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Registration

Welcome Reception

Breakfast

Keynote by Alexander Kott, Chief, Network Sciences Division, US ARL- "Inseparable Influences: How Interactions of Dissimilar Networks Drive Distributed Cognition"

Chair: Mica Endsley (SA Technologies, USA)

Inseparable Influences: How Interactions of Dissimilar Networks Drive Distributed Cognition

Alexander Kott (U. S. Army Research Laboratory, USA)

Much (and possibly all) human decision making occurs in a distributed fashion. Human (and recently also artificial) agents form their situational awareness and arrive to decisions through interactions within a social or organizational group. An important way to theorize about, and model such decision making is to view it as a network phenomenon. In my talk I will argue for greater emphasis on recognizing that several highly dissimilar genres of networks are actually involved in this process: besides the obvious network of decision-making agents (a social-cognitive network) there is also a communication network and an information network. What happens in the social-cognitive network is very much influenced by the structure and dynamics of the communication network and information network. I illustrate the importance of these inter-genre interactions using examples from the military domain. Many military-relevant complex phenomena involve interactions of dissimilar genres of networks, yet theories, models and methods to predict and influence the interactive behaviors are largely unknown. I will discuss the related needs for practical tools in important applications, and the challenges in researching approaches to achieving such capabilities.

S1 - Situation Awareness and Decision Support I

Chair: Po-Chun Chen (The Pennsylvania State University, USA)

Collaborative Incremental Model Development for an Adaptive Model-Driven Planning System

Alice Mulvehill (Raytheon BBN Technologies, USA); David Rager (Raytheon BBN Technologies, USA); Renu Bostwick (BAE Systems, USA)

Military planners would benefit greatly from a planning system that dynamically incorporates real-world domain information, allowing plans to adapt easily to new information. The Joint Air Ground Unified Adaptive Replanning System (JAGUAR) system provides a model-driven planning paradigm for such a dynamic air mission planning domain. Developing models for this distributed and dynamic environment proved challenging, both for building models that were meaningful for all of the components and for creating models that could be fed in seamlessly to the running system. In this paper we describe the methodology used to create and adapt models to support the real time model adaptation objective in JAGUAR, and describe some of the challenges we faced with model development and usage. We also present a historical account of the model development process and describe how the involvement of the software component developers influenced the tempo, form, and content of the resultant models and knowledge representation.

pp. 1-6

Situations and Policies

Brian Ulicny (VIStology, Inc., USA); Gerald M. Powell (U.S. Army Research Laboratory, USA); Won Ng (VIStology, Inc., USA); Jakub Moskal (VIStology, Inc., USA); Mieczyslaw Kokar (Northeastern University, USA)

In this paper, we first describe a system we have implemented that takes expressions of policies, expressed in a fragment of English called SBVR SE (Semantics of Business Vocabulary and Rules Structured English), an OMG standard, and automatically translates them into an executable semantic web formalism (OWL 2 and semantic web rules). Specifically, we describe how these policies can be used to automatically enforce compliance with policies and to reconcile multiple policies specified by independent parties. The scenarios implemented concern information sharing via XMPP ("instant messaging"). We then outline how situations can be characterized as policycompliant or policy-violating. In some cases, situations are policy compliant or violating because of events and actions that they contain. We show that our formalism supports this analysis. Index Terms—Situation Theory; Actions; Events; Policies; Deontology; Rules
pp. 7-14

Battle Management Language as a "Lingua Franca" for Situation Awareness

Kellyn Rein (Fraunhofer FKIE, Germany); Ulrich Schade (Forschungsgesellschaft fuer Angewandte Naturwissenschaft, Germany)

In this digital world, the sheer volume of available information forces us to look for ways to automate the gleaning of the proverbial needles of useful information from this immense haystack. Information gathering for situation awareness is complicated by numerous factors today due to the ever-increasing use of various technologies which are contributing to the massive load of digital information that needs to be processed in order to keep up with an ever-changing situation picture. Among these technologies are sensors, unmanned vehicles such as robots and drones, and human communication technologies such as smart phones, blogs and social media. Human communications are inherently complex in that they are generally imprecise or ambiguous. Further, within many areas of endeavour in which situation awareness is vital such as joint military, peacekeeping or disaster relief operations, not only are various natural languages are used, but also specialized variants of each language may be used by different players in the area of endeavour. For example, the Red Cross may use abbreviations or specialized terms which are unfamiliar to police or military (and vice versa), which can lead to confusion or misunderstanding. Furthermore, as seen in the "Arab Spring" of 2011, new modes of communication such as Twitter can provide valuable, on-site and rapid communications. Unfortunately, Tweets are limited in size, resulting in abbreviations of both words and structures, which humans decipher relatively easily, but which are problematic for automatic processing. Vital environmental information is collected from devices such as sensors on robots or video cameras on drones but needs to be merged with information which is provided by human sources or which is contained in ontologies or databases. This merging is often done by human analysts, and in times where events are unfolding rapidly, where there may be not only a variety of organizations involved, but a large number of individuals (using a variety of languages) as well, increasingly the chance that vital information may not be as widely disseminated as is necessary for a complete overview of current activities and the anticipation of future actions as needed for true situation awareness [1]. Clearly there is an information advantage to be gained if it were possible to easily combine the information from all of these sources. Combining information from a variety of sources is most easily accomplished by the use of a standard representation for this information. We propose the use of Battle Management Language (BML). Originally designed for commanding simulated units, BML is a standardized language for military communication (orders, requests and reports) which has been developed under the aegis of the NATO MSG-048 "Coalition BML" and has been expanded to communicate not only orders but also requests and reports. BML is based upon the Joint Consultation, Command and Control Information Exchange Data Model (JC3IEDM) which is used by all participating NATO partners. As NATO standard, (STANAG 5525), JC3IEDM defines terms for elements of military operations, whether wartime or non-war, and thus provides a vocabulary sufficiently expressive to formulate both military and non-military communications for a variety of different deployment types. It also provides a basis for standardized reporting among NATO coalition partners. BML has been designed as a controlled language [2] based on a formal grammar [3]. This grammar has been designed after one of the most prominent grammars from the field of computational linguistics, Lexical Functional Grammar (LFG) [4]. As a result, BML is an unambiguous language which can easily be processed automatically. Particularly interesting is the fact that BML statements can be represented as feature-value matrices, allowing fusion of individual communications through unification, a standard algorithm in computational linguistics [5]. Since data retrieved from databases and ontologies may also be easily represented as feature-value pairs, BML structure facilitates the fusion of not only field reports from deployed

soldiers and intelligence sources, it also supports fusion of these reports with previous information stored as background information. While BML has been predominantly developed for use by the military, the principles underlying the grammar and standardized representation of natural language text can be expanded into any domain. Extensions of BML for other domains such crisis management, e-government and criminal activity already exist or are in development. We have previously presented a method to analyze HUMINT reports written in natural languages [6,7] such as English and German and converting them to BML using information extraction. Extensions of BML to cope with shorthand notation such as used in Twitter or texting are also being planned. BML has likewise been expanded to control unmanned vehicles such as robots, and to formulate sensor and video information from them in BML [8]so that this information may be easily and automatically disseminated as needed within the area of activity. In this paper we will demonstrate how BML supports effective use of inflowing information for effective situation awareness. REFERENCES: [1] M.R. Endsley. Toward a theory of situation awareness in dynamic systems. Human Factors 37(1), 32-64. 1995. [2] W.-O. Huijsen, "Controlled Language - An Introduction," in Proc. of the Second International Workshop on Controlled Language Applications (CLAW98). Pittsburgh, PA: Language Technologies Institute, Carnegie Mellon University, May 1998, pp. 1-15. [3] U. Schade and M.R. Hieb, "Development of Formal Grammars to Support Coalition Command and Control: A Battle Management Language for Orders, Requests, and Reports." 11th ICCRTS. Cambridge, UK, 2006 [4] J. Bresnan. Lexical-Functional Syntax. Malden, MA: Blackwell, 2001 [5] U. Schade and M.R. Hieb, "Battle Management Language: A Grammar for Specifying Reports." 2007 Spring Simulation Interoperability Workshop (Paper 07S-SIW-036). Norfolk, VA, Mar. 2007 [6] C. Jenge, S. Kawaletz and U. Schade, "Combining Different NLP Methods for HUMINT Report Analysis." NATO RTO IST Panel Symposium, Stockholm, Sweden , October, 2009 [7] S. Kawaletz and K. Rein, „Methodology for standardizing content for fusion of military reports generated in different natural languages" Proceedings of MCC 2010, Wroclaw, Poland, 2010. [8] T. Remmersmann and B. Brüggemann. "Reporting Sensor Information Using Battle Management Language", Proceedings of MCC2011, Amsterdam, 2011.
pp. 15-21

Case-Based Situation Awareness

Nuka Nwiabu (Robert Gordon University, United Kingdom); Ian Allison (Robert Gordon University, United Kingdom); Patrik Holt (Robert Gordon University, United Kingdom); Peter Lowit (Robert Gordon University, United Kingdom); Babs Oyeneyin (Robert Gordon University, United Kingdom)

Situation-aware case-based decision support (SACBDS) systems comprise of two distinct parts; situation awareness (SA), and case-based reasoning (CBR) parts. The SA part keeps a finite history of the time space information of the domain and uses rules to interpret cues from the environment with respect to an individual user context, and then anticipates future situation by performing statistical inference from these historical data. The CBR part is the part that seeks to accomplish a particular task. Knowledge of the domain situation from the situation awareness part is used to extract situations that have happened in the past, in similar contexts, and for similar states of the environment. Although the approach improves both similarity assessment and problem solving prediction, the situation awareness component of the system is limited in processing incomplete data from partial knowledge sources because of its classical rule-based capability. This paper discusses the fusion of the CBR model and the SA model into a case-based situation awareness (CBSA) model for situation awareness based on experience rather than rules, similarity assessment and problem solving prediction. The CBSA system senses the users' context and the environment and uses them to understand the current situation by retrieving similar past situations. Every past situation has a history. The future of a new situation (case) is predicted through knowledge of the history of a similar past situation. The paper evaluates the concept in the flow assurance control domain to predict the formation of hydrate in sub-sea oil and gas pipelines. The results provided the CBSA system with greater number of accurate predictions than the SACBDS system.
pp. 22-29

Coffee Break

S2 - Situation Modeling

Chair: Adam Stotz (CUBRC, USA)

Scenario Reliability Assessment to Support Decision Makers in Situations of Severe Uncertainty

Tina Comes (Karlsruhe Institute of Technology (KIT), Germany); Niek Wijngaards (D-CIS Lab / Thales Research & Technology Netherlands, The Netherlands); John Maule (Leeds University Business School, United Kingdom); David Allen (University of Leeds, United Kingdom); Frank Schultmann (Karlsruhe Institute of Technology (KIT), Germany)

Decision making under uncertainty is fraught with pitfalls for human thinking: biases prevail. The combination of a scenario-based approach with multi-criteria decision analysis assists in making value judgements, trade-offs and uncertainties explicit. Scenarios, which are constructed in a distributed manner involving multiple experts from different domains, assist in overcoming e.g. the prominence effect and confirmation bias. Furthermore, support is provided to handle the uncertainty associated with each scenario without imposing unjustified assumptions on each piece of information. We develop a relative reliability concept, which differs from standard probability assessments as it is sensitive to the context, such as the decision problem at hand, the decision makers' requirements and the available information. This approach maintains the flexibility of the distributed system by allowing the experts to adapt the information they provide and the likelihood assessments thereof to the situation. Our approach is illustrated by an emergency management example.
pp. 30-37

Improving Event Co-reference By Context Extraction and Dynamic Feature Weighting

Katie McConky (SUNY Buffalo & CUBRC, USA); Rakesh Nagi (University at Buffalo, USA); Moises Sudit (State University of New York at Buffalo, USA); William Hughes (State University of New York at Buffalo, USA)

Event co-reference is the process of identifying descriptions of the same event across sentences, documents, or structured databases. Existing event co-reference work focuses on sentence similarity models or feature based similarity models requiring slot filling. This work shows the effectiveness of using a hybrid approach where the similarity of two events is determined by a combination of the similarity of the two event descriptions, in addition to the similarity of the event context features of location and time. A dynamic weighting approach is taken to combine the three similarity scores together. The described approach provides several benefits including improving event resolution and requiring less reliance on sophisticated natural language processing.
pp. 38-43

A New Signal Primitive for Monitoring Complex Information Networks

John Zachary (RedJack, LLC, USA); John C. McEachen (Naval Postgraduate School, USA)

Complex information networks provide globally ubiquitous real-time, unstructured, and social information with the result that humans are overloaded with "big data". Complex information networks are characterized by many interacting entities with well- or semi-defined protocols. Intelligent data reduction methods are needed to understand and exploit dimensional variances and dynamics of information networks, thereby improving search, understanding, and situational awareness. We present a new signal primitive called conversation exchange dynamics (CED) that accentuates novel or anomalous patters in complex information network, reduces network data, and provides an aggregated primitive upon which to build monitoring and detection systems. Two complex information networks applications that present significant challenges are computer network intrusion detection and social media network analysis. We demonstrate CED utility in a variety of simulated and actual network intrusion detection settings, specifically, attacks from the MIT Lawrence Livermore IDS data set and an actual Code Red attack detection. We conclude with a description of CED applied to social media network analysis.
pp. 44-50

Lunch (on your own)

S3 - Modeling Human Situational Behavior

Chair: Sebastien Tremblay (Université Laval, Canada)

Training Systems Thinking and Adaptability for Complex Decision Making in Defence and Security

Daniel Lafond (Defence R&D Canada, Canada); Michel DuCharme (Defence R&D Canada, Canada); François Rioux (Thales System Canada, Canada); Sébastien Tremblay (Universite Laval, Canada); Bradley Rathbun (Royal Military College of Canada, Canada); Jerzy Jarmasz (DRDC, Canada)

Interactive learning environments are increasingly used to help people better deal with complex situations. One way to improve decision making effectiveness is to train systems thinking skills using interactive simulations in order to reduce the occurrence of "unintended side-effects" of interventions and catastrophic failures. We present a prototype training procedure intended for military officers and civilian personnel engaged in "full spectrum" operations. The Complex Decision Making simulation environment (CODEM) is the core of the proposed training procedure. CODEM aims to improve systems thinking skills, adaptability and other abilities associated with the integrative concept of cognitive readiness. Four training scenarios are designed to reproduce key properties of complex decision making situations. An intelligent tutor providing corrective feedback on decision making behaviors is integrated into each scenario. The tutor interventions help avoid tunnel vision (i.e., the opposite of systems thinking) by discouraging the use of overly simple heuristics. Nine behavioral metrics are monitored by the intelligent tutor - five are related to information seeking behaviors, and four are related to specific decision patterns. The effectiveness of this prototype training procedure is currently being assessed experimentally.
pp. 51-58

Intraindividual and Interindividual Multimodal Emotion Analyses in Human-Machine-Interaction

Ronald Böck (Otto-von-Guericke-University Magdeburg, Germany); Kerstin Limbrecht (Ulm University, Germany); Steffen Walter (University of Ulm, Germany); David Hrabal (Ulm University, Germany); Harald C. Traue (University of Ulm, Germany); Stefan Glüge (Otto-von-Guericke-University Magdeburg, Germany); Andreas Wendemuth (Otto-von-Guericke-University Magdeburg, Germany)

Interactive computer systems today interact nearly effortlessly with humans by menu-driven mouse- and text-based input. In case of other modalities like audio and gesture control systems still lack on flexibility. To respond appropriately, these intelligent systems require specific cues about the user's internal state. Reliable emotion recognition of technical systems is therefore an important issue in computer sciences and applications. In order to develop an appropriate methodology for emotion analyses, a multimodal study is introduced here. Audio and video signals as well as biopsychological signals of the user are applied to detect intraindividual behavioural prototypes that can be used for predictions of the user's emotional states. Additionally, interindividual differences are considered and discussed. Statistical analyses showed results in most cases with statistical significance of probability value $p < 0.05$ and an effect size $d > 1.05$.
pp. 59-64

A Complex Adaptive Model of Information Foraging and Preferential Attachment Dynamics in Global Participatory Science

Ozgur Ozmen (Auburn University, USA); Jeffrey Smith (Auburn University, USA); Levent Yilmaz (Auburn University, USA); Alice E. Smith (Auburn University, USA)

Recent developments in cyber-infrastructure and emerging virtual science collaboratories are enabling scientists to transparently co-develop, share, and communicate diverse forms of knowledge artifacts in real-time. Using collective action theory as a basis, we introduce an agent-based of model of such collaborative environments as complex adaptive social communication systems. By examining empirical data from the Open Biomedical Ontologies (OBO) Foundry,

we present a conceptually grounded agent-based model of what we call Global Participatory Science (GPS). The model represents the dynamics of GPS in terms of the information foraging, social exposure and learning, and preferential attachment mechanisms. Social network metrics and activity patterns are used as proxy metrics to infer innovation potential of knowledge and collaboration networks. In this paper, we demonstrate the impact of foraging and preferential attachment mechanisms on emergent social network structures. The objective is to further our understanding of the dynamics of GPS and facilitate developing informed policies fostering innovation potential.
pp. 65-72

idsNETS: An Experimental Platform to Study Situation Awareness for Intrusion Detection Analysts

Vincent Mancuso (Pennsylvania State University, USA); Dev Minotra (Pennsylvania State University, USA); Nicklaus A. Giacobe (Pennsylvania State University, USA); Michael McNeese (Pennsylvania State University, USA); Michael Tyworth (The Pennsylvania State University, USA)

In this paper we present a new simulation designed to help research better understand the role of the human in a cyber analysis task. Based on qualitative research, previous literature within the cyber security, and our experience creating simulations, we built a new system, idsNETS, which is capable of simulating both the environment and data that is present in a cyber security intrusion detection task. This simulation, which is the first built upon the NeoCITIES Experimental Task Simulator (NETS), was implemented to mimic the task of an intrusion detection analyst. From this work, we present an overview of the scaled-world definitions, the NETS Simulation Engine, and the Simulation User Interface, as well as discuss how this simulation can be leveraged to measure situation awareness in cyber security. Finally we discuss the future research that the idsNETS system will enable us to conduct.
pp. 73-79

Coffee Break

S4 - Agent-Based Situation Management

Chair: Christofer Waldenström (Stockholm University & Swedish National Defense College, Sweden)

Cooperation in A Distributed Hybrid Potential-field/Reinforcement Learning Multi-agents-based Autonomous Path Planning in a Dynamic Time-Varying Unstructured Environment

Dalila B. Megherbi (Unversity of Massachusetts, Lowell, USA); Vikram Malayia (University of Massachusetts Lowell, USA)

In a time varying environment multi agent path planning is a challenging problem. In our previous work we have shown, for both the static and dynamic cases, how a given single agent can learn to successfully avoid the obstacle(s) in its given (centralized) environment and reaches the target using the shortest path [1,2], [27-44]. Here we propose a new approach to solve this method by using what we name here "dissolving potential field" and "selective reinforcement learning". In particular, here we consider more than one agent in the environment, where each agent starts from a different initial position in its environment (world) with no knowledge of the world and the location of the other agent (s), and where the environment and agents are distributed over several computer node. We focus on the study of the behavior of the agents in such a setting. The agents are designed to be homogenous with a similar goal. The agents are cooperative and inform the main knowledge base which is shared by all the agents about any obstacle or goal they might encounter. Such knowledge could be helpful to an agent in the vicinity of such an obstacle. The reason for implementing path planning in a multi-agent system is due to the intrinsic advantages of this system over a single agent system, a multi-agent system provides parallelism, robustness, fault tolerance, scalability, geographic distribution and cost effectiveness over its single counterpart [4, 10]. The field of parallel and distributed machine learning is of considerable importance, but also is rather young and still searching for its defined boundaries and shapes. Most of the available work in this kind of learning is centered on large-scale inductive learning [10]. In particular, this paper implements a machine learning problem as a case of distributed artificial

intelligence. The experimental setup has two agents which have access to a global knowledge base both the agents can read and write to this knowledge base. This knowledge is apart from agents own map of the real world which is based on its experience and information obtained from the global knowledge base. The global knowledge base allows the agents to learn from each others experience and become intelligent with time. Finally, in a dynamic environment where mobile obstacles could be moving randomly path planning for an autonomous agent(s) becomes a challenging problem. In particular, in such an environment it is desired to have the agent not only be equipped with intelligence to avoid the obstacles but also be able to learn the shortest path to the goal in minimum amount of runs. In particular, this presents a reinforcement-learning-based technique which allows the agent to converge to the shortest path in a small number of runs of two. As mentioned above, we use a combination of potential field and reinforcement learning to solve the proposed path planning problem. When used alone these two approaches have their limitations. The paper describes a method to use these approaches such that it guides the agent (s) to accomplish its/their goals in time-varying dynamically changing environments.
pp. 80-87

An Agent Based Model for Trust and Information Sharing in Networked Systems

Kevin S Chan (US Army Research Laboratory, USA); Sibel Adalı (RPI, USA)

Vast amounts of information are generated, shared, and processed in tactical networks. In such systems, human cooperation is a crucial component for effective processing of information. However, often human behavior is mediated by social and organizational relationships between team members and system level characteristics, such as network delays. For example, a team member trying to achieve a task may choose to maximize her energy by collaborating with the best people for a given problem, those who are providing the best information and the highest throughput. However, the quality and the quantity of information is impacted by the underlying communication network issues such as network delays and packet loss. The "trust" a person places in another is then based on the human behavior observed through a channel that may have perturbed actual behavior. Trust in turn changes information sharing behavior in the network. By understanding the interplay between social trust and communication reliability, we can develop methods to maximize situational awareness in different network settings. In this paper, we take the first step in addressing this problem. We develop an agent based model for information sharing that incorporates trust into decision making. The nodes in our model are decision makers and are primarily responsible for the disambiguation of received information to obtain correct situational awareness as quickly as possible. Additionally, each node must share information with other nodes to enable the network to attain shared situational awareness. In our model, team members make trust evaluations for fellow team members that they cooperate with. The trust for other members is based on an initial trust distribution obtained from prior experiences. In some cases this prior interaction may be very little as information is generated by a wide range of sources. Our model allows us to model a variety of settings along two separate axes: 1. Competence: the ability of a team member to send pertinent or useful information. 2. Willingness: the amount of effort a team member is willing to spend on the given node. Note that both components are crucial to deciding which node to interact with. For example, a team leader may be very competent but may not be willing to interact directly with a subordinate. In our model, the nodes have a prior trust distribution and collect evidence for both types of trust throughout the task execution. This evidence is used to update the trust value using a Bayesian approach where evidence is evaluated based on existing trust values and how new evidence is viewed as a function of existing trust distribution can be modeled in various ways. This allows us to introduce cognitive biases into our model. We then convert these trust values to general labels for other nodes based on two main components: the amount of trust and the amount of uncertainty in the trust value. To test out this proposed model, we use a command and control experiment platform called ELICIT (Experimental Laboratory for Investigating Collaboration, Information-sharing and Trust). The ELICIT platform has configurable scenarios that enable groups to focus on the task of identifying details of a fictional insurgent threat. Packets of partial information are distributed so that no one participant receives all the information necessary to perform the task; thus, information sharing is required in order for any participant to determine a solution. Human-agent models have been created to enable ELICIT experiments to be run in place of human participants. We consider the behavior of ELICIT agents with regard to the labels generated using our proposed model of trust. We also add a communication network emulation environment EMANE (Extendable Mobile Ad-hoc Network Emulator) to ELICIT which allows for the study of the impact of communication network quality of service on the mission success. We give initial experimental results that show how trust of nodes change in an ELICIT information sharing task for various settings of initial team trust, the biases of the nodes and possible communication channel disturbances.
pp. 88-95

Using Federated Adaptable Multi-Agent Systems in Achieving Cyber Attack Tolerant Missions

Gabriel E. Jakobson (Altusys Corp., USA)

The overall goal of the processes of cyber attack impact assessment that was discussed in our earlier works was strictly to increase the cyber security situation awareness. In this paper we will move further, from the cyber security situation assessment task to the task of achieving of missions that are tolerant to the cyber attacks committed against the information assets that support the mission operations. We will introduce a notion of cyber attack tolerant missions and propose a framework of building cyber attack tolerant missions based on federated adaptable and situation aware multi-agent systems.
pp. 96-102

Poster Session

Identification of Adaptive Behaviors and Decision Heuristics in a Simulated Strategic Decision Making Task

Jean-François Gagnon (Université Laval & Thales Canada, Canada); Daniel Lafond (Defence R&D Canada, Canada); Michel DuCharme (Defence R&D Canada, Canada); Marie-Ève St-Louis (Universite Laval, Canada); Sébastien Tremblay (Universite Laval, Canada)

We report a study that investigated the role of system exploration and outcome assessment behaviors in a complex strategic decision making simulation. After a tutorial on how to use the simulator and a practice session, 32 subjects completed a turn-based counter-insurgency (COIN) scenario against a simulated adversary without time pressure. Subjects played the role of a commander whose goal was to stabilize a failing state by allocating resources (points) in various spheres of intervention like "infrastructure development" and "security operations". We measured performance based on multiple goal attainment and subjects' behaviors in terms of system exploration (seeking information on the relationships between system variables) and outcome assessment (time consulting the feedback after each turn). Results show that overall performance was rather low (15.62%, min = 5%, max = 32%). Two behaviors were positively associated with performance: system exploration behaviors at the first turn of the simulation and outcome assessment behaviors for subsequent turns were related to better goal attainment. Other results suggest that the nature of the information that is sought, and the nature of the decision heuristics that are used played a critical role in the degree of achievement of mission goals. Results are discussed in light of strategic decision making training and support requirements.
pp. 103-106

Mixed-Initiative Data Mining with Bayesian Networks

Robert F Stark (Charles River Analytics, Inc., USA); Michael Farry (Charles River Analytics, Inc., USA); Jonathan Pfautz (Charles River Analytics, USA)

Complex information systems make a wide variety of data types available, but it can be difficult for users to gain insight from pure inspection of those data sets. This need has led to data analytics research and resulting technologies such as online analytical processing (OLAP) and data mining. While these research efforts provide a necessary and useful component of many information systems, they are lacking the ability to capitalize on both human and computer capabilities. A mixed-initiative approach to data mining would enable the integration of human and machine capabilities for search and review of data. Because Bayesian networks (BNs) allow for deductive and abductive reasoning under uncertainty, they are a good fit for supporting human-computer collaborative data mining. To support this type of mixed-initiative data mining that capitalizes on BN strengths, we present a technical concept and task flow in which the human and computer work collaboratively to construct a joint knowledge model from a complex data set.
pp. 107-110

Information Entropy and Structural Metrics Based Estimation of Situations as a Basis for Situation Awareness and Decision Support

Andrey Belkin (Karlsruhe Institute of Technology (KIT) & Vision and Fusion Laboratory, Germany); Jürgen Beyerer (Universität Karlsruhe (TH) / Fraunhofer IITB, Germany)

Modern autonomous systems are challenged by complex, overwhelming computer processing power, though, time critical tasks. Handling of reactive and proactive activities in real time requires an exceptionally well designed autonomous system for constant situation awareness and decision support. The basis for such situation awareness and decision support is a robust and comprehensive representation of the environment of the autonomous system, called world modeling. The world modeling sub-system is responsible for a representation of the current state of the environment, as well as a history of past states and forecasts for possible future states. It receives information from sensors, processes it and fuses into existing environment description. Since the incoming information contains uncertainties and can be treated, for example, by means of Degree-of-Belief (DoB) distributions, powerful statistical methods can be employed for the information fusion process (e.g. Bayesian fusion). The history of past states allows for advanced information analysis, such as qualitative situation estimation. On the other hand, a direct analysis of the DoB distributions, for example, information entropy calculation, gives a quantitative estimation of situations. The future states can be predicted on the basis of known evolution parameters of the environment, for example, by attributes and objects aging modeling. The qualitative and quantitative situation estimations, as well as the comprehensive environment description itself allows for permanent situation awareness and intelligent support for decision making sub-systems. Both information flow and modeling situation can be evaluated numerically with the information entropy calculation. The difference between entropies of an attribute before and after the observation fusion gives a numerical estimation for the information gain. On the other hand, the evaluation of entropies of all attributes can give an overall estimation of the object representation. Extending entropy analysis on groups of objects and their relations allows for numerical estimation of situations. In order to numerically estimate attribute sets of all modeling objects, the entropy calculation must be unified for both discrete and continuous DoB cases. In order to overcome the infinite discrepancy between the entropy of quantized random variables and the entropy of discrete random variables, the unification introduces a notion of the least discernible quantum (LDQ). The LDQ defines the utmost precision for any operation over the attribute. The proposed analysis was developed within the German Research Foundation (DFG) Collaborative Research Center (SFB) 588 ``Humanoid Robots -- Learning and Cooperating Multimodal Robots''. The main goal of the project is to build a humanoid assisting robot. For development and tests, a kitchen environment has been created as a test field. Within this environment, several humanoid robots are cooperating with humans and performing complex tasks, e.g. interactive objects and concepts learning, context recognition, analysis of situations and intentions.

Adventurous Robots Equipped with Basic Emotions

Mohammad Mansour Riahi Kashani (Islamic Azad University, North Tehran Branch, Iran); Mehrdad Jangjou (Islamic Azad University, Emirates Branch, Iran); Nima Khaefinejad (Azad University, Tehran North Branch, Iran); Touraj Laleh (Azad University, Tehran North Branch, Iran)

One of the grand challenges of the future generation intelligent systems is how to build a robot thinking human way. In this case, cognitive robotics attempts to embed cognitive abilities of the natural intelligence and specially the human brain in robotics applications. The context of such an objective can be provided by merging disciplines like artificial intelligence, cognitive informatics, psychoanalysis, and neuroscience. In this paper, the Motivation/Attitude-Driven Behavior (MADB) model is exploited to design the behavioral mechanism of adventurous robots. The MADB model provides a plausible computational model of human behavior for simulating robots equipped with basic humanoid emotions. The proposed model has resulted in giving adventurous robots the ability to show emotional behaviors. Finally, adventurous robots and conventional ones are implemented in a virtual ecosystem separately and their effort for survival is compared. The simulation results show that adventurous robots have a greater chance to survive in the simulated environment.

The New Environment Model Building Method of Penetration Mission Based on the Artificial Potential Field Approach

Ying Li (Beihang University, P.R. China)

The rationality of planned penetration route depends on the accuracy of environment model of penetration mission. The existing penetration route planning method can not describe the detecting characteristic of radar and radar network exactly. According to these limitations, this paper proposed a new environment model building method of penetration mission by introducing the APF (Artificial Potential Field) for robot path planning. As this new method took both the detecting characteristics of radar and the anti-stealth principle of radar network into account, the environment model of penetration mission built up by this new method can reflect the dynamic detecting characteristic exactly. The two examples in this paper also show the reasonability of this new kind of environment model of penetration mission.
pp. 121-125

Designing Collaborative Automated Planners for Dynamically Changing Environments: Supporting Agile Adaption to Changing Priorities

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A common challenge in resource constrained environments, where demand exceeds available resources, is to define and communicate priorities that can be used to guide effective allocation. This challenge is accentuated in environments where: (1) there are multiple, organizationally distinct customer groups vying for the same resources so that relative priority across groups is difficult to gauge; (2) the individuals assigned the responsibility of allocating resources are organizationally distinct from the customer groups, and must rely on input from the customers to assess relative priority; (3) there are gradations of priorities that are not fully captured by the formal, fixed, prioritization schemes ; (4) priorities dynamically change within and across groups with changing circumstances. One example of such an environment is a military organization that supports planning and scheduling of transportation assets (e.g., aircrafts, ships, rail, trucks). The organization supports multiple, geographically dispersed commands, and units within the commands that have requirements to move personnel and cargo during particular time-windows. The totality of transportation demands at any point in time can exceed available assets to support the movements. In this paper, we describe a collaborative automated scheduler for this domain, that utilizes innovative visualizations and mixed initiative techniques, to enable users to more effectively uncover, communicate and dynamically revise priorities as circumstances change. The system would include visualizations to foster improved situation awareness of available resources vs. total demand on those resources at any given point in time, as well as improved shared situation awareness of relative priorities of movement requirements. It will facilitate more effective communication and balancing of priorities within and across organizational boundaries. In this paper we describe the issues that arise in the design and development of a collaborative automated scheduler. These ideas are a significant extension of our past work on decision support systems based on collaborative automation. The planning and execution of transportation moves is a complex endeavor. The basis of transportation planning is the ability to estimate and balance the needs for both lift (i.e., vehicle) capacity and port capacity. The transportation planning organization is faced with the situation where the capacity needs for long lead-time movements must be balanced together with the capacity needs for very short lead-time movements. The best possible information about capacity needs must be evaluated as early as possible in order to make the best use of limited resources. This goal conflicts with the very real operational need to keep from committing capacity resources too soon to allow for support of late requirement changes. The technical solution to this web of intricately related constraints is a carefully thought-out system of incremental optimization, providing a continuously updated plan of operations. Research indicates need of a constraint-based scheduler to prepare a rough schedule of projected air movements very early in the planning process in order to enable more accurate early projections of airlift capacity needs. Providing planning personnel an early look at how air movement requirements compare to available airlift capacity, enables the possibility to work with customers to reschedule movement requirements before they are locked into their proposed schedules. An important piece of this approach is the design of both visualizations and controls to allow planning personnel to understand and explore alternative planning options when airlift capacity demand exceeds supply. In this case some movement requirements will be either delayed or canceled. The system design allows planning personnel to iterate with the scheduler over possible options about which movements to support. This process depends on providing explicit shared representations of

priorities across movement requirements. While the transportation planning organization has a formal priority scheme in place, it is relatively coarse. Most movement requirements have the same formal priority, reducing the usefulness of this prioritization scheme for guiding resource allocation. In practice, there is a richer set of informal priorities, which may change as often as daily, and are generally communicated verbally between customers and planning organization personnel. In this paper we present a system that would allow planning personnel to enter information about requirements to reflect the actual current priorities, within and across military commands. Users can flexibly define as many levels of priority as is required to accurately reflect relative priorities across requirements. Users are allowed to dynamically revise these priorities, as conditions change and/or as their customers come to uncover and more effectively articulate their priorities, when confronted with concrete resource constraint trade-offs. The scheduler respects those changing priorities, resulting in scheduling options that better reflect the current needs and concerns of the military transportation enterprise. References: Roth, E. M., Stilson, M., Scott, R., Whitaker, R., Kazmierczak, T., Thomas-Meyers, G. and Wampler, J. (2006). Work-centered Design and Evaluation of a C2 Visualization Aid. Proceedings of the Human Factors and Ergonomics Society 50th Annual Meeting (pp. 255- 259). Santa Monica, CA: Human Factors and Ergonomics Society. Scott, R., Roth, E. M., Truxler, R., Ostwald, J., Wampler, J. (2009)a. Techniques for effective collaborative automation for air mission replanning. In Proceedings of the Human Factors and Ergonomics Society 53rd Annual Meeting. (pp. 202-206). Santa Monica, CA: Human Factors and Ergonomics Society. Scott, R., Roth, E. M., Wampler, J. L., Kean, E. (2009)b. Symbiotic planning: Cognitive-level collaboration between users and automated planners. In Proceedings of the 14th ICCRTS, June 15-17, Washington, DC, 2009
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Evaluation of Multimodal Displays for Waypoint Navigation
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Point to point navigation is a critical and demanding task for dismounted operators, especially while traversing hostile terrains. Visual displays such as a compass, maps, and global positioning systems have been the ubiquitous means of navigation and have proven to be effective; however, these tools require visual attention in an already visually demanding environment. Multiple resource theory proposes that time-sharing between two tasks with the same sensory modality can produce interference and the use of separate perceptual channels can be more effective. Since the dismounted operator's visual attention is already engaged in examining their environment for potential threats, the use of auditory and/or tactile displays could supplement the visual display to provide enhanced waypoint information. The reduction of the operator's visual load to allow for undivided attention to their environment could allow for more efficient and secure navigations through novel environments. The study investigated the effectiveness of waypoint navigation with the use of a visual map, spatialized auditory and tactile displays in a virtual environment. In addition to performance data, as measured by root mean squared error and time of completion, the participants completed usability and perceived mental workload questionnaires pertaining to the utility of the different displays.
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Robots vs. Machines: Identifying User Perceptions and Classification
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Although much literature focuses on robots and robotics, there is no one clear, and universally accepted definition of what a "robot" is. This makes interpreting the existing research on human-robot interaction a difficult enterprise. The aim of the current work is to examine the human perception of machines and to determine the specific physical characteristics that lead humans to classify certain machines as robots or non-robots. Identifying these characteristics can assist us in understanding how humans view machines as opposed to how they perceive robots. Outcomes from this investigation have important implications for human-robot interaction, as a human's perception of a robot may influence the perceived intentions and actions of the robot. In addition, certain characteristics may make some machines appear more "robot-like" than others, which may have important practical implications in the design of both robots and non-robots alike. Such perceptions are especially important in high risk environments that employ human-machine teams, where a human's trust in a robot may be critical to the success. While types of robots have been identified extensively in the literature, there is ongoing debate regarding the characteristics

that differentiate a machine from a robot. Fong and colleagues (2001) posit that human-robot interaction (HRI) is closely related to human-machine interaction (HMI), but they differ in a number of crucial ways. First, robots are complex, dynamic systems that show a degree of autonomy and cognition and operate in real-world environments. This implies that "machines" do not possess some or all of these characteristics. Second, robots can operate through direct or distal interaction, where interfaces simply serve as translators. In other words, tele-operated systems could be considered robots. However, Matarić (2007) has suggested that a robot cannot be completely controlled by a human, opening the argument that tele-operated machines cannot be true robots. Mahoney (1997) proposed that a robot is programmable automation, in which case a dishwasher or a refrigerator could be considered a robot. Yet from another perspective, Yagoda (2011) defined a robot in terms of intelligence and automation and therefore argues that robots are distinctly different from a refrigerator, and expert system, a robotic arm and even artificial intelligence. While professional roboticists, who work with such systems on a daily basis, may have different ways of classifying robots, it is essential to explore both the expert and the naïve users' perception of a robot. Only then will researchers be able to accurately address other aspects of human-robot interaction, such as trust and perception of intent. Therefore, the current research takes an empirical approach to determine how humans perceive robots as opposed to machines, as well as to identify the characteristics of a robot that make some machines appear more "robotic" than others. This research represents an important first step in modeling human interaction and trust with a robot. Participants were undergraduate students from a university in a large metropolitan area in the southeast United States. Following an informed consent, participants viewed different images of humans (e.g., child, adult, etc.), objects (e.g., hammer, ball), machines (e.g., washing machine, refrigerator) and robots (e.g., Talon). They were asked to rate these images on a 7 point Likert scale as to the degree to which each image could be classified as human, machine, robot, and object. Images were randomly displayed and participants then observed the same images a second time and rated their trust of each on a 7 point Likert scale. Additional questionnaires included the Big Five Personality Inventory, Negative Attitudes Towards Robots (NARS), and a demographics survey. Participants completed the entire web-based study in approximately 30 minutes. Data collection is currently ongoing. The results from this exploratory research will assist in differentiating between a human's perceptions of machines and robotics. Findings will have implications for human-robot interaction, as a human's perception of a robot may influence the perceived intentions of the robot and the human's interpretation of the robot's actions. In addition, perception may be key to understanding the extent to which a human will trust the robot to perform a task. Furthermore, prior research has demonstrated the importance of taking robot attributes (including physical appearance) into account when designing robots that facilitate trust (Hancock et al., 2011). Therefore, findings may reveal that certain characteristics may make some machines appear more "robot-like" than others, which may have important practical implications in the design of robots. This is specifically important in high risk environments that employ human-robot teams, where a human's trust in a robot may be critical to the success of the team.
pp. 138-141

Framework for Assessing the Trustworthiness of Cloud Resources

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Computing power is shifting from local computers to a globally distributed system of servers. Data that used to be stored on the user's machine as well as applications that process this data are now part of the "cloud". While there are various advantages in doing so such as cost, performance and availability; security and trust relationships now become major issues. For instance, in the cloud, computations (i.e. data processing) are often distributed among multiple servers which are not necessarily controlled by the user or even a single entity. Therefore, the user needs to determine what part of the processing that produced the results can and cannot be trusted. In order to secure individual resources such as individual applications, operating systems and hypervisors in the cloud we have developed a new framework which embeds them in an armor that protects the resources. The armor works by constantly monitoring and evaluating the environment surrounding the armor and checking the resources it is protecting in order to assess the trustworthiness of cloud resources. Based on these assessments and trust relationships with other armor components it makes decisions such as redeployment or migration in the event that resources have been compromised. The framework provides mechanisms for extracting measurements from resources and derives a trustworthiness assessment for each measurement (of whether it has been compromised) based on a rich set of data and meta information from multiple resources and contexts. This includes a rigorous process of how to derive confidence intervals from data by evaluating history, expected behavior and context information. Furthermore,

we present a flexible decision scheme which allows for the estimation of belief that a resource has been compromised based on the assessment and confidence intervals of the individual measurements, their meta information and context.
pp. 142-145

A Microworld for Investigating the Effects of Visualizing Expanding Search Areas in Naturalistic Naval Warfare Tasks

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Presents an microworld for investigating the effects of visualizing expanding search areas to support the building of a naval force's common operational picture. The microworld simulates naval warfare operations, and in it, two participants can play against each other in an operations area where both own units and neutrals may be present. The participants control combat vessels used to locate and attack the enemy, and high value objects that should be protected. The map of the operations area is configurable and the units' weapons and sensors can be defined by the experimenter. The microworld displays an individual operational picture to each player complied from the sensor information provided by that player's units. To investigate visualization, expanding search areas can be added to enhance the operational picture, and algorithms based on these areas can be used to let the computer help the participant identify enemies from neutrals. The integration of expanding search areas into the operational picture is illustrated. The unit classification algorithms based on expanding search areas are explained, and examples of how they work are presented. Experimental setups are presented together with initial evaluations of the microworld.
pp. 146-149

A Distributed Behavioral-based Technique for Multi-agent Sensory & Event-driven Autonomous Formation and Navigation

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Many complex systems necessitate concurrent task planning and decision making. Often these systems are implemented on automated systems with distributed architectures on heterogeneous operating systems and hardware platforms. In this work we aim to build an autonomous multi agent system in a distributed computing environment. In particular, autonomous trajectory planning is achieved for each agent to reach its destination via an unstructured environment filled with dynamic obstacles and other agents. Each agent has knowledge of its destination and a sensory-based map of its environment. This requires knowledge of the global environment and an establishment of an abstract communication interface by the whole system which enables the agents to share and exchange information among each other. The crucial part is the construction of the architecture to achieve goals under real time constraints. The control architecture of the system should possess both the safety of guaranteed real time computing and flexibility to allow utilization at multiple layers. We propose a multi-threaded architecture. Threads are used here as they standardized OS independent way to achieve light-weight concurrency in modern operation systems and as they allow separation between address space and the thread control. Additionally, a threads-based architecture appears to be appropriate for cooperative concurrency. Unlike processes, multithreaded applications can largely benefit from non-blocking system calls. We show that to guarantee coherence in decision making there is a need to search for a new concept dispersed activities and decision making. Additionally, our aim in this paper is to show models, methods, and results in the design of architectures for distributed motion planning systems with their applications to autonomous multi-agent systems. More importantly special emphasis through this work will be given to distributed objects, mobile objects, and intelligent agents. Finally, experimental results are presented to show the potential of the proposed method
pp. 150-157

Multi-Organizational Distributed Decision Making in the Power Grid Industry

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This paper focuses on the need for rapid and effective response to unknown, undefined, or unplanned system events that remain a core challenge for grid operators and their related power grid entities. This research analyzes the elements of inter-organizational communication and explores the impact of better inter-organizational communication and coordination among power grid entities on improving their distributed decision making under uncertainty. This poster also

discusses methods for identifying and organizing communication methods and distributed decision making processes under uncertainty with an aim to support future decision support models allowing for rapid and adaptive power grid reliability decision making.

A vector-space retrieval system for contextual awareness

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This paper introduces a retrieval system based on context rather than content. The system uses a set of vector spaces to represent the different contextual characteristics (position, time, sound environment, etc.). In this model both the current context and the items in the corpus are represented by vectors. We then use vector similarities to identify the relevant items given the context. In order to take into account the user's own perception of the context we also use learning techniques based on the user feedback. This paper also presents two applications we are currently developing, which make use of this retrieval system: a contextual adaptive User Interface selecting the right configuration profiles matching the current context as acquired by a computer, and an augmented reality application for iPhone suggesting to the user activities and places that could be of interest to him given its current environment.

Enhancing optical networks with cognition: Case-Based Reasoning to estimate the quality of transmission

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Connections established in optical fiber networks should comply with Quality of Transmission (QoT) requirements. Hence, tools to predict the QoT of those connections, before establishing them, are required. In this paper, we propose a cognitive QoT estimator, based on Case-Based Reasoning (CBR), which achieves more than 98% successful classifications of optical connections into high or low QoT categories, and is much faster for on-line operation (around three orders of magnitude) than an existing approach. Moreover, we also evaluate the performance of two algorithms to determine the relevance of the attributes of the cases which are stored in the knowledge base of the CBR system.

Cognitive Algorithm to Solve the Impairment-Aware Virtual Topology Design Problem in Reconfigurable Optical Networks

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A key problem in current optical telecommunication networks is that of virtual topology design, where a set of optical connections (or lightpaths) are established between network nodes in order to accommodate traffic demands. Those virtual topologies are designed with the aim of optimizing a set of network parameters while complying with quality of transmission requirements. In this paper, we show the advantages of using cognition when solving that problem. In particular, we present two multiobjective genetic algorithms (one of them enhanced with an additional cognitive technique) and evaluate their performance under realistic traffic demands. Results show that the new method enhanced with cognition obtains more and better results than the other method.

The Distributed Nature of Cyber Situation Awareness

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We present here preliminary findings from our ongoing study of situation awareness in cybersecurity (cyber-SA). Analysis of data collected from the field has produced two preliminary findings. One, cyber-SA is distributed across individuals, technological agents, and functional domains. Two, an absence of effective boundary objects inhibit cross-boundary collaboration and reduce individual cyber-SA.

A Cognitive Task Analysis-based Evaluation of Remotely Piloted Aircraft Situation Awareness Transfer Mechanisms

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Over the past few decades, the immense capability that remotely piloted aircraft (RPA) can deliver has been realized, exploited and continually advanced by military, government and commercial industries. Consequently the demand for medium to high-altitude RPA operations, especially within the US Air Force, continues to grow at insatiable rates. However, the assets and requisite resources to support those operations are far from unlimited and struggle to keep pace. This situation has inevitably led innovators to seek out RPA force-multiplying efficiencies to assist in bridging the resource/demand gap. One such consideration is simultaneous control of multiple aircraft by a single pilot, or Multi Aircraft Control (MAC). Past research has identified several formidable impediments to MAC, to include dynamic and emergency task saturation, communications interruptions, and effective and efficient transfer of operational situation awareness (SA) from a losing pilot to a gaining pilot. This SA transfer occurs at the conclusion of a typical shift and is termed "change-over". Currently, change-over activities can consume approximately 10% of a pilot's mission time. During MAC, if a pilot accepts control of three or four aircraft, the transfer time and effort balloons to consume an unreasonable percentage of the pilot's effective mission time. Such a reduction in mission time runs counter to the objectives of implementing MAC in the first place. The cognitive tasks, modalities, and transfer mechanisms imposed by the complexity of achieving operational Situational Awareness (SA) on multiple aircraft is examined. This paper describes research that utilized a Multiple Resource Theory (MRT)-based dynamic, stochastic simulation to perform a cognitive workload study of SA transfer amongst RPA pilots during change-over. The study sought to identify tools, tactics and protocols that may reduce RPA pilot cognitive workload and expedite the change-over process, thereby increasing mission effectiveness and RPA availability.

Managing Critical Events: Designing an Attention Allocation System

Joseph DiVita (Space and Naval Warfare, Systems Center Pacific, USA); Robert Morris (Space and Naval Warfare, Systems Center Pacific, USA)

Future interfaces that intend to support a Commander's decision-making process must be able to recommend prioritized actions such that the decision maker can dynamically focus attention in response to changing environments with uncertain information. A technique will be investigated that will monitor the environment by sampling current utility values of criteria and aggregate this information to provide a means to determine the most important information and critical tasks. The computational tool that we will use to do the prioritization is the Choquet integral. The Choquet integral is a fusion operator that allows one to aggregate interacting criteria to accomplish multi-criteria decision-making. The Choquet integral assumes that there is set of criteria and that each alternative has a utility score on each criterion. The Choquet integral takes into account interactions among the criteria by aggregating over non-additive set functions, or fuzzy measures. In order to apply the Choquet integral, the set of criteria used to evaluate each alternative must be specified. The next problem is to determine the relative importance (weight) of each criterion and the degree to which they interact. This may be done by having experts rank reference sets of alternatives (Maricahal & Roubens, 2000). The key to Maricahal and Roubens' approach is that experts are asked to make pair-wise comparisons of the relative importance of alternatives. When this data is analyzed by linear programming, the solution is the set of weights for each criterion and

subsets of criteria that are necessary to compute the Choquet integral. In this manner the relative importance of alternatives may be ranked. We will present research in progress applying these techniques to: 1)Ranking alternative Naval surface assets for re-deployment and tasking. 2)The prioritization of counter illicit trafficking cases within the Joint Inter-Agency Task Force - South (JIATF-S) area of operations. This prioritization will allow decision makers to better focus attention in a dynamic and uncertain environment with limited resources. We envision these prioritization and allocation models to evolve to support more general Navy Maritime Domain Awareness (MDA) and asymmetrical warfare targeting missions. 3)The ranking of robotic controllers based on human performance data over several tasks while using these controllers.
pp. 183-186

Individual Differences in SA Measurement and Performance in Human-Robot Teaming

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Maximizing operator situation awareness (SA) during human-robot interaction is a long-sought goal and a continued challenge for both research and military interests. Although robots provide substantial benefits, their implementation comes at a high cost to the operator's resources, including SA; therefore, performance may be affected. To address this problem, measures are needed to capture SA in live environments. SA measurement techniques vary in their practicality as well as their psychometric properties. For example, some techniques self-reported, while others are objective measures. Because SA is the result of cognitive processes within an operator, capturing SA without affecting safety or performance is difficult, especially on the battlefield. As a potential solution, measurement of individual differences across operators may augment situation awareness measurements. The present study examined individual differences as determinants of SA in a human-robot team task. To establish the efficacy of measures of SA for this task, an exploratory study was conducted in which the effects of individual differences on multiple measures of SA were compared. The purposes of this study were to: (1) determine if SA measurement techniques capture task-relevant individual differences, such as spatial ability, (2) determine whether measurement of SA predicts performance above and beyond what individual differences predict, and (3) to obtain qualitative data on the feasibility and effectiveness of the measures of SA for use in a live mission environment. Two SA measures were selected for their representativeness of widely used SA measurement techniques. The two techniques selected were the Situation Present Assessment Method (SPAM) and the Situation Awareness Rating Technique (SART). The SPAM questions were presented within the participant's vehicle interface, and the SART was administered at the end of the participant's mission. The mission environments were sections of the Team Performance Laboratory's Scale Military Operations in Urban Terrain (MOUT) facility. Video from this facility was prerecorded and loaded into the simulation to simulate an autonomous unmanned ground vehicle. Within this task, the participant had to cooperate with the robot to complete a reconnaissance task. For each driving segment, the appropriate video was displayed. The participant was tasked with route planning and identification of soldiers, while the robot navigated roadways and manipulated the vehicle's camera. Variance was shared across SA measurement techniques and individual differences, suggesting that SA could be affected by individual differences. Both the visual patterns test and spatial ability were positively related to the SPAM, but not the SART. Practical differences in the development of SPAM questions versus inclusion of the standardized SART may account for this and are discussed along with practical implications for the use of SART and SPAM in human-robot interaction.
pp. 187-190

Human-Centered Automation for improving Situation Awareness in the Fighter Aircraft Domain

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Over the years, several support systems have been implemented within the fighter aircraft domain so as to, ultimately, improve the pilots' awareness of the situation. These support systems incorporate different automatic or semi-automatic support functions anticipated to aid fighter pilots perform their tasks and to make decisions fast in an often rapidly changing environment and where the data used might be both uncertain and contradictory. However, both positive and negative effects of automating pilots' tasks have been documented, such as decreased workload on one hand, but a loss of individual and team situation awareness (SA) on the other hand. Thus, which tasks to automate must be carefully investigated so as to create an appropriate working environment for the pilots as well as a better foundation for obtaining good individual and team SA.

Human-Centred Automation (HCA) has been suggested as an approach for designing automated systems that brings forward the positive effects of automation. However, how to apply the concept of HCA to the specific prerequisites and demands of the modern fighter aircraft domain has, to our knowledge, not been fully investigated. This paper presents the results from interviews made together with system developers at Saab Aeronautics in Sweden so as to receive knowledge of the state of the art of HCA in the modern fighter aircraft domain. The purpose of the study was to get better insight into how HCA is acknowledged in the system development process of today. An evaluation of the identified HCA guidelines in relation to a proposed decision support system, aiding the pilots in achieving individual and team SA of the expected survivability when flying a given route, is also presented. The results from the study indicate that HCA is indeed a crucial concept in the fighter aircraft domain, especially in light of the new demands posed on the pilots, such as the increasing need of acquiring and maintaining good team situation awareness (for example during international missions where larger collaborating teams including UAVs are involved) as well as due to the increasing amount of automated technologies incorporated into the aircraft. In relation to the proposed support system, identified HCA requirements have been analysed, modified and incorporated into the first simple prototype of the system.
pp. 191-197

Data Exchange for Shared Situation Awareness

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The Command and Control (C2) system that provide information to the actors in a conflict has always been a key target for technology advancement. The ongoing development of automated digital military information systems has enabled, and is demanding the development of specific functional area support systems. The focus of communication systems and methods is shifting away from human to human communication towards human to machine and machine to machine communication. Along with this change have come proliferation of operating systems, data representation schemata, data exchange methods and other aspects that now confront us with a "confusion of languages" [1]. The objective of a C2 or a C4ISR system is to provide the users of the system with Situation Awareness. This Situational Awareness is based on large amounts of data acquired from various sources, which include heterogeneous sensor systems, information provided by the actors in the field, a range of military and civilian agencies, including sources in purely civilian domains, such as social media. The exploitation of these disparate information sources requires consistency analysis of uncertain and heterogeneous information using automated fusion techniques as well as human expertise, if reliable automated processing is not available or acceptable. The information flows between heterogeneous information sources and the consumers of data (i.e. the fusion/analysis processes) can be distributed geographically and logically, the data can be owned by different stakeholders with complementary capabilities and different levels of security clearance. This type of information exchange must take place in the existing communication infrastructure and support semantic interoperability in systems that contain users separated by organizational and/or cultural boundaries and may have different security clearances. One can clearly differentiate between models for information representation/ storage and models for information exchange in the context of C4ISR systems. Common models for information representation/storage are a prerequisite for achieving semantic interoperability and thus for conveying information successfully from one system to another. Models for information exchange are focused on movement of information on the communication paths between the system components. Data representation models enable to represent the structural component of situation modeling [4]. For modeling shared situations we need in addition explicit data exchange models - we cannot rely only on structural components and a generic communication protocol. In terms of situation management concepts [4] - to model shared situations an additional interaction component should be introduced. On application level such models are often called either data exchange models or information exchange model etc. The issues of information exchange between different architectures and systems have been a massive challenge for the last three decades. Problems typically arise when a perfect model that deals with the precise exchange of information among different systems and architectures is required for a successful operation of the system. In the context of military frameworks on a common battlefield, exchange of efficient and precise information is the key for correct decision making. Information exchange within different nodes has been and still is a challenge. In [2] a general reference model is proposed to integrate different Command Control Communication Computer & Intelligent (C4I) systems operating under different defense forces of different coalition groups involved in a common-battle-field. The paper describes the information exchange issues and challenges involved in creating shared situation awareness in the described systems. Some existing models

for both information representation and exchange are described and a proactive communication model for information exchange in a distributed system is presented. The proactive communication model caters for the data requirements of the data consumers, the objective being to provide the information required for forming good situational awareness of the data consumer. The proactive communication model relies on a middleware [5] that is able to acquire the information required by the consumer and to cater for the restrictions set by the data consumer on the requested data. The paper describes the middleware and how it can be applied in the above-described systems. References [1] Kofi Apenyo. 2008. Relationship Discovery Ontology in Asymmetric Warfare. In Proceeding of the 2008 conference on Formal Ontologies Meet Industry, Stefano Borgo and Leonardo Lesmo (Eds.). IOS Press, Amsterdam, The Netherlands, The Netherlands, 144-155. [2] Abdullah S. Alghamdi, Zeeshan Siddiqui, and Syed S. A. Quadri. 2010. A Common Information Exchange Model for Multiple C4I Architectures. In Proceedings of the 2010 12th International Conference on Computer Modelling and Simulation (UKSIM '10). IEEE Computer Society, Washington, DC, USA, 538-542. DOI=10.1109/UKSIM.2010.104 http://dx.doi.org/10.1109/UKSIM.2010.104 [3] Walt. O, DoD-CIO/ASD-NII Enterprise Architecture & Standards Directorate, Presentation to DAU IRM Class Level III, July 28, 2008. [4] Gabriel Jakobson, John Buford and Lundy Lewis. Situation Management: Basic Concepts and Approaches. INFORMATION FUSION AND GEOGRAPHIC INFORMATION SYSTEMS, Lecture Notes in Geoinformation and Cartography, 2007, Part 1, 18-33, [5] Motus, L.; Meriste, M.; Preden, J. (2009). Towards Middleware Based Situation Awareness. In: Military Communications Conference - 2009. MILCOM 2009, 18-21 Oct. 2009: 5th IEEE Workshop on Situation Management (SIMA 2009), Boston, 19-21 October. Boston, USA: IEEE Operations Center, 2009, 1 - 7.
pp. 198-201

Lessons identified from the use of automated information fusion in collaborative environments

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In this paper, we present lessons identified from a number of research projects where users at different levels are presented with a situational picture from the same technical system. We discuss how their need for interacting with the system, and for obtaining shared situation awareness affects the choice of data- and information fusion techniques.
pp. 202-205

Real-time Information Driven Decision Support System for Evacuation Planning

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Evacuation planning during an emergency is an important and critical public safety task. Recent mass evacuations during events such as Hurricanes Rita and Katrina have highlighted the inherent limitations of many existing planning based evacuation models that rely on data from historical events rather than current and emerging situations during an emergency. Evacuation dynamics are complex due to the number of people and vehicles, road networks, the uncertainty and perception of the event, public safety advisories, and human decisions regarding evacuation routes and behaviors. We describe a system under development for real-time information driven decision support system for evacuation planning and response. This system consists of an evacuation traffic prediction model injected with situational information extracted from multiple heterogeneous information sources, such as the Louisiana Department of Transportation Division (DOTD)'s traffic cameras, Automatic Traffic Recorders (ATR), and social networking sites. Evacuation traffic is modeled as a space time graph that represents the state of evacuation traffic at any location and time in the evacuation network. The evacuation traffic model periodically generates estimates of traffic at future time intervals based on the situational information updates. The model utilizes evacuee sentiment data mined from social networking sites. The model then fuses sentiment information with current traffic data obtained from ATR's and traffic cameras, available transportation capacity, and public advisories on contraflow and road closures. The situational awareness information obtained multiple sources is processed, combined and synthesized with historic stated-preferences behavior data. Our model is novel because it augments standard evacuation models with evacuee sentiment via social media networks.
pp. 206-209

Framework for the Analysis of Information Relevance (FAIR)

Richard Breton (Defence R&D Canada Valcartier, Canada); Éloi Bosse (DRDC, Defence Research and Development, Canada); Robert Rousseau (Neosapiens Inc, Canada); Sébastien Tremblay (Universite Laval, Canada)

Many consider today's world as more chaotic, complex and unpredictable as any period in the history. The increasing complexity of today's warfare contributes to the challenge of developing adequate DSS. Military environments, supported by important technological advances, are moving very fast. While more information are made available to provide better, clearer and more certain operating pictures, the time window to process those information sources may shrink considerably. This raises the need to qualify these information sources based on their level of relevance to the situation. With important time pressure where limited number of information sources can be processed, only the most relevant ones should be considered. To illustrate the impact of a time window on the execution of a task, Hollnagel [1] proposes the Contextual Control Model (COCOM). COCOM was developed to model how the control of a system depends on the temporal context. Hollnagel proposes the existence of four control modes that range, in a continuum, from a complete lack of control (scrambled mode) to a complete control state (strategic mode). Feigh and Pritchett [2] proposed the application of these parameters to define the COCOM control modes: Strategic: Number of Goals: Unlimited; Available plans: Pre-defined or generated; Execution Mode: Mix of subsumed feedback; Horizon: Extended Tactical: Number of Goals: Several but limited; Available plans: Available and used SOPs; Execution Mode: Feedback (with comparison to expected outcome; Horizon: Normal Opportunistic: Number of Goals: One or two (often competing); Available plans: Negligible or limited Feedback (with observation of effects on systems); Execution Mode:Feedback (with observation of effects on systems); Horizon: Narrow Scrambled: Number of Goals: One; Available plans: None; Execution mode: Subsumed; Horizon: None The most predominant contextual feature to determine the control mode is the perceived available time to execute [1, 2]. As the time available perceived is short, the control mode will shift towards opportunistic and scrambled modes. As the time available subjectively perceived is longer, the favored control modes will be tactical or strategic. The rationale under this statement is that if subjectively available time is greater an individual will look for more information and undertake deeper analytical processes. In the context of Command and Control, the concept of time window is central to determine the mission success. More specifically, the advantage of the battlefield will be given to the one executing better and quicker to Observe-Orient-Decide-Act (OODA) loop. This interpretation suggests the existence of differing response times associated with action [3]. In reactive mode, operators' actions are following the attack of the adversary. Parallel can be made between this reactive mode and the scrambled one of the COCOM model. In a proactive mode, the operator's action happens during the decision process of the adversary. In the preventative mode, the operator's action happens during the orient phase. Again, there are similarities between these two modes and the tactical and strategic ones of COCOM. A better collection of relevant information should lead to a better understanding of the situation which in turn should support a better and quicker decision-making process. This would lead to more proactive or preventative decisions and tactical or strategic cognitive control modes. The key in that statement lays in the quality of the process of collecting relevant information. In the information era where much information is made available to the decision-maker, the importance needs to be shifted toward the quality (relevance) as opposed to the quantity. In time pressed situations where fewer information sources can be processed, the information sources considered should the most relevant ones. This raises the need to a methodology to filter and prioritize the information based on their level of relevance related to a given situation. This paper proposes an analytical framework, called Framework for the Analysis of Information Relevance (FAIR), to define the level of relevance of the information. FAIR serves to filter and prioritize different information sources based on their level of relevance. The objective is to support the development of Decision-Support System that can filter and prioritize information made available to the end-user involved in a given task execution in a given context characterized by different levels of uncertainty and time pressure. This stepwise approach is fed from the results of Goal-Directed Task Analysis or any other task analyses that identify Situation Awareness (SA) requirements. In FAIR, these SA requirements are classified into the METT-TC classification (Mission, Enemy, Terrain, Troops, Time and Civilians) and associated to one of the three SA-levels (Perception-Comprehension-Projection) of Endsley' SA theories [4]. The prioritization of the information requirements is based on COCOM. FAIR identifies which of these SA requirements are the most relevant to support the four cognitive control modes as defined in the COCOM model. To illustrate the FAIR approach, this paper uses as a case study the Situation Awareness for Tactical Army Commanders (SATAC) project. The objective of this project was to define a set of situation awareness requirements in order to design decision support systems for the tactical army commanders. A set of more than 150 situation awareness requirements resulted from this analysis and is used as an input to illustrate

the FAIR approach. [1] Hollnagel, E. (1998). Context, cognition, and control. In Y. Waern, (Ed.). Co-operation in process management -Cognition and information technology. London: Taylor & Francis. [2] Feigh, K., & Pritchett, A. (2006). Design of Support Systems for Dynamic Decision Making in Airline Operations. Systems and Information Engineering Design Symposium, IEEE. pp. 136-141. [3] Blasch, E. (2005). Proactive Decision Fusion for Site Security", Intl. Conf on Info. Fusion - Fusion05. [4] Endsley, M., R. (1995). Towards a Theory of Situation Awareness. Human Factors, 37, 32-64.
pp. 210-213

Support of Collaborative Work in Battlespace Management: Shared (Loss) of Situation Awareness

Sébastien Tremblay (Universite Laval, Canada); Richard Breton (Defence R&D Canada Valcartier, Canada); François Vachon (Universite Laval, Canada); Dave Allen (Defence R&D Canada Ottawa, Canada)

The importance of promoting situation awareness (SA) in human operators and decision makers has proved to be a central issue for system design in military command and control (C2). One key challenge is to provide officers involved in the operational-to-tactical battlespace management with support systems that can increase SA accuracy, facilitate the process of shared SA, and therefore enhance their management capability. In this paper, we report results from a large-scale military experiment with Canadian Forces (CF) officers on the impact of collaborative work support systems—in the present experiment, a set of integrated tools such as operations planning systems, joint fire systems and other logistics tools—on individual and shared SA. In order to measure SA and the ability to share SA, we used the Quantitative Assessment of Situation Awareness (QUASA) technique and computed the level of response concordance within and across groups (three different Operational Commands of the CF). QUASA, as developed by Edgar et al. (2000) is one of the most frequently used method of collecting and analyzing data on SA (e.g., McGuinness 2007; see also Kirlik & Strauss, 2006, for a review). The technique combines both objective SA—from accuracy of responses to queries (true/false probes) about the situation—and subjective SA—from self-ratings of confidence for each probe response. QUASA also includes calibration estimates that provide an index of over- and underconfidence. The QUASA probes that were administered twice daily corresponded to the events seeded into the scenarios: Participants were asked to identify if specific statements on the overall situation were True or False. A total of 10 statements were used at each session (20 statements per day). Of course, in battlespace management, not all Operational Commands are expected to be aware of the full spectrum of situational elements. This was taken into account in the analyses. The large-scale experiment—a simulation of battlespace management that involved the close collaboration of three Operational Commands—was conducted over a period of eight days at the Canadian Forces Warfare Centre Joint Battle Lab. The experiment compared two conditions that differed based on the systems available to the participants: A baseline set of systems (representative of the current set of tools used by the relevant military organizations) and a prototype set of systems (that involved modern systems of which tools were designed to increase the ease of integrating information from different sources, and facilitate communication and coordination between officers within and across Operational Commands). The experiment scenario included three main Areas of Operations at the domestic and international levels with critical incidents such as the highjack of a ship transporting military equipments and drug smuggling into Canada. Metrics extracted from QUASA can be divided into two classes. A first class, at the individual, is concerned with measures of SA quality (sensitivity, response bias, accuracy) and metacognition (level of confidence, and calibration bias). A second class of measures evaluates the extent to which SA is shared among team members. Shared SA is reflected through the level of response concordance. The impact of the new support system on the levels of SA and shared SA of each group was analyzed separately for the first two and the last two days of testing in order to assess the effect of familiarization with the system. The addition of the new system led to a drop in sensitivity (i.e. this ability to discriminate between true and false descriptions of the situation) for most days and groups. In the first two days, sensitivity to SA probes decreased with the addition of the prototype C2system. Although calibration improved eventually for two of the operational command groups (mainly due to the diminution of the confidence level with the new system), most individuals were more overconfident (i.e., perceiving accuracy as better than it is actually) with the new system. Overall, the prototype C2 system had a rather detrimental impact on both objective and perceived individual SA. With regards to shared SA, according to the Kappa magnitude guidelines (Landis & Koch, 1977), each group showed a relative agreement between its members. Most importantly, the prototype C2 system was beneficial to the level of shared SA. From this pattern of results, we conclude that there might a tradeoff between sharedness and accuracy in terms of costs and benefits. Supporting the process of sharing SA through enhanced means of information integration and exchange, communication and coordination can lead to a decrease in individual SA.

Team-Based Cyber Defense Analysis

Michael Champion (Arizona State University, USA)

Situation awareness (SA) in the cyber security domain is particularly relevant to teams of security analysts who are responsible for detecting cyber threats by perusing continual floods of data such as intrusion alerts and network logs. The challenges that analysts face are matched by those of researchers attempting to understand, measure, and impact SA in the cyber arena. The ground truth is not available except in simulated cyber situations. In this paper we outline a cognitive task analysis (CTA) focused on teams of analysts and the subsequent preliminary study conducted using a cyber defense simulation environment, CyberCog, built based on the CTA findings. Results from the CTA suggest three areas of fundamental challenge surrounding security analysts: team structure, communication, and information overload. These challenges could be associated to maladies such as cognitive tunneling and increased false alarms. These results are mirrored in the CyberCog pilot simulation study.

Conceptual and computational insights from a holistic framework for infrastructure management

Camilo Gómez (Universidad de los Andes & Rice University, USA); Diego Castiblanco (Universidad de los Andes, Colombia); Mauricio Sánchez-Silva (Universidad de los Andes, Colombia); Leonardo Dueñas-Osorio (Rice University, USA)

A holistic approach for engineering problems involving public infrastructure implies considering a series of actors and interactions that must not be neglected nor considered in isolation. This paper seeks to incorporate the relationship between public decision-makers and private providers into traditional technical problems, such as making decisions about maintenance and risk mitigation. Conceptual and computational aspects of such holistic approach are discussed with regards to two complementary approaches to incorporate the multi-party nature of the decision-making problem. First, a game theoretical approach is used to model a basic example of a private-public-partnership for infrastructure operation, where the use of incentives is discussed from the perspective of the public agent to influence the private agent's behavior. Second, an optimization approach is used to evaluate the action of several stakeholders into the problem of executing maintenance on a simplified model of a transportation network. The current state of this research provides the framework and means to define a variety of (even adversarial) stakeholders and evaluate the strategies and outcomes that emerge from coupling different interests and decisions.

Probabilistic Situations for Reasoning

Jared Culbertson (Air Force Research Laboratory, USA); Kirk Sturtz (Universal Mathematics, USA); Mark E Oxley (Air Force Institute of Technology, USA); Steven Rogers (Air Force Research Laboratory, USA)

One of the most substantial advantages that human analysts have over machine algorithms is the ability to seamlessly integrate sensed data into a situation-based internal narrative. Replicating an analogous internal representation algorithmically has proved to be a challenging problem that is the focus of much current research. For a machine to more accurately make complex decisions over a stable, consistent and useful representation, situations must be inferred from prior experience and corroborated by incoming data. We believe that a common mathematical framework for situations that addresses varying levels of complexity and uncertainty is essential to meeting this goal. In this paper, we present work in progress on developing the mathematics for probabilistic situations.

A Framework for Cognitive Robots to Learn Behaviors through Imitation and Interaction with Humans

Huan Tan (Vanderbilt University, USA); Qian Du (Nankai University, USA); Na Wu (Tokyo Institute of Technology, Japan)

This paper proposes a general learning framework for robots to learn behaviors through imitation and interaction. A modified codebook based method is used for robots to segment and recognize new objects in the environment. Task related semantic information is learned by robots through the speech communication with humans. Dynamic Movement Primitive method is used to generate

similar behaviors to complete similar but slightly different tasks. Experimental results are given to verify the effectiveness of this framework.
pp. 235-238

SSIM: Using social science to model the effects of influence campaigns on attitudes and behaviors

Victoria Romero (Charles River Analytics, USA); Corey Lofdahl (Charles River Analytics, USA); Eric Carlson (Charles River Analytics, USA)

The inclusion of social science theories of persuasion can improve influence operators' ability to predict the effects of influence campaigns. However, providing operators with a means to use these theories in predicting target audiences' attitudes and behaviors presents several challenges. Operators often have limited time and data and may lack the expertise to effectively leverage social science theories or the output from models built upon these theories. The Social Science Influence Modeling (SSIM) tool addresses these challenges by offering models at three levels of increasing complexity and by employing theories that are can accommodate the needs and limitations operators encounter.
pp. 239-242

Breakfast

Keynote by Pat Hayes, Senior Research Scientist Florida Institute for Human and Machine Cognition-"Situations, Contexts, States of Affairs, and the Limits of Formalization"

Chair: Mieczyslaw Kokar (Northeastern University, USA)

Situations, Contexts, States of Affairs, and the Limits of Formalization

Patrick J. Hayes (Florida Institute for Human and Machine Cognition, USA)

The idea has been lurking around ever since people first tried to analyze language: meaning depends on context. Things change; circumstances alter; points of view differ. What is true here might not be true over there, or said to a different person, in a different culture. And therefore, simplistic notions of 'truth' must be made somehow more nuanced or multifaceted, in order adequately account of all of this. And yet, virtually all formalized semantic theories do still rest on a robust, straightforward, simple notion of truth, which is a foundational cornerstone for much of modern formal logic. This talk will review this, um, situation, and try to explain the reasons for it. Along the way we will explain recent work on a self-descriptive logic called IKL which was developed as a lingua franca for a variety of apparently incompatible context- and tense-relative formalisms. The most important conclusion is that contexts (etc.) are best seen as a central topic for logics to describe, rather than as altering the basic nature of the logic itself. The extensions required are in ways of naming things, rather than in the logical reasoning that is made using the names. This ontological approach to situational truth provides richer, more expressive and more useful formalizations, but at a cost of making them less like natural language. As we will show, the ontological approach can also be used in a variety of other areas, including the logic of business rules.

S5 - Situation Awareness and Decision Support II

Chair: Kellyn Rein (Fraunhofer FKIE, Germany)

Experience-Based Cyber Situation Recognition Using Relaxable Logic Patterns

Po-Chun Chen (The Pennsylvania State University, USA); Peng Liu (Pennsylvania State University, USA); John Yen (The Pennsylvania State University, USA); Tracy Mullen (The Pennsylvania State University, USA)

Cyber situation awareness is a growingly important issue as the world becomes more and more connected. Unfortunately, the amount of data produced by existing intrusion detection tools usually significantly exceeds the cognition throughput of a human analyst. In attempting to align a huge amount of information and the limited human cognitive load, we developed a systematic approach to leverage experiences of security analysts to enhance cyber situation recognition. We used a logic-based approach to efficiently capture and utilize experts' experience, which can be categorized as kind of knowledge-based intrusion detection. However, knowledge-based intrusion detection relies on the establishment of a knowledge base created from cyber attack signatures, but building a comprehensive knowledge base that covers all variations of attacks is impractical under large-scale networks since knowledge engineering can be a time-consuming process. Therefore, how to effectively leverage limited number of human experience became the second focus of our research. In this paper, we presented the logic-based approach under an experience-driven framework, followed by the concept of experience relaxation for mitigating the limitation of knowledge-based intrusion detection. Our experimental results showed a significant improvement in the knowledge base coverage by applying experience relaxation.

A System for Shared Battlefield Situation Awareness Exploiting Common Knowledge and Theory of Mind

Albert Esterline (North Carolina A&T State University, USA); Srinivas Banda (North Carolina A&T State University, USA); William Wright (North Carolina A&T State University, USA); Kiran Krishnamurthy (North Carolina A&T State University, USA)

This paper will report on work on a battlefield command and control system that maintains shared situation awareness among units. The goal of the US Army's Tactical Information Technologies for Assured Net Operations (TITAN) Program is to show how emerging information technologies can improve tactical operations. A key area is Information Dissemination and Management (ID&M), which will use an XML-based common information exchange data model for command and control information. The key software for the ID&M part of TITAN is a collection of agent-based software services that collaborate during tactical mission planning and execution. A TBS (TITAN Battle Command Support) is a suite of services associated with a unit in a command hierarchy. Since there is a hierarchy of commanders, there is a hierarchically integrated set of TBSs. The TBS for a unit must communicate with its peers in its echelon and with its subordinates. It also must be communicate with its parent in receiving command and control documents and updates to them and in sending feedback and warnings. We describe prototypes of several services of TITAN, the most important here being the WOS (Workflow Orchestration Support) service, which generates workflows from XML-encoded operational orders (OPORDs). Three paradigms for collaboration are used: multiagent systems, Web services, and JMS. JADE is the agent framework and provides bridges to JMS and to Web services. Agent collaboration via agent messages occurs only within a TBS, and JMS is the means of communication among TBSs. TITAN's main goal is for TBSs to coordinate, and a prerequisite for coordination is common knowledge, which can be defined in several ways (outlined in the full paper). In all cases, a nested self reference within the group is critical. Common knowledge in a situation, or common state knowledge (CSK), can arise under certain physical or linguistic co-presence conditions. There is also common knowledge by virtue of a mutual sharing of social scaffolding. The notion of common knowledge has proved useful in a wide array of disciplines. It has been used in the analysis of protocols (scaffolding) in distributed systems with an eye to CSK as the distributed state evolves. In game theory, games of complete information assume players' strategies and payoffs as scaffolding, while games of perfect information take players' moves as CSK. In TITAN, the protocols and ontologies are designed into the TBSs as scaffolding, and the XML documents communicated are essentially coordination scripts. Given such coordination scripts, JMS messaging maintains CSK. (We characterize the common knowledge as shared by TBSs, but the commanders using the TBSs share in it as well. The analysis can focus on the TGBs because of the way communication is managed in modern warfare.) TITAN CSK is similar to common ground in conversation, but communication is scripted and has larger scope. What the literature on shared situation awareness often ignores is the simple but critical self-referential nature. Because of communication constraints, the workflow that directs the child TBSs uses proxy agents to represent the children. This implements a scaled-back version of what is called theory of mind (ToM) in developmental psychology, the ability to attribute mental states (beliefs, desires, intentions, etc.) to oneself and others and to understand that others have mental states different from one's own. With the appropriate scaffolding, ToM provides a mechanism for achieving CSK. ToM emphasizes differences, and in cooperation it is critical that these differences be common knowledge. Generally, the roles assigned to participants and their intentions are common knowledge that involves recognizing differences. We review our previous work showing how

the physical co-presence heuristic for CSK may be used for groups of artificial agents to attain common knowledge by perceptual means given an appropriate ToM. To focus on the episodic nature of co-presence evidence, we introduced into epistemic logic a modal operator for agent a seeing at time t that ? and provide time parameters for other operators. For TITAN, the threat of being overwhelmed with messages is met by a hierarchical organization and scripting that passes only relevant messages, and the full paper will consider the implications of hierarchy for common knowledge. (This topic relates to the notion of a holon, something that is both a part and a whole, and must address Simon's notion of near-decomposability.) Suppose G and H are the units comprising a larger unit GH (the members of GH are all and only the members of G and H). For G and H to coordinate as two separate units, it suffices that group G has the distributed knowledge required for the coordination and that group H likewise has this distributed knowledge. (A group has distributed knowledge that φ if its members can pool there knowledge and infer that φ.) That is, the required common knowledge may be distributed among the members of each group, and it need not be the case that the common knowledge required for GH coordination be common knowledge among the members of G and the members of H individually. A particularly simple case is where a representative of each group on its own has the common knowledge required for the intergroup coordination; such a representative is often, but not always, identified as the leader. In military hierarchies, a unit with subordinate units G and H usually has a headquarters group that overlaps with neither G nor H. In this case, coordination is actually required among three groups (with headquarters being a singleton group if it consists only of the unit commander). ToM in this context becomes a sociological notion.
pp. 251-258

A negotiated-text method for assessing situation awareness information requirements from emergency responders

Norman Groner (John Jay College of Criminal Justice, City University of New York, USA); Charles Jennings (John Jay College of Criminal Justice, City University of New York, USA); Amy Robinson (John Jay College of Criminal Justice, City University of New York, USA)

Role-specific situation awareness (SA) requirements analyses have the potential to significantly improve public safety agency responses during the ambiguous incipient stages of emergencies. The results of such analysis can be used to both (1) filter out information that is not goal-related, and (2) help people in other roles to understand how and why they should provide relevant information to first responders. SA information requirements need to be analyzed separately by roles and locales because findings often do not generalize across emergency scenarios, and because different locales allocate responsibilities differently. Given the number of analyses required, existing methods require prohibitive levels of expertise and resources. This project adapted existing approaches to create an easily deployed method that does not require technical human factors expertise. The method is based on a semi-structured negotiated text approach where informants review data as it is recorded by the interviewer. In our study, interviewers entered data into a shared display that shows a table with four levels of an easily understood goal hierarchy: (1) high level goals (strategies) pursued by persons in the role; (2) objectives (tactics) that are the means to achieve the goals; (3) actionable decisions that are used to achieve the objectives; and, (4) information needed to make those decisions. Because agency goals typically vary depending on scenarios, we collected data about three high-rise building scenarios (1) a reported fire; (2) a reported person who is hostile and potentially armed; and (3) an apparent release of a potentially toxic airborne contaminant somewhere inside or near the building. Data were obtained from representative of three first responder roles: firefighters, police officers and emergency medical technicians. Because data is collected using a structured data table, analysis of field notes or transcriptions is avoided and analysis only requires consolidation by roles and scenarios. The paper discusses advantages to using the approach in addition to its ease-of use. Negotiated text enhances trust between interviewers and informants because informants review and can modify data. Because the analysis reveals how required information is derived from explicit goals, trust between agencies can be enhanced, and the goal-basis of interface and protocol design can be improved. The study also revealed some important limitations. Subject matter experts need to be included in the data consolidation process to reveal possible errors of omission and commission. Finally, before the findings are sufficient to guide the design of interfaces and protocols, additional data collection and analysis is required to examine the sources and flow of required information during scenarios.
pp. 259-263

Avoiding High Impacts of Geospatial Events in Mission Critical and Emergency Networks using Linear and Swarm Optimization

M. Todd Gardner (University of Missouri, Kansas City & Federal Aviation Administration, USA); Cory Beard (University of Missouri-Kansas City, USA); Deep Medhi (University of Missouri-Kansas City, USA)

Geospatial events continue to plague both wireless and wireline communication networks. The immediate effect of a large scale geospatial event is generally complete or partial loss of situational awareness caused by a lack of communications and media availability in the affected area, effectively isolating many people affected. Significant challenges have been reported by emergency responders, victims, and other involved persons immediately following the recent U.S. tornados and the earthquakes worldwide. Riots and protests can also act as geospatial events that stress communications resources in a geographic area. This research develops novel optimization models to identify and mitigate geospatial vulnerabilities in network designs before they occur. We use an integer linear program (ILP) to add nodes that reduces geographic vulnerability thus preventing users from being isolated by geospatial events. To expand the scope to include more solutions and a wider range of objective functions, a swarm optimization approach was also developed. Wireless propagation models that include obstructions like buildings and other terrain features are tested with these models as well.
pp. 264-271

Coffee Break

Panel - Situation Awareness: Cognitive Architectures and Processes

Chair: Mieczyslaw Kokar (Northeastern University, USA)

Lunch (on your own)

S6 - Case Studies

Chair: Alice Mulvehill (Raytheon BBN Technologies, USA)

A Complex-Event-Processing Framework for Smart-Grid Management

Srivathsan Srinivasagopalan (Louisiana State University, USA); Supratik Mukhopadhyay (Louisiana State University, USA); Ramesh Bharadwaj (Naval Research Laboratory, USA)

Real-time detection and processing of both normal and abnormal event patterns in cyber-physical systems are imperative for advancing early warning and response capabilities. We integrate fundamental principles from logic-based program synthesis and multiagent systems to lay out the foundations of novel complex event processing (CEP) techniques and tools for intelligent reliable management of power systems. We investigate the formal underpinnings of a novel distributed, complex event-triggered, knowledge-based control system for situation-aware, provably-correct, declarative control of the logic of large power systems.
pp. 272-278

Dynamic Emergency Response Communication: The intelligent Deployable Augmented Wireless Gateway (iDAWG)

Janet Marsden (Syracuse University, USA); Joseph Treglia (Syracuse University & Madison County Office of the Sheriff, USA); Lee McKnight (Tufts University, USA)

Situation management has traditionally been based on iterative planning activities that call for a high level of coordination between multiple stakeholders: first responders, citizens, volunteers, subject matter experts, scientists, technicians and managers with different yet important responsibilities. In a crisis event existing systems and communications infrastructures may not provide necessary information in a timely fashion due to damage, incompatible media,

geographically limited coverage, fragmented technology or social and policy issues. The effective coordination of multiple response units/resources is stymied by incompatible communication technologies and social/policy incongruences. Crisis events are characterized by initial and ongoing uncertainty with regard to scale, location, direction and magnitude. More and better information sharing and cooperation is needed. The Intelligent Deployable Augmented Wireless Gateway (iDAWG) technology creates direct communication networks between remote coordinators, local response teams, volunteers and others on location by using or replacing existing communication or network infrastructures. Remotely sensed information and communications can be shared in real time via iDAWG-enabled devices that can be configured on the fly using edgeware (a new class of software developed for the wireless grid) applications. Existing web, cellular and radio communications network devices are bridged to build dynamically scalable heterogeneous wireless grids. Technical, social, governance and policy issues are addressed to facilitate this paradigm change in emergency response.
pp. 279-286

Situation Awareness Issues in Tactical Cognitive Radio

George Thomas (University of Louisiana at Lafayette, USA)

Cognitive radios (CR) are supposed to be capable of sensing their radio environment and adjusting their transmit/receive frequencies and other radio parameters intelligently. Software-defined radios (SDR) implement the radio functionality in software using a general-purpose digital signal processor and reloadable software. SDR has proven to be an ideal platform to implement CR applications. While the recently adopted IEEE 802.22 WRAN standard currently leads the civilian applications of CR technology, we point out that there are far more potentials and challenges for military applications of CR in the tactical arena. We consider the example of a team of soldiers who need to slip into enemy territory individually and make mutual contact using CR equipment by forming an ad hoc network. The situation awareness problem here is exacerbated by the likely lack of accurate knowledge of usage patterns of the radio spectrum in the alien territory. This is in sharp contrast with the civilian (e.g. 802.22) case where the frequencies and bandwidth allocations and user activity patterns in the bands of interest (e.g. VHF/UHF TV broadcast bands) are known in advance. The paper reviews the radio environment situation awareness issues in tactical military communications, points out specific problems, and proposes approaches to robust solutions for network establishment and management using CR technology in unknown radio environments. Recent results from simulation studies are presented.
pp. 287-293

A Granular Approach to the Automation of Bioregenerative Life Support Systems that Enhances Situation Awareness

Gregorio Drayer (Georgia Institute of Technology & Fulbright and Sam Nunn Fellow, USA); Ayanna Howard (Georgia Institute of Technology, USA)

Bioregenerative life support systems introduce novel challenges for the development of model-based approaches to their control given the varying characteristic of the biological processes that constitute them. Switching control paradigms provide an alternative to manage such uncertainty by allowing flexibility into the control path, enabling different control modes depending on the situation of the system. This paper presents a perception-based approach that combines sensor information to define those conditions and act upon them. Combined sensor information creates sensing spaces in which the operational conditions of the system are found. The decomposition of the sensing spaces into perceptual elements or granules allows for situation assessment, system integration strategies, and the implementation of fail-safe and fail-operational mechanisms - all these critical in a wider range of complex socio-technical systems. This paper proposes the use of intelligent agents based on fuzzy associative memories (FAM's) to decompose sensing spaces into granular structures composed of n-dimensional non-interactive fuzzy sets. Granular structures resulting from such decomposition allow for the incremental development and automation of the system by associating a control task to each operational condition. Furthermore, the real-time information obtained from the membership value of the granules may provide a resource for situational awareness and for the design of new ecological interfaces to enhance human-system interaction and real-time decision making. The approach presented in this paper is applied to the dynamic model of a reconfigurable aquatic habitat that serves as a small-scale bioregenerative test bed for life support control research. Results show how information generated by the FAM enhances the situation observability of the system.
pp. 294-300

Coffee Break

S7 - Formal Methods for Situation Management

Chair: Peeter Lorents (Cooperative Cyber Defence Centre of Excellence & Estonian Business School, Chair of Information Technology, Estonia)

Decision-support systems for situation management and communication through the language of algebraic systems

Erika Matsak (Tallinn University, Institute of Informatics, Estonia); Peeter Lorents ((NATO) Cooperative Cyber Defence Centre of Excellence, Estonia)

Decision-support systems for situation management and communication through the language of predicate calculus Let us consider the situations and developments, where decision making process must be very quick and must be based on a very large amount of information. This is important, for example, in the case of certain kinds of major natural disasters, but even more in the case of attacks in cyber space (Lorents, Ottis 2010). We need the support of artificial intelligent systems for such situations. The right decisions require logically correct deductive tools (Gentzen 1936, Takeuti 1975, Maslov 1987). For implementation of such deductive tools, the existing, possible and plausible descriptions of situations must be "translated" into logical formulas. (Barwise 1989, Ye, Coyle, Dobson, Nixon 2008, Jakobson 2011, Lorents, Matsak 2011). The following problems are related to the creation of expected artificial intelligent systems: ? How to transform the texts created by humans (natural language text) to logical formulas (Matsak 2010) ? What kind of tools are technically suitable for implementation of the deductive process (Matsak, Lorents 2010, 2011) ? How to transform any logical formulas to human-understandable text (to natural language) ? How to make the text created by any user understandable for the users speaking in other languages ? How to create the possibility to simultaneously use a number of different human languages in the system One way for the development of the above mentioned systems is by creating the so-called constrained language fragments, which are based on the types of situations, and linking them to the suitable predicate calculus language, (Yang, Read, Miller 2005). The following scheme is considered in the present paper: [type of situation ? time-dependent algebraic system ? suitable predicate-calculus constructs] ? [(constrained language A) ? (predicate language P) ? (constrained language B)]. Simple calculations show that by implementing such an approach the workload can be multiple times lower in comparison to the useof "full translating" (where the translation between languages A and B is done in the traditional way). It is important to note, that the constrained language suggested in the present paper is richer in the sense of language and logic than language used in many classical solutions (eg Prolog). The reliability of systems is the most important question when creating artificial intelligent systems. The necessary mathematical constructs, which allow the relation between the notation and denotation of different languages, are given in the current work. One of the contribution of this paper is the presentation of the principles of design of a semantic Multilanguage framework and possibilities of its implementation in artificial intelligent systems that use the deductive process. Such systems are particularly necessary in cases of situation management, where the amount of information and required speed are out of human's brain "power". References Barwise J. (1989). "The Situation in Logic". CSLI Lectures Notes Nr 17. Jakobson G. (2011). Extending Situation Modeling with Inference of Plausible Future Cyber Situations. The 1st IEEE Conference on Cognitive Methods in Situation Awareness and Decision Support (CogSIMA 2011). Miami Beach, FL. Gentzen G. (1936). Untersuchungen über das logische Schliesen. I, II. Mathematische Zeitrschrift, B.39. 176-210, 405-443. Lorents P., Ottis R. (2010). „Knowledge Based Framework for Cyber Weapons and Conflict." Conference on Cyber Conflict. Proceedings. June 16th - 18. 2010. Tallinn, Estonia. CCD COE Publications. p. 129 - 142. Maslov, S. (1987). Theory of Deductive Systems and its Applications. The MIT Press. Matsak E., Lorents P. (2010). Digital solutions for inference rules in decision-supporting systems. Fifth International Conference on Digital Information Management. Thundar Bay, Canada: IEEE, 2010. Matsak, E (2010). Discovering Logical Constructs from Estonian Children Language. Germany: Lambert Academic Publishing Matsak, E., Lorents, P. (2011). Knowledge in Digital Decision Support System. HCI International 2011, Orlando, Florida, USA. Lecture Notes in Computer Science, 2011, Volume 6768/2011, 263-271, Springer. Ottis, R., Lorents, P. (2010). Cyberspace: Definition and Implications. Proceedings of the 5th International Conference on Information Warfare and Security. ICIW 2010. Dayton, US, 8-9 April. Takeuti G. (1975). Proof Theory. North-Holland Publishing Company. Amstardam, London. Ye J., Coyle L., Dobson S., Nixon P. (2008) Representing and Manipulating Situation Hierarchies using Situation Lattices Revue d'Intelligence

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pp. 301-307

Supporting Threat Analysis Through Description Logic Reasoning

Jean Roy (DRDC, Defence Research and Development, Canada); Alexandre Bergeron Guyard (Defence R&D Canada − Valcartier, Canada)

Whether it is in the military or public security domain, threat analysis plays a key role generally acknowledged to be of an ever-increasing importance in this unstable, insecure and asymmetric world. It is also recognized that experienced operators and intelligence analysts do have some significant know-how about detecting and categorizing all sorts of threats; unfortunately however, they are often overwhelmed. In recent years, a number of research activities have been conducted at Defence R&D Canada - Valcartier aiming at capturing this valuable threat analysis expertise and using it in computer-based tools capable of handling the huge amount of data and information provided by the wide variety of sources available, thereby reducing the cognitive overload of the operators/analysts. In particular, knowledge-based system technologies have been investigated. Different knowledge representation paradigms (e.g., if-then rules, situation cases, and description logic) have been explored and used to encode the operators/analysts expertise and make it exploitable in a variety of automated reasoning software components. As part of these research efforts, this paper describes a proof-of-concept prototype of an automated reasoning service exploiting ontologies expressed in description logic to support the intelligence staff in detecting and categorizing threats. The development of such ontologies, here making use of the features of the OWL DL web ontology language, is first discussed. Then, the main aspects of automated reasoning with description logic (e.g., classification and realization) are presented, along with a discussion about reasoning within the framework of an ontology of entities (or subjects) with characteristics and facts. How the class equivalence mechanism can be used to infer the characteristics of a subject based on either facts about this subject or some other characteristics of this subject is considered, and the inference of relationships between subjects through the composition of several object properties involving intermediate individuals is discussed. The paper then switches to the application of these notions to the threat analysis domain. The key concepts of this domain (e.g., intent, capability, opportunity, behaviour, consequences, etc.) are discussed, and the threat analysis ontology and reasoning framework (actually composed of multiple interrelated sub-ontologies) are presented, along with a practical reasoning example. Finally, the description logic reasoning service exploiting the threat analysis ontology is briefly presented. This service has been developed, while rigorously adhering to the principles of service-oriented architectures, as a component of a multi-reasoner inference system.
pp. 308-315

SSC Pacific, Experimentation and Transition of the Personalized Assistant that Learns

Doug Lange (Space and Naval Warfare Systems Center - Pacific, USA)

Paper describes activities conducted at SSC Pacific on intelligent personalized assistant systems

Conference Banquet

Breakfast

Keynote by Joe Mitola, Distinguished Professor, School of Engineering and Science, School of Systems and Enterprises, Stevens Institute of Technology- "A Vision for Cognitive Radio in Situation Management"

Chair: Mieczyslaw Kokar (Northeastern University, USA)

A Vision for Cognitive Radio in Situation Management

Joseph Mitola (Stevens Institute of Technology, USA)

Common to the systems pf interest to the CogSIMA community is the need to adequately perceive, reflect and act according to the situational changes happening both in the surrounding world and within the systems themselves. Cognitive radio (CR) was founded as a cognitive

situation management system for radio. In its first decade CR has generated technologies for network-based RF situation awareness (SA) and response called dynamic spectrum access (DSA). Leveraging RF sensing technology developed for DSA, RF could contribute significantly to human-machine situation management, especially in stressful situations such as large scale first responder use cases where the presence of RF transmitters may indicate the presence of victims (cell phone under rubble), bystanders with applicable skills, and a diversity of responder capabilities in RF, computing, equipment, and skills. RFSA could assist future first responders in overcoming physical impediments to awareness such as smoke and rubble, could assist in the discovery of paths for access to survivors, could assist in determining the availability of specialized equipment, and could provide and real-time planning and coordination needed to get the right equipment to the right survivors optimally, which is an NP-Hard problem. Other significant use cases include elder car and agriculture. Ultimately, the user should become the 8th layer of the protocol stack via rich computational models of physical and information capabilities along with robots and the Internet of Things. This talk shares a vision of the social benefits of such evolution of a system of systems of CogSIMA, promoting interdisciplinary dialog among cognitive radio, mission planning, electronics standards, network management, and RF location awareness communities.

S8 - Situation Awareness and Decision Support III

Chair: Nuka Nwiabu (Robert Gordon University, United Kingdom)

INFUSION: A System for Situation and Threat Assessment in Current and Foreseen Scenarios
Giusj Digioia (Università degli Studi Roma Tre & Engineering - Ingegneria Informatica, Italy); Stefano Panzieri (Università degli Studi Roma Tre, Italy)
This paper describes INFUSION, a system for the evaluation of situations and threats in simulated military scenarios and for scenario projection, in order to support the decision making process in strategic and tactical context. The system deals with fuzzy variables that model information acquired from the on-going scenario; it adopts the Evidence Theory approach to fuse information and classify situations; moreover, it evaluates threats measuring the risk of on-going situations on the items of interest. INFUSION is able to foresee possible future scenarios, through the projection of the item of the simulated scenario to a desired time or position. Trajectory projection of items depends on their intent, estimated through the Bayesian approach. INFUSION has been tested on different terrestrial scenarios where the situations of encirclement, collision and engagement have been simulated. Considerations on operative results and future works are also reported.
pp. 316-323

Acceptance of Automatic Situation Assessment in Surveillance Systems
Yvonne Fischer (Karlsruhe Institute of Technology (KIT), Germany); Jürgen Beyerer (Fraunhofer IOSB, Germany)
In today's surveillance systems, there is a need for enhancing the situation awareness of an operator. Supporting the situation assessment process can be done by extending the system with a module for automatic interpretation of the observed environment. In this article we introduce a consistent terminology for the domain of intelligent surveillance systems. We clarify the separation of the real world and the world model, which is used for the internal representation in the system. For the definition of an automatic situation assessment module, we make use of an existing conceptual framework. We will further introduce a concept for an internal representation of situations of interest and show how the existence of such situations can be inferred from sensor observations. Based on these considerations, an automatic situation assessment module for a maritime surveillance system was developed. The module was evaluated with a small user group and the results show that such an automatic support reduces the workload of the user and is highly accepted.
pp. 324-331

User Interface Design for Situation-aware Decision Support Systems
Nuka Nwiabu (Robert Gordon University, United Kingdom); Ian Allison (Robert Gordon University, United Kingdom); Patrik Holt (Robert Gordon University, United Kingdom); Peter Lowit (Robert Gordon University, United Kingdom); Babs Oyeneyin (Robert Gordon University, United Kingdom)

Information recall about general situations incurs memory and cognitive loads on operators. Recognition of information for specific situations identified with users' context and the state of the world is helpful to operators in performing tasks in complex environments. The emergence of ubiquitous, ambient, and pervasive technologies is increasingly providing methods to help operators to perform their tasks in smart and intelligent ways. Existing user interface design does not solve the problem of drawing together the information required for situation-aware decision support systems in a way that minimises cognitive loads. This paper discusses a framework for user interface design of situation-aware systems that exploit inputs from users and the environment to provide information tailored to the users tasks in specific situations. The user interface has the ability to execute reconfiguration after input variation so as to stay adapted to the current situation. The adaptation of the user interface to the current situation and the presentation of a reusable sequence of tasks in the situation reduces memory loads on operators. Hierarchical Task Analysis (HTA) is used to describe tasks for various types of situations. HTA is supplemented with scenarios to stimulate design ideas and requirements analysis is used to represent interrelationships between tasks.
pp. 332-339

Coffee Break

Panel: Organizational Cognition as a Strategic Competitive Advantage

Chair: Ali Mostashari (Stevens Institute of Technology, USA)