RELIEF 10-04

Report on the RELIEF 10-04 Experiments at Camp Roberts

Humanitarian Technologies for Domestic and International HADR Operations

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Center for Technology and National Security Policy
National Defense University

In Partnership with the
Naval Postgraduate School

RELIEF 10-04

From 3-6 August, RELIEF convened its fifth session of field experiments for humanitarian information management and crisis mapping at Camp Roberts in Paso Robles, CA. The RELIEF experiments occurred within a partnership of the National Defense University's Center for Technology and National Security Policy and the Naval Postgraduate School.

Background

RELIEF 10-04 focused on the collection of imagery and mapping data by fielded staff during disasters and stability operations. The goal was to create a complete feedback loop for situational awareness using low-cost tools that can be used at the village level during HADR/SSTR operations.

In technical terms, the team set out to collect imagery from small UAVs and weather balloons, mosaic and orthorectify the imagery, trace it into OpenStreetMap and provide paper-based tools that can ground truth the resulting vector road data. This work was divided into four teams:

1. *Grassroots Mapping with Balloons and COTS Cameras.* Description
2. *Automating Imagery Processing with Google Earth.* Description
3. *Walking Papers with Balloon-Imagery Basemaps*:
4. *Integration of Road Traces from Balloon Imagery in GeoCommons*:
5. *Offline Maps*.

APPROACH. The RELIEF experiments bring together leading members of the open source software commonly and provide a venue for them to work on shared problems. In this case, RELIEF convened a panel of top humanitarian technologists from industry and the open-source domain. This team included the following software developers:

- **Christiaan Adams,** Google Crisis Response Team and Google Earth.
- **Kate Chapman**, FortiusOne/GeoCommons and Humanitarian OpenStreetMap Team.
- **Stewart Long,** Gonzo Earth and Grassrootsmapping.org, pioneer in low-cost (sub $150) rigs for collecting imagery via balloon, kits, and model aircraft.
- **Michael Migurski**, CTO of Stamen Design and inventor of Walking Papers.
- **Josh Livni,** Google Developer Relations and contributor to Walking Papers and OpenStreetMap.
- **Ka-Ping Ye,** Google Crisis Response Team and maintainer of the Person Finder Interchange Format (PFIF) used for tracking missing persons from Hurricane Katrina to the present.

The RELIEF team also convened SMEs who focused on the social and policy problems around the use of open-source software in the field, including including:

- **John Crowley**, experimentation lead and crisis mapping coordinator at both the Harvard Humanitarian Initiative and National Defense University Center for Technology and National Security Policy.
- **Phil Stockdale,** lead of the JCTD called Prepositioned Expeditionary Assistance Kit (PEAK).
- JD . SOUTHCOM representative to PEAK.
- **Jon Perez,** Booz Allen support contractor who manages SOUTHCOM's JCTD programs, including DARPA TIGR and Transnational Information Sharing Consortium (TISC).

Problem 1: Balloon Mapping

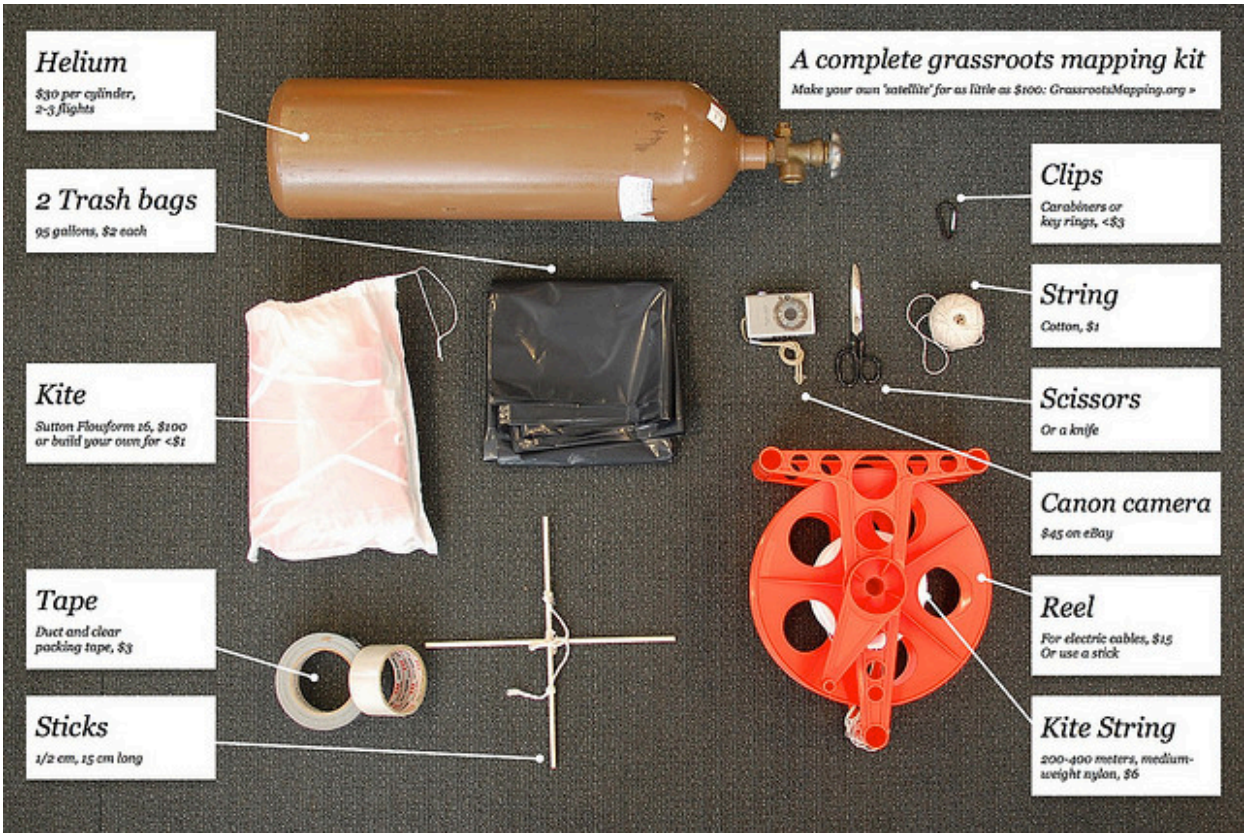
Problem Statement:

During HADR/SSTR operations, satellite imagery rarely makes it to field staff quickly. Imagery collection is dependent on satellite flyovers. When available, aircraft such as the P3 or large UAVs like Globalhawk can also perform collection. The delay in all cases is—at minimum—several hours. For small areas in the immediate vicinity to an NGOs area of operation, imagery of the affected area can prove very useful to both planning and reporting the situation to central nodes. If such imagery collection kits can be made sufficiently low cost, imagery could be collected in many areas of critical importance by staff on the ground with balloons and kites, and a composite picture taken of just the areas where the most humans are affected. The RELIEF team set out to demonstrate an existing, low-cost capability used by volunteers during the Gulf Oil Spill over the spring and summer of 2010.

Work Completed

Stewart Long of Gonzo Earth was not permitted to fly his low-cost rig on government land, due to the inability to find insurance for the rig. The team improvised. Thanks to WinTech, Stewart flew a low-cost, point-and-shoot Canon camera on a WinTech balloon that was participating in tests later in the RELIEF and TNT weeks. Stewart collected imagery from the area around McMillan airfield from an altitude of approximately 1000 AGL.

It is worth including a description of the gear that the team would have liked to have flown. This rig costs less than $200 total and requires on small amount of training to use. It consists of a weather balloon (or as a low-cost substitute, two trash bags), a helium canister, a COTS camera, and tethering/mounting gear for controlling flight and mounting the camera to the balloon:



Remaining Challenges:

Stewart has already demonstrated the capability of the platform in Louisiana, teaching over 20 people to fly balloon rigs that collected 4cm imagery from beaches affected by the oil spill. The main issue is one for RELIEF: to obtain an insurance package that enables small aircraft and balloons to fly at Camp Roberts.

Problem #2: Automating Balloon Imagery Processing

Problem Statement

Cameras tethered to balloons tend to take images at oblique angles, sometimes up to 30 degrees from vertical. As a result, mosaicking the imagery and orthorectifying it is still a manual task. A human with moderate training and skill must stitch each image to the next and warp (rubbersheet) those images to the terrain. This process takes many hours for a small area. The RELIEF team set out to find methods for accelerating this manual process ahead of future work to find a fully automated method of imagery processing.

Work Completed

The Google Earth team of Christiaan Adams and Ka-Ping Ye approached the problem from the perspective of an analyst who needs to take an SD card of imagery and quickly place them into Google Earth, where they can be placed approximately in the

location where the camera was pointing. The Google Earth team created a Python script that processed a file directory of images and placed them all in a virtual stack at a given GPS coordinate. The pictures could then be moved by hand to the area in Google Earth where they belong, and the mosaic could be exported as a KMZ file for further fine tuning. This script dramatically increased the speed by which an analyst can process imagery, getting an 80% solution at low cost and high speed.

The tool was used to process imagery from the Gulf:

Remaining Challenges

The script enables an analyst to place images in an AOI. This meets the minimum bar for making a field operation viable. However, the RELIEF team is seeking a solution to the problem of automated stitching, rubbersheeting, and orthorectification of balloon and kite imagery.

Problem 3: Walking Papers Integration with Balloon Imagery

Problem Statement:

During modern field operations, paper is still a go-to display and distribution technology. It is a portable, durable technology with high-resolution medium that requires no power. It is also an ideal medium for ground-truthing vector road and POI data from maps with a local population, whose literacy or geospatial knowledge

may be very low. That said, maps are generally abstractions that require literacy. The general notion that the RELIEF team had was to show imagery collected from balloons in a format that enabled a local resident to annotate the imagery, and to have those annotations be scannable into a format that automatically geopositioned those annotations very close to the objects to which they refer.

Work Completed

Walking Papers already offered the ability to use satellite imagery as a base map, and to overlay vector road data and MGRS gris on the map. However, this code needed to be cleaned up for release into the main Walking Papers codebase, and to make that code have the ability to accept a user-defined GeoTIFF that could be used as a basemap. Mike Migurski completed both functionality and prepared it for deployment on the main Walking Papers site.

Mike also worked with the Google team in Problem #5 to build a fieldable package (in a virtual machine) that brought OpenStreetMap and Walking Papers into an offline format. This would enable a field operation to collect imagery, process it using Google Earth, export the GeoTIFF to Walking Papers, where it could be annotated and traced into OpenStreetMap—all offline and without any connection to the main OpenStreetMap.org or Walking-Papers.org web sites.

Remaining Challenges:

The virtual machine enables a team to take OpenStreetMap offline. However, any changes made in OpenStreetMap remain local; they cannot be synchronized back into the public geospatial wiki at openstreetmap.org. This functionality will need to be added in the future.

Problem 4: GeoCommons Integration into Offline OpenStreetMap Services

Problem Statement:

GeoCommons is normally configured to provide geospatial visualizations of structured data inside an office where connectivity to the public Internet can be assumed. It has been reconfigured for use in Afghanistan in an offline format, but this code still needed further work based on lessons learned in the field.

One key aspect was simplifying the networking configuration so that the tool could be addressed using local network names instead of needing special hostname confirguration. Previously the URLs looked like http://finder.geoiq.local and http://maker.geoiq.local, which required adding 3 hostfile entries.

Another issue was in making the data created in an offline version of OpenStreetMap available in GeoCommons and enabling users to upload GPS tracks directly into GeoCommons using the Garmin data format, GPX. This feature enables users to turn their handheld GPS units into road-tracing tools.

Work Completed

Kate Chapman created a new short networking name for offline GeoCommons instances, so that the URL for offline instance http://geoiq.local for example there is not extra configuration to access Finder and Maker. Now the URLs look like http://geoiq.local/finder and http://geoiq.local/maker. This means just an IP address can be used or a single hostfile entry is required, simplifying configuration for users who are not trained as system administators.

Kate also created a tool the enables users to upload GPX files into GeoCommons, so that GPS tracks collected by GPS units can be turned into OpenStreetMap road tracings inside of an offline GeoCommons platform.

Remaining Challenges

The GeoCommons server will be sent to Afghanistan again. Field testing will likely reveal additional areas for improvement.

Problem 5: Offline Mapping

Problem Statement:

In Haiti, the Humanitarian OpenStreetMap team discovered that it was critical to have offline digital maps in an environment where public Internet access was not always reliable. It was also critical for teams to be able to deploy quickly, downloading all available imagery and OSM data and taking it with them. Teams in Nangarhar, Afghanistan made the same request. The RELIEF team also wanted to enable users to process balloon imagery coming from Stewart Long's work. As a result, Mike Migurski, Ka-Ping Ye, and Josh Livni worked to create an offline mapping stack that included OpenStreetMap, Google Earth, and Walking Papers.

Work Completed

The current, first-cut mapping stack packages OpenStreetMap, Google Earth, and Walking Papers into a virtual machine. This package is providers laypersons with the ability to download imagery from Google in GeoTIFF (where license allows) and vector data from both OpenStreetMap and Google MapMaker. The tool also packages Walking Papers, so that users can print out versions of Walking Papers for use in the field.

Remaining Challenges

The team did not complete work to enable offline users of Walking Papers to scan annotated paper maps into the package and trace new elements into the local instance of OpenStreetMap. The team also needs to package the installation of the imagery and vector data into the virtual machine into a script, as the current process requires careful attention to 30-40 steps.

Appendix: Report from Gonzo Earth on Balloon Mapping

PEAK JCTD

Gonzo Earth Balloon Report
Stewart Long
gonzoearth.com
August 11, 2010
Camp Roberts RELIEF Report

Grassrootsmapping.org propagates a neogeographical approach to aerial imaging. Consumer-off-the-shelf (COTS) products and low cost are core to the grassrootsmapping field mapping methodologies. The methods are designed to be approachable to a wide audience of volunteer citizen mappers. A sub $200.00 cost, and brief training regime has been established by the group. All work is in the public domain, and all necessary instructions and resources can be found online at the grassrootsmapping.org domain. Grassrootsmapping can empower a RELIEF crisis mapping toolkit to incorporate aerial imaging as an aerial image raster accompaniment to vector based OSM data.

The agenda for RELIEF contained two separate hardware and software demonstrations. In the hardware demonstration, the grassrootsmapping toolkit is employed to fill a 5' helium balloon and fly it with a lightweight camera and GPS payload. The balloon is attached to a simple ground based tether that can be deployed by hand, or with a power drill. The focus of the demo is low cost COTS components, simplicity, low cost, short mission time, ease of operation, and the collection large amounts of aerial data for the surrounding area. The kit is also very small in size, and can fit within a backpack if used with a compact tank.

The software demonstration involves the processing of the collected aerial images into standard GIS data for OSM and other vector overlay. Two different techniques are outlined; simple image overlay for each separate image, and advanced image mosaicing where one composite image mosaic is stitched from separate aerial images.

Due to the necessity of operational certification and insurance, both demonstrations were adapted to the available resources at Camp Roberts. In place of the grassrootsmapping toolkit, a large balloon system that included a full size tuck, trailer, hydraulic system, and crew. A Rascal UAS provided the aerial imagery for demonstration of the image overlay and stitching techniques.

Full certification of the grassrootsmapping toolkit, is main goal for the next RELIEF camp. Using the actual gear will demonstrate the simplicity, power, and low cost of the grassrootsmapping system. While the change in program allowed for an augmented demonstration to occur, it was abstracted from the intended message.

The balloon and Rascal UAS systems were larger, expensive, sophisticated, and not approachable to citizen volunteers in a crisis situation. Flying at higher altitudes can demonstrate a larger image swath that contains more essential information in a crisis situation.

Additionally, there are 4 new activities for proposal towards the next CR RELIEF in November in addition to the full certification of the grassrootsmapping toolkit:

1) 2.4GHz wireless video transmission. Real time information in a crisis situation.
2) Android smartphone video streaming over 3g networks (ustream, knocking live)
3) ”Mobile Live Processing” Android project. Open source project to port or recreate Pict’Earth mobile live processing ap for Android. The app creates kml overlays from images for either offline transfer after the phone is back on the ground or for live near-real-time transmission if a data connection is present.
4) Inclusion of the Sofcoast ASAP aerial platform. This product will provide a robust alternative to the COTS grassrootsmapping balloon for comparison. John Surmont of Sofcoast.com has established that this platform is available for November if the certification is in order.