Abstract

Current knowledge-based decision support systems in nondestructive testing and evaluation (NDT&E) are too specific and therefore scaling them vertically (improving their decision support efficiency) and horizontally (extending them to nondestructive testing areas other than those for which they are originally designed) becomes very difficult if not impossible. In such cases where scaling becomes necessary, re-writing major software components and logic of the decision-support system, is involved. Therefore, if it would be possible to create a software architecture that is generic to a wide spectrum of nondestructive testing (NDT) decision-support tasks, the dividends would be rich.

Present day knowledge-based systems (KBS) for nondestructive testing are not designed to be generic and open-ended. In order to meet the evolving needs of nondestructive testing, a KBS must be able to support a wide variety of problem solving tasks, which can be broadly classified into numeric and symbolic. It is also desirable that KBS for NDT&E allows constant addition of tools to its repertoire of decision support tasks, without breaking its basic architecture.

The prime objective of this study is to identify, design and develop a generic knowledge-based systems' architecture, specifically aimed at decision support tasks of materials evaluation. This is achieved by identifying the common problem solving threads in NDT&E decision support tasks and by designing an architecture that takes care of each of these threads. The development of such a generic system involves study of current systems, their shortcomings and how these shortcomings affect the efficient functioning of knowledge-based systems (KBS) for materials evaluation. More importantly, the motivation is to create a common architecture for supporting decision-making in a wide variety of nondestructive testing (NDT) tasks and domains.

Based on a hybrid, blackboard architecture, the developed decision support system is called DESKPACK, which stands for DEcision Support Knowledge PACKage. It is a comprehensive, single, unified platform for (a) processing and analysing 1-dimensional (1-D) signals, (b) processing and analysing 2-dimensional (2-D) images, (c) extracting, analysing, ranking and using features from both 1-D and 2-D data mentioned above, (d)
designing, developing and using two major neural network classifiers, including the multi-layered error back-propagation neural network which is an universal approximator, (c) loading, editing, using and reasoning with symbolic knowledge, (f) reasoning with both crisp and approximate (fuzzy) reasoning and (g) articulating and testing our ideas of decision making in an empirical domain. Together with its administrative and security modules, it forms a complete architectural framework, called the DESKPACK Software System (DSS).

The contribution of the DESKPACK Software System (DSS) can be viewed from many perspectives: (a) from a software perspective, it gives valuable methods of handling inhomogeneous decision-support problems such as NDT, which requires combining different programming paradigms, (b) from a systems point of view, the architecture opens up new areas of hybrid computing, integrating both symbolic and numerical approaches, as applied to domains such as materials evaluation, (c) from a purely automation point of view, the architecture provides a means to efficiently capture, store, use and update vast amounts of nondestructive testing and codes & standard practices knowledge, with little or no human intervention, (d) from a distributed computation perspective, the architecture highlights both the problems involved and the methods to overcome in consulting knowledge bases that are not localised, but are present in different geographical locations and (e) finally, from a functional perspective, all the modules have performed seamlessly and efficiently.

The designed DSS architecture has been tested with a variety of input data and knowledge, and the results are presented. The complete DESKPACK architectural framework is devoid of any domain specific knowledge, and can hence be used for decision support, even in other, similar empirical domains such as finance, business planning, medicine, credit rating, etc. In addition, the DSS architecture offers a number of interesting research threads, which can be pursued to enhance its decision support efficiency, breadth and utility.