Abstracts of the Postgraduate Research Theses

Degree: *Doctor of Philosophy*
Title: *Cluster-based Specification Techniques in Dempster-shafer Theory for an Evidential Intelligence Analysis of Multiple Target Tracks*
Author: *Johan Schubert*
Institution: *Royal Institute of Technology*
Department: *Department of Numerical Analysis and Computing Science*
Date: *1994*

This thesis is based on five articles:

I. On Nonspecific Evidence, Int. J. Intell. Syst. **8**(6), 711-725, 1993.
II. Specifying Nonspecific Evidence, Manuscript.
III. Finding a Posterior Domain Probability Distribution by Specifying Nonspecific Evidence, Manuscript.
IV. Dempster's Rule for Evidence Ordered in a Complete Directed Acyclic Graph, Int. J. Approx. Reasoning **9**(1), 37-73, 1993.
V. On Rho in a Decision-Theoretic Apparatus of Dempster-Shafer Theory, Manuscript.

In Intelligence Analysis it is of vital importance to manage uncertainty. Intelligence data is almost always uncertain and incomplete, making it necessary to reason and taking decisions under uncertainty. One way to manage the uncertainty in Intelligence Analysis is Dempster-Shafer Theory. We may call this application of Dempster-Shafer Theory *Evidential Intelligence Analysis*. This thesis contains five results regarding multiple target tracks and intelligence specification in Evidential Intelligence Analysis.

When simultaneously reasoning with evidence about several different events it is necessary to separate the evidence according to event. These events should then be handled independently. However, when propositions of evidences are weakly specified in the sense that it may not be certain to which event they are referring, this may not be directly possible. In the first article of this thesis a criterion for partitioning evidences into subsets representing events is established.

In the second article we will specify each piece of nonspecific evidence by observing changes in cluster and domain conflicts if we move a piece of evidence from one subset to another. A decrease in cluster conflict is interpreted as an evidence indicating that this piece of evidence does not actually belong to the subset where it was placed by the partition. We will find this kind of evidence regarding the relation between each piece of evidence and every subset. When this has been done we can make a partial specification of each piece of evidence.

In the third article we set out to find a posterior probability distribution regarding the number of subsets. We use the idea that each single piece of evidence in a subset supports the existence of that subset. With this we can create a new bpa that is concerned with the question of how many subsets we have. In order to obtain the sought-after posterior domain probability distribution we combine this new bpa with our prior domain probability distribution.

For the case of evidence ordered in a complete directed acyclic graph the fourth article presents a new algorithm with lower computational complexity for Dempster's rule than that of step by step application of Dempster's rule. We are interested in finding the most probable completely specified path through the graph, where transitions are possible only from lower to higher ranked vertices. The path is here a representation for a sequence of states, for instance a sequence of snapshots of a physical object's track.

The fifth article concerns an earlier method for decision making where expected utility intervals are constructed for different choices. When the expected utility interval of one alternative is included in that of another, it is necessary make some assumptions. If there are several different decision makers we might sometimes be interested in having the highest expected utility among the decision makers. We must then also take into account the rational choices we can assume to be made by later decision makers.