Information Fusion for Collaborating Commanders at Different Levels

*Position paper intended for discussion*

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Overview

• Position paper to stimulate discussions on how information fusion methods and information sharing affect command and control

• Main questions:
  • How is the choice of data/information fusion methods, and the presentation of their result (“Situational picture”) affected when information should be shared between different levels of command?
  • Does automated information fusion affect the flexibility of a commander?
Background

• Sensor networks will be used to a greater extent
  • Low level data fusion – results in information about different objects
  • Time critical for fusion and delivery of result to local user
  • Rule based often good since we know what to expect
    • Problem when an ordinary car contains specific people or goods
  • Result is an “intelligence report”
  • Raw data meaningless for external user since data formats are optimised for speed and resource usage
Background

• **Information Fusion**
  • High level fusion – results in information on how objects are connected, on situations, and threats
  • Longer time-scale
  • Completely rule-based difficult since everything depends on context
    • New methods continually developed
  • Data-driven methods difficult since not enough data available
  • Results in a “Situational picture”
  • Raw data are sensor fusion results, intelligence reports, information from media, etc.
Collaboration between different command levels

• Different abstraction levels are (obviously) required
  1) How can varying abstraction levels be maintained and represented?
  2) How to maintain trust for the system and for other users?

• Solutions:
  • Data available at different abstraction levels
  • Representation of ambiguity and noise
  • More important that each user gets relevant information than maintaining a COP
Consequences

• Automated fusion can be used to obtain different abstraction levels
  • We need fusion methods that can use data of different types
    • Methods used in sensor networks NOT suited for high level data
    • Expert systems can use sensor data, but too slow and too resource consuming
    • Data mining techniques useful for high level fusion, but (so far) only used off-line for sensor networks
    • Semantic methods can be used (e.g. attribute fusion)

• The point is: Choice of fusion methods is very important in each subsystem if data/information should be used by users at different levels
Flexibility

• Well-known that information given to humans affect their performance
  • Count passes – see monkey
  • Also valid for military scenarios
    • Spak, U., Lind, M., Submitted to: European Intelligence and Security Informatics Conference (EISIC) 2011, September 12-14, 2011, Athens, Greece.
  • How is C2 affected when information has been fused automatically?

• Traditionally data is handled by intelligence

• Using automated fusion, rules must be set (by experts) beforehand
  • New rules can be generated automatically, but only based on experience from current mission
Flexibility

• Does automated fusion influence the flexibility of a commander?
• What is flexibility?
• Can flexibility be measured?
• If this is a problem, how should data be handled to provide information at different abstraction levels and still not affect the flexibility of the commander?
• Is less flexibility at lower levels desired since it gives high levels commanders better control of their subordinates?
Open questions

- Is it possible to scale simple approaches to semantic fusion to higher-levels?
  - Semantic reasoning does not scale today!
- How construct and maintain/update ontologies that are useful?
  - Low-level ontologies
  - High-level ontologies
- How to construct abstraction methods that reduce the amount of information that needs to be displayed, while retaining everything important?
Discussion

• Thankyou for your interest!