Research on a Case-Based Decision Support System for Aircraft Maintenance Review Board Report

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Abstract. Aircraft Maintenance Review Board Report (MRB Report) is necessary one of the most important Continuing Airworthiness documents. Determination Maintenance interval in MRB Report depends mainly on experience and there isn't a rigorous and quick method. The paper proposes a multi-stage framework for determination maintenance interval using case-based reasoning (CBR), which uses fuzzy generalized nearest-neighbor matching (FNN) to retrieve case and fuzzy Group decision making to determine attributes' weight. An example illustrates the proposed approach and the average relative error is under 3.21%. Finally the developed civil aircraft CBR-MRBR decision support system is described. The method enriches the MRB Report developing method.

1 Introduction

Continuing Airworthiness documents require, when the aircraft Type Certificate is issued, the presenter should produce MRB Report. MRB Report is approved by the Regulatory Authority in establishing initial scheduled maintenance tasks and intervals for new types of aircraft and/or Power Plant. In the literatures, there are a few papers about how to determine maintenance tasks in civil aircraft MRB Report [1][2]. The method to determine maintenance tasks is mainly based on Maintenance Steering Group (MSG) logic method. The method to determine maintenance intervals mainly relies on the engineer experience. Most new products are improved from old ones, their structures, functions, working conditions, function failure and failure effects have certain similarities, and some products have standard systems. There isn't maintenance knowledge in the developing new aircrafts. Therefore analysts consult the experience of resemble aircrafts. The kind of idea is the same as case-based reasoning (CBR). CBR is a method of solving a new problem by using or adapting solutions to old problems. So the paper proposes to determine maintenance interval using CBR.

The paper is organized as follows. A multi-stage framework for determining intervals using CBR is briefly described in Section 2. In the section also, every stage about case representation, selection and adaptation & retention is presented in detail. An instance is given in Section 3. Section 4 describes the developing CBR-MRBR decision support system. Finally, some conclusions and future works are drawn in Section 5.

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2 The Proposed Framework to Determine Maintenance Interval

The method for determining the scheduled maintenance tasks of Systems/ Power Plants (including components and APU's) MRB Report uses a progressive logic diagram. This logic is the basis of evaluating each maintenance significant item (MSI) including system, sub-system, module, component, accessory, unit, part, etc. Principally, the evaluations are based on the item's functional failures and failure causes. After determining the maintenance tasks, we propose a multi-stage framework based on CBR as shown in Fig.1.

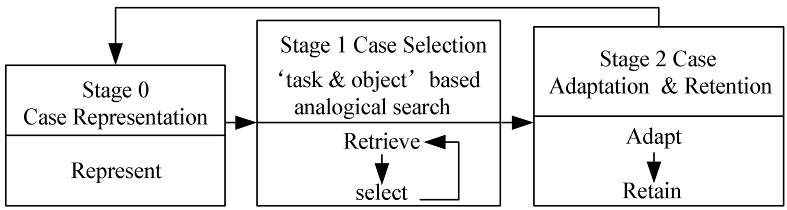

Fig. 1. A multi-stage framework for case-based reasoning decision analysis

2.1 Stage 0: Case Representation

Maintenance interval cases include plenty of MSG analysis knowledge. It is difficult to describe the whole knowledge in detail during case representation. Therefore we mainly research "task and object" based analogical case and pick up main attributes concerned with maintenance intervals. These attributes are divided into two classes:

①maintenance object knowledge: MSI NO., MSI name, structure, manufacturer, function.

②maintenance task knowledge:

Task category: Lubrication or Servicing; Operational or Visual Check; Inspection or Functional Check; Restoration; Discard.

Failure Effect Category (FEC): 5-evident safety; 6-evident operational; 7-evident economic; 8-hidden safety; 9-hidden economic.

These attributes should be preprocessed, such as one qualitative attribute has one kind of description. The MSI name is the case name and the case is stored in hierarchy, which is expressed as:

$$\text{Case}= (P_1, P_2 \ldots P_i \ldots P_m; I) . \tag{1}$$

Where $P_i = (a_{i1}^c, a_{i2}^c, \ldots a_{ij}^c, \ldots a_{in}^c; I_i^c)$ represents *i*th case, *n* is the total number of attributes in a case; a_{ij}^c is the *j*th attribute value of the retrieved case *i*; I_i^c is the interval attribute value of the *i*th retrieved case.