

A Visual Analytics Multimedia Mobile System for Emergency Response

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Abstract—We present a novel visual analytics system and multimedia enabled mobile application that allows emergency management (EM) personnel access to timely and relevant disaster situation information. The system is able to semantically integrate text-based emergency management disaster situation reports with related disaster imagery taken in the field by EM responders and community residents. In addition, through an intuitive and seamless Apple iPad application, users are able to interact with the system in diverse places and conditions and thus provide a more effective response. The system is demonstrated via its iPad application which aims at providing relevant and actionable information.

Keywords-disaster situations; mobile computing; iPad applications

I. MOTIVATION

Natural and man-made disasters can cause significant damage both in terms of property loss and human lives; which is why preparedness and rapid response activities are performed by highly trained emergency managers around the world. During a disaster event, Emergency Management Offices execute their disaster response plans by integrating jurisdictional resources, coordinating multi-agency response, and establishing management processes among the various government, non-government, and private sector entities involved in recovery.

However, command personnel commonly rely on situation reports that only provide a textual description of the disaster scenario, which makes the task of assessing the disaster situation difficult since often these textual reports are unable to describe the situation at the desired level of detail. The work of emergency management (EM) personnel could be enhanced if they could analyze situation reports along with images and videos taken at the disaster scene by emergency first responders and community residents as well. A system able to combine both textual reports and multimedia data taken at the disaster scene would add potentially new insights to the command personnel in assessing the situation in the field. Furthermore, EM responders and command personnel would need to be able to access reports and multimedia information at any place at any time, a requirement that prompts mobility as a must-have feature for such system.

This demo paper presents a system that integrates situation reports and disaster-related multimedia data and provides

EM personnel with an iPad application that conveys all the information via a unified and intuitive graphical interface. Moreover, since the front-end interface of the system is an iPad application, EM personnel can take advantage of the mobility offered by iPads and thus be able to interact with the system both at command centers and at the actual disaster area.

II. SYSTEM ARCHITECTURE

The system follows a three-tier architecture. The front-end tier consists of an iPad application; the logic tier provides a RESTful, JSP-based API; and the data tier runs a database server.

The database stores all the data related to the situation reports and related multimedia data as well as user-account information. Its schema models the semantic relationship between the situation reports and the multimedia data. Situation reports cover one or more geographic *locations* and *subjects*, which are in turn depicted by images taken at the disaster area. For example, in the scenario of a hurricane affecting South Florida, geographic *locations* may be Miami-Dade or Miami Beach. Images may describe a location before or after the natural hazard. The *subject* of an image depicting a location after the impact of the disaster is the type of damage occurring at the location. For example, the subjects of post-hazard images may be “building collapse”.

The RESTful, JSP-based API fulfills requests from the user interface by retrieving the necessary information from the database. The API follows the Model-View-Controller (MVC) design pattern, and requests and responses are in terms of XML documents. For example, through this RESTful API, the front-end application can retrieve the list of reports, the list of locations and subjects the reports reference to, and the list of images that related to such locations and subjects, etc.

The iPad application makes up the front-end layer. Following the MVC design pattern, this layer is a complete system by itself. The application communicates with the server layer via XML-based, RESTful requests and presents all the information to the users an intuitive way. The presented functionality is further described in section III.

Semantic Integration

The presented system achieves the integration of situation reports and related multimedia data by semantically associating them through location and subject entities. Subject and location entities are extracted from situation reports using WordNet [1] and the GATE framework proposed by Cunningham et al. [2]. The related multimedia data are classified into subjects and locations using the Hierarchical Disaster Image Classification (HDIC) framework proposed by Yang et al [3]. In addition, the system is capable of taken feedback from the users to improve the semantic association between the data.

III. DEMONSTRATION

The system will be demonstrated via its front-end iPad application. The set of reports to be used in the demonstration consists reports gathered from Miami-Dade's Emergency Operations Center, and related images of disaster areas were collected from the web. The functionality presented to the users is described as follows.

The main page of the iPad application is the report list page shown in Figure 1. This page shows the list of reports available in the system; each row in the figure represents a specific report, and the small thumbnails shown to the right of each report are the images associated with the report. Only up to three thumbnails per report are shown in this page. Once a specific report is opened, the text of the report is shown full-screen, and a side bar appears on the right of the screen which enables users to see comments, tags, or the list of images associated with the report.

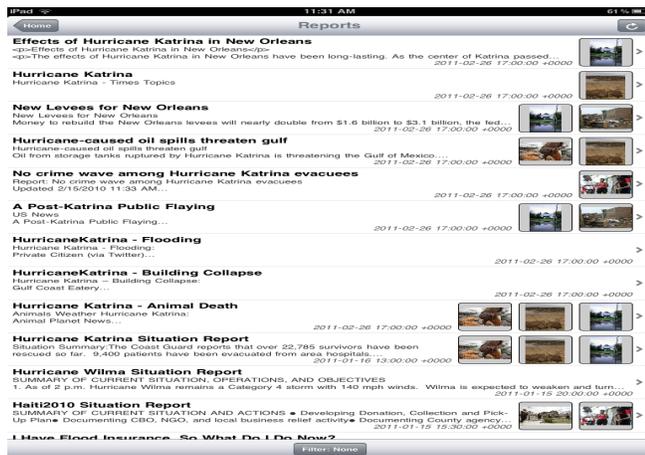


Figure 1. List of reports and associated image thumbnails

Upon tapping the the tab for related images, the window shown in Figure 2 is presented to the user, who can scroll through all the available images for the selected report. The user can long press an image to bring up three voting buttons that appear on top of the image and allow the user to provide feedback about the image; these three buttons are for

indicating to the system that (a) the image is inappropriate and thus has to be removed from the system or that the image is (b) highly relevant to the report or (c) not relevant to the report.

Besides voting, the user can tap an image to show the the timeline for the image. The timeline is a set of images that depict the same location and are organized by date from earliest to latest. For example, in the event of a hurricane impact, earliest images in a certain timeline may show how a building looked before the hurricane, and later images may depict the building with some visible physical damage after the impact of the hurricane. In order to traverse the timeline of images, the user can pan the screen by holding and dragging across the iPad's surface or press indicating arrows that appear on the horizontal sides of the screen.

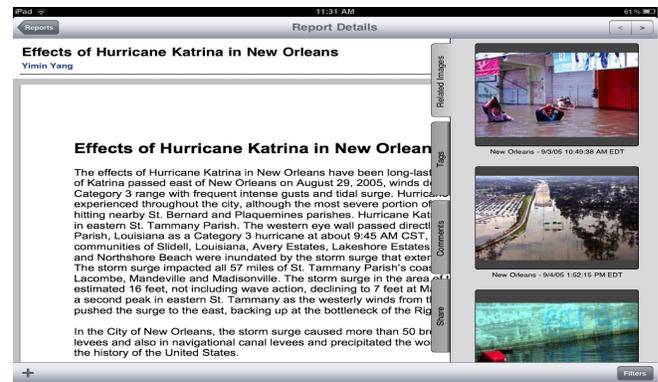


Figure 2. List of images for a report

ACKNOWLEDGMENT

This research was supported by the U.S. Department of Homeland Security under grant Award Number 2010-ST-062-000039, the U.S. Department of Homeland Security's VACCINE Center under Award Number 2009-ST-061-CI0001, and NSF HRD-0833093. We would like to also acknowledge the work of Jesse Domack, Mark Oleson, and Jason Allen and highlight our collaboration with Miami-Dade's Emergency Management Department.

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