InSTEDD

UAVs for Disaster Response

Discovery Workshop at Singularity University

Supported by

CISCO Foundation

Workshop Goals

- ✓ Understand challenges around disaster response
- ✓ Discover potential applications of UAVs to address those challenges.

Attendees

Dr James F. Roberts

CEO + Founder JFR-INNOVATIONS PTY LTD.

Dr James F. Roberts is an Australian entrepreneur and flying robot specialist with more than a decade of experience in Unmanned Aerial Vehicles.

While working in two challenging and inspiring Start-up companies abroad, James has been bridging the gap between research and product commercialization.

Geoffrey Pinnock

Regional Emergencies Officer, WFP Asia - Regional Bureau

Geoff is the regional emergencies advisor for the United Nations World Food Programme (WFP) in Asia-Pacific. WFP is the food assistance arm of the United Nations with global mandates in emergency logistics, food security and telecommunications.

Geoff's work includes establishing humanitarian response operations during large-scale emergencies, and supporting WFP, cluster partner and national government emergency preparedness in-between. Recent operations include Pakistan (floods), South Sudan (conflict), Vanuatu (cyclone), Papua New Guinea (drought), Philippines (typhoon) and Nepal (earthquake).

Geoff's background is in emergency logistics, food assistance programming and bartending.

Sebastiaan van Herk, PhD

Partner at B&W, Researcher at UNESCO-IHE, UN-ISDR Resilient Cities campaign advocate

Sebastiaan holds a joint PhD degree from UNESCO-IHE and Delft University of Technology and an MSc degree (cum laude) in systems engineering, policy analysis and management from Delft University of Technology (2003). He studied industrial engineering at the UPC Barcelona and economics at the Erasmus University in Rotterdam.

Mr. van Herk mainly works in the domains of environment, water and construction. He is a founding member and researcher at the Flood Resilience Group at UNESCO-IHE. He has been appointed UNISDR (United Nations International Strategy for Disaster Reduction) campaign Advocate for Resilient Cities and is a member of its Working Group on Urban Planning and Disaster Resilience.

Oriol López Guirao

Researcher and Field Logistician at MSF

Oriol has worked as a Field Logistician, as well as in IT positions in MSF HQ and on the field. Currently, he leverages those experiences in MSF's R&D. His astounding portfolio includes:

Using fixed wing systems for transporting medical items in Papua New Guinea.
Redesigning the NFI emergency kit with solar lamp and phone charger, efficient cooking stoves and transitional shelter. Evaluating the use of biometrics for identification of patients or refugees with link to electronic medical records.Solutions for the identification of medical structures from airforce airplanes to avoid bombing. Developing cold chain solutions: improved coolboxes, peltier cold generator, monitoring, etc. Leading the design & development of the learning app AllAgainstEbola. Industrial design, build & 3D printed several drone designs.

Krishna Devkota

Disaster Risk Management Specialist at Terrasense Switzerland

Krishna holds a PhD in Geology from Kyungpook National University. He has a substantial body of research on landslides, with a current focus on geohazard risk reduction in Nepal. He was extensively involved in preparing the concept paper for fire hazard management in Nepal and had series of meetings with the Ministry of Federal Affairs and Local Development of Nepal while working with Asian Disaster Preparedness Center based on Bangkok. He has also experience in geological disaster and flood hazards in the region including Nepal, South Korea and Lao PDR.

Jake Pelk

Fire Captain at Central County Fire Department

Jake Pelk has been in the fire service for over 20 years. Jake started his career as a volunteer in Boulder Creek, CA in 1992 and was promoted to Fire Captain in 2009 at Central County Fire Department in San Mateo County.

In 2010 Jake was assigned to the Central San Mateo County Training Division on a 40 hour week. Jake has been very active in the development and implementation of the San Mateo County RIC policy. Jake served as a co-chair for the RIC/FF Survival sub-committee for the California State Fire Training re-write and is also a LARRO Instructor. He began teaching thermal imaging classes in 1998. He co-founded the "Nobody Gets Left Behind" Training Group and is currently the Director. In November of 2010 the California Training Officers honored Jake with the "Ed Bent" Award (California Instructor of the Year).

Patrick Meier

Humanitarian Technology & Robotics Consultant

Dr. Patrick Meier is an internationally recognized expert and thought leader on humanitarian technology and innovation. His new book, "Digital Humanitarians" has been endorsed by Harvard, MIT, Stanford, Oxford, UN, Red Cross, World Bank, USAID and others. Over the past 14+years, Patrick has worked in the Sudan, Kenya, Ethiopia, Uganda, Somalia, Liberia, India, Nepal, Philippines, Timor-Leste, Kyrgyzstan, Turkey, Morocco, Western Sahara, Haiti, Vanuatu and Northern Ireland on a wide range of innovative humanitarian projects with multiple international organizations including the UN and World Bank. In 2010, he was publicly praised by Clinton for his pioneering digital humanitarian efforts, which he continues to this day. His influential blog iRevolutions has received 1.8 million+ hits. (Patrick joined us remotely)

Martín Verzilli

UX Designer at InSTEDD

Martín is an expert in Interaction Design and its applications in resource-constrained scenarios. He has helped InSTEDD partners all around the world, from Haiti to Congo, apply User Centered design principles and innovate without losing sight of the context constrains. He has worked with UN OCHA during disaster simulations in Colombia, with UNICEF mapping environmental risks in Haiti and Slums in Brazil, and prototyped a number of disease surveillance applications for Tanzania. In 2011 Martin was invited to give a seminal presentation on Interaction Design for Emergencies and Disasters at the Interaction Design South America conference in Belo Horizonte, Brazil.

Martín holds a degree in Computer Science and has done his thesis around Cardiac Arrhythmia simulations.

Juan Wajnerman

Software Architect at InSTEDD

Juan has more than 20 years of experience designing and developing complex software systems. He has academic training in Electronics Engineering and Mathematics and has applied his skills to diverse domains ranging from Aerial Photogrammetry to IVR applications. Juan has consulted for Microsoft to improve the scalability of highly-distributed systems. At InSTEDD he oversees the architecture, scalability, security and performance of all cloud systems.

Nicolás di Tada

Director of Engineering at InSTEDD

Nicolás leads the design and development of InSTEDD's software platform, and works with InSTEDD partners through the whole lifecycle of project design, development and implementation. During the last 8 years, he has facilitated more than 10 design workshops around the world, bringing multi-disciplinary teams together to work on humanitarian challenges.

Lessons learned

1. Striking the balance between a group's multi-disciplinary expertise and a common goal is key to a diverse and engaging exploration.
2. UAV hardware capabilities are better developed than software components (planners and data processors) in terms of maturity and ease of use.
3. Disaster and Humanitarian Responders are working with UAV tools developed for other domains (Agriculture & Mining); **tailored and appropriate design would enable many new uses.**

Discovery of gaps - Key Areas

1. Mapping/counting people
2. Modelling water depth & flow
3. Routing vehicles & people
4. Payload delivery
5. Augmenting places & buildings with data
6. Where are my resources?
7. Communicating with populations
8. Signal coverage mapping
9. Soil and water sampling with sensors
10. Near real-time situational awareness


Mapping/Counting People
Modelling Water Depth & Flow
Routing Vehicles & People
Payload Delivery
Communicating w/Population
Where is my Stuff & People?
How to augment places & building w/data?
Real-Time Situational Awareness/Mapping
Signal Cove
Mapping
Sensors/ Soil Sampling
Geoff
Jake
Oriol
Krishna
Jake
Oriol

Criteria for area selection

1. Feasible in the near-term future with investment < 1M.
2. Unlikely for private sector to have enough incentives to solve on their own.
3. Challenge affecting a wide-range of users


ASIAN
3DR

Situational awareness pipeline

Plan

Operator designs the flight plan in a notebook or mobile device and uploads it to UAV

Fly

UAV executes the flight plan capturing elevation points and imagery.

Collect

Once mission is over, the operator downloads data from the UAV onto the notebook or mobile device.

Process

Software at the notebook processes the captured data to build the model

Augment

Humans or software analyze the imagery and model, and add additional information.

Disseminate

Imagery and models are distributed to decision-makers and responders.


PAKISTAN
Helo/LZ Distribution Points (displaced pop)
- potential for crowd-sourced analysis
Airlift Capacity
Tracking & Coordination
- Multiple Militaries (tasking & airspace deconfliction)
Flood Defenses → Worse Floods

Challenges

The current pipeline through which an operator needs to push through in order to go from a disaster situational-awareness need, to distributed information in the hands of responders is made of a mishmash of non-appropriate interactions with different components. By non-appropriate we mean that the interactions where not designed for the context of disaster response.

1. Lots of “elbow grease” required to move through the pipeline.
2. Solutions are vendor-specific with no integration or interoperability.
3. Operationalizations are non-repeatable nor scalable.
4. Unique and specific skills required to operationalize a mission.

Opportunities

Rather than a single intervention we have found that a number of improvements and additions to the *situational awareness pipeline* would have the greatest impact. Those improvements would not only streamline, simplify and integrate the process but most importantly they would tailor the user experience to disaster specific use cases, making the use of UAVs for disaster response much more relevant and appropriate.

Additionally, there are several opportunities to overlap and even parallelize some of the steps in the pipeline, getting the experience closer to a real-time situational awareness.

Plan

CHALLENGES

1. Flight planners are designed for agricultural and mining domains, where the need is to map in detail an area roughly rectangular. This is not the case in disaster situations where the interest area could be the road network or the bank of a river.
2. Flight planners are designed for situations that are assumed to remain static throughout the flight; i.e. nothing learned during the flight affects the flight plan.
3. Flight planners are designed for single UAVs. There are no tools available to distribute a flight plan among several UAVs.

OPPORTUNITIES

1. Disaster-specific flight plans: follow roads or power-lines, find people or animals, hailing loudspeakers, 3G or radio signal tracking.
2. Dynamic flight plan updated by real-time ground feedback.
3. Coordination of multiple smaller/cheaper UAVs to map a large area in parallel.

Fly

CHALLENGES

1. No imagery or DEM on-board processing capabilities; limited only to flight control.
2. No airspace awareness, avoidance of no-fly-zones or kill-switch when nearby aircrafts.

OPPORTUNITIES

1. Onboard image processing: thermal feature extraction, use to update dynamic flight plan and live-relay to ground operator for Search and Rescue ops.
2. Airspace awareness: no-fly-zones detection through beacons and “drop-dead” signal from nearby aircrafts.

Collect

CHALLENGES

1. Data download to ground computer is vendor-specific making it very difficult to integrate diverse vendor data sources.
2. No data collection happens until UAV is back on the ground which introduces delays in urgent situations.

OPPORTUNITIES

1. Seamless cross-vendor data collection and integration to support consumer-end UAVs crowd-sourced efforts.
2. “Plug-and-play” data download to ground computer from multiple UAVs.
3. Initial low-resolution data transmitted during flight to provide progressive awareness.

Process

CHALLENGES

1. Processing for DEM and imagery is extremely slow taking up to 12 hours for dense models.
2. No useful information is provided to the responders until the processing is over.

OPPORTUNITIES

1. Local parallel processing for DEM and photo draping: use multiple computers in a LAN to distribute processing load.
2. Progressive-rendering: provide lower-quality intermediate outputs that might be still actionable for urgent operations.

Augment

CHALLENGES

1. No standard platform to extend or augment DEMs or imagery. External augmentation is a different ad-hoc process for each software.
2. Available crowdsourcing platforms require a lot of manual and technical interventions and do not integrate at all with the rest of the pipeline components.

OPPORTUNITIES

1. Standard-based platform for external augmentations and software interoperability.
2. Differential analysis: highlight areas that have changed by performing automatic comparisons with satellite imagery.
3. Cloud crowd-sourced feature extraction for damage assessment: both unbounded (volunteer-based) or bounded (vetted experts).
4. Machine-learning based people estimation: counting approximate numbers of people during displacement situations.

Disseminate

CHALLENGES

1. Distribution of processed data to decision-makers and responders is mostly manual.
2. As additional or updated information is available, redistribution of data needs to happen again; responders have no way to access ‘latest’ version.

OPPORTUNITIES

1. Distribute point-of-interests to responders in real-time: victim locations, structural dangers, safe routes, landing zones, etc.
2. “Live” situational awareness shared map: responders locations, latest imagery, relevant points, etc.

Summary of components maturity

Pipeline component	Disaster Response appropriateness	Tech Maturity	UX Maturity	Integration Maturity
Flight Plan	✘	✔	✔	~
Flight control	~	✔	✔	✔
Data collection	✘	✔	✘	✘
Data processing	✘	✘	✔	✘
Data augmentation	~	✘	✘	✘
Data dissemination	~	~	✘	✘

Conclusion

1. Appropriate contextual design would enable big opportunities in the use of UAVs for disaster response.
2. The use-case of fast *situational awareness* strikes a perfect balance between feasibility and high-impact.
3. Streamlining (optimizing both for timeliness and ease of use) the experience of situational awareness can be done by a combination of several mid-size to large efforts.
4. Incremental benefits can be obtained by gradually resolving the major obstacles in the pipeline.

Thank you!

InSTEDD

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