KNOWLEDGE ACQUISITION PROCESS FOR STEEL MANUFACTURING KNOWLEDGE-BASED SYSTEM

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PROCES ZÍSKAVANIA INFORMÁCIÍ V ZNALOSTNOM SYSTÉME PRE VÝROBU OCELE

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Abstrakt

Informácie zohrávajú kľúčovú úlohu v procese riadenia systémov. Možno ich získať prostredníctvom senzorických meraní, komunikáciou medzi systémom a prostredím a pod. Veľa praktických problémov, vyskytujúcich sa v prostredí výroby ocele je relatívne zložitých, nepresných, neúplných a pod.. Znalostné inžinierstvo tvorí významnú súčasť umelej inteligencie. Zahŕňa v sebe predovšetkým proces získavania znalostí, reprezentáciu znalostí a odvodzovacie mechanizmy, ktoré sú schopné vytvárať nové vedomosti z už existujúcich poznatkov. Jednou z najdôležitejších otázok znalostného inžinierstva je otázka spôsobu získavania znalostí. V súčasnosti je pochopiteľná snaha vybaviť jednotlivé systémy časťou, ktorá by umožňovala získavanie a zaznamenávanie údajov a znalostí čo najviac automatizovať a znížiť potrebu sprostredkovania človekom. Avšak získavanie znalostí priamo od expertov tvorí doposiaľ zatiaľ nenahraditeľnú súčasť tohoto procesu. Od kvalitných informácií závisí v rozhodujúcej miere aj kvalita rozhodovacieho procesu znalostného systému ako "inteligentného poradcu".

Znalostný systém je programový systém, ktorý sa od bežných programových produktov líši spôsobom, akým sú v ňom znalosti organizované, začlenené do jeho prostredia a využívané, a tiež spôsobom interakcie s užívateľom. Na rozdiel od väčšiny konvenčných programov, v ktorých sú znalosti implicitne roztrúsené, je rozhodujúca väčšina znalostí dôležitých pre riešenie problémov daného typu v rámci znalostného systému sústredená explicitne v samostatnej modulárnej štruktúre, v báze znalostí. Pri doplňovaní a modifikácii bázy znalostí už nie je potrebné modifikovať ostatné časti znalostného systému. V príspevku je uvedený jeden z algoritmov procesu získavania znalostí, ktorý bol overený a viacnásobne odskúšaný v rámci riešenia problematiky výroby ocele, pričom je načrtnutý aj následný spôsob formálneho spracovania takto získaných znalostí.

Key words: information, knowledge-based system, knowledge acquisition, fuzzy model, membership value

Abstract

Information plays a key role in systems control and decisions. In general, information can be gathered through sensory measurements, man-machine interface and/or signal (data) communications. However, in many industrial processes, some information or knowledge can not be observed real-time through sensor measurement. As a result, this kind of internal information has to be constructed by a state estimator, or so-called "software based sensor", in terms of system observed inputs and outputs. To insure that the gathered information is of good quality and useful content, the signal processing, e.g. signal filtering and pattern quantization, may be used, if necessary [1].

Many practical problems, arising in the manufacturing environment, related to complexity, ambiguity, incompleteness, and ill-formed structures are dealt with in Artificial intelligence (AI) efforts. Most manufacturing problems have these characteristics. The effective acquisition of domain-specific knowledge may be the key to the success of knowledge-based systems. This conclusion was confirmed also by solving of the steel manufacturing knowledge-based system. Problem solving was concern in the knowledge acquisition in the manufacturing context.

1. INTRODUCTION

Knowledge engineering as a part of Artificial intelligence research works on the solution of problems, which normally demand "human intelligence". This includes knowledge acquisition, knowledge representation and deduction mechanisms, which create new knowledge from existing knowledge.

Knowledge acquisition is the collection and analysis of information from one or more domain experts and any other sources leading to the production of a number of documents which form the basis of a functioning knowledge base. A substantial subset of knowledge acquisition is knowledge elicitation.

Knowledge elicitation is that area of knowledge acquisition which deals with acquiring information directly from domain experts.

It must be noted, that some writers of knowledge acquisition seem to be drawn into discussing the domain or a specific application, and confusing this with the knowledge engineering techniques. They make statements about the knowledge engineering which seem more properly to belong to the domain.

2. PROBLEM SOLVING

Knowledge acquisition has three major subdivisions - interviewing, analysis and implementation. Knowledge bases are developed by capturing the rules and procedures human experts use in solving problems. When knowledge of a human expert is captured - through an interviews or observation - it is reduced to simple statements. Even the most complex reasoning processes can be reduced to simple statements. In created knowledge-based system knowledge is represented in the simple form of IF and THEN rules.

"*IF* the sensor reads 250 units/second

THEN the machine is functioning normally,

IF the sensor reads 10 units/second *THEN* check the drive belt ",

are examples of how knowledge were represented in this knowledge base. It is this IF-THEN structure that enables an knowledge-based system to make pattern matches to solve problems.

Because knowledge bases are separate entities from inference engines, the knowledge contained in the knowledge base is easy to modify. Just as in a spreadsheet, where numbers can be changed independently of the arithmetic operand programs, knowledge-base system knowledge bases can be changed just as easily. When you make changes to a knowledge base you simply add rules, change old rules, or remove obsolete rules, in any order. Because the inference engine controls how searches occur, it doesn't matter the order in which rules are structured. However, rules are most often structured in the same hierarchical order that is representative of a procedure or process as it is performed by a person.

Knowledge-based systems may be characterised as to the type of knowledge they use. The greatest problem associated with the use of rules is their acquisition. The most common methodology for building a rule based system, knowledge-based system for manufacturing, is represented in Figure 1.

Fig.1 Knowledge engineer role in knowledge-based system

This methodology was applied in constructed expert systems. The most common type is diagnostic rules which pair observations and diagnostic conclusions.

Within the framework of long-term research of knowledge acquisition process was also created a generally usable algorithm which was verified in knowledge acquisition process during creating of expert system for steel manufacturing, (Figure 2).

Knowledge acquisition through a human expert is a delicate task that needs to be well thought out and carefully and deliberately conducted. Guidelines to this approach exist as a result of the observations of those who have used such a procedure in earlier efforts. However, such guidelines are obviously subjective and incomplete. One can only truly appreciate this task through actual experience.

Designed knowledge (expert) system is rule based. The complexity of the solved problem is based on the number of rules at each point of production. The continuous caster presents the largest number of rules or constraints. It may vary from seventy to more than one hundred depending on the definition of rules. Other units may have from thirty to forty rules and generally the constraints are not as severe as for the casters. A single rule may comprise multiple constraints - in mathematical terms - but in a rule based expert system, multiple rules may be formulated with a single rule statement.

Many of the rules are guidelines or soft, which make mathematical or algorithmic statements difficult. A typical soft rule may be stated as follows: *"try to avoid making low carbon steel as the first product after start up of the caster"* or a rule such as special alloy production should occur in batches of three in afternoon shift if possible. These rules come from the intuitive experience gained from the equipment by the operators.

There was used the production rule representation of the form:

IF (condition) ***THEN*** (action).

In this system all the productions interact with a global list, or working storage, which stores information representing the current state of the world (Fig.3), [2]:

"when the (condition) part of a production is satisfied,

the (action) portion of the rule is executed."

Fig.2 Knowledge acquisition algorithm

Fig.3 The Rule Co-operation

Within this work, in knowledge acquisition process, was applied also a membership function rule learning method, which is the part of the expert system learning module. The designed method will contain two kinds of predicates. The low level predicates are used to describe the instances. The high level predicates are used to compile the knowledge by building consequents in the method. Background knowledge, i.e. the knowledge which is used in both deduction and induction, but its representation is different from the representation of designed theory (method).

Here was also introduced an optimization oriented membership function learning algorithm. Without loss of generality, suppose a fuzzy model with two inputs x1, x2 and one input y and the fuzzy rules can be described as:

IF x_1 **is** A_{1i} **and** x_2 **is** A_{2j}

THEN y **is** W_{ij}, i=0,m; j=0,n

where i,j denote the rule numbers, $A_{1,j}$ and A_{2j} are the linguistic values of x_1 and x_2 represented by the corresponding membership values m_{1i} and m_{2j}, and W_{ij} is an initial fuzzy value of y with respect to the input combination.

The membership values are governed by the following equation:

(1)

While the products of m_{1j} and m_{2j} are used as the corresponding output membership m_{yij} , the output y can be represented by a weighted average:

(2)

It must be noted, that $\sum m_{yij} = 1$.

The goal of self-tuning is to determine the values - a_{1i}, a_{2j}, W_{ij} - which minimize a cost function:

$$\min E = 0.5 \; \Sigma (y_k^p - y_k)^2 \qquad (3)$$

with a set of learning data - x_{1k}, x_{2k}, y_k - where y_k^p denotes the predicted output given by the fuzzy model.

To solve this problem, many optimization techniques can be used. In addition, self-learning in fuzzy systems can also be performed by modifying the fuzzy rules (fuzzy relations and rule structure) with fuzzy system identification.

3. CONCLUSION

Manufacturing processes are likely to changes with advances in technology. If many steps in a complicated process remained the same, their representations may be used *directly, without change*. Knowledge only needs to be acquired for new or modified steps, and in the latter case much of the old representation of a step may be still be relevant. In addition, when a step or sequence of steps are used in several manufacturing processes, knowledge about them need only be acquired once because the knowledge represented about a step, aside from its ordering, is context free. It is obvious that to the extent that knowledge can be reused, knowledge acquisition effort is reduced both in time and cost.

An expert system can be viewed as a problem solving program to solve a sophisticated and difficult problem with some human-like behaviour in a specialized problem domain. From an application point of view, both knowledge acquisition and learning are the bottleneck in developing an expert system under an environment with incomplete and/or imprecise information and knowledge. In fact, learning plays an important role in either knowledge acquisition or knowledge base update. Similar to learning in a neural network or a fuzzy system, the concepts of learning from examples offer potential for domain experts to interact directly with a machine to transfer knowledge. The concept of learning methods can be divided into similarity-based, hierarchical, function induction, and explanation-based knowledge intensive techniques. On the other hand, knowledge representation is another important dimension in an intelligent system. The traditional forms of knowledge representation can be production system, semantic networks, frames and scripts, logic procedural representation, etc. During the last decade, both neural networks and fuzzy rules have been becoming the alternative schemes of knowledge representation. Obviously, the learning policy designed should depend on the form of the knowledge representation.

Literature

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