Enabling GeoCollaborative Crisis Management Through Advanced GeoInformation Technologies

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ABSTRACT

Crisis events have dramatic impact on human society, economy and our environment. Geographical information and intelligence play a key role in crisis management activities. However, the use of geographical information technologies in responsible government agencies has been mostly confined to single users, and within single agency. An interdisciplinary team from Penn State University (comprised of GIScientists, information scientists, and computer scientists) has joined efforts with collaborators from federal, state, and local agencies to develop advanced geospatial information technologies that support *GeoCollaborative Crisis Management* (GCCM). In this demonstration, we present our progress in the design and implementation of a GIS-mediated collaborative environment that enables crisis managers and collaborating agencies to work together with geographical information. The system features multimodal interactions, mixed-initiative conversational dialogues, and map-mediated communication. It can be used by managers in emergency operation centers (EOC) as well as first responders in the field.

Categories and Subject Descriptors

H.5.3 [**Information Interfaces and Presentation**]: Group and Organization Interfaces – *Computer-supported cooperative work.*

Keywords

Crisis Management, Geocollaboration, GIS, Multimodal Dialogue

INTRODUCTION

Crisis events, like the 9/11 attack and the recent tsunami devastation in South Asia, have dramatic impact on human society, economy, and our environment. Geographical information systems (with their ability to map out evolving crisis events, affected human and infrastructure assets, as well as actions taken and resources applied) have been indispensable in all stages of crisis management, involving immediate response, recovery, mitigation, and preparedness. Their use, however, has been mostly confined to single users within single agencies. The potential for GIS and related geospatial technologies to be the mediating environment for collaborative activities among distributed agencies and teams has been discussed [4], but feasible technological infrastructure and tools are not yet available. An interdisciplinary team from Penn State University has joined efforts with collaborators from federal, state, and local agencies to develop technologies to support "GeoCollaborative Crisis Management" (for an overview, visit our project website (http://www.geovista.psu.edu/grants/GCCM/). This demonstration presents our progress towards GIS-mediated group work with geographical information. We have applied principles from cognitive-semiotic theories of human-map communication and collaborative discourse theories of human-human communication, and have integrated core technologies such as vision-based gesture recognition, speech understanding, multimodal fusion, spoken dialogue technologies, groupware, and geospatial portals (for details, see [1-3; 5]).

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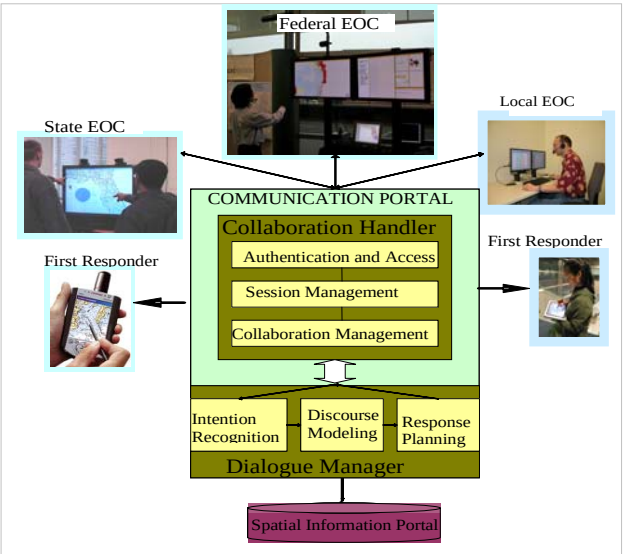

Fig.1 GCCM_Connection

The DEMO SYSTEM AND SETUP

The system underlying our demos is a map-enabled groupware environment called GCCM (see figure 1). It has a server component, called GCCM_Connection, and a client component, called GCCM_Client. *GCCM_Connection* centrally manages discourse, collaborative sessions, and information access, while *GCCM_Client* handles multimodal input and presentation in a device-specific fashion (see Figure 2). During actual use, GCCM can (1) understand and act on natural multimodal requests for geographical information from crisis managers, (2) allow team members to work with geospatial information individually or collaboratively with each other, (3) manage mixed-initiative dialogues for cooperative decision-making, and (4) access existing data and services from an enterprise spatial (and non-spatial) informational infrastructure.

Figure 2. A screen shot of GCCM_Client

The demonstration setup will be a subset of the equipment shown in Figure 1, which includes a high-end PC (functions as the GCCM_Connection server as well as the client in an EOC) and two Tablet PCs (serve as mobile clients), all with speech recognition and pen gesture capabilities. During the demo, each of the machines will run a copy of GCCM_Client which communicate with and through GCCM_Connection.

APPLICATION SCENARIOS

We demonstrate the utility of GCCM using two crisis management scenarios. These scenarios are based on a series of ethnographic field studies in real crisis management environments, and they reflect our understanding of the needs and practices across our government agency collaborators.

Common to both scenarios is that emergency operation centers (EOC) work in cooperation with teams of field responders through communication of the situation and coordination of actions. In such collaborative processes, maps, when shared, serve as mediator to facilitate the construction of team knowledge, and to coordinate perspectives. In this role, maps encourage efficient communication of knowledge, perceptions, judgment, and actions.

Scenario 1: *A category 4 hurricane has struck the south east part of Florida. Evacuation alerts have been sent out to affected communities, and emergency management forces must make sure that residents evacuate in time and (if needed) be sheltered in designated facilities. First responders, commanders in the Emergency Operations Center, and transportation managers must work together to deal with newly discovered situations. Joe, a member of first responder team, was in the field locating people who need assistance. He found 12 elderly people in Palm Beach city, some of them with health problems. Joe reported this situation to Sue (at EOC), and asked for assistance. Using the GCCM environment, Joe and Sue exchanged a few items of information (such as location of the residential building and the type of shelters needed) through natural language dialogues and annotations on a common map view. Based all the geospatial information she has, Sue suggested a few candidate facilities to Joe, and Joe chose one of them to use. Then, Sue, Joe, and Tim (a transportation manager) work collaboratively to arrange a vehicle that can get the group of elderly people to the designated facility.*

Scenario 2: A gas leak has been detected on the Penn State University Park campus and the University has been notified. The gas leak is very close to the Campus Reactor, and potentially induces a large scale disaster. Using maps of the campus and Centre county (created on site using GCCM), emergency managers first place a hazmat marker on the map to indicate the location of the gas leak. Then, they set up a mobile command center near the hazard site (maps are used to select a location for this command center). A radiation team, a gas leak repair team, and a team from the University's Office of Physical Plant (OPP) are alerted and sent to the scene to take actions. These teams carry Tablet PC based GCCM_Client which is used to keep in touch with the command center. The OPP team is tasked with repairing the gas leak. For a reference, they need to view aerial images of the area along with the same map the commander sees. After having disabled the gas valves feeding the gas leak, the OPP team will alert the commander. In the same time, the commanders are gathering information about gas dispersion using a plume model (based upon typical weather conditions and EPZ zones at 3, 5, and 10 miles radius. Based upon such information, the commander at least knows that the gas is moving away from the Reactor. While this is happening, the team in the field reports back that the gas leak has been contained and all is well.

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REFERENCES

[1] Cai, G., Wang, H., MacEachren, A. M. and Fuhrmann, S. Natural Conversational Interfaces to Geospatial Databases. *Transactions in GIS*, 9, 2 (2005). 199-221.

[2] MacEachren, A. M. *How maps work: representation, visualization and design*. Guilford Press, New York, 1995.

[3] MacEachren, A. M., Cai, G., Sharma, R., Brewer, I. and Rauschert, I. Enabling collaborative geoinformation access and decision-making through a natural, multimodal interface. *International Journal of Geographical Information Science*, 19, 3 (2005). 293-317.

[4] Muntz, R. R., Barclay, T., Dozier, J., Faloutsos, C., Maceachren, A. M., Martin, J. L., Pancake, C. M. and Satyanarayanan, M. *IT Roadmap to a Geospatial Future, report of the Committee on Intersections Between Geospatial Information and Information Technology*. National Academy of Sciences Press, Washington, DC, 2003.

[5] Sharma, R., Yeasin, M., Krahnstoever, N., Rauschert, Cai, G., Brewer, I., MacEachren, A. and Sengupta, K. Speech-gesture driven multimodal interfaces for crisis management. *Proceedings of the IEEE*, 91, 9 (2003). 1327-1354.