

## 博士学位信息公示（补充）

序号	学号	姓名	学科	院系	学生类别	导师	申请学位门类	论文题目	答辩日期
1	1110193	赵淑玉	机械工程	机械与能源工程学院	学历教育博士	沈斌	工学	数控机床故障诊断专家知识表示与推理研究	2017-6-17

### 科研成果情况

学号	1110193	姓名	赵淑玉	学科	机械工程	导师	沈斌
论文总数	推荐论文数	论文检索情况	专利数	个人著作	科研成果		
4	0	EI : 3	0	0	0		

### 发表论文情况

序号	论文题目	发表刊物	刊物类型	发表年月	类别	收录情况	作者排名
1	Ontology-based Fault Diagnosis Knowledge Representation of CNC Machine Tool	Applied Mechanics and Materials	国内会议	201310	其他	EI	第二（导师第一）
2	Graphical fault diagnosis expert system of CNC machine tool based on B/S	Advanced Materials Research	国内会议	201407	其他	EI	第二（导师第一）
3	An improved case-based reasoning for fault diagnosis of CNC machine tool	Journal of Information & Computational Science	国外刊物	201506	其他	EI	第二（导师第一）
4	Grey Ontology Model for Expert Knowledge Representation	Advance in Engineering Research	国外会议	201609	其他		第二（导师第一）

### 中文摘要

数控机床在制造领域有着举足轻重的地位，其正常运行对现代制造企业的正常生产有着极其重要的作用。数控机床故障诊断专家有扎实的机床理论方法及丰富的故障诊断经验。对专家知识的获取、研究和应用，实现数控机床的快速维修，是故障诊断的重要研究方向。本文以数控机床故障诊断专家知识为研究对象，结合本体技术对专家知识进行规范化和标准化处理，构建了专家知识的本体模型，研究了专家知识的推理方法和推理策略，主要内容如下：

（1）专家知识的获取和诊断策略研究。确定了数控机床故障诊断专家知识的研究范围，阐述了理论性知识和经验性知识中的相关概念和获取方法。基于这些方法，初步获取并整理了数控机床故障诊断的专家知识。对专家在故障诊断过程中的思维过程进行了讨论，提出了诊断系统的双重加工诊断策略，使其满足人类专家的思维方式。

(2) 专家知识的灰色本体表示研究。针对数控机床故障诊断专家知识中的灰色不确定性,提出了灰色本体表示模型 g-Onto,阐述了该模型中的灰色属性和灰色关系。扩展了本体描述语言 OWL 并描述了灰色本体知识。构建了数控机床知识本体模型、规则知识本体模型和案例知识本体模型,实现了数控机床故障诊断专家知识的规范化和标准化。

(3) 专家知识的规则推理和案例推理算法改进。为纠正专家的主观经验可能存在的偏差,提出了证据重要度的概念,给出了组合结论可信度的改进算法。提出了基于编辑成本的案例相似度计算方法,从结构差异度和内容差异度上分别给出了编辑成本算法,解决了案例相似度计算中的属性不匹配问题,并通过对比实验证明了该方法具有更高的准确性。

(4) CBR 和 RBR 集成方法研究。提出了 CBR-RBR 综合推理方法,定义了 CBR-RBR 综合源、综合空间及综合定位。给出了部件选取和生成、结构赋值和生成方法,阐述了综合空间数据的规范化过程,给出了基于欧几里德距离的综合定位方法。通过实例验证了 CBR-RBR 综合推理方法的有效性。

(5) 数控机床故障诊断系统的设计和开发。确定了系统的网络拓扑结构和开发需求,设计了四层开发架构并以 C# 为编程语言,实现了信息收集与处理、故障诊断推理、知识库管理和人机交互等主要功能,为数控机床故障诊断专家知识的表示和推理探索出了切实可行的技术途径。

## 英文摘要

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 hypotheses 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.