities
  – civil protection
  – fire fighters
  – public
• They are not getting the information needed
  – Not frequent enough
  – Too complex
  – Not delivered in the form (way) needed
Copernicus

- Global Monitoring for Environment and Security – GMES
- European information services based on satellite Earth Observation and in situ data
- Overall funding by the EU and ESA has reached over 3.200 million €
- Large part – 738 Mio € – dedicated to the development of satellites (Sentinels)
- EU Multiannual financial framework for 2014–20 includes 3.786 million € for the Copernicus
- Emergency Management Service - natural or man-made disasters
Satellite data is available

There are several sources of satellite data

- Copernicus
- Space and Major Disasters Charter
- Disaster Monitoring Constellation

However

- Triggering is difficult
- Only authorized users can start mapping
- The users do not need data → they need information
- Data is not easy to get
- Processing is not provided or not optimal
Firefighters and GIS technology
System that connects all stakeholders

- Public
  - Crowd generated reports

- Protection Authorities
  - Satellite System Triggering

- Satellite Operators
  - Data collection

- Value Added Providers
  - Image processing

- Data Providers
  - Data delivery
Crowd generated disaster reports

- Use of crowd-sourcing to get information about the disasters
- Simple smart phone or web apps
- Used for detecting location and extend of disaster
Triggering of a small satellite system

- **Collaborative network**
- **Semi automatic operation**
  - reports are aggregated and delivered to the expert
  - Expert notifies the satellite operator(s)
- **Space and ground segment**
  - Optical
  - Radar
  - Network of GS
- **Different nation and different operators**
Image collection and processing

- Images have to be acquired automatically and simultaneously
- Received in the ground station
- Delivered to the value added providers
- Data has to be in a standard format
- Available to value added application providers
- Simple well defined processing steps
- Products defined by disaster type and end user (e.g. flood map, fire map, …)
- Cloud computing should be used
Flood detection, modeling and mapping
Data delivery

- **Maps**
  - Image – informative
  - Interpretation – experts

- **Textual information**
  - Warning system

- **Use internet technologies**
  - Web mapping
  - Web GIS

- **Crowd delivered maps and products**
### Mission requirements

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Imaging mode</td>
<td>High resolution  ↔  Low resolution</td>
</tr>
<tr>
<td>Image size (swath)</td>
<td>20 by 20 km  ↔  100+ by 100+ km</td>
</tr>
<tr>
<td>Imaging area per day</td>
<td>10,000+ km²  ↔  100,000+ km²</td>
</tr>
</tbody>
</table>
| Spectral resolution      | 0.45-0.90+ μm  
Multispectral R, G, B, NIR  
Panchromatic if used for pan sharpening  
Radar sometime in the future |
| Spatial resolution       | <= 5 m MS  
1-2 m PAN  
10-20 m MS |
| Temporal resolution      | Daily coverage of selected (smaller) area  
Weekly coverage of larger area  
Less than daily for selected (smaller) area |
| Spatial coverage         | -60 deg S to +60 deg N                                                |
## Mission requirements

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Value (range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orbit</td>
<td>Not necessary Sun synchronous</td>
</tr>
<tr>
<td>Pointing accuracy</td>
<td>&lt; 500 m on the ground</td>
</tr>
<tr>
<td>Sensor type</td>
<td>Full frame, Line scanner</td>
</tr>
<tr>
<td>Of-nadir imaging</td>
<td>Up to 30 deg in any direction</td>
</tr>
<tr>
<td>Imaging</td>
<td>Agile, sweeping, non-continuous area imaging, orientation during imaging, target following</td>
</tr>
<tr>
<td>Image compression</td>
<td>Allowed</td>
</tr>
<tr>
<td>Downlink latency</td>
<td>1-2 h Real-time</td>
</tr>
<tr>
<td>Time to the end user</td>
<td>&lt; 6 h Near-real-time</td>
</tr>
<tr>
<td>Video</td>
<td>Beneficial</td>
</tr>
</tbody>
</table>
Main advantages of the proposed mission

• Collaborative or distributed small satellite system
• Multisensor and multiresolution (spatial and temporal)
• Standard protocols for triggering, data collection, processing and delivery
• End users have an important role in the system
• Available to the end users including public
• Crowd sourcing is used (to collect the need) for triggering
Contact

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