# INTERPRETATION OF THE GRADIENT AND THE DIRECT DECOUPLING OF THE ADAPTED RESIDUE

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***Abstract :*** ***The objectives are quality improvement and cost reduction, because these are more and more important in the industrial applications, especially for automatic systems, because of their increased complexity. The quality concept is not a new parameter in system design: in this way the command who use the statistic method it was used in USA in 1930. The quality administration began in 1970 in Japan and then in 1980 in Europe. The quality improvement and the diagnosis reside in the detection, localization and identification of variances and/or of the faults that affect the electrical system. The diagnosis can be generally defined as being the supervising of an electrical system. This allows the improvement of quality and the reduced intervention cost in different phases in the life cycle of the product.***

***Keywords:*** *gradient ,calculation,faults,parameters*

## 1. INTRODUCTION

For the adapting of the heat residue $r_T$ the gradient calculation is used $\delta_T = \partial r_T / \partial \hat{d}_T$ and it is obtained from the following equation:

$$\begin{bmatrix}\dot{\hat{x}}_e \\ \frac{\partial \hat{x}_e}{\partial \hat{d}_T}\end{bmatrix} = \underbrace{\begin{bmatrix} A(\Omega,\hat{d}_T) & 0 \\ \frac{\partial A(\Omega,\hat{d}_T)}{\partial \hat{d}_T} & A(\Omega,\hat{d}_T)\end{bmatrix}}_{\tilde{A}_C(\Omega,\hat{d}_T)} \cdot \begin{bmatrix}\hat{x}_e \\ \frac{\partial \hat{x}_e}{\partial \hat{d}_T}\end{bmatrix} + \underbrace{\begin{bmatrix}B\\0\end{bmatrix}\cdot K_{23}\cdot u}_{\tilde{B}_C} \qquad (1)$$

$$r_T = K_{22}\cdot y_e - C\cdot \hat{x}_e$$

$$\delta_T = \frac{\partial r_T}{\partial \hat{d}_T} = -C.\frac{\partial \hat{x}_e}{\partial \hat{d}_T} \qquad (2)$$

$\delta_{T,k}$ represents locally and a given moment k, the direction in which $r_T$ is moving when $\hat{d}_T$ increases. Suppose that the modelled errors are neglected and that $\hat{d}_T \approx d_T$, $\delta_T$ is a very good estimate direction in which $d_T$ (and not $\hat{d}_T$ ) acts above them. The component of $r_T$ is parallel to $\delta_T$, notated $r_T^{''}$ , is the one that can be expressed with $d_T$ variances. If the $\hat{d}_T$ adapting was perfect, this composition would be null; but in practice , there is always a difference between $d_T$ and the convergency of $\hat{d}_T$. The orthogonal composition $r_T$ on $\delta_T$, notated $r_T^{\perp}$ is the one that can not be express with $d_T$ variances.

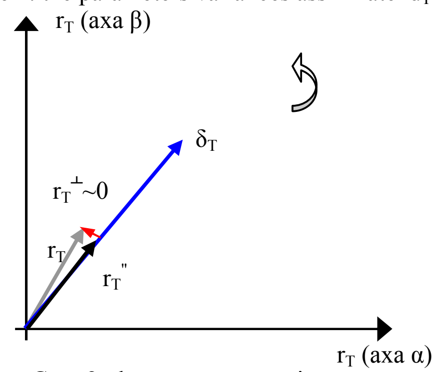
$$r_{T,k}^{''} = \frac{\delta_{T,k}^{\ T}\cdot r_{T,k}}{\left\|\delta_{T,k}\right\|}, \qquad r_{T,k}^{\perp} = \frac{\delta_{T,k}^{\perp\ T}\cdot r_{T,k}}{\left\|\delta_{T,k}^{\perp}\right\|} \qquad (3)$$

NOTE: in the relation no. (3), the orthogonal direction of the $d_T^{\perp}$ gradient is unique, because $\delta_T$ is a vector of dimension 2. The generalization to a superior dimension of 2 is given by:

$$r_{T,k}^{''} = \frac{\delta_{T,k}^{\ T}\cdot r_{T,k}\cdot \delta_{T,k}}{\delta_{T,k}^{\ T}\cdot \delta_{T,k}}, \qquad r_{T,k}^{\perp} = r_{T,k} - r_{T,k}^{''} \qquad (4)$$

The diagram (1) reflects the relative positions of $r_T$ and of $\delta_T$ in the two situations: in the first case, the variances of the system parameters are being assimilated with a $d_T$ variance; and in the second case they don't vary.

Case 1: the parameters variances assimilate $d_T$




Case 2: the parameters variances assimilate $d_T$

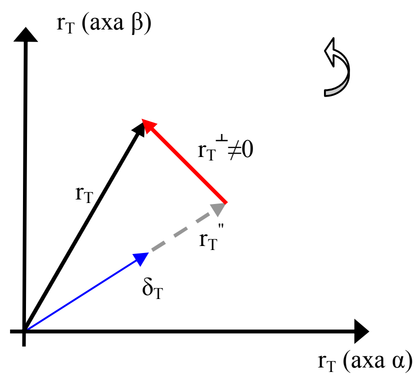
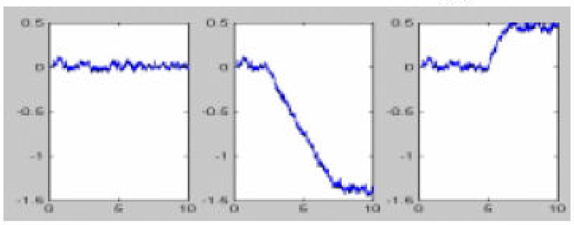



Diagram 1. The local interpretation of the gradient.

The $d_T^{\perp}$ residue is senzitive to the transitory conections with the estimate onvergency and it remains approximately 0, when the parameters variances are assimilated with $d_T$ (in the first case). The $d_T^{\perp}$ residue is senzitive to all parameters variances not assimilated with $d_T$ (the second case): this residue can satisfy the objectives points for detection. Moreover, the $r_T$ residue and its gradient $\delta_T$ are subjected to the same sinusoidal stimuli, (1) and (2). Thereby, $r_T$ and $\delta_T$ are two vectors rotating at the same speed [1] in the $(\alpha,\beta)$ plan. Consequently, the $r_T^{\perp}$ residue presents a continuous, not null composition when a variance of parameters is produced that is not assimilated with $d_T$ (and null in the opposite case). The presence of the continuous composition allows the use of a down pass elementary filter for the signal increase and for the improvement of the senzitivity in detection. The diagram 2 reflects that the faults L and $f_\Omega$ can be difficult to detect starting from $r_T^{\perp}$; in addition, $r_T^{\perp}$ is very little sensible at R.

R:30% L:5% $f_\Omega$:10%



The diagram 2: $F_{0,999}$ residue ($r_T^{\perp}$) for different and simple scenaries (ScSi).

The transitory regime of small amplitude on $r_T^{''}$ for the R (heating) scenario reflects a difference between $d_T$ and the "real" value $d_T$ (diagram 3). On the hole time of existence of peak amplitude (from 2s to 7s) the gradient algoritm <short> shows up after the <real> value of $d_T$ without interceding directly. Therewith, the linear approximate being very good locally, $r_T^{\perp}$ stays null, in these conditions (diagram 2).

R:30% L:5% $f_\Omega$:10%

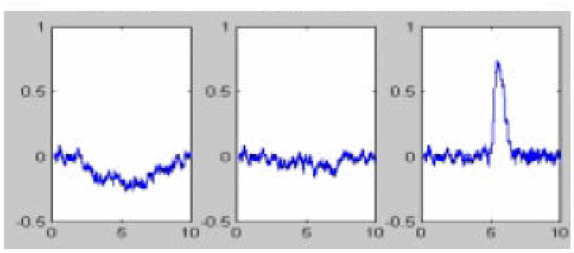


Diagram 3: $F_{0,999}$ residue ($r_T$) for different and simple scenaries (ScSi).

This speed can very well vary in time: for example the behavior to a varying speed MAS((

The $r_T^{''}$ residue is very weak for the L scenarion (diagram 3). This means that the inductances variances seem very small compared with the resistance variances. This result confirms the graphic study of the senzitivity that we used, where, the area associated to resistance variations considerably increased together with the area associated to inductance variations. On the contrry, the $f_\Omega$ action is only partially assimilable with this resistance variances, in any place where $f_\Omega$ is present (between 5s and 6s). This similitude is next to be confirmed with a new graphic study for senzitivity, in the next paragraph.

In order to study the $r_T^{\perp}$ behavior in more realistic conditions, complexe scenarios (ScSo) were simulated, and the faults are dusplayed in the same time with the resistance variances (heating). Moreover, the resistance variances model dependent on heating (5) is not known (the "aprox." mentioning from diagram 4): when the simulation of the physic system is accomplished with $k_s=k_r$, the generator residue is calculated for $k_s=0.8*k_r$, that is a 20% deviation from the relative magnitude arrangement of the $R_s$ and $R_r$ variances.

$$R_s = R_{s0}\cdot(1+k_s\cdot d_T)$$
$$R_r = R_{r0}\cdot(1+k_r\cdot d_T) \qquad (5)$$

Some simulations, which are not presented in this work, show that, on the one hand, the "aprox." effect and the simultaneous presence of R faults on the other hand, does not significantly modify the results of diagram 2. Passing from a simple scenario (ScSi) to a complex scenario (ScCo) influences much more fault senzitivity: variances of 5% thus correspond to the senzitivity limit (diagram 4).

R:30% Aprox.,(ScSi) R:30% Aprox.,(ScCo) L:5%R:30% Aprox.,ScCo) $f_\Omega$:10%, R:30 Aprox., (ScCo)

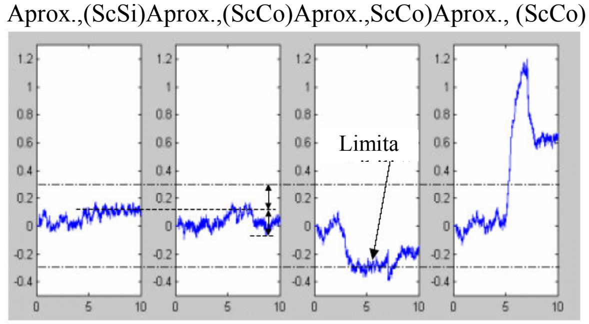



Diagram 4. $F_{0,999}$ residue ($r_T^{\perp}$) with afferent incertitude of heating model. for simple scenary (ScSi) and complex scenary (ScCo)

**II. CONCLUSION:**

1) a possible interpretation for the weak influence of "aprox." is as follows: even if the heating model is not so precise, it modells the last one by the resistance variances (and not other parameters) and denotes the fact that the variances are being achieved in the same way (when $k_s$ and $k_r$ have identic signs). Without keeping account of the relative magnitude arrangement of resistance variances, this type of information is important (diagram 4).

2) when the fault is missing, $\hat{d}_T$ gives an indication about the thermic state of the engine. Let us note that an abnormal highest value of $\hat{d}_T$ can be utilized when deciding to switch off the engine.

The $r_T$ residue and it's orthogonal composition of the gradient, $r_T^{\perp}$, allow us to perform the objectives of the robust detection, viewing in the same time the charge couple and the different resistance variances induced by a heating. The continuous composition $r_T$ allows fault detection of the "open switch in ondulator " type ($f_v$) and the electrical current capture type ($f_I$) and locating this grup of defects. The parameters faults (the engine faults $f_P$ and the translator of rate faults $f_\Omega$) are detected with its assistance.

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