A Video-aided Semantic Analytics System for Disaster Information Integration

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***Abstract*—We present a novel web-based system and a video-aided mobile application that allows emergency management personnel to access to prompt and relevant disaster situation information. The system is able to semantically integrate text-based disaster situation reports with related disaster videos taken in the field. The system is adapted to the video concept detection model and automates the procedure of file deployment and data manipulation. In addition, through an intuitive and seamless Apple iPad application, the users are able to interact with the system in various places and conditions and thus provide a more effective response. The system is demonstrated via its iPad application, which aims to provide relevant and feasible information for a disaster situation of interest.**

***Keywords*-disaster information; mobile computing; iPad applications**

I. MOTIVATION

There have been many disasters in recent years. Both natural hazards and man made disasters cause huge damages on properties and human lives. When a disaster approaches, time becomes vital, since the emergency operation center (EOC) needs to update the situation reports immediately in order to provide the latest situation evaluation. The situation reports are mostly not too long and contain only highly abstracted critical information. Hence, many details are ignored, which in fact can be important for the emergency management personnel.

Multimedia data, including images and videos, can provide lots of useful information to aid the understanding of the situation reports due to its rich semantics. In particular, video data has become more and more popular since the rapid development of the Internet makes the transmission of large videos possible. Furthermore, video data has image frames, audio and motions, which better assist in the understanding and visualization of the text-based situation descriptions. In addition, the use of mobile devices can also be very helpful, since during the disaster event, people can capture and share the most current situation relevant data as fast as possible. This enables people to have a plan in an early stage instead of being trapped in the field.

Besides the potential enhancements from the front-end, there are many back-end optimizations (for the server-side) that can be considered. The enhanced web-based system could handle the video concept detection task by integrating with any machine-learning framework using standardized outputs at the back-end. It would enhance the system capability that provides as many related multimedia data as possible to expand the details that assist in the assessment of the current situation. Several automated functional triggers in the server-side can be implemented in order to further elevate the performance of the system. The triggers are responsible for different types of inputs. One would be to launch when new items are received, which aims to avoid losing any relationship with the existing stored items.

In this demo paper, we present a system that integrates situation reports and disaster-related multimedia data and provides an iPad application that conveys all the information via a unified and intuitive graphical interface. Moreover, the server-side of the system provides several interface components that integrate the video concept detection model and automatic event triggers to improve the performance of the semantic integration procedure.

II. SYSTEM ARCHITECTURE

The proposed system has a front-end client side that consists of an iPad application; the server-side contains a JSP-based API, and a database server. The JSP-based API mainly contributes to the indirect communication between the database and the client side by handling XML-based requests and information retrieval [1].

The database stores all the data related to the situation reports and the multimedia data as well as the user-account information. Its schema models the semantic relationship between the situation reports and the multimedia data. The situation reports cover one or more geographic *locations*, which are in turn depicted by videos taken at the disaster area. The videos that were taken in one geographic *location* could contain several semantic *subjects*. For example, in the scenario of the storms affecting Alabama, geographic *locations* may be Tuscaloosa, Birmingham, and Hackleburg. Videos may describe the event or activity of one *location* before or after the natural hazard happened. The *subject* of a video depicting a location after the impact of the disaster could include the types of activities that were taken at the location. For example, the subjects of post-hazard videos may be “human relief”, “disaster recovery”, etc.

The presented system semantically associates the situation reports and related multimedia data through the location and subject entities. The geographic locations of the captured videos and report documents are extracted using the GATE framework [2]. In addition, a disaster-related video concept detection framework [3] as an independent component, is also integrated to the system, which helps to automate the entire process of semantic relationship deployment.

III. DEMONSTRATION

The system will be demonstrated via its front-end iPad application. The videos to be used in the demonstration were gathered from the Federal Emergency Management Agency (FEMA) website, which contains video contents not restricted to only the disaster event but also the disaster-related activities such as disaster beforehand preparation, disaster recovery, and training programs. The functionality presented to the users is described as follows.

The main page of the iPad application is a list of reports, which shows all the reports available in the system. Each row represents a specific report, and there are at most three small thumbnails shown on the right, which indicate the key frames of the videos associated with the report. Once a specific report is opened, the content of the report is shown full-screen in the PDF format, and a side bar appears on the right of the screen which enables the users to see the list of associated videos as well as other information. The page also has a search function available for the users to locate the semantic connection between videos and the report (as shown in Figure 1). The users can scroll through all the available videos listed in the tab view for the selected report, and press the play icon to play the video in the current position.

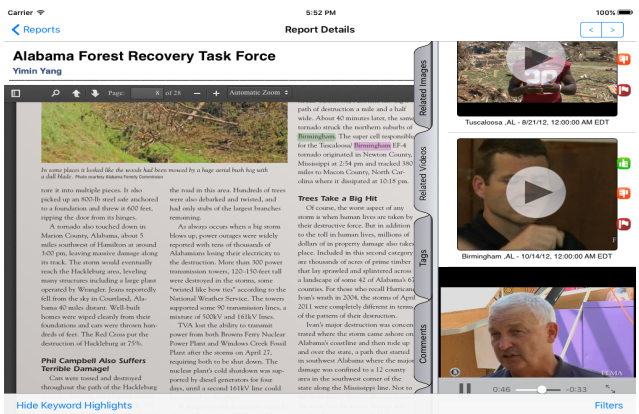

Figure 1. List of videos for a report with highlighted keywords

Also, the user can tap any other place inside the video cell to bring up the timeline view of the video. The timeline is a set of videos that depict the same location and are organized by the dates from the earliest to the latest. For example, in the event of hurricane impact, the earliest videos in a certain timeline may show how the community prepares before the hurricane landfall, and the later videos may depict the disaster recovery process with some visible damages. In order to traverse the timeline of videos, the user can pan the screen by holding and dragging across the iPad's surface if the indicating arrows appear on the horizontal sides of the screen.

Furthermore, on the vertical sides, the indicating arrows represent the existing videos having high affinities with the one currently shown on the screen. That is, the videos that are classified into the same subject will appear when the user swipes the screen up or down. By holding the description button at the bottom of the video page, the text information about the current video will show, as illustrated in Figure 2. The reference video will be shown as a thumbnail at the upper right corner, where the voting buttons are available for the users to interact with the system to provide feedback about the classification results.

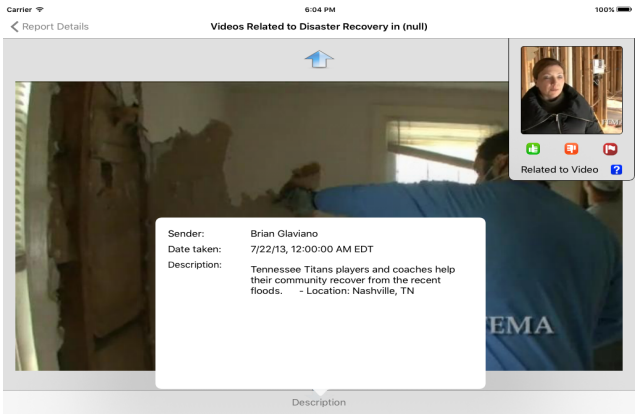

Figure 2. Video panel shows related videos for the subject "Disaster Recovery" with the video description button pressed

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