Intelligent Decision Support for Emergency Responses

Ali Khalili-Araghi
School of Interactive Arts and Technology,
Simon Fraser University
aka52@sfu.ca

Brian Fisher
School of Interactive Arts and Technology,
Simon Fraser University
bfisher@sfu.ca

Uwe Glässer
School of Computing Science,
Simon Fraser University
glaesser@sfu.ca

Piper Jackson
School of Computing Science,
Simon Fraser University
pjj@sfu.ca

Hamed Yaghoubi Shahir
School of Computing Science,
Simon Fraser University
syaghoub@sfu.ca

Significance and Relevance

Canada and its allies have identified the vulnerability of sea lanes, their ports and harbors to a variety of threats and illegal activities. With a total length of over 243,000 kilometers, Canada has the longest coastline of any country in the world.

Scarce surveillance and tracking capabilities make it difficult to perform large volume surveillance, keeping track of all marine traffic. While increasing use of innovative technologies such as unmanned aerial vehicles (UAVs) that may be deployed in large numbers mitigate the problem, this aspect also adds to the complexity of the overall coordination task. In addition, operating in an adverse and uncertain environment and the ability to flexibly adapt to dynamic changes in the availability of mobile resources and the services they provide are critical for the success of surveillance and rescue missions (Farahbod, Glässer and Khalili, 2009). This situation poses considerable challenges for the Marine Security Operation Centres (MSOC):

"The primary purpose of an MSOC is to produce actionable intelligence, concentrating on national security, organized crime and other criminality and to communicate the information to the appropriate jurisdiction in a timely fashion."[1]

In order to achieve above goals, an intelligent decision support system can be exploited to improve coordination in emergency response services during critical situations and to detect and prevent illegal activities.

Abstract

With a coastline touching upon the Pacific and Atlantic Oceans, the Great Lakes and the Arctic Sea, the Canadian MSOCs are faced with a daunting task. They are responsible for both routine duties, including patrolling coastal areas and collecting satellite data, as well as critical missions, such as emergency response and crime intervention. Both kinds of mission require the fusion of data from a variety of sources and the orchestration of myriad heterogeneous resources over great physical distances. They must deal with uncertainty, both in terms of what can be known and also in the outcomes of actions, and must interact with an environment prone to dynamic change.

We present the architecture and core mechanisms of a decision support system for marine safety and security operations (Glässer, Jackson, Araghi, When and Shahir, 2010). The goal of this system is to enhance complex command and control tasks by improving situational awareness and automating task assignments. This system concept includes adaptive information fusion techniques integrated with decentralized control mechanisms for dynamic resource configuration management and task execution management under uncertainty. Autonomously operating agents employ collaboration and coordination to collectively form an intelligent decision support system.

[1] Royal Canadian Mounted Police, Marine Security Operation Centres (MSOC), http://www.grc-rcmp.gc.ca/mari-port/msoc-cosm-eng.htm (Last visited: January 2012).

Decision support is provided by the interactions of different components in the system. These components are responsible for decomposition of complex tasks (Planning), finding appropriate resources for task assignment (Tasking) and monitoring the execution of each task (Execution). In order to fulfill goals, task assignments are arranged according to plans generated by methods such as Hierarchical Task Network (HTN) planning (Glässer, Jackson, Araghi and Shahir, 2010). This system design meets the challenges posed by a distributed network of diverse resources operating asynchronously by emphasizing robustness and scalability.

To give a better understanding of the information flow in the system, a generic scenario can be used to represent the functionalities of the system in action. In general, missions are introduced to the system by chief commander. After that, the complex mission is decomposed into subtasks which could be assigned to single resources. Execution of each task should be monitored by the system as well to maintain situation awareness and can be used for report generations. By completion or failure of these tasks, the commander should get notified and resources are released for further assignments.

In order to evaluate the robustness of the system, a number of typical Search and Rescue (SAR) scenarios have been given to the system in which task assignments were evaluated based on the knowledge from domain expertise. In addition, to resemble the dynamic nature of the environment, resources were randomly chosen to be disabled during execution of the tasks. As a result, type I and type II errors have been measured for task assignments and the promising results confirmed the ability of the system to work in critical circumstances.

The adaptive mechanism of the proposed architecture makes it possible for the system to be used in a variety of domains such as Emergency Operation Centres (EOC). In addition, distributed nature of system components can be further expanded to provide virtual access for decision makers in critical situations where accessing a physical EOC is difficult, if not impossible.

Therefore, in order to fulfill such needs, the system can be extended in a way that it can be used as a virtual Emergency Operation Centre (vEOC). Such a system facilitates the possibility of "remote access" for different participants and also decision makers. In addition, information can be shared among various EOCs to improve decision making process and situational awareness.

In this regards, as future works, characteristics of a vEOC will be more thoroughly studied and the proposed decision support system will be further enriched to provide virtual access for Emergency Operation Centres.

References

[1] R. Farahbod, U. Glässer, A. Khalili, A multi-layer network architecture for dynamic resource configuration and management of multiple mobile resources in maritime surveillance, in, 2009, pp. 734508.

[2] U. Glässer, P. Jackson, A. Araghi, H. Wehn, H. Shahir, A Collaborative Decision Support Model for Marine Safety and Security Operations, Distributed, Parallel and Biologically Inspired Systems, (2010) 266-277.

[3] U. Glässer, P. Jackson, A.K. Araghi, H.Y. Shahir, Intelligent decision support for Marine safety and Security Operations, in, IEEE, 2010, pp. 101-107.