INTERNATIONAL JOURNAL OF INTELLIGENT CONTROL AND SYSTEMS
VOL.12, NO.2 JUNE 2007 208-216

A Visual Communication Language for Crisis Management

Siska FITRIANIE and Leon J.M. ROTHKRANTZ

***Abstract*- In crisis situations, decision-making capabilities rely on reports from all parties involved. For achieving the necessary capabilities of crisis technology, a communication-interface prototype representing concepts and ideas has been developed. To support language-independent communication and to reduce the ambiguity and multitude of semantic interpretation of human observers' reports, the messages are constructed using a spatial arrangement of visual symbols. We developed a dedicated grammar to interpret and convert the visual language messages to (natural language) text and speech. The communication interface also provides an icon prediction to have faster interaction in next icon selections. The system processes the incoming messages to build a world model by the employment of ontology. A blackboard structure in a Mobile Ad-Hoc Network is used to share and distribute information. We deployed our visual language interface in a serious game environment of a disaster and rescue simulator. The current implementation of this environment is capable of simulating real disaster situations using information from human user observers' reports.**

***Index Terms*—Crisis management system, visual communication language, natural language processing, disaster simulator.**

1. INTRODUCTION

Recent crisis events have shown that existing communication infrastructures can become overloaded or even breakdown. The need for crisis-management technology to cope with nondeterministic environments resulting from the global wired-communication breakdown has never been more apparent. The terrorist strikes against U.S. targets on September 11, 2001, for example, have disabled the crisis management services that provided information support service for rescue teams, victims, witnesses and families [13]. This type of major incidents generally involves much information and operational chaos. In such situations, personal devices, such as Personal Digital Assistants (PDAs), which offer both portability and wireless interfacing, may be available for communicating.

PDAs typically offer a small set of user-interaction options limited by small sized touch screens, the number of physical buttons and (for some PDAs) small sized keyboards. Although some researchers have proposed mechanisms for adding multimodal capabilities, for example [9][12][41], the current speech input technology is still less suitable for mobility. The environment in which the technology is used should be the same as the training environment of the system [6], whereas PDAs are often used in various environments under various conditions. In many cases, this results misrecognition of commands, which is frustrating to the user. This leads us to aim at a natural interaction style based on GUI for communication.

Observation reports during crisis situations must clearly describe events in order to facilitate effective problem solving and prevent further damage. In our view, data that observers sense in a crisis location is transformed into reports for others using their mobile devices. Although speech and text communication are commonly used for reporting any events, the descriptive meaning of these modalities misses a more direct mapping with "real world". These types of communications demand or afford more reflective thinking as one must constantly update one's mental model of the spatial relation [32].

Human's observations are context sensitive. They are based on multimodal input in a given context. One's observations may be affected by one's emotional state and mood. Such knowledge, belief and opinion are personal, and conceptual. In the process reporting observations, the information may become ambiguous, incomplete and language dependent. In addition, human observers are typically remote in both time and place. The lack of standard communication representation hinders information sharing during crucial emergency situations [13]. In order to facilitate the exchange of information, to promote universal understanding, and to adequately address the communication of mission critical information across different disciplines and cultures, a common representation for communication needs to be developed [38]. The meaning of the various information objects, their interrelationship, and their potential relevance in crisis situations have to be agreed by multiple users who are working collaboratively in resolving crisis. Related theories and concepts from semiotics have been selected for a communication representation by (an arrangement of) icons.

Icons have been investigated for representing concepts that are objects, actions or relations [34]. Concepts are used in human communication for representing internal models of human themselves, the outside world they perceive, and anything with which they interact. By virtue of resemblance between a given icon and the object or the movement it stands for, an icon functions as a means of communication and offers a direct method of conversion into other modalities. As icons offer a potential across language barriers, any interaction using the icons is particularly suitable for language-independent context. Furthermore, direct icon manipulation allows faster interaction to take place [22]. As pictorial signs, they can be recognized quickly and committed to memory persistently [15]. Therefore, icons can evoke a readiness to

The research reported here is part of the Interactive Collaborative Information Systems (ICIS) project, supported by the Dutch Ministry of Economic Affairs, grant nr: BSIK03024
Siska Fitrianie and Leon J.M. Rothkrantz are with Man-Machine-Interaction Group, Delft University of Technology.
Mekelweg 4 2628CD Delft, The Netherlands.
E-mail: {s.fitrianie, l.j.m.rothkrantz}@ewi.tudelft.nl.

situation awareness. The VCMC model is also using a web interface [33]. It allows its users to share data about crisis situations in real-time and to discuss information.

An iconic interface for reporting observations in a Mobile Ad-hoc Network (MANET) has been developed by Tatomir and Rothkrantz [40]. The system allows its users to share and merge topological maps in damaged buildings using observations from individuals present in an infrastructure-less network. Apart from representing crisis events like fire, explosion, etc, a set of icons is also used for constructing a map representing features such as crossing types and road blocks. The featured knowledge can be thus used for providing guidance to given locations, finding the nearest exit, coordinating rescue actions of individuals and groups, collecting information concerning crisis indicators, and reasoning about the state of the building.

Modeling and simulation plays an important role in testing a new technology in disaster setting, as pointed by Robinson and Brown [37]. An agent-based simulation, DRIFTS, was designed to model the information flow between agents involved in a crisis situation. The simulation models the influence of decisions and actions of an agent to other agents. It allows human users to modify the disaster data and agents' characteristics. In contrast, Loper and Presnell have developed an agent-based simulator that simulates information flow in the crisis center [28]. A few efforts have been directed toward integrating real life user interactions and simulations. For example, Jain and McLean integrated gaming and simulation systems for emergency response training [21]. DrillSim simulates real training activities that are integrated the actual instrumented sensors and communication infrastructure [2]. In assessing the usability of a user interface, a mixture of computer and live simulations is necessary. Therefore, we can capture the interaction between human users and the interface.

3. Visual Language Interface

Crisis management relies on teams of people who must collaboratively derive knowledge from geospatial information [17], that are usually presented via maps. Our developed user interface also provides an observation map to which users may attach visual symbols describing situations relevant to a particular location (see Fig. 1).

Symbols can be icons, geometrical features or icon strings. Geometrical shapes, such as arrows, lines, ellipses, rectangles and triangles, can be used for indicating a given area on the map. They can also be used for highlighting or emphasizing an object, an event or a location on the map. Each icon has several attributes which enable the user to provide additional information. For instance, the icon for "fire" has the attributes status, size and intensity (for example under control, big, high). The interface, however, is not limited to providing icons for the representation of atomic concepts such as fire, ambulance, victim, etc, but also caters for icon strings. The icon string can be formed using a dedicated pop up window where the intended information can be submitted.

Fig. 1. Icon-Map Application on PDA

For ensuring accurate and complete user reports, the interface provides menus for deleting and inspecting or altering the observation form, and menus offering map zoom and pan functionality. When user observations are submitted, the system processes the data, adapts its world model accordingly, and transmits the changes to the network.

3.1 Constructing Icon String

Fig. 2. The developed visual language interface

Our users can select a sequence of icons for communicating observations (see Fig. 2). Our developed visual language interface is able to interpret the sequence and convert it into natural language. The iconic sentence constructions are based on the notion of simplified speech by significantly reducing sentence complexity. Each constituent icon provides a portion of the semantics of the sentence it forms. The meaning of an icon string is derived