KNOWLEDGE BASED SYSTEM TO INTERPRET THE WEIGHT REGULARITY OF THE YARN IN SPINNING TECHNOLOGIES

L.C. Hanganu, Fl. Tudose- Sandu-Ville, E. Murăraşu
Technical University „Gh.Asachi" of Iassy

At present the defect detection on the yarn is based on Fourier's analysis, but other kinds of analysis can be used. An overview of the working of the software is as follows: first, a signal stemming from the weight regularity sensor is received by the software; second, the user must define the yarn manufacturing process, and if necessary, the test conditions (speed of the yarn in the sensor, unknown manufacturing process, etc.); then, the software detects the defects on the weight regularity signal and suggests their possible causes.

As shown in figure 1, the signal treatment module receives the weight regularity signal and, using Fourier's transformation, one class is allocated to each defect.

The defect, and some information about the testing yarn and its manufacturing process are passed on to the interpretation module which then proposes possible causes for each defect.

The storage in memory of the signal, the defects and their real causes, is planned for the manufacture.

This software needs to assist humans. This implies two things: the software must contain the present knowledge which permits the evaluation of yarn quality and defects and it must be able to pick up new sets of knowledge.

Human knowledge is varied, it can be intuitive, and it is based on quantitative, qualitative and heuristic notions. Then the software will have to be able to accept all types of knowledge.

In conclusion, the software will have to be more flexible and adaptable in order to accept new sets of knowledge, new sensors and new methods of analysis.

Object-oriented programming offers several advantages, so that different parts will be functionally well split. Each object has a well-defined functionality and the links between the different objects constitute the framework of the programme. Furthermore, the programme tolerates a lot of signal-type documents, process-type documents, screen result documents if the memory contains enough space to store everything. So, for the same process several signals can be analyzed, or for one single signal several processes can be proposed, and the results of each analysis can be seen in a different resulting document.

Later on, a data base has been planned for addition to the system, so that the history of the defect, signals, statistical data, the characteristics of the machines, and the badly identified defects can be stored.

The main difficulty which came up during the implementation of this module has been looking for the fundamental wavelength and the harmonics. First of all a criterion meant to locate the energy peaks associated with a fundamental wavelength had to be defined. Then an algorithm had to be designed with a parameter of degree of tolerance in frequency and energy to detect the harmonics associated with the fundamental wavelength.

However, all the ambiguities have not been removed and when the system hesitates between two types of defects for a detected defect, it creates two defects with the same fundamental wavelength but of a different type. It is up to the expert system to remove the ambiguity. The weight regularity signal is noisy. This noise can be decomposed into two noises of different origins: a measure noise, and a noise due to the random distribution of the fibers within the yarn.

Currently, the two noises cannot be separated. Models for the theoretical distribution of the fibers in the yarn exist, but it is essential to know which case actually comes up for each test.

In this field, statistical studies are to be done. It is possible, when such studies are conducted, to create an island of knowledge which, according to the qualitative and quantitative criteria, will choose the noise model to be applied; the purpose of the system being either to filter this noise by computer, or to evaluate its power in relation to the power of the pure signal of weight regularity.

Because of the noise, the detection of defects is semi-automatic because it is necessary to pre-adjust the various filters to try to eliminate this noise without eliminating too much significant information contained in the signal.

This module is meant to replace the human in 80 percent of cases. This module consists of an expert system. We will first see the data in the knowledge base and then the different options

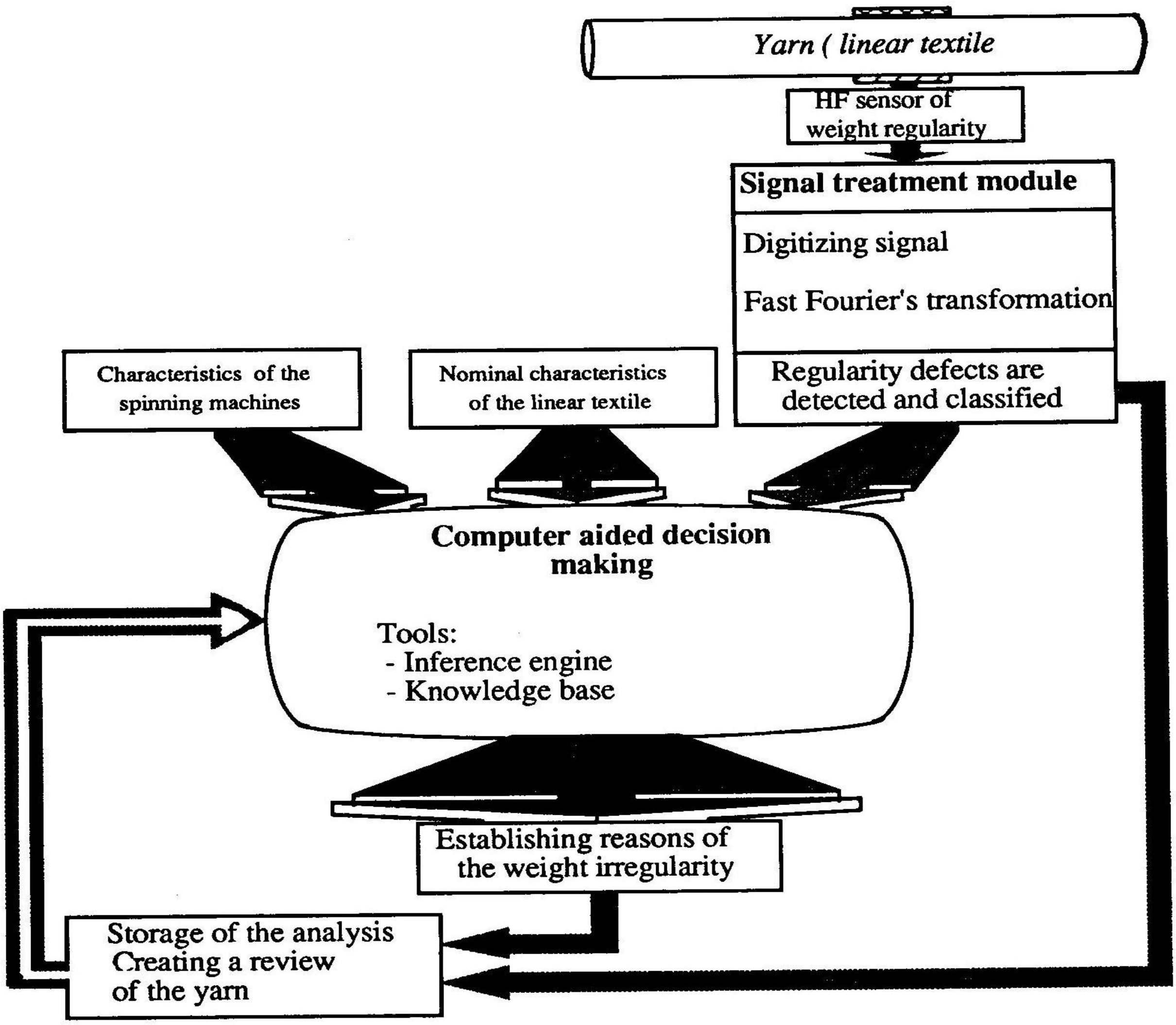

Figure 1.

which make it possible to achieve this knowledge base for weight regularity.

To propose a set of possible causes, that are at the same time coherent and limited, human experts go through successive filtrations to eliminate infeasible solutions. Using the classes of defects that can be identified from the spectrogram as the basis, it is possible to find the possible causes for a class of defects; then the possible sources in the manufacturing process can be identified based on the existing machines and the wavelength of the defect. These machines constitute a M set which in fact is the intersection of the two following sets:

- the set of all the machines which can contain the component which actually generated the defect,

- the set of the existing machines in the manufacturing process of the tested yarn.

At this stage, causes associated with machines can therefore be proposed for a defect.

But the wavelength of the defect has not yet been taken into account. Now this can reduce M set to a M' set of machines whose wavelength intervals of the defect they generate are compatible with the wavelength of the considered defect. To achieve this new filtering operation, one has to know: the intervals of the wavelength of the defect that can be generated for all the spinning machines and for each machine, the draft between the input and the output of the machine so as to successively correct the wavelength of the defect by different drawing operations of the machines that are not concerned.

The Knowledge Base is a model of the specific knowledge of the application field. It comprises a base of facts and a base of rules.

The Base Of Facts*:* facts are a set of assertional knowledge used to describe the considered situation either as established, i.e., true, or to be established, i.e., facts that are looked for which there are hypotheses.

So, the rules to be exploited can be conditioned and achieved. They can be created or destroyed by exploiting the base of rules.

The structure which groups the set of facts is composed of objects and classes, each object or class having properties. A fact can then be defined as a specific property of an object or of a class. All the objects and classes together are called the world of objects. There are proposed two structures as far as the world of objects is concerned:

- either a flat world in which all the objects are independent. This world enables a simple reasoning to be performed but we will see later that the performance is poor, or a

hierarchical or genealogical world in which each object or class can be the child or the father of one or several other objects or classes. This world has an oriented graph structure.

Various types of inheritances are possible between the elements which constitute the base of facts:

- property inheritance: an object can inherit properties of the class or of the object it is the son of;

- value inheritance: an object can inherit the value of a property of the class or of the object it is the child of;

- method inheritance: for each property of a class or of an object, actions can be defined to be triggered off in relation to the value of this property, these actions can be inherited.

The Base Of Rules*:* rules are a set of operational knowledge which represents the know-how of the considered application field. They indicate which consequences are to be triggered off and/or which actions to be carried out when a situation is established or is to be established. The rules are interconnected by their hypotheses and the whole set of rules builds up a graph which can be displayed. The base of rules has a tree structure. This structure highlights the backward chaining in relation to the forward chaining, but the latter remains possible.

So, suggesting hypotheses and validating values can be proposed for some properties and this makes it possible to operate the inference engine by changing at will the initial state of the base of knowledge and of the pile of hypotheses to suggest.

The Inference Engines. It is a deductive computer system which exploits the knowledge of the previous base by considering them as data and therefore as different types of knowledge which are likely to be changed.

There are three types of actions on the knowledge base:

- checking and/or questioning the validity of the knowledge;

- reaching the knowledge;

- triggering off specific actions according to the state of the knowledge; in general this entails modifications of the knowledge base, particularly in its 'facts' part, but sometimes in its 'rules' part.

In fact, one or the other classical strategies to develop the search can be superimposed on the releasing mode of the rules: in depth-first strategy, in breadth-first strategy, in ordered search strategy.

However, forward chaining can be used in two cases:

- to question the solutions that have been found with new facts; in this case, it is the user that introduces the new facts and starts the interpretation again. In no case, can the ES question an object solution; this protection has been designed to prevent the ES from looping indefinitely and thus never giving any solution to the user;

- to link two islands of knowledge which model different sensors. This mechanism has been tested on two islands of knowledge. But it is not currently used in this system for only the weight regularity sensor is taken into account.

CONCLUSIONS

The knowledge based expert system offers different strategies:

- according to the case, one can opt to use only the forward chaining or only the backward chaining during the evaluation mechanism sequence of the hypothesis;

- to establish the value of an hypothesis, all the rules leading to it can be evaluated (exhaustive evaluation), or the rules leading to this hypothesis can be evaluated until a true one can be found (non-exhaustive evaluation);

- in forward chaining pertaining to the hypothesis, the value of truth of the hypothesis enables its context to be taken into account.

Bibliography

1. **Hanganu, L., C.** *Implementarea sistemelor expert în filaturi, Conferinţa internaţională de Inginerie Integrată C2I 2002, 25-26 aprilie, Timişoara, ISBN 973-8247-92-6.*

2. Hanganu L. C. *Maşini pentru filatură, Ed. „Gh. Asachi", ISBN 973-8292-46-8 Iaşi, 2001.*