An Agent-Based Distributed Smart Machine Tool Service System

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Abstract: This research utilized software agent based technology in expanding remote machine tool service system by constructing related remote service ontologies to facilitate its smart and distributive characteristics. These service agents could be used for remote smart machine tool services underlying Internet through the communication protocols supported by both KQML (Knowledge Query Manipulation Language) and FIPA ACL (Agent Communication Language, Foundation for Intelligent Physical Agent) performatives. The mobile agent service for the developed system has also been successfully implemented by transmitting the mobile agent in a file to the serviced side through the Internet.

Keywords: Agent-based, Machine Tool Service

I. Introduction

The information, computer and communication technologies (ICT) have been advanced and innovated rapidly in these years. There are great potentials for new innovative applications to be created if the conventional mechanical design and CAD/CAE/CAM technology [1], remote monitoring and pro-diagnostics [2, 3, 4] could be successfully integrated with these emerging technologies.

Distribution oriented technology research and development has also been paid more and more attention in the last decade and successfully applied in manufacturing system. Hung, Cheng, and Yeh [5] developed a distributed Web-Service-Based e-Diagnostics framework to enhance the CIM of a semiconductor factory where C++ programming language and CORBA [6] were adopted. Further e-Diagnostics and e-Maintenance system were studied where security analysis and design were considered and explored [7]; A generic virtual metrology framework [8] was also proposed as well. Chiang, Trappey, and Ku [9] had worked on a knowledge-based intelligent system to support dynamic design and reasoning for collaborative design so as to improve traditional computer-aided design (CAD) and Product lifecycle Management (PLM) environment; an automatic dispatching intelligent manufacturing system was developed for an LCD (liquid crystal display) manufacturing system. Software agent technology was adopted by Feng et al [10] for manufacturing planning and predictive process model integration where CAD, manufacturing resources database, and NC programs were integrated to develop a multi-agent system. This intelligent network-integrated platform consists of a manufacturing planning agent, a material removal rate model agent, a tool material selection agent, a tool life model agent, and an NC machining agent. An updated review for the application of software agents in intelligent manufacturing was conducted by Shen and Norrie [11] where intelligent agent based methodology was successfully applied in manufacturing system integration, collaboration, and manufacturing process planning related mechanism and technology. Zhang and Xie also reviewed the application of software agents in collaborative process planning. The enabling agents technology included agent architecture, communication, and protocols with regard to technologies and functions related to manufacturing system [12]. This intelligent agent integration architecture could be applied in manufacturing domain, i.e. intelligent distributed integrated platform is worthy of development in new application domain.

II. Agent-based Distributed Smart Machine Tool Service System

The proposed system architecture is shown in Figure 1. This system consists of a few agents that can work for remote services in distributed environment. These agents are: (1) MT_Data Agent – machine tool monitoring agent, (2) MT_CAM Agent – machine tool machining service agent, (3) MT_CAPP Agent – machine tool process planning agent, (4) MT_Tooler Agent – machine tool cutter management agent, (5) Knowledge Base Agent – Knowledge Management Agent, and (6) User_Agent – user interface service agent. The communication between users and service agents went through protocols underlying KQML and FIPA ACL. Smart service agent could offer intelligent remote machining engineering services while mobile agents could be transmitted through the Internet to provide users with local user interface and with smart engineering local services. The efficient systematic information extraction could be achieved in the proposed distributed environment with regard to the data collection of equipment, pro-diagnostics, and machining processes data by the proposed MTSS (Machine Tool Service System) and EDSS (Embedded Data Service System) middle-wares underlying the MT connect standard protocols. Furthermore, since different CNC machine tool controllers (MTC) may support their own communication software development kit...
(EDSS) for pro-diagnostics.

**VI. References**


**Figure 3** Sample remote machine tool service request sequence diagram

**Figure 4** User-Agent-MT-DATA-Agent communication sequence diagram

**Figure 5** Mobile Agent service simulation example

**V. Acknowledgements**

The authors would like to thank the assistance from Professor Hsin-Yu Cheng and Yu-Chuan Su, Department of Computer Science Information Engineering, Far East University, Taiwan for the assisting the integration for MTSS and EDSS.