Cognitive Situation Awareness for Information Superiority

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ABSTRACT

We present a summary of the drawbacks and deficiencies that we noticed in the currently available Command Support Systems (CSS) and the methodology we propose to improve them: Situation Awareness support through Cognitive Fusion of Information stemmed out of document analysis. Our approach is divided into two parts: a methodology for situation representation out of document analysis and a methodology for situation analysis and reasoning to support decision-making. The situation representation part is based on the use of conceptual graphs and fusion of nodes in graph structures, whereas the situation analysis part follows Complex Event Processing methodology.

1.0 INTRODUCTION

In current information systems, a large amount of data is available for giving clues about a situation and its evolution. Furthermore, as these data stem from different sources, the vision they give is more global and is made up of several points of view of the situation. Being aware of all these information sources is a big benefit for the operator in charge of making decisions because the situation is then more fully described. In the meantime, it is also a major drawback because such an amount of data to analyse induces cognitive overload and thus errors in perception, comprehension and projection.

Good decision necessitates a clear vision of the ongoing situation, so an efficient Command Support System should provide it as well as cognitive function to support decision-making.

In this paper, we present a summary of the drawbacks and deficiencies that we noticed in the currently available Command Support Systems (CSS) and the approach we propose to improve them. The first section presents the notion of information superiority, as well as the limitations of the state of the art CSS and our vision to solve them.

In the second section, we give a general presentation of our approach to Cognitive Information Fusion for Command Support Systems[1]. This approach is divided into two parts: a methodology for situation representation out of document analysis, which is described in more details in the third section, and a methodology for situation analysis and reasoning to support decision-making, described in the fourth section. We then conclude and briefly introduce our future works.

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2.0 COMMAND SUPPORT SYSTEMS: STATE OF THE ART

2.1 Information Superiority: A new challenge for Command Support Systems

The aim of a Command Support System (CSS) is to support decision-making by providing the Commander with an edge over knowledge. To reach that objective, one of the main challenges is to make the operator and CSS pair more efficient at the lowest possible cost by providing core Information Superiority[2] functions such as Situation Awareness (SAW), Common Relevant Operative Picture (CROP) or Common Operational Picture (COP). We claim that one of the key issues is to build a good situation understanding based on a context sensitive information interpretation and through a well-constructed situation representation.

The understanding of the situation gains from the total sum of relevant information provided to make a correct decision-making regarding the allocated objectives and/or the desired state. Further more, a large amount of different information sources such as textual or radio messages, raw data radar, images and optical images are now available in order to give clues about an ongoing situation.

The result of this variety of information sources causes information inundation. The deficiency of, or errors in, situation understanding are important reducing factors to information superiority, potentially provoking decision-making errors which could have been avoided if operators had correctly analysed the situation in time. Such errors occur in the following levels: [1][2]

- Perception: A person may wrongly *perceive* task-relevant information or not perceive it at all. Contributing factors are related signal characteristics, perception strategies in complex environments or faulty expectations.
- Comprehension: A person may wrongly *interpret* perceived information. Contributing factors are misuse or non-existence of proper mental models of the environment.
- Projection: A person may wrongly predict a future status, in the case of a good mental model but memory limitations for instance.

Errors may also occur due to information overload. For instance, an operator in a stressful context may focus on a piece of non-significant or incomplete information and not on the relevant information.

Therefore, given an objective and to obtain a well constructed situation representation, one needs, at first, to extract relevant information items among the large amount of incoming information. These items have then to be grouped in order to obtain a synthetic view of the ongoing situation.

The challenge of an automated construction of relevant SAW is to enhance operators' capabilities in achieving information superiority needed to dominate modern warfare. Meeting this challenge would allow CSS to be more efficient through the reduction of the time needed to construct a good situation awareness, as well as a reduction of information overflow to the operator. To do so, we have to construct a good model for representing the operator's mental analysis process in order to reach the quality requirements for this automatic construction of the situation representation, including heterogeneous information fusion.

[2] The concept of Information Superiority is defined by the CJCS (Chairman, Joint Chiefs of Staff) in Joint Vision 2020 (U.S. DoD) as “the capability to collect, process, and disseminate an uninterrupted flow of information while exploiting or denying an adversary’s ability to do the same.”

2.2 Limitation of Current Command Support Systems

More and more information is spread across a variety of channels, in a range of structured formats (signal, image, database, GIS) and unstructured formats (text, speech, video). But often the vital pieces of information are also spread across several formats, and must be combined in accordance with (i) the final goal of situation awareness, (ii) their reliability and relevance, (iii) the semantics of these formatted pieces of information, in order to get the complete set of information desired at the right time. Up to now, each format has been processed on the basis of appropriate and distinct theories. Moreover, there is a deficiency of a sound theoretical but computational framework for modelling the understanding of the situation and for integrating disparate relevant sources of information in order to support the ongoing phenomena analysis and to avoid cognitive overload.

No model is available to support an in-depth understanding of the situation in order to assist with decision-making in complex situations. Furthermore, due to limitations of information coming from a single source (uncertainty, missing observations, etc), there is a lot to gain by integrating and fusing multi-source information.

2.2.1 Deficiency of semiotic cognitive information processing for situation understanding

A good representation of the situation needs to capture a number of aspects of the situation: the essential entities, their organizational and spatial structures, and the possible actions that can be taken to affect internal states and external environments. "Gestalt principles" and "Situation Theory" model individuals, properties, relations, spatio-temporal locations, and situations.

Gestalt theory [3] arose in 1890 as a reaction to the prevalent psychological theory of the time - atomism. Atomism examined parts of things with the idea that these parts could then be put back together to make wholes. Unlike atomists, Gestalt theorists were intrigued by the way our mind perceives wholes out of incomplete elements. The main vision of the Gestalt theory is that things are "more than the sum of their parts" [4]. Gestaltists believed that context is very important in perception and therefore in understanding a situation. Gestalt theory is widely studied in the Human-computer interaction community.

Situation theory is a mathematical theory of meaning [5]. According to the theory, individuals, properties, relations, spatio-temporal locations, and situations are the basic ingredients. The world is viewed as a collection of objects, sets of objects, properties, and relations. Individuals are conceived as invariants; having properties and standing in relations, they persist in time and space. Objects are the parts of individuals. (Words are also objects, i.e., invariants across utterances.) All individuals, including spatio-temporal locations, have properties (like being fragile or red) and stand in relations to one another (like being earlier, being under).

The earliest formal notion of situation was introduced by Barwise in [6] as a means of giving more realistic formal semantics for speech acts than what was then available. In contrast with a "world" which determines the value of every proposition, a situation corresponds to the limited parts of reality we perceive, reason about, and live in. With limited information, a situation can provide answers to some but not all questions induced by the decision problem.

Situation Semantics is a semantic framework in which basic properties, relations, events and even situations are reified (i.e., made concrete) as objects to be reasoned about [7]: "One of the starting points for situation semantics was the promotion of real situations from second class citizens to first class citizens. By a situation, then, we mean a part of reality that can be comprehended as a whole in its own right - one that interacts with other things. By interacting with other things we mean that they have properties or relate to other things." Note that once a situation is made into a concrete object, various properties can be associated with the situation. That is to say that the objects may be complex, incorporating both other objects as well as their properties and relations among the objects. It can even include other situations. While Barwise's situation semantics is only one of the many alternative semantic frameworks currently available, its basic themes have been incorporated into most others.

In Situation Semantics invariants and uniformities across situations are highlighted, allowing the formation of particular views of reality: a flow of types of situations related by uniformities like e.g. individuals, relations, and time-space-locations. These uniformities constrain a system's external world to become its view of reality as a specific fragment of persistent (and remembered) courses of events whose expectability renders them interpretable.

According to Situation Semantics [8], any language expression is tied to reality in two ways: by the discourse situation allowing an expression's meaning to be interpreted and by the described situation allowing its interpretation to be evaluated truth-functionally. Our aim is to extend this assertion from any language expression to any high level piece of information.

SAW plays a central role in cognition, which spans the entire spectrum of cognitive activities, from situation analysis (perception + comprehension) to near future forecast. All of these processes (perception, identification, and interpretation of external structures) are considered information processing which (natural or artificial) systems are able (or unable) to perform. Human beings appear to be very particular information processing systems whose outstanding plasticity and capability to cope with changing situational conditions is essentially tied to their use of natural languages in communication to acquire knowledge. Their knowledge based processing of information makes them cognitive, and their sign and symbol generation, manipulation, and understanding capabilities render them semiotic.

Semiotics is the general theory of signs. It can be broadly defined as a domain of investigation that explores the nature and function of signs as well as the systems and processes underlying signification, expression, representation, and communication. "Semiotic Cognitive Information Processing (SCIP) is inspired by information systems theory according to which living systems process and structure environmental data according to their own structuredness." [8]. The interest of SCIP is the study of cognitive foundations of sign organization and manipulation processes. The main domain for the application of semiotic cognitive information processing is currently restricted to natural language.

2.2.2 Deficiency of current information fusion technology

Information Fusion encompasses the theory, techniques and tools conceived and employed for exploiting the synergy in the information acquired from multiple sources (sensors, databases, information gathered by humans, etc.) such that the resulting decision making or action is in some sense better then (qualitatively or quantitatively, in terms of accuracy, robustness, etc.) than would be possible if any of these sources were used individually without such synergy exploitation.

The field of information fusion is a multidisciplinary research area and overlaps with a number of other areas that have their own, partly overlapping, research and development communities: cognitive sciences, mathematics and computer sciences. Over the years, a lot of fusion models have been proposed. However, no model has become as influential in data fusion as the Joint Directors of Laboratories (JDL) or the Waterfall fusion model. However, while the JDL data fusion model provides a methodology for organization of research in fusion [10], it doesn't provide an architectural framework for design of systems, or model it from a cognitive perspective.

In [1] and [11], Endsley provides an alternative to the JDL model that addresses SAW from this viewpoint (i.e. Mental Model). This model is defined as "the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future".

Current fusion methods are built around the hypothesis of a "closed world". This hypothesis is a modelling simplification but it does not reflect the real world. Future command support systems will have to cope with missions with low background intelligence and little knowledge about the behaviour of the adversary. Therefore, keeping this closed world hypothesis imposes on designers the need to create or constantly modify the models used for SAW [12].

Information fusion has also been studied from a high-level cognitive point of view in the logic-based artificial intelligence community. The focus is then on the fusion and merging of several sources of knowledge, taking the various possible epistemological role of information into account (knowledge, beliefs, goals, plans, uncertain data etc.)

Kokar, in [13], argues that it is a much more difficult problem to automatically construct a good human-oriented representation of a situation (SAW) than to achieve situation assessment as it is described in the Level 2 of the JDL data fusion model, because, SAW is not only knowing objects but also relations between them. Therefore, the four main difficulties are the assessment of the relations, their relevance, the complexity of their derivation algorithms and, the uncertainty dimension of these objects and their relations.

In spite of significant progress in research on information fusion, there is still a deficiency of a unified theoretical framework and a human-oriented modelling approach for information fusion. This is a major impediment to the development, evaluation, comparison or reuse of fusion technology and systems in CSS.

2.3 Our Vision

We claim that a CSS can relax the cognitive overload and construct the current situation in a comprehensible way, based on a situation model and a generalized information fusion engine. Our vision relies on two strategic foundations:

- **Model user perception:** dealing with cognitive overload requires a model of the user's cognitive situation in terms of a situation model which enables the semantic interpretation of each type of information. The situation model can be seen as a unified semantic universal model supporting the understanding process of types of information with distinct initial semantics. The key idea is to generalize the notion of context in natural language understanding to all other types of information.

  Based on the Gestalt theory, our aim is to analyse the notions of perceptive items, grouping and good form in the information synergy domain. The idea is to apply the Gestalt theory to information synergy by extending or redefining the laws that have been defined for visual perception (and particularly proximity, similarity and continuity laws) to the perception of any kind of information. This will allow us to build a picture of what is understood by the individuals. Based on that picture, we believe that efficient information synergy construction will be possible because individual needs and perception will be taken into account.

  As Situation Semantics argues that it is sufficient and fruitful to start with partial description or partial information, we propose to adapt the models developed in Situation Semantics approach to our purpose: to represent a reality described through several heterogeneous pieces of information, stemming from diverse sources with different trust and precision levels.

  We will also study the extension of SCIP from natural language based information (texts, speech) to any type of information.

- **Revisit information fusion methods and Generalise information fusion mechanisms**: relevant information fusion will be revisited along two dimensions: the systematic account of situation model as provided above, and a systematic investigation (existing gaps in the efficiency of the method and identification of solutions) of the relevance for other types of information. Finally, the revisited fusion methods will be merged into a single theoretical framework. This framework will formalize all the previously identified fusion methods and will be extended to all other types of information.

  An information fusion engine will carefully combine the relevant fusion approaches for several information sources (e.g. text and audio, text and image...) in order to construct a comprehensible situation for the user.

Our aim is to render a relevant but comprehensive situation awareness picture supported by cognitive information fusion. To address that goal, the very substance is deeply rooted in "Situation Semantic theory", in SCIP and in "fusion". Before being able to fuse information coming from heterogeneous sources, it is necessary to define a unified information frame.

Some challenges of Information Fusion for CSS are to transform the raw, imprecise, conflicting and often paradoxical information received from the different sources into statements understandable by both man and machines, the ability to adapt efficiently to changing environmental conditions, learning how to anticipate possible changes in its environment is inescapable. Combining the semiotic with the cognitive paradigm, will allow us to define information perception and comprehension models for a SAW system in which the user will be able to browse without cognitive overload.

Semiotic cognitive information processing where dispersed information coming from discrete sources are analysed through cognitive prisms and correlated to provide the right information at the right time should support the system. The goal is, thus, to establish a process of multi-source information fusion, where a qualitatively new meaning is assigned to the fused data.

3.0 PROPOSED APPROACH

3.1 Terminology

For a matter of comprehension, we define here several of the terms that we will use in the following sections of this paper.

- **Domain**: The domain is the operational context, which defines the point of view to apply on the raw data. It gives the *significance* of the activity. The domain knowledge is the amount of information that is known by the operator.
- **Situation**: The situation is the whole set of events and their actors that are happening on a field of observation. The situation can be **expected**, that is to say that it hasn't been observed yet, but a set of events are expected to happen on the field of observation. In this case, we call this situation **sought-after situation** or **abstract situation**. The abstract situation is somehow the formal description of specific domain knowledge. On the contrary, a situation can be **observed**.
- **Mission**: The mission of an operator is the task that has been assigned to him. In our domain, it is comprised the observation of the field of action, making deductions and projections into the future, applying strategy rules and to making decisions.
- **Observation:** An observation is a small part of a situation that has been "seen". In our case, an observation is the result of the analysis of an input document, such as a description of entities on the field of action, a radio recording etc. Several different observations can correspond to a single event or entity as observations are subjective.

3.2 Hypothesis

Our approach concentrates on document analysis for situation comprehension and, more particularly, on the fusion process of information extracted from several documents in order to build a clear vision of an ongoing situation. Therefore, we suppose that documents have been filtered in a previous step. This filtering step is supposed error free, so that all documents arriving to our system are relevant to the operator's mission and have to be analysed in detail.

Because of its genericity, our approach will allow the inclusion of any type of document in the analysis process, but in our first study, we will concentrate on textual news or image description and phone or radio tapping. These restrictions are due to the availability of information extraction systems. The information extraction systems that we work with are able to process textual and audio documents only.

3.3 Information flow and situation analysis

In this section, we briefly present the flow of information in our system as well as the different steps of the analysis. Figure 1 summaries this information flow as well as the processes applied on it.

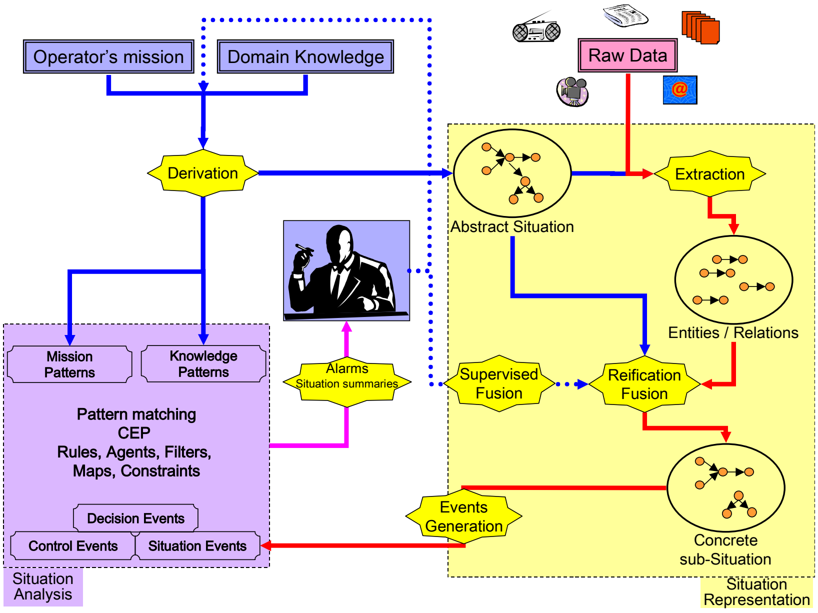

Figure 1: Information Flow

Our approach relies on two separate blocks of processes: the Situation Representation and the Situation Analysis. The inputs for these processes are the operator's mission, the domain knowledge and the incoming row data stemming from the available captors. We choose to separate the two blocks of processes because of the difference in their nature (one processes static information, while the other one takes dynamic aspects into account) and their complementarities.

In the Situation Representation part, the ongoing situation is understood at any moment through the analysis of incoming information. A picture of the ongoing situation is built which doesn't take into account the dynamic vision of the situation nor is any inference made to plan a possible future state of the situation. To build this picture, relevant information is extracted from the input data, on the basis of what has been defined as relevant regarding the static elements of the operator's mission and the domain knowledge. The relevant information is expressed through entities representing actors and events and relations among them. As it is not the main object of our paper, the extraction process won't be detailed in the following sections. We will only focus on the structure that we have chosen to represent domain knowledge and the sought-after situation.

The second process occurring for Situation Representation is a reification and fusion process. The extracted information is aggregated into a common structure, representing the ongoing situation. The aggregation is realised based on a reification of the Abstract Situation thanks to observations (i.e. entities and relations) extracted from incoming data. That fusion could be needed between partial observations in order to instantiate the abstract situation. The result of this process is the representation of the ongoing situation (Concrete Situation), given the observations available through the input document analysis. The structure used in this step is based upon the one used to describe the expected situation (Abstract Situation) and is a semantic graph, partially instantiated.

The Situation Analysis part focuses on understanding the dynamic of the ongoing situation. This analysing part is based on the study of the dynamic aspects of the operator's mission, regarding the different pictures of the situation build by the Situation Representation part and their temporal relations.

Once the situation is represented, reasoning upon it can take place. We use the Complex Event Processing (CEP) approach to realize this step of the analysis. Based on the representation of the situation of the previous step, events corresponding to the current state of the situation are generated and sent to the reasoning module. During the reasoning step, changes to the graph representing the situation can be proposed to the operator. Indeed, the reasoning engine can detect changes in the situation (due to temporal aspects for instance) or unlinked elements that belong to the same event (proposition of fusion of events). It can even create new knowledge based on business reasoning rules for instance.

4.0 SITUATION REPRESENTATION

4.1 From raw data to entities

Our work will concentrate on the representation of a situation and its analysis. In order to execute these two processes, a first step is necessary: the extraction of entities and relations among entities from the input information sources. The entities and relations that are to be extracted from the source documents are actors and events of the observed situation as well as the relations amongst them.

This step of identification and extraction of actors and events can be either done manually, or semi-automatically with systems such as Sem+ [14] for entities and relations extraction from textual corpus. Sem+ allows the operators to express relations they are looking for through examples of utterances expressing the sought-after relations. The examples are then processed by the system in order to define patterns of the required relations. The patterns are then used on the input corpus and relations are extracted. Our work focuses on the processes that follow the extraction step.

4.2 Abstract description of the situation

Gestaltist principles of perception rely on the idea that context is very important in perception and thus in the way our mind interprets observations to elaborate a picture of the whole underlying situation. What makes someone able to build complete and complex situations, out of a set of partial observations of these situations, is the fact that the complete situations are somehow familiar. Therefore, typical patterns, such as known relations between entities, can be observed and recognized and from then on a human mind creates representations of the missing elements of the situation, even if they can't be observed, in order to build an internal picture of the whole situation and reason about it. This process explains how decisions can be taken even in situations where all the single elements are not known, provided that the operators are well experienced and thus know exactly what they are looking for, when observing a field of action.

As we want to provide cognitive functions to CSS, we propose to follow and apply Gestalt principles to situation perception. The observed situation has therefore to become somehow familiar to the CSS. Therefore, we propose to explicitly define the typical features of the business domain and of the sought-after situation. Whenever these features, or a subset of them, will be observed (i.e. extracted from input documents), we will suppose that the situation has been found (with a degree of certainty that will depend on observations, their reliability and the proportion of observed elements among all the sought-after elements). Inferences will then be allowed according to the possible evolutions in time and space of the situation, and thus help will be provided to the operator in order to make decisions.

On the contrary, if incoherent elements related to a situation that was supposed to be recognised are detected (observed), automatic analysis of them will emphasize the inconsistencies and will then thwart cognitive and human analysis of the situation, allowing operators to review the previous analysis and inferences in order to detect a change in the situation as soon as possible. We believe that automatic and mechanic analysis of the situation has to be closely linked to human and cognitive reasoning in order to avoid errors in perception and comprehension levels by rising alerts when both analysis don't match anymore. Cognitive capabilities of humans have to be supported by large set of data processing capabilities of automatic information systems. There must be collaboration between the two, hence cognitive functionalities have to be integrated in the CSS.

To describe the domain knowledge, or as we called it before, the sought-after situation, we choose to use a conceptual graph. The nodes of the graph will describe the actors and events of the situation and relations that can exist between them will link them to each other. The sought-after situation will be an abstract graph: the nodes of the graph won't be concrete instances of actors and events but will be labelled with their conceptual types. The relations, as for them, are conceptual relations such as composition, part-of, etc.

4.3 Instantiation of the situation

Once the abstract situation is defined, observations made through the analysis of input documents will be used to build a (partially) concrete one. This concrete situation is mainly the observed situation but inferred elements can also be included, as we will see in the following section. The first step to be realised in order to instantiate the situation is to collect all the entities and relations extracted from the analysed input document and identify the nodes to which it must be linked. The result of this operation is a collection of instantiated pieces of graph, representing a collection of observations of the situation.

Once the collection of pieces of graph are available they will be analysed, regarding on the one hand, the abstract situation and, on the other hand, the distance calculated between the different nodes, in order to process to a fusion step. The observations (pieces of nodes) and the abstract situation will be gathered together so to build a whole (partially un-instantiated) picture of the complete situation. The different parts of the graph are weighted according to the trust accorded to the different sources of information that provided the related observation.

The construction of the pieces of graph representing the observations, as well as the fusion of two pieces of graph into a single one can require mechanisms to solve reference problem. These reference problems can occur while analysing a single document (e.g. several paragraphs of one text) but also between several documents dealing with a single object. We will use cognitive mechanisms to solve this sort of problem. The salience of the observed facts, for instance, will allow us to solve some of the reference problems. More generally, reference resolution methods exist for dialog analysis, which are based upon natural language analysis. We plan to extend and modify them if needed to resolve reference between several sources of information.

5.0 SITUATION ANALYSIS

Whereas the previous sections presented our approach to static situation representation (i.e. a picture of the situation at a given moment), our aim is to allow our system to reason about a dynamic situation given a specific mission, in order to make decision. Therefore, subjectivity and mission specificities have to be taken into account. Moreover, the mission of an operator is specific and expressed through business rules (for instance strategy rules, deductions that can be made given a set of observations and temporal development...). It is very different, in structure and in meaning from general knowledge of the domain that is used to express the sought-after situation. The use of the same graph structure as the one used to build the picture of the situation for representing this reasoning knowledge is thus, in our opinion not appropriate. We propose to use a reasoning module based on mission-specific rules and events observed and thus induced by the situation representation and are specific to the operator's mission.

5.1 Analysing the situation

To manage situation analysis, we propose to follow the Complex Event Processing (CEP) approach [15].

CEP is a set of techniques and tools to help operators understand and control event driven information systems. The goal of CEP is to enable the information contained in the events flowing through an information system to be discovered, understood in terms of its impact on high-level management goals and business processes and acted upon in real time. CEP employs techniques such as detection of complex patterns of many events, events correlation and abstraction, event hierarchies, and relationships between events such as causality, membership and timing ordering.

As we derive an abstract situation graph, we define some mission and knowledge patterns, which set alarms on when events situation match them. It is as an inference rules base engine but not a classical one. It takes into account the dynamic aspect of a situation (through the continuous flow of events) and the life time duration of an event.

The analysis of the ongoing situation will allow the system to automatically raise alerts when some inconsistency is detected, or when a strategic business rule has to be applied. The picture of the situation (situation representation) will also be enriched according to deduction made by the reasoning module. In this case, if knowledge is added in the situation representation, a typical level of confidence will be used in order to quote this new knowledge as being inferred and not observed.

5.2 Typology of events for situation analysis

Mission and knowledge patterns

The mission patterns are the events aggregation to match describing the mission of the operator, as well as the state of accomplishment of this mission. These patterns are for instance business rules that the operator applies in order to make decisions or infer the future state of the situation. Mission patterns can be strategy rules for instance. The knowledge patterns are the same but derived from the domain knowledge. Some patterns can be the result of both mission and domain knowledge.

The situation analysis consists in matching these patterns with situation and control events, and then provides decision events (which can be re-injected in the module as new situation events).

Situation events

Situation events concern the situation, taking into account the operator's mission and giving value of some of the observations made. They are useful pieces of information for the decision making process of the operator and don't necessary reflect the whole observed situation. These events are generated by the situation representation module and sent to the situation analysis module each time a change is detected in the graph representing the current state of the ongoing situation. They are dated in order to allow reasoning according to temporal development of situation changes. Each time nodes in the situation graph will be fused and each time a new observation will be introduced in the complete situation representation, replacing an abstract concept, one or more of these events will be generated in order to make any change in the current situation explicit.

Note that, following the Gestalt principles, events can be generated even if no observation has been made in order to simulate the cognitive way of building whole out of incomplete pieces. A particularly low weight will then be associated with these events as they are particularly un-trustful because being un-observed.

Control events

Control events are process management events. They result from pattern matching rules but are not enough to conclude on the situation analysis. They are used, for instance, to manage the correlation of several events.

Decision events

Decision events are events result from the situation analysis process and give clues concerning the decision that has to be made by the operator. Decision events are produced when the business rules defining the mission of the operator are applied to both situation and mission events.Decision events can lead to the proposition of the fusion of several nodes in the situation representation graph. The operator will supervise any fusion in the situation representation.

New knowledge resulting from decision events can also be created. Then, new instantiated graph pieces will be introduced in the situation representation module. These pieces of graph will have a particular (low) weight, indicating that the knowledge introduced was not observed directly but derived from business rules. This creation of new knowledge corresponds to a projection of the evolution of the observed situation into a future state.

6.0 CONCLUSION AND FUTURE WORKS

We proposed a general approach to information analysis for situation representation and analysis. This approach is human centred as well as cognitive because a human is supervising the whole process and the system is aimed at helping the operators in their mission by supplying useful information. We claim that integrating cognitive functionalities into CSS will provide useful assistance to the operators.

However, we now have to define the different algorithms that are necessary to realise our system. This includes the calculation of distance between two nodes in the situation graph, the definition of fusion operators between nodes in the graph and, more generally, the definition of the properties that are necessary for the abstract and concrete situation graphs. These processes and properties must take into account the specificities of the domain in which we are working: two nodes representing two observations of the same object can each be related to several other nodes. The two sets of related nodes can be different or partially equals. In the same way, two nodes representing the same physical object can have different attributes because the observations from which they result take different points of view into account or stem from different sources.

Concerning the cognitive functionalities, one of the possible extensions that we would like to study is how to apply the gestaltist notions to different types of information. Indeed, these notions have been widely studied in field such as Human-computer interaction, but we would like to generalize the approach to situation perception in general. The aim is to highlight the elements that make a situation to look familiar as well as the characteristics that drive humans to recognize a whole situation out of incomplete and local observations and descriptions. On the other hand, we would like to extract typical features that allow human operators to realize they made mistakes on a situation recognition and evaluation.

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