Expert system of inspection planning for aircraft sheet metal parts based on case based reasoning

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ABSTRACT

It is one of key technologies of improving its production cycle and achieving design, product and inspection closed chain Inspection and planning technology of aerospace sheet metal parts. Expert system of inspection and planning technology for aerospace sheet metal parts is researched in this article on the basis of case-based reasoning. It focuses on the typical aircraft sheet metal parts. Knowledge of aerospace sheet metal parts inspection is divided into plate knowledge and its case library, section knowledge and its case library, skin knowledge and its case library, panel knowledge and its case library. Case feature attributes are expressed in production rules, reasoned and recognition based rules and then modifying case and getting inspection card of aircraft sheet metal part.

KEYWORDS

Aerospace sheet metal parts; Inspection and planning; Case-based reasoning; Expert system.

INTRODUCTION

Sheet metal parts are widely used in machinery, light industry, automobile parts, these parts are made of flat plate blank by punching or deformation of stamping and processed, processing them processing and general machine parts exist great differences, bending deformation of sheet metal parts is the main processing the way to produce complex spatial relation, while the other is in flat plate have raised or depressed and gaps, holes and edge shape[1]. Large aircraft, tens of thousands of sheet metal parts[2], and shapes, the varieties, metal material specifications abundantly. So the aircraft sheet metal parts inspection planning is also more representative. If, for every kind of sheet metal parts is assigned a corresponding inspection planning, not only in great number, task, and unrealistic. In view of the above situation, if we can adopt effective sheet metal parts inspection planning expert system, you can complete the inspection plan with high efficiency, and even can replace the human expert to complete sheet metal parts inspection planning, and can overcome the weakness of human experts can not be avoided. Expert system in this paper has many human College Home relates to sheet metal parts of knowledge and many typical sheet metal Parts of the test case, efficient, reliable application expert. The sheet metal parts of system planning possible.

STRUCTURE OF AIRCRAFT SHEET METAL PARTS INSPECTION PLANNING EXPERT SYSTEM

This paper studies the aircraft sheet metal parts inspection planning expert system consists of knowledge base, reasoning machine, context (blackboard), learning system, sheet metal parts inspection features information, the composition, as shown in Figure 2. Knowledge: knowledge base to store a lot of human expert knowledge, examples of knowledge by a set of production rules (if-then) description. Reasoning: examples and the problem to be solved is to find the most matching from case database, and application of knowledge to solve problems. Context (blackboard): to show the reasoning of the whole process. Learning system: the learning functions of expert system, can better improve, enrich the expert system. The attribute information of sheet metal parts inspection characteristics: select the type selection and inspection of sheet metal parts is a description of the problem, provides entrance conditions for reasoning. Interpreter: to remind the user, the user of the system operation process to better understand, to achieve transparency in operation process.

DESIGN OF THE SYSTEM

The expert system based on case based on the description of the problem, the retrieval of similar instances in the instance database according to the retrieval of rules, examples and then modified the retrieved, so that it can meet the instance to be solved, get the solution of the problem. The system is shown in Figure 1.

Retrieval of similar characteristics is to treat according to solve the case description, find similar cases from the case base.

Case retrieval Rules refers to the principle, algorithm and so on, to retrieve similar cases of the skin. Modified example refers to the retrieved similar case modification, which can meet the instance to be solved, in order to solve unsolved case. Learning examples, and save the instance refers to an expert system has the function of learning, knowledge base, perfect the expert system[3]. The knowledge expression and knowledge base. Due to the type of aircraft sheet metal parts and the diversity of shape anisotropy, knowledge base uses production rules (if-then) expression. See Figure 2. First, extract the similar example, solution according to the specific parameters of the knowledge base instances found problems.
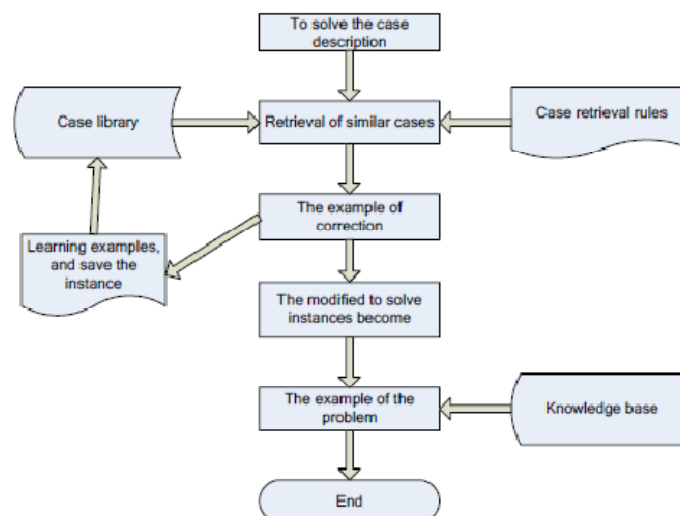

Figure 1 : System structure

The corresponding rules in Figure 2:
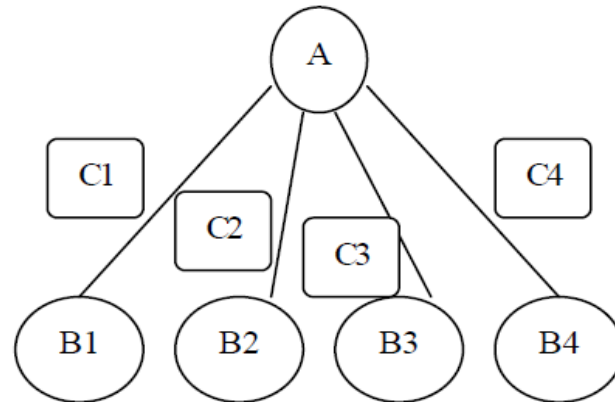IF A and C1 then B1
IF A and C2 then B2

Figure 2 : Production rule expression

In order to better express the knowledge base, the aircraft sheet metal parts is mainly divided into four categories: plate type of aircraft sheet metal parts, section type of aircraft sheet metal parts, skin class aircraft sheet metal parts and panel for aircraft sheet metal parts. In each type of aircraft sheet metal parts, tests were carried out according to their common characteristics of planning inspection, including inspection tools needed, on the inspection requirements, inspection tolerance inspection matters needing attention, etc.[4]. The plate type as an example, the structure shown in Figure 3.
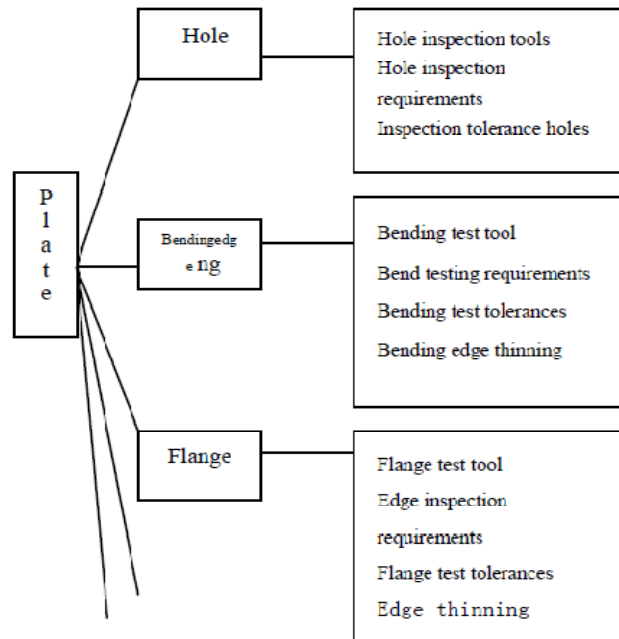

Figure 3: Sheet metal components repository structure diagram

Below is the sheet metal parts of the knowledge base of a program: The type rules 1:IF hole is pilot hole, THEN can know the guide hole inspection tools, inspection requirements and inspection tolerance etc.. The type rules 2: IF hole pin hole or holes is tool, THEN can know the pin hole or tool hole inspection tools, inspection requirements and inspection tolerance etc..

REASONING MECHANISM

This paper adopts the method based on knowledge retrieval example wizard, the case feature attribute with a set of production rules (if-then) are described, and then use the ES technology in the matching method based on rules of inference to identify[5].

Expression of the examples

The examples in this article and the name was not a sheet metal parts, because the nomenclature and classification of aircraft sheet metal parts is not yet clear norms, cross level process in the manufacturing of high process flexibility, division. Name of a lot of parts based on difficult to discern its manufacturing and test method. Therefore, according to the parts of the structure, shape features, specifications to develop inspection process more reasonable. This paper is a type of sheet metal parts and containing species, the number of test characteristics as the original instance.

Case retrieval

Because of various kinds of sheet metal parts, we has carried on the classification, reasoning after the start, first of all requires the user to select the type of sheet metal parts is a plate type, section type, skin type or panel sheet metal parts; then according to the main features of sheet metal parts inspection contains and the number of species, found the original instance similarity from various in the case base; then is to the original instance modification because of the sheet metal parts, different test characteristics, they may have the same species, but the specific characteristics of size, location and other parameters are not the same, in the inspection standard in different size, different characteristics of the test position tolerance is also different, so be to modify the original instance, which can meet the instance to be solved; then according to the specific parameter modification to search the solution to the knowledge base; finally the optimal solution to write test card and output the test card. The reasoning process is shown in Figure 4.
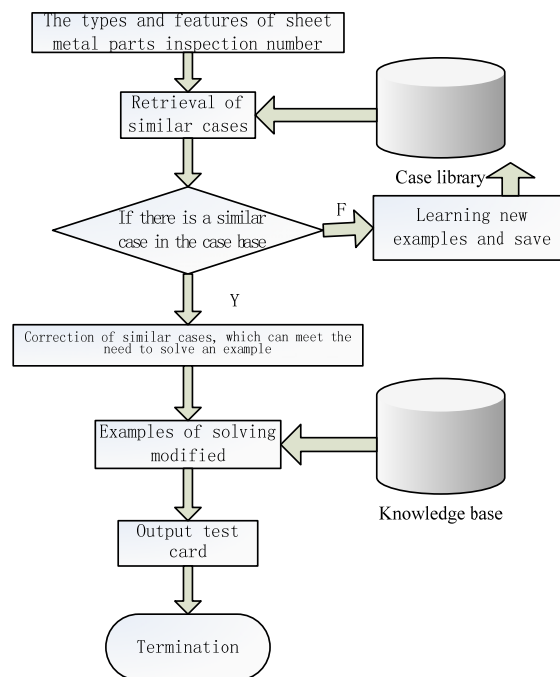

Figure 4:The reasoning process of intelligent inspection planning system for sheet metal parts

The following paragraph is a example of plate type of aircraft sheet metal parts of the retrieval of a part of the process:

RULE 00001
FACT MISSION. Sheet metal type = "Board"
THEN Send ("DESIGN") to "Plate";
RULE 00002
FACT MISSION. Sheet metal type
= " Section"
THEN Send ("DESIGN") to "Section";
……
RULE 00076
FACT Plate. Number plate features
="一个"
THEN Send ("PLATE_ONE") to _FRAME;
RULE 00077
FACT Plate. Plate type main feature number ="Two"
THEN Send ("PLATE_TWO") to _FRAME;

RULE 00078
FACT Plate. Plate type main feature number ="Three"
THEN Send ("PLATE_THREE") to _FRAME;……

Examples amendment

The original case in the case base is typical of aircraft sheet metal parts is removed from the aircraft manufacturing industry, these examples have been running and identification of many, have achieved very good results, but with the concrete practice of sheet metal parts and some differences, these differences can be the same as the original instance modification, supplement to overcome. Characteristics of species, sheet metal parts of the system considering the actual situation of the feature size, features of material on the inspection planning, input by the user description and inspection to the original instance difference, the system will call the original instance rules in the knowledge base and knowledge retrieval to make corresponding revision. For example:

For aircraft sheet metal parts bending changes include a few rules:

(1) by the type of sheet metal parts is the type (plate type, section type) in the curved edge characteristics;

(2) by bending type, bending height, bending angle, bending and the outer edge of the relationship between the theory of decision on the bending test tools, test requirements, tolerance etc..

According to the above rules, users need to know the type of sheet metal parts in the inspection planning before, attribute information etc.. To complete the revision to the original instance.

Output test card

Output test card. The problem with the output format, inspection, the content of the output on the EXCLE table, Figure 5 is a sheet metal parts, sheet metal parts for this example, test planning, Figure 6 is the output of aircraft sheet metal parts.
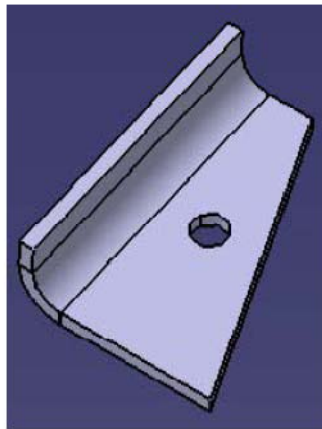

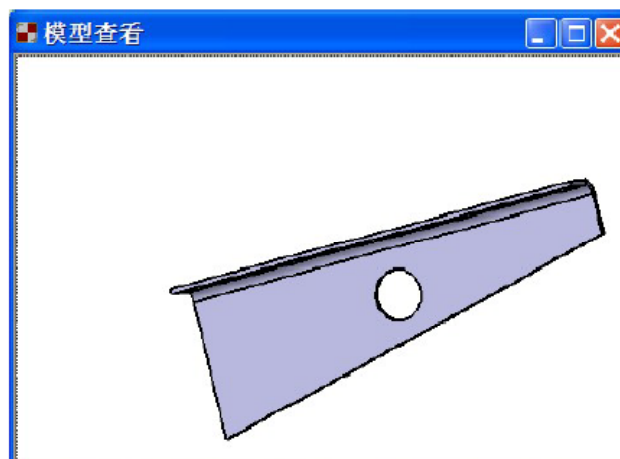**Figure 5: Model of parts in 3D environment**

Figure 6: Aircraft sheet metal parts

CONCLUSION

This chapter mainly describes the design of intelligent inspection planning system based on expert system, reach the level of inspection planning and outputs a detection process card of sheet metal parts. First introduces the key technology of intelligent inspection planning system design and development environment, the expert system tool and its working principle. In order to output detection process card, then introduces the two development technology of VC++6.0. Formulation system function realization scheme of the intelligent inspection planning system to realize the function, the overall structure of the system. In order to facilitate the detection of the operating personnel is based on sheet metal parts were detected, and record test results, will be through the intelligent inspection planning system results from detection process card, detection process card generation is realized by the VC++6.0 development word document.

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