

complied with, thus giving warning at a very advanced stage of any incidents or accidents that could arise.

These techniques necessitate predefining rules for detecting events, usually defined as exceeding thresholds
 5 of one or more parameters, which may trigger alerts so that the expert analyses more closely the flight.

A problem is that these techniques do not make it possible to detect singular events beyond the predefined rules, which may lead to a non detection of an abnormal
 10 flight.

DESCRIPTION OF THE INVENTION

~~An aim~~ Embodiments of the invention ~~is seek~~ to make it possible to detect abnormal flights without having the
 15 need to define detection rules.

~~To this end,~~ According to an aspect of the present invention, ~~proposes there is provided~~ a method of analysing flight data recorded during N flights of at least one aircraft, by means of a flight data recorder of
 20 an aircraft, the data being grouped together by flight i in a signature vector of the flight X_i of size d , the components of which correspond to data recorded during said flight i of the aircraft, a flight i being thus defined by the signature vector X_i , the method
 25 comprising the following steps:

- Gaussian kernel entropy component analysis of the flight signatures X_i to obtain a zone of normal flights and classifying the flight signatures X_i with respect to their distance to said zone;

- determining, for each flight i , an abnormality score z_i defined by the distance of a flight signature X_i with respect to the zone of normal flights;

- detecting, as a function of the abnormality score z_i , at least one abnormal flight.

The—Embodiments of the invention is—are advantageously completed by the following
 5 characteristics, taken singly or in any technically possible combination thereof:

- for each abnormal flight detected, a phantom flight the nearest to the abnormal flight detected is determined while being in the zone of normal
 10 flights.
- the parameters of the abnormal flight detected are compared with those of the phantom flight determined in order to detect at least one parameter of the abnormal flight that has rendered abnormal said
 15 abnormal flight detected.
- the Gaussian entropy component analysis comprises the following sub-steps:
 - o determination of a matrix of similarity K of size $N \times N$, the components of which quantify the
 20 proximity between two flight signatures X_i ;
 - o breakdown into eigen vectors of the matrix of similarity K to obtain N eigen vectors $a_1, \dots, a_N$ and N eigen values $\lambda_1, \dots, \lambda_N$ such that $\forall i=1, \dots, N \quad K \cdot a_i = \lambda_i \cdot a_i$;
 - o determination, for each eigen vector, of its
 25 entropy coefficient γ_i
 - o selection of a sub-assembly of eigen vectors $\{a_m\}_{m \in \{1, \dots, N\}}$ such that the sum of the entropies γ_m is greater than the percentage of the sum of
 30 the N entropies γ_i .

- the data of a flight i are grouped together in a matrix F_i of dimension $T \times P$ with T the number of data recorded during the flight i and P the number of parameters recorded, the vector X_i having for components the average, the variance, the minimal value, the maximal value of a parameter among all the recordings of this parameter, the vector X_i being then defined by:

$$X_i = [\text{mean}(F_i(p=1)), \text{var}(F_i(p=1)), \text{max}(F_i(p=1)), \text{max}(F_i(p=1)), \\ \vdots \\ \text{mean}(F_i(p=P)), \text{var}(F_i(p=P)), \text{max}(F_i(p=P)), \text{max}(F_i(p=P))]$$

10 | ~~The Embodiments of the invention has~~ may have numerous advantages.

With ~~According to embodiments of the invention, the detection of abnormal flights is~~ can be automatic and does not necessitate the intervention of an expert for
15 | said detection.

With ~~According to embodiments of the invention the detection is~~ may be implemented in a statistical manner while taking into account parameters. In this way, there
20 | ~~is~~ may be an automatic learning that takes place.

20 | ~~The Embodiments of the invention enables~~ may enable unexpected problems to be highlighted.

~~The Embodiments of the invention enables~~ may enable problems stemming from the contribution of several parameters to be detected.

25 | The method according to embodiments of the invention may be used by a non expert in statistics or data mining.

Moreover, ~~with~~ according to embodiments of the invention, the diagnosis of abnormal flights is simple because it makes it possible to create a reference

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flight, the phantom flight for each abnormal flight detected.

CLAIMS

1. Method of analysing flight data recorded during
5 N flights of at least one aircraft, by means of a flight
data recorder of an aircraft, the data being grouped
together ~~(E2)~~ by flight i in a signature vector of the
flight X_i of size d , the components of which correspond
to data recorded during said flight i of the aircraft, a
10 flight i being thus defined by the signature vector X_i ,
the method comprising the following steps:
- Gaussian kernel entropy component analysis ~~(E4)~~ of
the flight signatures X_i to obtain a zone of normal
flights ~~(E)~~ and classifying the flight signatures
15 X_i with respect to their distance to said zone;
 - determining ~~(E5)~~, for each flight i , an abnormality
score z_i defined by the distance of a flight
signature X_i with respect to the zone of normal
flights ~~(E)~~;
 - 20 - detecting ~~(E6)~~, as a function of the abnormality
score z_i , at least one abnormal flight.

2. Analysis method according to claim 1, in which,
for each abnormal flight detected, a phantom flight the
25 nearest to the abnormal flight detected is determined
while being in the zone of normal flights.

3. Analysis method according to claim 2, in which
the parameters of the abnormal flight detected are