HIGHER LEVEL FUSION FOR SITUATION MANAGEMENT (a half day tutorial)

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The tutorial objective is to discuss specific requirements, major challenges, and approaches to designing higher level fusion processes.

Key words: situation and threat assessment, situation management, domain representation, user perspective, inter-and intra level processing, reasoning, abduction

Intended audience: This tutorial is intended for both researchers and practitioners who are interested in understanding the problems of situation and threat assessment in dynamic uncertain environment and building methods for solutions of these problems.

Abstract

Situation management is a collection of methods and tools aimed at helping decision makers to monitor, understand and control dynamic situations, and act effectively to mitigate their impact. Situation management problem exists in many domains such as traditional and asymmetric warfare, man-made and natural disasters, network management, border and harbor protection, and transportation.

One of the critical enabling technologies of situation management is higher level fusion (situation and threat assessment). The core purpose of higher level fusion is to infer and approximate the characteristics and critical events of the environment in relation to specific goals, capabilities and policies of the decision makers. The higher level fusion processes utilize fused data about objects of interest, dynamic databases, maps, and expert knowledge and opinions for context processing to produce a coherent composite picture of the current and predicted situation. The dynamic situational picture is built by analyzing spatial and temporal relations of the situational entities considered at different levels of granularity and their dynamics within the overall situational context. Situation and threat assessment processing for situation

management is complicated by highly dynamic environment, uncertainty of observations, relationships and behavior, and variable quality of the data and information sources. Threat can be unknown, or even unimaginable. Therefore the higher level fusion processing has to be adaptive to resource and time constraints, new and uncertain environments and reactive to uncertain heterogeneous inputs. An important component of situation and threat assessment is detection of this unknown, unconventional, or unimaginable based on abnormal characteristics and behavior of situational items along with discovery of underlying causes of such characteristics and behavior.

The tutorial will consider each step of the processes of situation and threat assessment, its problems and possible solutions. Specific scenarios will be also considered to show how the processes discussed can be used for the solution of real world problems.

Outline:

1. What higher level fusion is.
2. Possible scenarios in the domains of homeland security and disaster management.
3. Higher level fusion processing requirements.
4. General architecture, which includes multi-step inter-level and intra-processing information exchange comprising both quality and consistency control steps. The role of users and context within this architecture will also be discussed.
5. Domain representation including ontological analysis situations and threat, as well as users' goals, functions, hypotheses, and information requirements to support reasoning about situations and threat.
6. Inter-level and intra-processing quality control methods.
7. Dynamic reasoning about situational entities of interest and their characteristics and behavior over time within a specific context. Existing reasoning methods to be presented will include argumentation systems and graphical models utilizing various belief representations (Bayesian, Dempster-Shafer, fuzzy, Transferable belief models), case-based reasoning, and template matching. Special attention will be paid to abductive reasoning for discovery of underlying causes of observed situations.
8. Conclusions summarizing challenges and possible future directions of designing higher level fusion processes.
9. References.

Bio

Galina L. Rogova received both her MS and PhD in Moscow, Russia. Currently she is an independent consultant and adjunct professor at the State University of New York at Buffalo where she is affiliated with the Center for Multisource Information Fusion (CMIF) and the National Center for Ontology Research (NCOR). Her research interests include information fusion, pattern recognition, reasoning and decision making under uncertainty, machine learning, and image analysis and understanding. She has worked on a wide range of defense and non-defense problems such as threat prediction, situation assessment in the post disaster environment, information quality effect on information fusion, adaptive reinforcement learning in the distributed environment, computer-aided mammography, ontology of situation and threat, understanding volcano eruption patterns, and Intelligent Transportation Systems. She co-edited 2 books on information fusion and authored multiple papers. Dr. Rogova has been active in promoting Information Fusion internationally. She served as a program committee member and session chair and organizer for numerous International Conferences on Information Fusion. She also served as a member of organizing committee and lecturer for the NATO Advance Study Institutes (ASIs) and a NATO Advanced Research Workshop (ARW) on Information fusion as well as a NATO Observer for the NATO Research and Technology Organization (RTO).