Event-Centric Multimedia Data Management for Reconnaissance Mission Analysis and Reporting

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ABSTRACT

We demonstrate the concept of event-centric multimedia data management in the context of a multimedia eChronicle for the analysis, exploration, and reporting of events in military reconnaissance missions. Unlike the traditional media-centric approach, event-centric multimedia data management focuses on the management of real-world events; documenting media are regarded as event metadata. For the detection of mission events, we apply simple but robust spatio-temporal clustering of basic soldier state and media events with good results considering the uncontrolled environment a military patrol constitutes. The core of the architecture is generic and applicable for the event-centric management of multimedia data in other domains as well.

Categories and Subject Descriptors

H.2.4 [**Database Management**]: Systems – Multimedia Databases; H.3.1 [**Information Storage & Retrieval**]: Content Analysis & Indexing

General Terms

Design, Management

Keywords

Events, eChronicles, Life Logs, Media Management, Reconnaissance Mission Analysis, Spatio-Temporal Clustering

1. INTRODUCTION

People accessing media (like news, sports, or personal media) are very often looking for documentations of events they are interested in. For this purpose, today's multimedia data management infrastructure is only of limited use. Multimedia databases and retrieval engines are fundamentally *media-centric*; they focus on the management of media, their features, and metadata, commonly limiting themselves to one modality such as image or video. Events, if at all considered, form just another kind of media metadata [3].

We argue that an *event-centric* approach to multimedia data management is needed. People require simple access to the real-world events they are interested in. Media are just another kind of metadata about these events. Neither is the modality of media of primary importance, nor is it comfortable for users to skim heterogeneous unimodal media silos to establish a multimodal view on a real-world event.

Demonstrating this different approach to multimedia data management, the paper presents the event-centric architecture of a multimedia eChronicle for the analysis, exploration, and reporting of events in military reconnaissance patrols. The eChronicle was developed in the DARPA project EC-ASSIST with partners from IBM, MIT, and GeorgiaTech. The architecture founds on a generic event-centric multimedia data management core that is transferable to other domains, such as life logs, news, sports, or personal media.

2. PROJECT BACKGROUND

As in life log applications, reconnoitering soldiers in EC-ASSIST carry a wearable computer that records and aligns data from various sensors including helmet-mounted video and photo cameras, microphones, GPS receiver, compass, altimeter, and accelerometers. After the mission, this multimodal sensor data is loaded into the eChronicle for analysis.

In this scenario, the problems of media-centric multimedia data management are aggravated. Soldiers need a readily accessible multimodal overview of important events in a mission. They do not have time for (modality-specific) browsing and searching of the large volumes of media and sensor data recorded during a mission to obtain this overview.

Furthermore, reconnaissance missions constitute highly dynamic and uncontrolled environments. This results in a considerable degradation of sensor data quality: photos tend to be blurry, audio noisy, video shaky. Traditional feature-based content analysis applied in media-centric data management thus offers only limited reliability for high-level mission event detection. The unpredictable nature of reconnaissance missions also makes it difficult to define a fixed set of events to detect by content analysis: what are important events may change significantly between patrols.

3. SYSTEM ARCHITECTURE

Figure 1 gives an overview of the major components of the EC-ASSIST eChronicle:

EDB Event Store: Forming the heart of the EC-ASSIST eChronicle architecture, the EDB event store provides an
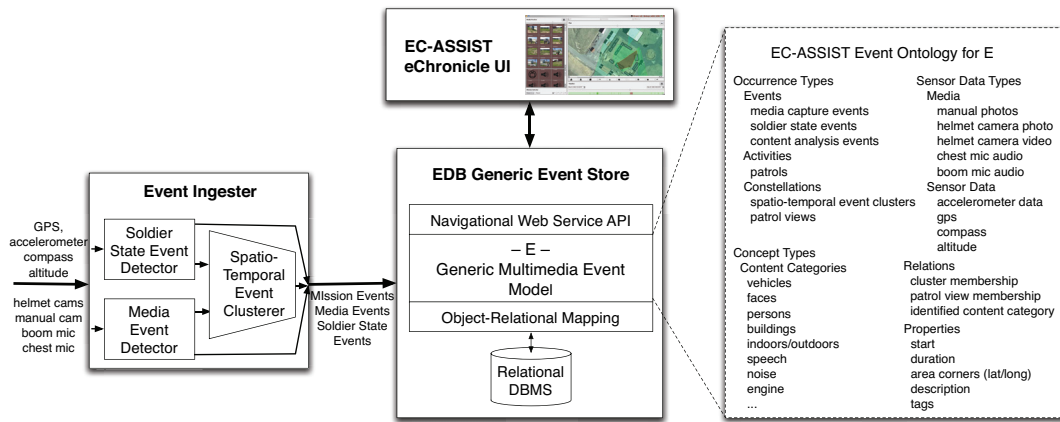
Figure 1: EC-ASSIST eChronicle architecture overview

application-independent database for the event-centric management of multimedia data. The store is based on the generic E multimedia event model [2]. E permits the representation of arbitrary events, activities, and constellations (n-ary associations) of events and activites. These occurrences can be extensively described by their relations to documenting media and sensor data of arbitrary modality, by their relations to domain concepts such as agents or objects involved, by arbitrary property values, and by tagging.

Implemented using Ruby and the Rails web application framework, the EDB event store maps E event structures to a relational database for persistence and offers a web service API for navigational access from applications.

EC-ASSIST Event Ontology: This ontology defines the various types of events, activities, constellations, sensor data and media, concepts, relations, and properties that are available for use with E in EC-ASSIST. As a language for the specification of application-specific event ontologies for E does not yet exist, it was necessary to augment the EDB event store with EC-ASSIST-specific validation code ensuring the abidance of the constraints defined by the ontology.

Event Ingester: The event ingester imports all events that occurred during a mission into the event store. Outgoing from basic soldier state events (e.g., running) derived from sensor data such as accelerometer data, basic media production events (e.g., photo taken), and basic content analysis events (e.g, face detected), the ingester infers higher-level mission events by clustering these basic events according to time and GPS position of their occurrence [1].

The simple rationale behind this approach to mission event detection is that a concentration of basic events likely indicates an incident of importance: either because soldiers produce more media to document the incident or they simply stay in the area of the incident for a longer time.

An inferred event is characterized by a probabilistic summary of the prevalent content and soldier state categories of the basic events in the cluster, under consideration of the (un)reliability of the applied content and sensor data analysis methods experienced in the past. Clustering is performed separately for each soldier as well as for all soldiers combined, producing soldier-specific and global mission views.

eChronicle User Interface: Based on Ruby and the Qt user interface library, the eChronicle user interface allows
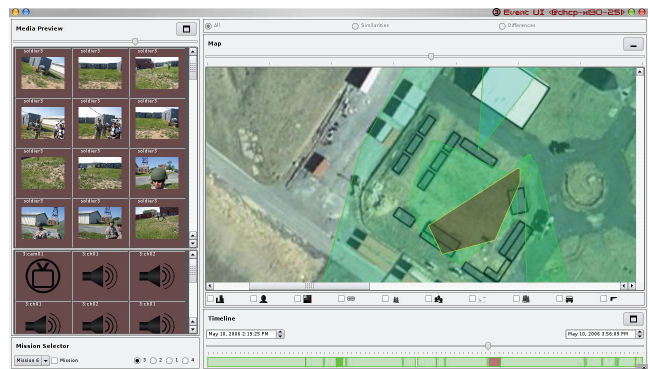

Figure 2: EC-ASSIST user interface

soldiers to explore and analyze the mission events and their documenting media in the EDB event store (see Figure 2). Inferred mission events are displayed on a map and on a timeline and available for user selection. Events can also be selected according to prevalent content and soldier state categories. When selecting a mission event, all media related to it are uniformly displayed and accessible in a media view, including photos as well as audio and video recordings.

4. CONCLUSION

The system has recently been evaluated by soldiers under realistic conditions in two training patrols. The soldiers appreciated the abstraction level offered by our event-centric approach to media management and its intuitiveness. The quality of the detected mission events was deemed good, considering the simplicity of the applied spatio-temporal clustering and the dynamics of the environment.

5. REFERENCES

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