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## The tools of Artificial Intelligence applied to monitoring

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| Informations                                                                                                                                                            | Abstract                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
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| <p><b>Mots clés :</b></p> <p>Monitoring<br/>Detection<br/>Diagnostic<br/>Artificial Intelligence (AI)</p> <p><b>*Correspondence :</b><br/>mehar.zohra@univ-oran2.dz</p> | <p>The purpose of this work is the presentation of the different tools of Artificial Intelligence for monitoring. These methods are divided into three major families: behavioral models, pattern recognition methods and explanatory models.</p> <p>Monitoring can be defined in several ways; this monitoring is composed essentially of two phases: flaw detection and fault diagnosis. The diagnosis is divided into two functions: location and identification of causes.</p> |

### 1. Introduction

The problems of great importance in industrial monitoring are constituted by the possibility of detecting false alarms and eventually predict failure.

The field monitoring needs mainly artificial intelligence either to exploit a know-how or to bring distributed intelligence to the lowest operational levels.

The methods by symbolic tools rely heavily on Artificial Intelligence (AI) techniques, familiar or at least shareable by the operator. Indeed, the use of Artificial Intelligence overcomes the complexity of the systems to be monitored. Moreover, in general, Artificial Intelligence due to these characteristics is relatively well suited to monitoring problems. Indeed, AI can be characterized by the ability to treat [1]:

- A large amount of information,
- non-homogeneous data, (numerical / Symbolic),
- dependent data context,
- incomplete data.

Overall, these methods will be grouped under the expression: « Symbolic modeling methods ». They are characterized by keywords that better reflect their objectives and their respective characteristics. A distinction is therefore made between symbolic models,

recognition methods, methods based on behavioral models and methods based on explanatory models, see [1].

### 2. Defining monitoring

Monitoring is a passive device and / or dynamic, informational, which analyzes the state of the system and provides indicators. Monitoring particular is to detect and classify failures by observing the evolution of the system, then diagnose by locating faulty elements and identifying the root causes, see [3] and [4,5].

#### 2.1. Detection

To detect system failures, you must to be able to classify observable situations as being normal or abnormal, [5].

#### 2.2. Diagnostic

The diagnostic system [6] suggests to the operator the possible causes of this problem, as well as fuzzy interpretations of these causes. The objective of the diagnostic system is to search for the causes and locate the organs that led to a particular observation. This function is broken down into two elementary functions: localization and identification. The localization makes it possible to determine the faulty functional subset, while identification involves

determining the causes that led to an abnormal situation. These causes may be internal (faulty subassemblies that are part of the equipment), or external to the equipment. See [7,8].

Monitoring has two main functions: fault detection and fault diagnosis, figure (Fig. 1).

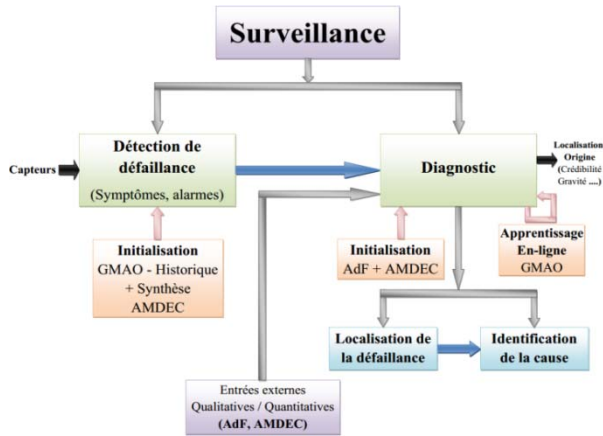


Fig.1 : The components of monitoring.

### 3. Purpose and objective monitoring

Monitoring is responsible for collecting permanently all signals, through indicators, from the production system, and monitors in real time the evolution of the controlled system. It thus includes all the tools to monitor the evolution of the system behavior in relation to normal operation, and to detect any anomaly or failure. In this last case, a diagnosis is established in order to locate the subsystem responsible for the malfunction and to identify the cause of the failure. This makes it possible to specify the maintenance operations to be carried out in order to restore the production system to working order. See [2].

### 4. Industrial Monitoring: Methods and Models

The methods of monitoring are generally divided into two groups: monitoring methods with model and without model. See [3,10] and [11] [12,13].

The figure (Fig. 2) illustrates the methods most used in industrial monitoring.

#### 4.1 Monitoring methods with models

These are the methods most used by industrialists today; they are based on the existence of a formal equipment model and generally use automatic techniques. Are likely to diagnostic methods by functional and material modeling: The principle of these methods

consists in establishing a priori and as completely as possible, the links between the initial causes of the failures and their measurable effects.

The most commonly encountered methods are Failure Modes, Effects and Criticality Analysis (FMECA) and Fault Trees (FT). These methods are used mainly for diagnosis, see [3]. And physical modeling surveillance methods: Surveillance methods with physical model have the principle of comparing the measurements made on the system to the information provided by the Frank model [14,12]. Any deviation is then synonymous with a failure. The tools of decision theory are then used to determine if this difference is due to normal hazards, such as measurement noise or if it reflects a system failure. Methods with physical model are the methods most familiar to automation engineers. In general, these methods can be separated into two techniques: physical and analytical redundancy techniques, and parametric estimation techniques, [3].

#### 4.2 Monitoring methods without models

There are many industrial applications whose model is difficult, or even impossible to obtain due to increased complexity or numerous stakeholder reconfigurations during the production process. For this type of industrial applications, only operational monitoring methods are those without model, they are distinguished on monitoring using signal processing statistical tools: Statistical tools fault detection are to assume that the signals provided by the sensors have certain statistical properties. A few tests are then carried out which make it possible to check whether these properties are present in a sample of the measured signals. A wide variety of tests is applicable on a sample of measurements. Among the most important, we mention: threshold-crossing test, average test and test of variance, found in [3,12] and [15]. And monitoring using Artificial Intelligence (AI) techniques, according to the bibliography studied, different categorizations monitoring methods by IA are given in general; Artificial Intelligence (AI) and use symbolic knowledge, familiar or at least shareable by the operator [16], artificial intelligence due to these characteristics are relatively well suited to monitoring problems. From our point of view, we propose a classification of these methods according to 3 types, [3]:

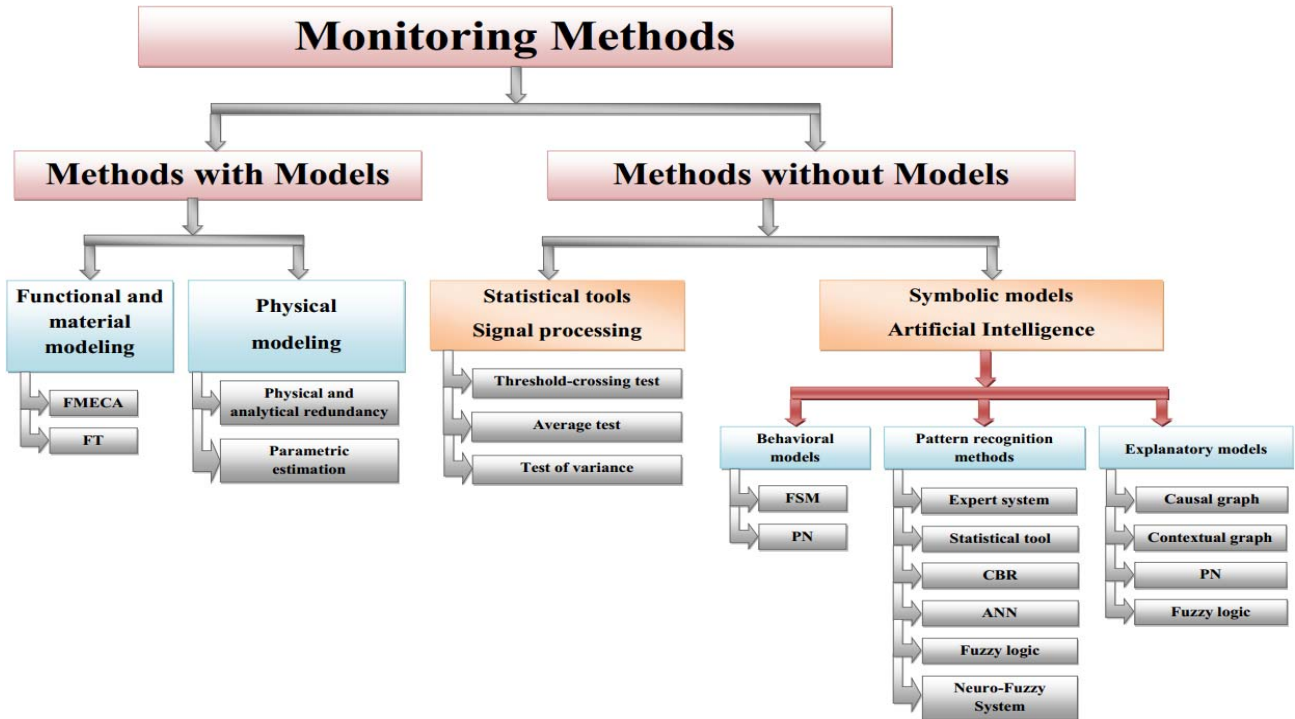


Fig. 2 : Classification of monitoring methods.

- a) **Method of modeling behavioral:** These methods are characterized in particular by the possibility of simulating the behavior of the system, from a modeling of its behavior. Most often these are models "of proper functioning" which, unlike digital models, are not based on the physical system but on a consideration in terms of mode of operation. These methods include tools such as Petri nets (PN) and the finite-state machine (FSM). In these methods, the associated keywords are: modeling / simulation, [3].
- b) **Method of pattern recognition:** These methods comprise the associative models and method of pattern recognition in the sense that they are characterized by the terms learning and recognition which apply to both pattern recognition and rule-based systems such as expert systems [3]. These techniques are more elaborate compared to simple statistical tests and are able to detect and diagnose failures [8]. These methods include: expert systems, statistical tools, case-based reasoning (CBR), Artificial Neural Network (ANN), Fuzzy logic, Neuro-Fuzzy systems, [3]. In these methods, the key words that best characterize these approaches are: learning / recognition [3].
- c) **Method of modeling explanatory:** These methods introduced by [16] are mainly

based on the representation of relationships between the different states failures and their effects (possibly observable). They are therefore based on a deep analysis of the system, so as to have sufficient knowledge in the expression of these relationships of cause and effect. The models thus obtained allow for a certain adductive approach which consists in going back to the causes of breakdowns from observations corresponding to the symptoms. Several tools of Artificial Intelligence allow such a formalization of the knowledge available on a system. These include causal graph, contextual graph, we also find approaches based on fuzzy logic or Petri nets. In these methods, the associated keyword is: causal analysis, [3].

## 5. Conclusion

In this work, a bibliographic review for industrial monitoring was presented. We addressed the most commonly used techniques in this field. The use of techniques and models is difficult, expensive and offering less and less satisfaction with more and more complex systems. The use of techniques without models is more suited to this problem and, more particularly the techniques related to Artificial Intelligence. Finally, we proposed a classification of these techniques into three classes.

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