

Help from the Sky: Leveraging UAVs for Disaster Management

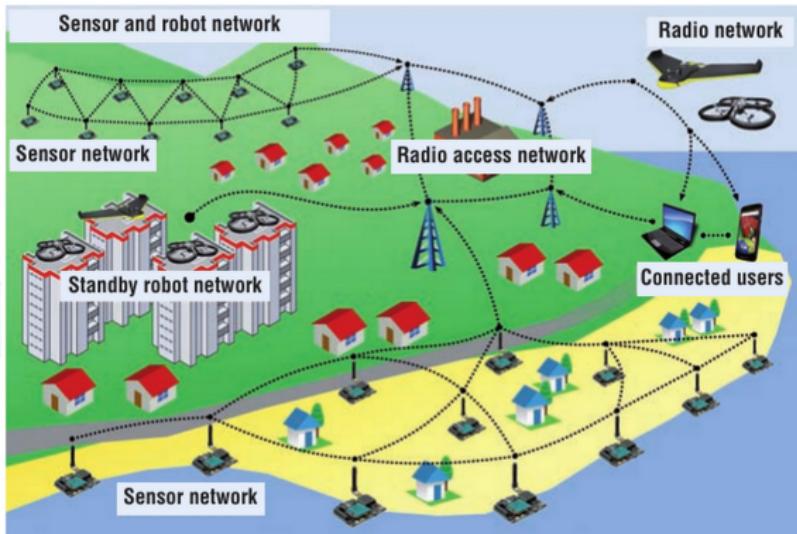
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UAVs and Wireless Sensor Networks

Different kinds of Unnamed Aerial Networks (UAVs) can be used to enhance disaster management together with Wireless Sensor Networks (WSN) based on differed disaster types and stages.



Applications of UAVs

- Monitoring and forecasting and early warnings
- Disaster information fusion and sharing
- Situational awareness and logistic and evacuation support
- Standalone communication system

Applications of UAVs - 2

- Search and Rescue (SAR) missions
- Damage assessment
- Media coverage
- Medical applications
- Infrastructure construction

Problems of using UAVs

- Power supply limitation
- Unreliable communication channel
- Unexpected node failure
- Maximal physical load size
- Maneuverability in harsh conditions

Features of UAV networks

- **Energy-effectiveness trade-offs:** They have small battery capacity so their network must be (sub)optimal
- **Dynamic topologies:** They have vulnerable localization abilities due to high impact of on-filed changes such as air drifts. As such error control approaches must be considered
- **Multi-objective downtime:** During downtime such as battery recharges questions such as keeping the same network with more redundancy or changing the topology should be answered.

Different Types of UAVs

- **Fixed Wings:** Large area coverage but expensive

Rotary wings: Can be sent exactly to critical spot

- **Helicopters:** Large payload delivery but expensive
- **Multi-rotor:** Low price but short flight duration



Tasks in Different stages of the Disasters

- **Stage 1 (Preparedness):** Early Warning System (EWS) for static threshold sensing and surveying by UAVs
- **Stage 2 (Assessment):** Situational awareness and damage study
- **Stage 3 (Response):** Supporting SAR missions - Building communication links for Radio Access Network (RAN).
Government related policy

Main argument: Static WSN is not sufficient and a dynamic topology supported by UAVs should be implemented for all the above stages.

Different Types of Disaster

- **Type A:** Geophysical(earthquake) and hydrological(flash-floods)
- **Type B:** Climatological (Drought)
- **Type C:** Meteorological (Tropical storm)

Preparedness Stage for all Types

WSNs should be used but UAVs at this stage will have limited role.

- Optimize WSN data acquisition and data analysis to assess the probability of future disaster occurrences, using UAVs as data mules

Assessment Stage

- **Type A:** Assessment only by UAV: **Improvement:** Use heterogeneous UAV networks comprising fixed-wing UAVs to scan the area and identify important points to be covered and surveyed by rotary-wing UAVs
- **Type B:** Assessment by UAV and parts of WSN which are still functional: **Improvement:** UAV network and WSN network can re-establish the partial connection losses
- **Type C:** Only WSN can be used for situational awareness: **Improvement:** fuse WSN and social media network data

Response/Recovery Stage

- **Type A:** Only UAVs for SAR, monitoring and communication restoration: **Improvement:** Use special UAV sensors and actuators mounted on UAVs
- **Type B:** UAVs and WSN restore broken connectivity:
Improvement: Maximal application of WSN data in UAVs for SAR
- **Type C:** Only WSN with integration of aerial surveys can be used for efficient decision support systems: **Improvement:** Use WSN to reconnect impaired UAV networks.

Open issues

For type A and B

- Creating and maintaining the information relay network.
- Supporting in-network data fusion
- Addressing handover issues

Open issues- 2

For Type C

- Develop specialize hardware for sever environmental conditions for UAVs
- Develop special software for controlling UAVs in sever conditions

Open issues- 3

General

- Automating network maintenance and UAV charging
- Increasing UAV network security and robustness
- Handling UAV failures
- Ensuring privacy and trust

Questions

Thanks a lot. Questions?