METHOD FOR DETETCTING WHETHER PERFORMANCE OF AIRCRAFT COMPONENTS IS IN THE DETERIORATION PERIOD

TECHNICAL FIELD OF THE INVENTION

[0001]The present application relates to a method related to the maintenance of an aircraft, in particular to a method for detecting whether the performance of the aircraft components is in the decline period.

BACKGROUND

[0002]Aircraft is an important vehicle. A lots of passengers travel by flying everyday. Therefore, the safety of flight must be ensured. When a component of the aircraft fails, the aircraft must be grounded and maintained until problems are resolved. Thus, it is possible that the aircraft is delayed and even grounded once a component of the aircraft fails.

[0003]At present, maintenance of the aircraft mainly is post-processing or performed on a fixed schedule. As mentioned above, post-processing is hard to avoid delay and grounding of the aircraft, since maintenance of some parts of the aircraft is a time-consuming process. Sometimes, there are no spare parts in the airport for replacing due to high price or using up thereof, which will directly cause grounding of the aircraft. Maintaining on a fixed schedule means a certain component of the aircraft is maintained or replaced after a fixed time, which can avoid delay or grounding of the aircraft to some extent, however, its cost is too high. In particular to some expensive parts, their performance may be well when they are replaced, which is huge waste. Furthermore, under some special circumstances, some components of the aircraft may decline quickly. And in this case, maintenance according to a fixed schedule cannot avoid the delay and grounding of the aircraft completely.

SUMMARY

[0004]To the one or more technical problems in the conventional technology, in one aspect of the present application, there provides a method for detecting whether performance of an aircraft component is in a decline period, comprising: obtaining one or more detection parameters reflecting operation status of the aircraft component; comparing data of the one or more detection parameters with respective desired values; and determining whether the performance of the

CLAIMS

1. A method for detecting whether performance of an aircraft component is in a decline period, comprising:

obtaining one or more detection parameters reflecting operation status of the aircraft component;

comparing data of the one or more detection parameters with respective predetermined values; and

determining whether the performance of the aircraft component is in the decline period based on the comparison results.

2. A method according to claim 1, wherein, the step of obtaining comprising:

obtaining multiple parameters related to operation status of the aircraft component;

associating data of the multiple parameters with failure events of the aircraft component; and

determining the detection parameters based on the associations between the multiple parameters and the failure events.

3. A method according to claim 2, wherein, the steps of associating data of the multiple parameters with failure events of the aircraft component and determining the detection parameters based on the associations comprising:

calculating correlations between data changes of the multiple parameters and the failure events; and

setting one or more parameters, which have greater correlations than a threshold, of the multiple parameters as the detection parameters.

4. A method according to claim 3, wherein, a range of the threshold is 0.3-0.5.

5. A method according to claim 3, wherein, a range of the threshold is 0.5-0.7.

6. A method according to claim 3, further comprising:

calculating correlations between the multiple detection parameters; and

removing one or more of the multiple detection parameters based on the correlations between the multiple detection parameters.

7. A method according to claim 1, wherein, the step of obtaining comprising:

obtaining multiple parameters related to operation status of the aircraft component; and

determining the detection parameters based on respective physical representations indicated by the multiple parameters.

8. A method according to claim 1, wherein, the predetermined value is an extreme value of the one or more detection parameters; and

the step of comparing comprising:

calculating differences or ratios between measured values of one or more detection parameters and their respective extreme values.

9. A method according to claim 8, wherein, the measured values of the one or more detection parameters are replaced with converted values under a specific condition.

10. A method according to claim 8, wherein, the step of determining comprising:

determining whether the measured values of the one or more detection parameters are close to or exceed the respective extreme values.

11. A method according to claim 8, further comprising:

assigning a weight to the ratio between the measured value of each of the one or more detection parameter and the respective extreme value.

12. A method according to claim 11, further comprising:

obtaining the weight of each detection parameter based on a correlation between data change of the multiple detection parameters and the failure events of the aircraft component.

13. A method according to claim 11, wherein, the step of determining comprising:

integrating the weighted ratios of the measured values of the multiple detection parameters to the extreme values thereof to obtain performance reference values of the aircraft component.

14. A method according to claim 13, further comprising:

determining the performance of the aircraft component is in the decline period if the reference value of the aircraft component is greater than a threshold value.

15. A method according to claim 1, wherein, the predetermined value is a reference slope of a change trend of one or more detection parameters, and

wherein the step of comparing comprising:

calculating a slope of a change trend of the measured values of the one or more detection parameters in a period.

16. A method according to claim 15, further comprising:

comparing the slope of a change trend of the measured values of the one or more detection parameters in a period with the reference slope to determine whether there is significant difference between them.

17. A method according to claim 16, wherein, the step of determining whether the performance of the aircraft component is in the decline period based on the comparison result comprising:

determining the performance of the aircraft component is in the decline period if there is significant difference between the slope of a change trend of the measured values of the one or more detection parameters in a period and the reference slope.

18. A method according to claim 15, wherein, the reference slope is a slope of change trend in a period after the aircraft component is initially installed.

19. A method according to claim 15, wherein, the reference slope is a slope of change trend in a period of the same aircraft component having good working condition in other identical model of aircraft.

20. A method according to claim 15, further comprising:

replacing the measured values of the one or more of the detection parameters with converted values under a specific condition.

21. A method according to claim 15, further comprising:

performing a smooth processing on the measured values of the one or more of the detection parameters.

22. A method according to claim 21, wherein, the smooth processing adopts multipoint average rolling mean algorithm.

23. A method according to claim 21, wherein, the smooth processing adopts following formula:

$$X_{new} = C1X_{smooth} + C2X_{old}$$

wherein, X_{old} is the measured value, X_{new} is a value after the smooth processing, X_{smooth} is a value of adjacent points after the smooth processing or is an average value of several adjacent points, C1 and C2 are the weight values.

24. A method according to claim 1, wherein, the step of comparing:

setting measured values of the one or more detection parameters in a period as a sample;

setting measured values of the one or more detection parameter in a pervious period of the same length as a reference sample; and

determining whether there is significant difference between the sample and the reference sample based on an independent sample test.

25. A method according to claim 24, wherein, the step of determining whether the performance of the aircraft component is in the decline period based on the comparison result comprising:

determining the performance of the aircraft component is in the decline period, if there is significant difference between the sample of the measured values of one or more detection parameters in a period related and the corresponding reference sample.

26. A method according to claim 24, further comprising:

replacing the measured values of the one or more detection parameters with converted values under a specific condition.

27. A method for maintaining an aircraft, comprising:

determining whether the performance of the aircraft component is in the decline period based on the method in any one of claims 1-26;

arranging a maintenance schedule of the aircraft if the performance of the aircraft component is in the decline period; and

maintaining the aircraft component of the aircraft.

28. A method for obtaining one or more detection parameters reflecting operation status of an

aircraft component, comprising:

obtaining multiple parameters related to operation status of the aircraft component;

associating data of the multiple parameters with failure events of the aircraft component; and

determining the detection parameters based on the associations between the multiple parameters and the failure events.

29. A method according to claim 28, wherein, the step of obtaining comprising:

calculating a correlation between a data change of the multiple parameters and the failure events; and

setting one or more parameters, which have greater correlations than a threshold, of the multiple parameters as the detection parameters.

30. A method according to claim 29, wherein, a range of the threshold is 0.3-0.5.

31. A method according to claim29, wherein, a range of the threshold is 0.5-0.7.

32. A method according to claim29, further comprising:

calculating correlations between the multiple detection parameters; and

removing one or more of the multiple detection parameters based on the correlations between the multiple detection parameters.

33. A method according to claim28, wherein, the step of obtaining comprising:

obtaining multiple parameters related to operation status of the aircraft component; and

determining the detection parameters based on respective physical meaning indicated by the multiple parameters.

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TECHNICAL FIELD OF THE INVENTION

[0001]The present application relates to a method related to the maintenance of an aircraft, in particular to a method for detecting whether the performance of the aircraft components is in the decline period.

BACKGROUND

[0002]Aircraft is an important vehicle. A lots of passengers travel by flying everyday. Therefore, the safety of flight must be ensured. When a component of the aircraft fails, the aircraft must be grounded and maintained until problems are resolved. Thus, it is possible that the aircraft is delayed and even grounded once a component of the aircraft fails.

[0003]At present, maintenance of the aircraft mainly is post-processing or performed on a fixed schedule. As mentioned above, post-processing is hard to avoid delay and grounding of the aircraft, since maintenance of some parts of the aircraft is a time-consuming process. Sometimes, there are no spare parts in the airport for replacing due to high price or using up thereof, which will directly cause grounding of the aircraft. Maintaining on a fixed schedule means a certain component of the aircraft is maintained or replaced after a fixed time, which can avoid delay or grounding of the aircraft to some extent, however, its cost is too high. In particular to some expensive parts, their performance may be well when they are replaced, which is huge waste. Furthermore, under some special circumstances, some components of the aircraft may decline quickly. And in this case, maintenance according to a fixed schedule cannot avoid the delay and grounding of the aircraft completely.

SUMMARY

[0004]To the one or more technical problems in the conventional technology, in one aspect of the present application, there provides a method for detecting whether performance of an aircraft component is in a decline period, comprising: obtaining one or more detection parameters reflecting operation status of the aircraft component; comparing data of the one or more detection parameters with respective desired values; and determining whether the performance of the

The invention claimed is:

1. A computerized method for detecting whether performance of an aircraft component is in a decline period, comprising:

obtaining one or more detection parameters reflecting operation status of the aircraft component and storing the detection parameters in a memory store;

comparing data of the one or more detection parameters with respective predetermined values, at least one of said values provided as a reference slope of a change trend of at least one detection parameter, and wherein the step of comparing comprises calculating a slope of a change trend of the measured values of the one or more detection parameters in a period;

using a processor to determine whether the performance of the aircraft component is in the decline period based on the comparison results; and

performing a smooth processing on the measured values of at least one of the detection parameters,

wherein the smooth processing adopts following formula:

$$X_{new}=C1X_{smooth}+C2X_{old}$$

wherein, X_{old} is the measured value, X_{new} is a value after the smooth processing, X_{smooth} is a value of adjacent points after the smooth processing or is an average value of several adjacent points, C1 and C2 are weighted values.

2. A method according to claim 1, wherein, the step of obtaining comprises:

obtaining multiple parameters related to operation status of the aircraft component;

associating data of the multiple parameters with failure events of the aircraft component; and

determining the detection parameters based on the associations between the multiple parameters and the failure events.

3. A method according to claim 2, wherein, the steps of associating data of the multiple parameters with failure events of the aircraft component and determining the detection parameters based on the associations comprising:

calculating correlations between data changes of the multiple parameters and the failure events; and

setting one or more parameters, which have greater correlations than a threshold, of the multiple parameters as the detection parameters.

4. A method according to claim 3, wherein, a range of the threshold is 0.3-0.5.

5. A method according to claim 3, wherein, a range of the threshold is 0.5-0.7.

6. A method according to claim 3, further comprising:

calculating correlations between the multiple detection parameters; and

removing one or more of the multiple detection parameters based on the correlations between the multiple detection parameters.

7. A method according to claim 1, wherein, the step of obtaining comprises:

obtaining multiple parameters related to operation status of the aircraft component; and

determining the detection parameters based on respective physical implications indicated by the multiple parameters.

8. A method according to claim 1, wherein, the predetermined value is an extreme value of the one or more detection parameters; and

the step of comparing comprises:

calculating differences or ratios between measured values of one or more detection parameters and their respective extreme values.

9. A method according to claim 8, wherein, the measured values of the one or more detection parameters are replaced with converted values under a specific condition.

10. A method according to claim 8, wherein, the step of determining comprises:

determining whether the measured values of the one or more detection parameters are close to or exceed the respective extreme values.

11. A method according to claim 8, further comprising:

assigning a weight to the ratio between the measured value of each of the one or more detection parameter and the respective extreme value.

12. A method according to claim 11, further comprising:

obtaining the weight of each detection parameter based on a correlation between data change of the multiple detection parameters and the failure events of the aircraft component.

13. A method according to claim 11, wherein, the step of determining comprises:

integrating the weighted ratios of the measured values of the multiple detection parameters to the extreme values thereof to obtain performance reference values of the aircraft component.

14. A method according to claim 13, further comprising
determining the performance of the aircraft component is in the decline period if the reference value of the aircraft component is greater than a threshold value.

15. A method according to claim 1, wherein, the predetermined value is a reference slope of a change trend of a plurality of detection parameters.

16. A method according to claim 15, further comprising:
comparing the slope of a change trend of the measured values of the one or more detection parameters in a period with the reference slope to determine whether there is significant difference between them.

17. A method according to claim 16, wherein, the step of determining whether the performance of the aircraft component is in the decline period based on the comparison result comprises:
determining the performance of the aircraft component is in the decline period if there is significant difference between the slope of a change trend of the measured values of the one or more detection parameters in a period and the reference slope.

18. A method according to claim 15, wherein, the reference slope is a slope of change trend in a period after the aircraft component is initially installed.

19. A method according to claim 15, wherein, the reference slope is a slope of change trend in a period of the same aircraft component having good working condition in other identical model of aircraft.

20. A method according to claim 15, further comprising:
replacing the measured values of the one or more of the detection parameters with converted values under a specific condition.

21. A method according to claim 1, wherein, the smooth processing adopts a smoothing average algorithm.

22. A method according to claim 1, wherein, the step of comparing:

setting measured values of the one or more detection parameters in a period as a sample;

setting measured values of the one or more detection parameter in a pervious period of the same length as a reference sample; and

determining whether there is significant difference between the sample and the reference sample based on an independent sample test.

23. A method according to claim 22, wherein, the step of determining whether the performance of the aircraft component is in the decline period based on the comparison result comprises:

determining the performance of the aircraft component is in the decline period, if there is significant difference between the sample of the measured values of one or more detection parameters in a period related and the corresponding reference sample.

24. A method according to claim **22**, further comprising:

replacing the measured values of the one or more detection parameters with converted values under a specific condition.

25. A method for maintaining an aircraft, comprising:

determining whether the performance of the aircraft component is in the decline period based on the method in claim 1;

arranging a maintenance schedule of the aircraft if the performance of the aircraft component is in the decline period; and

maintaining the aircraft component of the aircraft.

26. A computerized method for obtaining one or more detection parameters reflecting operation status of an aircraft component, comprising:

obtaining multiple parameters related to operation status of the aircraft component and storing the detected parameters in a memory store;

associating data of the multiple parameters with failure events of the aircraft component by monitoring a slope change in the parameters based on measured values, at least one of the parameters provided as a reference slope of a change trend of at least one detection parameter, and wherein the associating comprises calculating a slope of a change trend of the measured value of the one or more detection parameters in a period;

using a processor to determine the detection parameters based on the associations between the multiple parameters and the failure events; and

performing a smooth processing on the measured values of the one or more of the detection parameters,

wherein, the smooth processing adopts following formula:

$$X_{new}=C1X_{smooth}+C2X_{old}$$

wherein, X_{old} is the measured value, X_{new} is a value after the smooth processing, X_{smooth} is a value of adjacent points after the smooth processing or is an average value of several adjacent points, C1 and C2 are the weight values.

27. A method according to claim **26**, wherein, the step of obtaining comprises:

calculating a correlation between a data change of the multiple parameters and the failure events; and

setting one or more parameters, which have greater correlations than a threshold, of the multiple parameters as the detection parameters.

28. A method according to claim **27**, wherein, a range of the threshold is 0.3-0.5.

29. A method according to claim **27**, wherein, a range of the threshold is 0.5-0.7.

30. A method according to claim **27**, further comprising:

calculating correlations between the multiple detection parameters; and

removing one or more of the multiple detection parameters based on the correlations between the multiple detection parameters.

31. A method according to claim **26**, wherein, the step of obtaining comprises:

obtaining multiple parameters related to operation status of the aircraft component; and

determining the detection parameters based on respective physical meaning indicated by the multiple parameters.