Real-Time Analysis of Damage from Airborne Active Remote Sensing

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Abstract
We describe ongoing work at the University of Houston to develop a real-time data analysis capability to use 3 dimensional models acquired using airborne LiDAR (Light Detection And Ranging) to enable better dissemination of damage after a significant event such as a hurricane.

1. Introduction
The emergency response to a natural disaster requires effective leadership, and leadership "*requires good information. And a coordinated process for sharing it. And a willingness to use information – however imperfect or incomplete – to fuel action.*"[1] The collection of the right information is only one step in the process. The efficient and immediate **dissemination of that information**, and proper decisions made using the most up to date information, to the multitude of individuals responding to a disaster is also important. Increasingly, accurate mapping data and GIS software are being used to plan, coordinate and respond to specific threats from a disaster [2-3]. The primary geospatial data being used to respond to disasters comes from over flights of the disaster with a suite of passive and active electro-optical sensors (both airborne and space borne) that record timely and critical information about the conditions on the ground. Currently, however, the primary difficulty with geospatial response is that the mapping and situational data being collected **is not immediately available**. A post-mission analysis and review, along with an upload or conversion to the geospatial repository is required before the information can be disseminated to the users who require it to make vital decisions. This delay represents **a significant bottleneck** that can have catastrophic consequences as decision makers await the vital information or perhaps even worse make wrong decisions based on an incomplete understanding of the circumstances.

2. Objective
Unfortunately, real-time acquisition of the geospatial data is not enough to ensure the timely use of the information for critical post-disaster responses such as clearance of debris on essential road infrastructure and restoration of power to critical facilities such as hospitals. A decision support mechanism that is able to disseminate the large volumes of geospatial data is required in order to prioritize actionable items to identify the critical response issues and to identify the critical path for rapid recovery from the impact of a disaster [4-6]. To mitigate both the collection and decision support bottlenecks, our research team is working towards a fundamental paradigm shift in the way that geospatial data is collected and disseminated. We are designing, assembling and testing an integrated hardware and software solution that will capture, geo-reference and disseminate to a distributed user group geospatial data from a variety of sensors. We are also developing a GIS-based multi-infrastructure models, initially focusing on the flooding and impacts to the transportation infrastructure that will assist responders in distilling the large volumes of geospatial data into actionable items for both immediate response to the disaster and full infrastructure recovery over longer temporal scales.

3. Discussion

For the purposes of this study, we are using “simulated” pre- and post- event datasets. Our research team has obtained access to two airborne LiDAR surveys of Galveston Island, Texas acquired during October, 2002 and March 2010. In the time period between these two LiDAR collections, Hurricane Ike made landfall on Galveston Island as a Category II storm on September 13, 2008. The resulting winds, rain and storm surge created catastrophic damage to the island [7]. Although the second LiDAR collection was 18 months after Ike made landfall, the impact of the hurricane on the island is still readily evident in the dataset (see Figure 1).

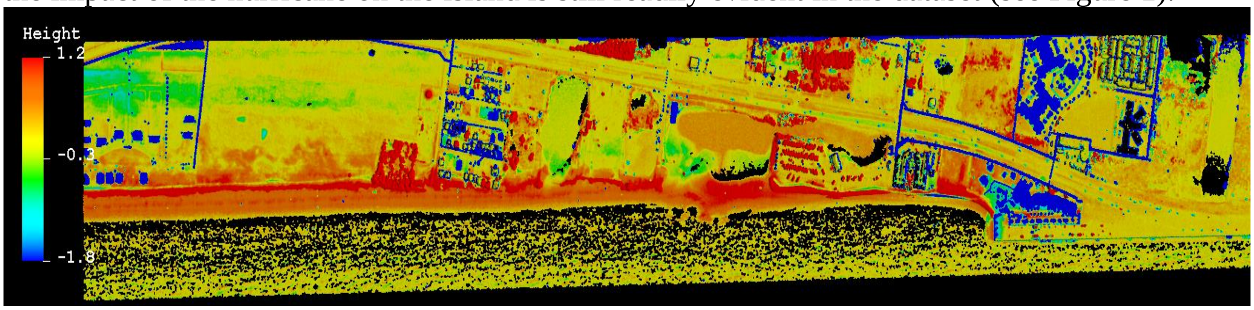

Figure 1. Vertical change between two airborne LiDAR datasets (2002 minus 2010) over a Section of Galveston Island

We are using this dataset to test the following hypotheses: (1) LiDAR data can be acquired and processed in real-time at an accuracy that will meet the requirements for spatial change detection, (2) Change Detection Algorithms can be implemented in real-time to determine change from 3D point clouds as they are acquired, (3) Multi-infrastructure Models Can Be Developed That Support Filtering of High Resolution Change Detection Results into Actionable Items by Emergency Responders. Currently we are working primarily on hypothesis tests (1) and (2). Some of the preliminary analysis of change is shown in Figure 2, showing removed vegetation and changes in buildings.

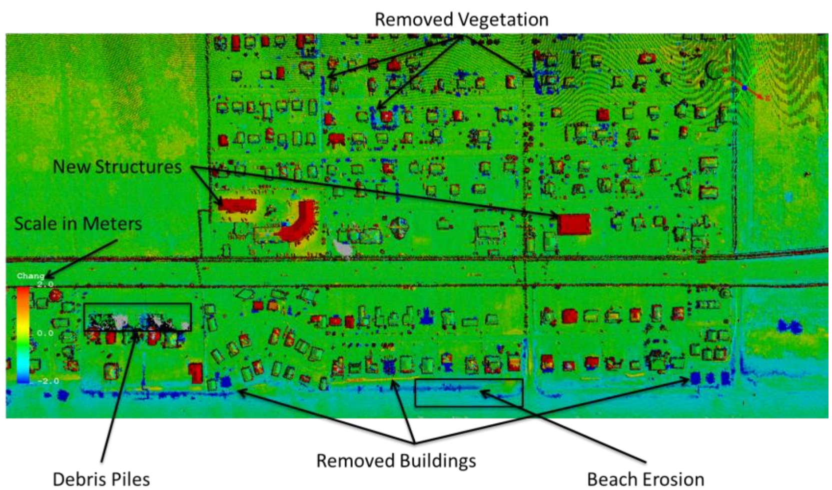

Figure 2. Digital Elevation Model of Galveston Island, colored by Vertical Differences Between 2002 and 2010 LiDAR Datasets (2010 minus 2002). Areas of blue represent volumetric removal from 2002 to 2010, while red indicates new features.

4. Conclusions

The research project is ongoing, and progress is being made toward efficient analyis 3D change from LiDAR data in near real-time to enable automated dissemination of damage for real-time situational awareness after a disaster. Project completion is currently scheduled for Sept. of 2015.

5. Acknowledgement

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6. References

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