On Intelligent Design and Planning Method of Process Route Based on Gun Breech Machining Process

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Abstract. The paper states an approach of intelligent design and planning of process route based on gun breech machining process, against several problems, such as complex machining process of gun breech, tedious route design and long period of its traditional unmanageable process route. Based on gun breech machining process, intelligent design and planning system of process route are developed by virtue of DEST and VC++. The system includes two functional modules--process route intelligent design and its planning. The process route intelligent design module, through the analysis of gun breech machining process, summarizes breech process knowledge so as to complete the design of knowledge base and inference engine. And then gun breech process route intelligently output. On the basis of intelligent route design module, the final process route is made, edited and managed in the process route planning module.

1. Introduction
Gun breech is widely used in military weapon system. It is generally used to install breechblock. It together with gun breech locks gun bore and connects gun barrel with recoil mechanism in the launch process of the gun. When a series of movements are completed like latching, locking, percussion and extraction, special parts need to be installed on gun breech. For fixed installation of special parts on gun breech, diverse features (such as plane, hole, bulge and groove) are processed on gun breech. Thus, it is necessary to design the rational gun breech process route.

The paper states an approach of intelligent design and planning of process route based on gun breech machining process, against several problems in traditional process of gun breech, such as unspecific process route in process files, cumbersome edit and inconvenient data storage of process route. Based on gun breech machining process, intelligent design and planning system of process route are developed by virtue of DEST and VC++. The system includes two functional modules--process route intelligent design and its planning. During the operation of process route intelligent design, basic information of parts (its shape, size and structure), main design parameters and proper process method are input. Through compilation, reasoning and auto-output of process route, process route intelligent design of gun breech is implemented. On the basis of process route from the previous module, finally process route is made, edited and managed in the process route planning module.

2. Intelligent Route Design Module Based on Gun Breech Machining Process
Intelligent route design module is a program system including rich technical knowledge and experience. According to the knowledge and experience provided by one or more experts in a field, it can apply artificial intelligence technology to infer and judge. And then drawing on simulating experts’
decision process, complex problems that require expert decisions are solved. As illustrated in Fig.1, it is the development process of intelligent route design module.

![Figure 1 The development process of intelligent route design module](image)

### 2.1 The DEST Development Tool

The DEST development tool applies to the Microsoft Windows platform. It is developed by object-oriented high-level C++, adopted object-oriented knowledge representation, constructed a mixed knowledge representation method by means of frame representation, production rules and process object-oriented thinking.

DEST consists of many modules, like knowledge editor module, knowledge compiler module, inference engine module and translator module. As showed in Fig. 2, it is the structure of the DEST. In the dashed box are knowledge base holding static knowledge (regular knowledge) and context database containing dynamic knowledge generated by system (executable knowledge generated by reasoning). Outside the dashed box is the shell of DEST. The domain experts’ knowledge need to be input into the knowledge base when running DEST. And then an intelligent design system of this field is formed through the compilation and reasoning of knowledge.

![Figure 2 System structure chart of DEST](image)

### 2.2 Framework Design

Gun breech is divided into wedge shape and spiral shape based on its structure. In this paper, Wedge-shaped gun breech is the research object, and its machining process is analyzed. According to the practical processing requirements of gun breech, the design of the expert system for breech process route is designed as follows: part name, blank information, part major design parameters, part structure features, processing method reasoning, gun breech surface processing and resulting output. Herein, part name frame mainly refers to gun breech parts; blank information frame to its materials and shapes; part major design parameters frame to the length of blank side, the inclination of convex groove, the full length of gun breech and bearing hole diameter; part structure features frame to the shape of gun breech; processing method reasoning frame to quenching, intermediate frequency annealing, phosphate, milling plane, surface turning, processing gun bolt, fixing coordinate hole, boring shaft and polishing; gun breech surface processing frame to polishing blanks, hot stamping and heat sealing blanks; resulting output frame to different process route for distinct machining process and outputting by the Microsoft Word (doc.) format.
2.3 The Process Technology Representation of Gun Breech

Considering DEST represents object by frames, the process technology representation of gun breech adopts binary tree representation. Frame consists of some slots; each slot includes a series of side information, each of which consists of some numbers. The framework uses a multi-tree expression with the frame name as its root, say, frame name is root; the slot attribute is the next child node; the slot name is the next (sub-node, and so on, the sub-node of the last layer is the value of the side. The number of branches for such a multi-tree structure is uncertain and difficult to directly represent, but as shown in Fig. 3, it can be converted to a binary-tree structure.

![Binary tree structure of gun breech frame](image)

**Figure 3** Binary tree structure of gun breech frame

2.4 Implement of Intelligent Route Design Module

Intelligent route design module base on gun breech machining process is developed, in accordance with the development process of intelligent route design module—problem definition phase, system design phase, knowledge acquisition phase, prototype implementation phase and test & improvement phase, as shown in Fig. 4.

![Process route intelligent design module](image)

**Figure 4** Process route intelligent design module

The intelligent design module encapsulates the process knowledge of gun breech in the knowledge base. According to the actual processing needs (like parts, size, attribute, materials and heat treatment), a rational reasoning mechanism is set up. And through compiling and reasoning knowledge base, process route of gun breech is automatically output by the Microsoft Word (doc.) format, as shown in Fig. 5.
3. Process Route Planning Module

Against the process route automatically output from intelligent route design module, functions such as process route customization, route editing, and route management are implemented in the process route planning module.

3.1 Process Route Customization of Gun Breech

As shown in Fig. 6, process route customization includes submenu management, new categories, and new templates, add templates and modify categories, etc. When a new classification (process route of gun breech) is made, browse classification folder on the interface displays the attribute set customization of breech process route. The serial number is automatically generated from the process planning system, according to the route template structure tree. The classification number is a serial number of template classification. From the “submenu” to “delete” in the right part of the dialog box are used to modify the template. The unit contents referring to sub-units or templates are directly chosen from submenu list or template list. Additionally, the unit order can be exchanged or deleted optionally. Breech process route customization not only paves the way for subsequent editing and management of breech process, but also facilitates the data management of breech process.

3.2 Process Route Editing of Gun Breech

Process route planning module provides editing schemes for process routes and sub process routes, which can call basic data, parameter table, coding and other modules. Breech process route output from intelligent route design module is edited and modified so as to improve breech process route. The specific operation is as follows:

As shown in Fig. 7, it is the editing interface of breech process route. The product process route planning is generated through adding desired machining Process selected in "New-submenu structure tree" into the route module column or through the compilation and modification of established process route template (typical process route). For process route with similar parts, the route can be quickly established through a typical process route to enhance the efficiency by avoiding duplication of efforts.
3.3 Process Route Management of Gun Breech

According to the actual enterprises' needs, process route management is divided into two cases: simple management and complex management. In order to edit, modify, improve and save the process data, the paper presents concretely simple management of breech process route.

As shown in Fig. 8, it is the management interface of breech process route. It shows main information of product parts, when you click "search", meanwhile, the initial interface below shows all the routes under the currently selected parts; this function supports multiple routes and sub-routes. In the child route module mainly includes a simple sub-route and the combination of sub-unit and sub-route. After selecting a breech process route, you click "extend" on the bottom right of route management interface. And then on a pop-up window about sub-unit attribute set editor, you can set and edit sub-unit process steps to facilitate the management of breech process route.

4. Conclusion

(1) The module of intelligent route design based on gun breech summarizes breech processing knowledge and encapsulates it into knowledge base with expert system base on the analysis of breech process technology. At the same time, according to the actual processing demands, the module establishes a reasonable reasoning mechanism. Then breech process route automatically output by the Word (doc.) format via compiling and reasoning of knowledge base. Thus, intelligent route design of gun breech is implemented. Such design improves the accuracy of knowledge input and work efficiency.
(2) Process route planning module implements the customization, editing and management of process route, solves problems of traditional gun breech like unspecific route, complex editing and inconvenient data storage of route, as well as reduces production cost and enhances productivity.

5. References
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