An Intelligent Knowledge Treasure for Military Decision Support

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ABSTRACT

Information integration is great for military operations because the range of pertinent information sources is significantly distinct and dynamic. This article develops an intelligent knowledge treasure comprised of military resource ontology and procedures, as a learning model for better interoperability of heterogeneous resources of the Indian military. This model can interpret and learn the context of military information automatically, thereby facilitating the military commanders with decision making in several operations, such as command and control, teaching and training, military coalition, situation awareness and many more. To design the military resource ontology, this article specifies the core concepts of the ontology based on terms derived from heterogeneous resources. WWW standard ontology language, OWL has been used to codify the ontology. This article develops an intelligent tool—“QueryOnto”—as an interface to the military resource ontology that provides a commander decision support service and demonstrates how to apply the military ontology in practice. The developed ontology has been verified and validated with the best known approaches and metrics available. The presented model is helpful for military commanders to train their juniors in a systematic way and will provide an efficient web-based learning of different military tasks in future.

KEYWORDS
Intelligent Knowledge Treasure, Military Resource Ontology, Teaching and Training, Web-based Learning

INTRODUCTION

Military Decision Support (MDS) refers to the task of taking decisions during various tasks involving multiple domains and a wealth of expert knowledge. The primary condition for providing efficient MDS is the formation of a steady mechanism for acquisition, representation and storage of domain knowledge. Military organizations have to deal with the growing number of documents taken from multiple sources and in different formats. These documents have to be analyzed, categorized and screened in order to translate their content. An intelligent knowledge treasure aims to serve decision makers valid, timely and fruitful military information based on any pre-coded domain knowledge. Jain (2013) defines the knowledge treasure as a combination of declarative knowledge and procedural knowledge of a domain. An intelligent system demands a better understanding of the tasks involved and the construction of reasoning based formal domain models (knowledge-based systems). In this context, ontological models (Bertossi & Milani, 2018; Khozouie et al., 2018) are well suited that

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could be used to automatically support information tasks. Ontologies have achieved increasing interest in the computer science community and their welfares are now identified for military applications as they serve a foundation for domain knowledge representation. They explicitly encode a common understanding of a domain that can be interpreted between application programs and people.

Ontology can enhance interaction and coordination among various military domains and provide integration, storage, data capture and querying of collecting data. It is well recognized to incorporate ontology into a framework of knowledge management and knowledge representation and intelligent decision support to lead decision experts with complex reasoning. The domain ontology (the domain knowledge base and the domain database) forms the declarative knowledge part of the intelligent knowledge treasure and makes it intelligent through the semantics involved. The literature identifies that there is no familiar ontology which defines the domain knowledge for teaching and training for military information. We have suggested better knowledge management for information integration of military domains by developing a Military Resource Ontology (MRO) providing reasoning over it. All the information requirements of military personnel are fulfilled by just querying this MRO with a simple user interface. The use of unified and common domain ontology is based on domain knowledge and respective experiences of significant responsible staff. MRO is an integration of military information based on various subject areas from various disciplines. The presented model can be helpful for military commanders to train their new recruiter and will present an efficient web-based learning for several military tasks in future.

One of the leading requisites to follow a domain-specific ontology is to find out its strength and efficiency over other ontologies in the common field, i.e. to evaluate it against a set of standards and certain criteria. Ontology evaluation needs the use of formal and explicit criteria that meet ontology development objectives. Several evaluation criteria and approaches have been proposed to validate and analyze ontologies since many years. These evaluation processes usually concentrated on particular domain issues, and were evaluated for validating a specific form of ontology. We have presented an approach in this paper, for developing and also examining the domain ontology for military intelligence. We have covered a huge survey of the current ontology evaluation approaches and present a systematic mechanism of evaluation relevant for the military ontology. This incorporates an evaluation of the proposed ontology by subject experts and from its usage aspects. We express the refinement and evaluation methods for testing the usability and verifying the contents of Military Resource Ontology, which include application-based and criteria-based evaluations. The Application-based evaluation defines the usage of MRO in different contexts such as visualization, searching, querying-answering and the criteria-based evaluation incorporates the refinement of Military Resource Ontology according to subject experts’ feedback. These procedures for visualization, searching, question-answering and many more make up the procedural knowledge part of the intelligent knowledge treasure. The main contributions of this paper are two-fold:

- First, we represent domain ontology for military information management, namely Military Resource Ontology (MRO) in four phases as identifying the concepts, analyzing them in a hierarchy, encoding in a language, and finally evaluating the developed ontology. We present a survey of state of the art approaches for ontology evaluation and afterwards verify and validate MRO.
- A tool for reasoning over this MRO has been developed named ‘QueryOnto’ tool. QueryOnto incorporates procedures for Visualization of MRO, KeywordSearch and Question-Answering.

This ontology also provides a standard and unified vocabulary of the domain and reduces the problem that can arise from deviations in terminology. It can be applied during the post-event and pre-event stages of military actions like Attacks, Wargames, Training and Integration. Both contributions of this paper provide a fruitful vision for military commanders and researchers in facing with critical decision situations. By using this ontology, these complex decision situations
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