OPPORTUNISTIC PROBLEM-SOLVING IN DATA FUSION: THE BLACKBOARD MODEL

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Army Vision 2010 defines information superiority as the key enabler for such force characteristics as dominant maneuver and precision engagement. These concepts are also central to the design and implementation of the Army's Future Combat System and Objective Force. To establish and sustain information superiority, analysts and decision-makers need to identify, analyze and interpret pertinent information relative to achieving their task requirements. The sheer volume of information presented to Army intelligence analysts significantly exceeds their capabilities to fully analyze and interpret it in a timely manner. Consequently, the answers to commanders' priority intelligence requirements (PIRs) are typically based on a hasty, partial analysis of the information available. This condition of information overload experienced by analysts has the potential to significantly worsen for various reasons. First, our capabilities to collect, communicate and store data/information are steadily rising. Second, faster, more precise, and more lethal battlespace systems of our adversaries cause an increase in operational tempo, as well as an increased risk to one's own forces, thereby resulting in more severe time constraints on analysis and decision-making. The last approximately two decades of research has observed significant progress in certain areas of data interpretation for intelligence analysis (also referred to as data fusion). However, that progress has been restricted almost entirely to only Levels 0 and 1 of the Joint Directors of Laboratory (JDL) Data Fusion Model (Steinberg et al. 1998). The JDL Data Fusion Model consists of Levels 0 through 4 (a Level 5 is under consideration). Level 0 focuses on detection of electronic emissions. Level 1 focuses on estimating the location, kinematics and identity (classification and type) of single objects (platforms such as a tank or a radar). Level 2 attempts to infer the presence of aggregates of objects and to estimate the relationships among aggregates (communications patterns, command hierarchy relations, functional relations, etc.) and to provide meaning to that interpretation in the context of the present mission, enemy, terrain, troops, and time available (METT-T). Level 3, also in the context of METT-T, attempts to infer objectives of an adversary and to develop plausible courses of action that could be used to achieve those objectives. Level 4 involves assessing the state of processing of the lower fusion levels, controlling the processing, and making decisions about what information needs to be collected next in order to drive the overall fusion process in a productive direction. The U.S. Army Communications-Electronics Command and the U.S. Army Research Laboratory have a proposed collaborative project in the Army Science and Technology Objective review process that is focused on addressing principally the problems associated with Levels 2 and 3 (Powell and Broome 2002).

Previous approaches to military data fusion typically have focused on only one JDL level of fusion at a time. There is evidence to support the hypothesis that fusion accuracy and speed at a given level can be improved by utilizing the knowledge, and solution evolution, associated with the other levels. The present poster presentation provides an initial description of how an opportunistic problem-solving paradigm (the blackboard model and framework) developed within the field of artificial intelligence can be used to explore how *all* levels of analysis (0 through 4) in the JDL fusion model can be exploited *concurrently* in a single data fusion architecture to increase our overall capabilities to address PIRs in the Army. The blackboard model has been used successfully on other complex military interpretation tasks (e.g., Nii and Feigenbaum 1982). Clearly, an increase in the Army's ability to provide more accurate and timely analyses and interpretations of reports against commanders' critical information requirements would support, minimally, the Objective Force concepts of being Responsive, Agile, Versatile and Lethal.

Steinberg, A.N., Bowman, C.L. and F.E. White, Jr. Revisions to the JDL Data Fusion Model. Proceedings of the 3rd NATO/IRIS Conference, Quebec City, Canada, 1998.

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Nii, P.H. and E.A Feigenbaum. Signal-to-symbol Transformation: HASP/SIAP Case Study. AI Magazine: 23-35, 1982.