Model of Diagnostic Knowledge Based System for Fail-Safe Application

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Abstract

The article is presenting simple model of diagnostic knowledge based system, based on knowledge acquired from safety analysis of the application, considering basic attributes the system should have and functionality it should provide.

1. Introduction

The diagnostic process consists generally of fault detection, fault identification and fault localization. If there is some diagnosis already applied, it is supposed that the process is mapped and incorrect function is detected. Fault detection and diagnosis is discussed for example in [1][2].

The task is then to identify, localize and dispatch the fault so that the system can be available as soon as possible. In order to improve the availability of system in such cases, knowledge-based system implemented in diagnostic level of system can be significantly helpful. Look at AI and knowledge based approach is given, among others, in [3][4].

As far as fail-safe system is concerned, in general the system itself as well as its processes including fault arising processes uses to be well mapped and described. [5] brings view of commonly used analysis of safety and models arisen from these analysis.

2. Knowledge Based System

If applying knowledge based system into the existing diagnostic system, it should dispose of knowledge about system, processes running in system, all faults being considered and dependences between in the system occurring events. So the knowledge base creation is the most significant part of knowledge system creation. It is needed to collect all available data about system structure and behaviour. The appropriate shell should be chosen according to the character of data being at disposal. To be able to process this data and bring them into desired formalism, it can be necessary to transform the data, from their source form into some well structured form, in order to be able to process it automatically.

On the other hand the knowledge based system should be able to gain the facts from process and provide the knowledge system with them. As the diagnostic system is assumed to be at disposal, it is needed to analyze the used diagnostic data, select the information relevant to the fault identification and to transfer them to the knowledge system using the corresponding form.

On basis of available facts about process and knowledge of system, inference mechanism should be able to make decisions with reasoning and provide a solution. After determining of solution it is needed to offer it to user.

Most of available software tools for creation of knowledge system offer the possibility to make the full-fledged stand-alone system disposing of all main features of knowledge system including ability to infer, make decisions with reasoning, explain, work with uncertain or incomplete data, or hold a dialogue with user.

Besides it is appropriate for application in existing diagnostic unit, if the knowledge system can be embedded in existing software, is able to communicate with external programs, gains the facts from the process being diagnosed in particular from accessible data and requires just minimum of necessary information from user.

2.1 Elementary model

The system should consist of the core executing the reasoning itself attended with a service application forming an interface to the process being observed (Fig. 1).

The core of the knowledge system includes working memory saving the facts about the actual state of the process, knowledge base to store the knowledge about the process rules and relations and inference engine, which is in position to bring possible solutions on the basis of information in working memory and dependences in knowledge base.

There are tree important sources of knowledge about the system, which could be more or less automatically processed.
Informal descriptions, manuals and instructions are mostly available. The recognition of knowledge in this kind of data is the most complicated and needs human assistance when selecting relevant data and transforming it to information that can be formalized to knowledge.

Models of safety analysis are generally well structured, available especially at fail-safe applications and describing the fault mechanism sufficiently.

Case bases are on the other hand seldom at disposal when considering fail-safe applications, cause there are rarely sufficient statistics of critical errors due to very low probability of their occurrence.

Knowledge acquisition should also provide some user friendly interface for human looking for knowledge in accessible data; apply some transformation mechanism, if data structured enough; or provide machine learning or automated knowledge discovery, if needed statistics available.

On basis of monitoring of process diagnostic data are obtained. The service application should access the process, get data from it, transform it into facts using required formalism suitable for chosen shell and provide the user with the results of reasoning. Actually it should be able to handle the base of facts – to provide the supplying with actual facts, recognize the requests to fill in the missing facts, to look for the absent facts in available data from process as well ask user for them when necessary.

3. Model Enhanced of Knowledge Validation Mechanism

Using the system new knowledge, dependences or relations can be recognized, or even imperfections in knowledge base discovered. When acquiring new knowledge, knowledge base should be enabled to be supplemented potentially adjusted or corrected.

The service application should thus also be able to create the interface to access the knowledge base (Fig. 2).
It should be always checked, how much the actual solution corresponds to suggested solution and in case, that some deviation is detected, list of knowledge participating in inference should be examined, and adjusted in corresponding way.

4. Model Using More Knowledge Approaches

Ordinarily there are more than just one sources of knowledge about the observed system, monitored processes and processes of fault arise and consequences. According to form of source information, various knowledge-based approaches are appropriate to build the knowledge base of the system. Hence it could be purposeful to build a system disposing of more knowledge-bases and corresponding inference mechanisms. In general two architectures of such a system can be considered.

In the first case all the decision mechanisms are working simultaneously in the table architecture, using the same space of table to store the facts (Fig. 3). The advantage is that all the inference engines can access it at the same time sharing all facts and partial solutions. Such a collective working memory has to dispose of sufficient facts management, to be ready to recognize which kind of fact the inference mechanism is demanding, and to prepare the fact in appropriate formalism.

The other architecture is based on condition, that the diagnosed system itself or the observed process can be divided into parts, whose faults or dysfunctions can be separated and do not affect and also are not affected by faults of other parts. In this case the task is to decide on the most upper level of the system as the whole, which part has caused the malfunction and the individual decision mechanisms are then considering the contribution of corresponding part (Fig. 4). The mechanism of facts management has to recognize in this case, to which part the fact is relevant and store it to appropriate working memory. Disadvantage of this solution is, that one event affecting more parts of the system,
especially on interface of single parts can be stored multiple.

Fig. 4. Extended architecture using separated working memories

5. Conclusion

The paper was written with motivation to present the basic approach to creation of knowledge system for diagnostic purposes, which should be embedded into existing diagnostic system. Basic models of such system were considered.

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Bibliography


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