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Detection of an Electrical Drive Failure by Parameters Estimation

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Abstract: The improvement of the safety and the availability of the complex industrial systems passes by the detection and the localization of the failures of their components. A failure can be a total breakdown of an element of the system or a modification of its characteristics sufficiently significant to deteriorate the total operation of the installation. Safety is affected when a failure occurs and that it is not detected, in addition a not known stop due to an alarm (false alarm) decreases the availability of the systems. The purpose of the monitoring systems are to detect and identify the failures which can affect the performances and the safety of an installation with a minimum of false alarm and within times weakest possible and this starting from information available on a system (order, measurement and a model of behavior). This study consists with the application of the method of estimate parametric (isolation resistance of the armature and the inductor) for the monitoring of the physical parameters of an electric drive. Various approaches of defects monitoring are mentionned. This research treats also the motors with D.C. current as well as the various possible defects and their remedies. Our essential contribution relates to the proposal of algorithm detection based on the method of least squares, which is validated by simulation. In addition, it would be interesting to study, from the new point of view, other parametric methods of estimate of which that of recursive least squares for the application on line in order to detect the anomalies in all the types of motors.

Key words: Numerical simulation, isolation resistance of the armature and the inductor, safety of an electrical installation

INTRODUCTION

At the time of the electromechanical system working it happen frequently enough that the maximal electric and mechanical parameter values pass their admissible levels determined by constructors and by their properties.

The inadmissible values can appear at the time of the different regimes of working as:

- Overcharges owed to the staff's false manœuvreses.
- Spoil them in facilities.
- The atmospheric phenomena.
- The engagement and the starting point of facilities.

To warn the deterioration of the different elements of the order it would be necessary that the one - is endowed here of protective devices against:

- Overvoltages on the main elements.
- Surintensitéses in the different parts.
- The apparition of regimes abnormal of working.

Finally, one can say that the faculty to the working of an equipment doesn't only depend on the quality of components of the good choice of a motor but also of precautions taken to protect these elements against constraints that their apply during the exploitation.

To answer to needs of productivity of quality and security process is automated more and more.

To the initial automatic device function that assured the regulation of processes as elaborating sizes of orders to shareholders comes to be added in case of other functions bound to the supervision and the maintenance. cette automation more and more thrust also results in an increase of number of sensors (to have a more complete picture of the process) and of shareholders (to have a thinner control)[1].

General gait of industrial facilities surveillance: Research in the domain of the surveillance actively develops these last years, its goal is to elaborate procedures that detect localize and diagnostic shortcomings appearing at the level of sensors; of shareholders of the physical process him-even.

Decomposition of a surveillance system: The system of surveillance analyzes itself classically in three stages:

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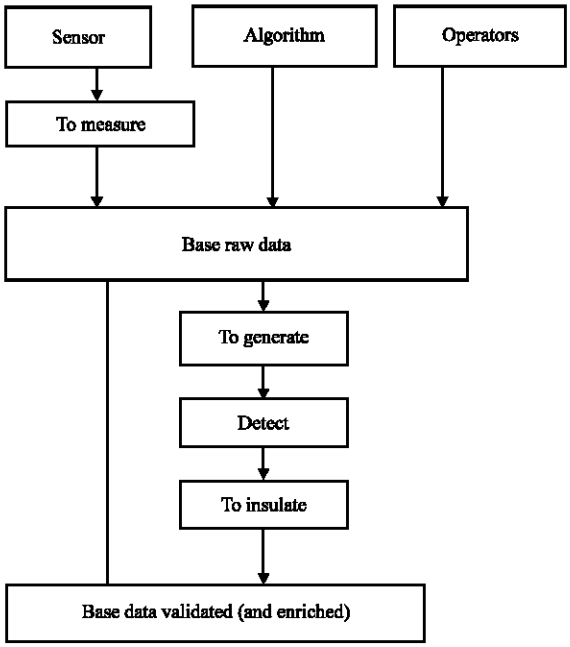

Fig. 1: Function of the monitoring system

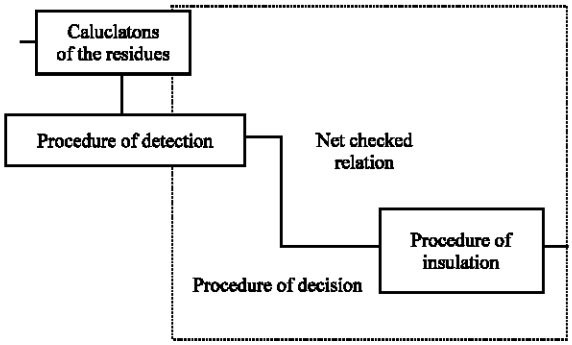

Fig. 2: Decomposition of a surveillance system

Definition and characters of failings: During the working of an event process as failings occur at all times.

A failing of a system is a change or cessation of its working normal (nominal).

It can be different natures and can describe briefly in the following Fig. 3.

Accommodation aux défauts: The presence of a system defect can be treated accommodated in a passive manner, the law of order is determined so that the system is tolerant to the defect, performances of the system depend directly on the hardiness of order stake laws in works.

The system of order requires a modification of his/her/its structure in order to maintain performances and the hardiness of the process in the limits acceptable of working one speaks in this case of reconfiguration or restructuring of the law of order of the system[2].

Two cases can occur according to the gravity of the defect: either the stake in position of emergency stop or the immediate intervention of the maintenance, either the reconfiguration: the objective is to determine parameters of the system in order to recover some optimal performances.

One speaks then of damaged working, the degree of deterioration is certain parameter function as the gravity of the defect or the hardiness of the initial order.

Problematic: The electric motor importance in the industry requires the application of a surveillance system to detect and to localize failings that can affect performances and the security of all I' installation.

Most the electric breakdowns in motors are consequences of the warming-up of the coil of the induced or in the inductive coils or in the two at the same time.

The increase of the temperature until an inadmissible value provokes the progressive or abrupt deterioration of the insulator; after the destruction of the insulator one falls in a short circuit between spireses of the spool herself or between the spool and the mass.

To decrease breakdowns that are consequences of the increase of the temperature it is necessary to place a system that measures and supervise the temperature. The electric parameter that defines the temperature is the resistance of the induced or the inductive, for it it is necessary to know the value of the resistance during working and after deducting the different values of the temperature of it we estimated this parameter therefore by the least square method.

Parametric identification: Identification constitutes an important phase in the definition of the model, it is by it that the choice of the model class to adopt values of parameters that characterize it then is going to become clearer[3].

The most often identification takes place while optimizing a criteria of quality that characterizes the gap between the behavior of the process (marked by a set of measures) and the one of his/her/its model (studied by simulation) for a set of solicitation data.

Numerous methods of identification are specified in the continuation the most often corresponding to one of face Fig 5 and 6.

Method of the least squares: Historically this method has been introduced by Kari GAUSS in 1809 it was to the basis of all methods of identification and evaluation of

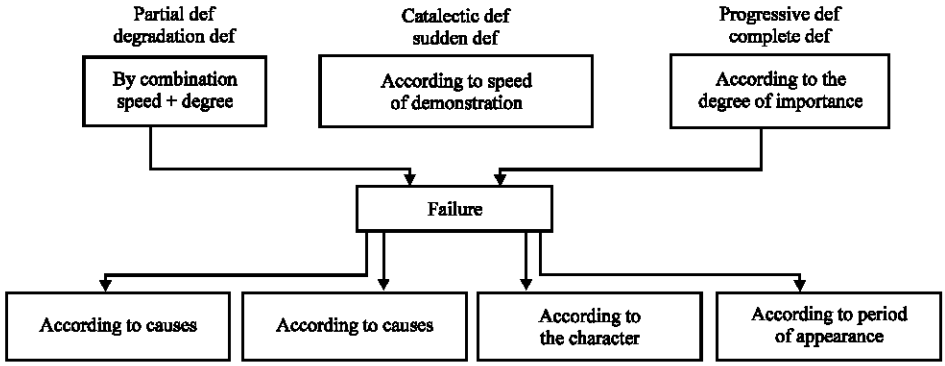

Fig. 3: Characters of failures

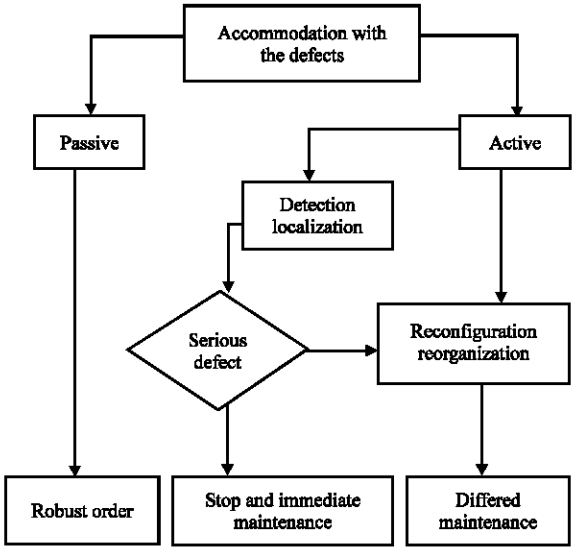

Fig. 4: Context of reconfiguration

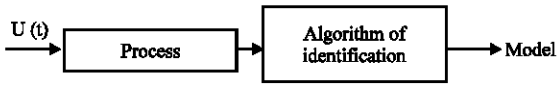

Fig. 5: Identification starting from the behavior input-output

parameters. GAUSS tried to foresee the movement of planets from observations by telescope call YI the different done measures and either OF IT (t) a combination [mayor of these measures pondered by parameters has that we try to determine

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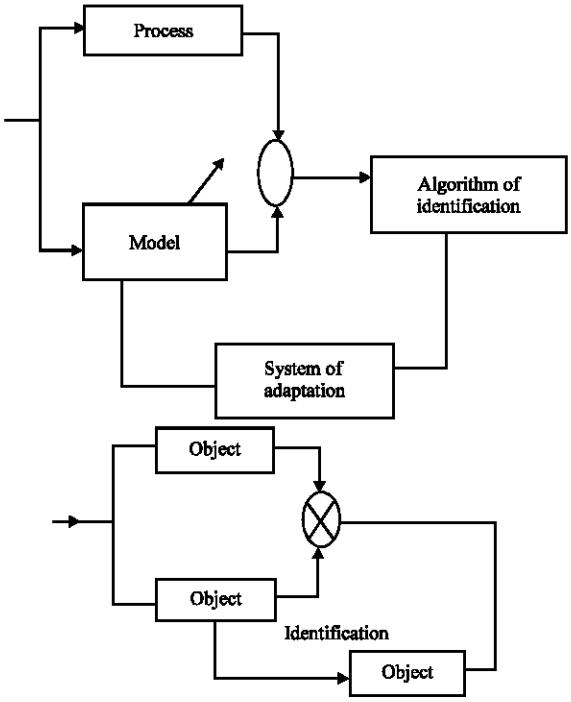


Fig. 6: Identification of the parametric type

combination [mayor of these measures pondered by parameters has that we try to determine

$$Y(t) = a_1 y_1(t) + a_2 y_2(t) + \ldots\ldots\ldots\ldots a_p y_p(t) \qquad (1)$$

To facilate the writen formulas we can adopt the following notions

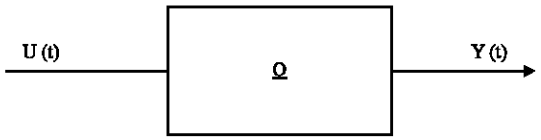
$$\underline{H} = [y_1, \ldots y_p]$$
$$\underline{O} = [a_1, \ldots a_p]^T \qquad (2)$$

$\underline{H}$ et $\underline{O}$ are respectively the measured and the calculated parameters

Then the relation (2.1) can be written as:

$$Y(t)=\underline{H}^{T}(t).\underline{O} \quad (3)$$

Remark: Formulation given by the expression (3) is sufficiently general to correspond to different formulations of problems. Indeed, let's consider a linear system of u entry (t) and of exit of it (t) being able to be scalar or vectorial.



One can also write

$$OF\ IT\ (T) = F\ (OH\ U\ (T)) \quad (4)$$

The problem in this case is to determine OH knowing the u entry (t) and the exit of it (t). If we suppose that our signals are sampled to the T period, the various samples seront[4].

$$Y(T),\ Y(2T),\ldots.\ Y(KT),\ U\ (T)\ \ldots\ldots\ U\ (KT) \quad (5)$$

That we will note of it more merely (K) and u (K) so the equation (3) will be written henceforth under the shape:

$$OF\ IT\ (K) = H\ (K).\ O \quad (6)$$

Problem: Our problem is how from the observation of(K) the parameters can be determined?

COMPUTING AND RESULTS

The numeric simulation is considered like a tool privilege of system survey,we used the software matlab (matrixe laboratry), it is a system of numeric calculation and intended graphic visualization.

It possesses a programming language at a time simple and fast and it permits to express solutions to problems in a comfortable way.

Matlab imposes itself in the academic world like a powerful calculation tool, it is used in the teaching of the linear algebra, the treatment of the automatic signal etc.

The content of the present example illustrates the gait followed for the conception of vestigial signals, indicatory of anomalies to nivauxes of resistances of 1'induît and the excitation of a motor to current continuous to separated excitation whose parameters are:

P = 5,8 [KWJ; U EXE = U1ND = 220 [V]; IIND = 34 [AJ. RIND = 0.62 LS [W]; IEXE = 1. 3[A] REXE = L69.23 [W]; F = 0.7*L0-2 [WB]; NINDICATEUR = 1800; Ninduit = 1112 ;2ps = 4; 2a=2; n = 750 ÷S 1500 [tr / min] ;ta = ambient temperature when the coil is chaud[c]; r2 = resistance of the coil to hot [W] RI = resistance of the coil to cold weather [W]; tl = temperature of the coil to cold weather [c]; 234 equal constant to l/a = 1/0.00427; Class TO;Admissible resistance = 0.882[W]

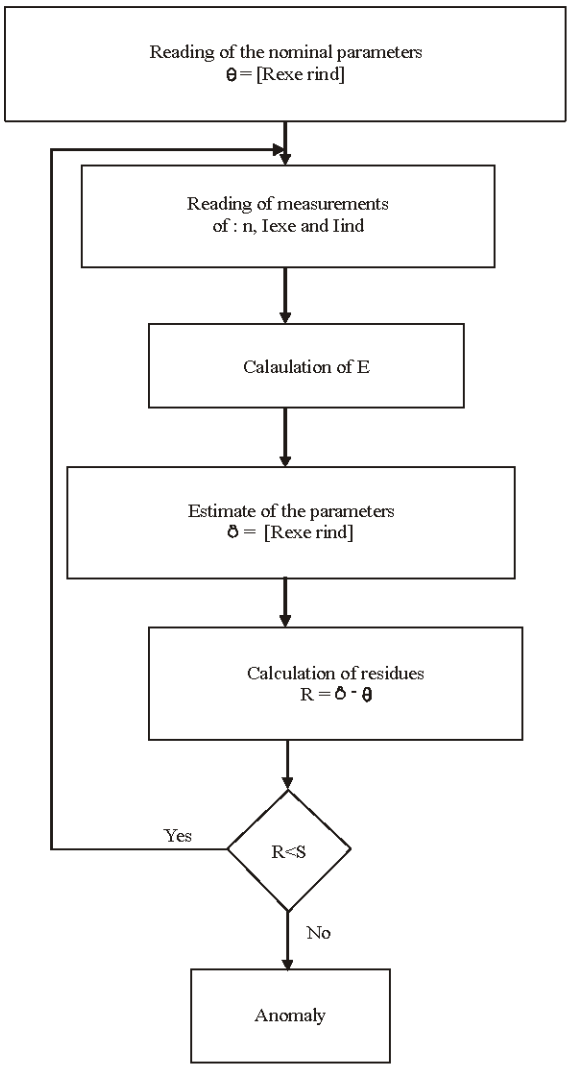


Fig. 7: Flow chart

The main stages of the program are described by the following organization chart:

Curves and comments: This face shows a normal evolution of two resistances (induced and excitation), according to several measured done distinctly during the working of the motor resistances to cold weather of the induced and the inductive are distinctly elevated, what is quite normal[5]. It shows a normal evolution of two

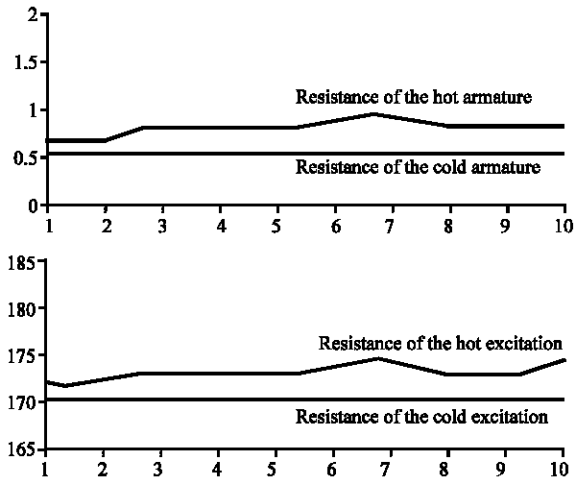


Fig. 8 Evolution of the parameters resistance of the armature and the excitation anomalies

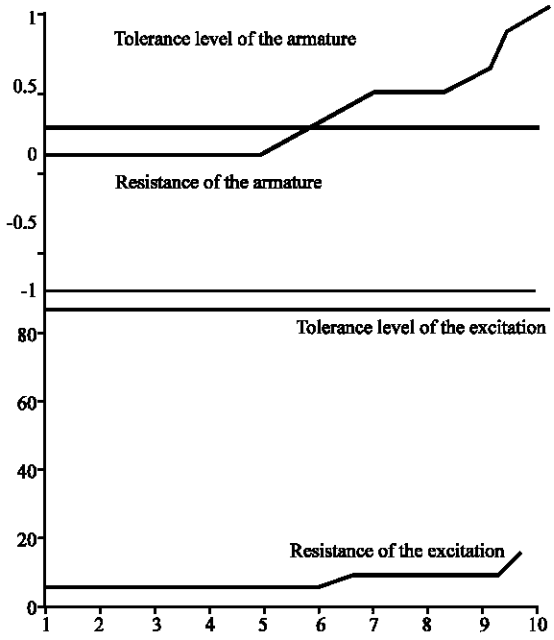


Fig. 9: Evolution of the parameters resistances of the armature and the excitation with going beyond

resistances (induced and excitation), according to several measured done distinctly during the working of the motor resistances to cold weather of the induced and the inductive are distinctly elevated, what is quite normal[5].

At another moment and in the same conditions of measures the evolution of parameters is not more identical one notices that from the 5érne sample measured the resistance of the induced increases quickly.

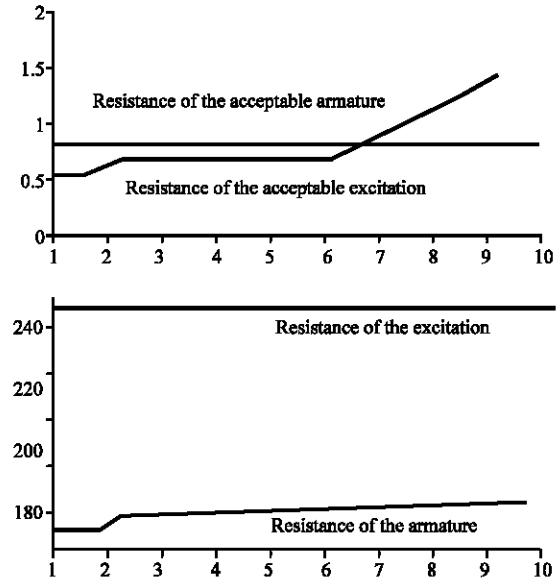


Fig. 10: Generation of the residues

And that to the level of the 6éme sample, him y'a overtaking of the admissible resistance that to been fixed to 0.886 WS].

As for the resistance of the inductive it followsalso an increasing evolution but very nit what lets it very far from the admissible resistance but that remains nevertheless close to the nominal resistance[6].

The doorstep of tolerance that was stationary as being the gap between the admissible value and the face value is a good indicator.

The difference of parameter evolutions nominal The doorstep of tolerance that was stationary as being the gap between the admissible value and the face value is a good indicator.

The difference of parameter evolutions nominal es réel génèrent un signal appelé résidu celui-ci reste proche de zéro en fonctionnement normal, mais il s'éloigne de celui-ci dès qu'il y a anomalie, on peut décider qu'il y a occurrence d'une anomalie si ça dépasse le seuil préfixe comme cela est le cas au niveau de la résistance de l'induit[7].

DISCUSSIONS

The previous curves show the evaluation of the electric parameters of a motor to current continuous to excitation separated that is has say resistances of the induced and the inductive during normal and abnormal working. One knows well that when the motor is loaded the current increases in the induced, what provokes the increase of losses by effects day, in coils of the induced and the inductive.

The total losses in the motor increase with the load, these losses turn into heat, it results an elevation of temperature of it. When a driver's temperature increases, the agitation of atoms becomes more pronounced, the opposition to the displacement of electrons (current) increases, because collusions between electrons and atoms increase, what explains the increase of the resistance and therefore the resistance of metals drivers (induced and inductive)[8].

GENERAL CONCLUSION

The evolution of the production requires an optimal working safety, this one must be required to avoid the alias of production and stops non wanted that cost dear to the industrial. These undesirable effects are consequences of component breakdowns non submitted to a system of surveillance and the ideal for the industrial is of tender toward the zero breakdown. From where requires it to conceive systems of surveillance whose role is to detect in real time failings and to avoid their propagation.

- This research appears in the general setting of the diagnosis of a motor to current continuous to separated excitation.
- It is especially interested in the detection of shortcomings of a level of resistances of the induced and the inductive.
- Our essential contribution, door on the proposition of detection algorithm on the method of the least square, that has been validated in simulation.
- Otherwise, it would be interesting to study, in news perspectives, of other methods of evaluation parametric of which the one of the least recursive squares for the in line application in order to detect anomalies in:
- All types of motors to continuous current (set, shunt, compound and separated): with the method of least square one can estimate the resistance of induced, 1a resistances of the inductive and the two in even temp.
- Motors have alternating current whose model is descended of the transformation of park.
- Detection at the level of the stator (r_s;1s).
- Detection at the level of the rotor (r_r,l_r).
- Detection of the mutual m_{sr}.

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