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1	Ontology-based Fault Diagnosis Knowledge Representation of CNC Machine Tool	Applied Mechanics and Materials		201310		EI	
2	Graphical fault diagnosis expert system of CNC machine tool based on B/S	Advanced Materials Research		201407		EI	
3	An improved case-based reasoning for fault diagnosis of CNC machine tool	Journal of Information & Computational Science		201506		EI	
4	Grey Ontology Model for Expert Knowledge Representation	Advance in Engineering Research		201609			

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g-Onto   OWL

3

4 CBR   RBR   CBR-RBR   CBR-RBR

CBR-RBR
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C#

CNC machine plays an important role in the field of manufacturing   and its normal operation is the fundamental guarantee to good operation of modern manufacturing enterprises. The experts of CNC machine tool fault diagnosis have the solid theoretical method of machine tools and rich experience in fault diagnosis. The acquisition, research and application of expert knowledge, to achieve rapid maintenance of CNC machine tools, are important research directions of fault diagnosis. The CNC machine tool fault diagnosis expert knowledge is researched as the object and standardized according to ontology technology. The ontology model of expert knowledge is constructed, and the reasoning methods and reasoning strategies are studied. The main contents are summarized as follows:

(1) Expert knowledge acquisition and diagnosis strategy research. The research scope of fault diagnosis expert knowledge of CNC machine tools is determined, and the related concepts and methods in theoretical knowledge and experience knowledge are expounded. Based on these methods, the expert knowledge of fault diagnosis of CNC machine tools is obtained and sorted out. The thinking process of experts in the process of fault diagnosis is discussed, and the dual-process diagnosis strategy is proposed to meet the thinking mode of human experts.

(2) Research on representation of expert knowledge based on grey ontology. According to the grey uncertainty of expert knowledge of NC machine tool fault diagnosis, the grey ontology representation model g-Onto is proposed. The ontology description language OWL is extended and the grey ontology knowledge is described. The CNC machine tool knowledge ontology model, the rule knowledge ontology model and the case knowledge ontology model are constructed to realize the standardization of the fault diagnosis expert knowledge.

(3) Improvement of RBR and CBR algorithm for expert knowledge. In order to correct the deviation of the subjective experience of the experts, the concept of the importance degree of the evidence is presented, and the improved algorithm of the confidence for combined hypothesises is given. The case similarity calculation method is proposed based on edit cost, to solve the case attribute mismatch problem in similarity calculation. Edit cost algorithm are given from the differences of structure and content.

(4) Research on integration method of RBR and CBR. CBR-RBR synthesis reasoning is proposed, and the definition of CBR-RBR synthesis source, synthesis space and synthesis positioning are present. The methods of component selection and generation are given, and the ways of structure assignment and generation are present. The standardization process of synthesis space data is expounded. Synthesis positioning method based on Euclidean distance is given. The validity of the CBR-RBR synthesis reasoning method is verified by an example.

(5) Design and development of fault diagnosis system for CNC machine tools. The network topology and development requirements of the system are determined, and four tier architectures are designed. The main functions of information collection and processing, fault diagnosis reasoning, knowledge base management and human computer interaction are realized based on the programming language C#. The practical and feasible technical approach is explored for the representation and reasoning of the expert knowledge of CNC machine tool fault diagnosis.