International Refereed Journal of Engineering and Science (IRJES)
ISSN (Online) 2319-183X, (Print) 2319-1821
Volume 7, Issue 7 Ver. I (Jul 2018), PP. 11-17

Smart Machine-Tools based on Knowledge-Evolution

Dong-Hoon Kim[1], Jun-Yeob Song[2]
[1,2]*(Department of Ultra Precision Machines and Systems, Korea Institute of Machinery and Materials, South Korea)*
[1,2]*Department of Nano-Mechatronics, University of Science and Technology, South Korea*
Corresponding Author: Dong-Hoon Kim

ABSTRACT:- *In the near future, machine-tools will be more improved in the form of a knowledge-evolution based intelligent device. The final goal of this study is to develop an intelligent machine-tools having knowledge-evolution capability in Machine to Machine (M2M) wired & wireless environment. The knowledge-evolution based intelligent machine-tools is expected to gather knowledge autonomously by producing knowledge, understanding knowledge, reasoning knowledge, making a new decision, dialoguing with other machines, etc. The concept of the knowledge-evolution intelligent machine is originated from the machine control being operated by sense, dialogue and decision of human-expert. With intent to develop the knowledge-evolution based machine-tools, the structure of knowledge-evolution in M2M and the scheme for a dialogue agent among agent-based modules such as a sensory agent, a dialogue agent and an expert system (decision support agent) are presented in this paper. And work-offset compensation from thermal change and recommendation of cutting condition are on-line performed for knowledge-evolution verification.*

KEYWORDS:- *Machine to Machine, Machine-tools, Knowledge-evolution, Intelligence*

Date of Submission:12-10-2018 Date of acceptance: 27-10-2018

I. INTRODUCTION

The machine-tools may be the subject of cooperation in future production systems. Specifically, it is expected that the machine-tools may construct M2M environment that automatically evolves its knowledge, maintaining the cooperation between various internal and external factors [1-3]. In this study, the design of dialogue agent module was presented on the basis of standard platform analysis and ping agent analysis, on purpose to design a dialogue module agent for developing the knowledge-evolutionary intelligent machine tool. It is because an enormous amount of knowledge and apposite processing system, which can substitute human experts, are so needed that the knowledge-evolutionary intelligent machine-tools can be developed [4-6]. Hereupon, it is necessary to develop an agent for inter-machine cooperation [5-7]. More than all, the concept of standard framework named 'FIPA-Open Source' was presented prior to the design of such a dialogue module. Likewise, a basic agent using named 'ping agent' was analyzed and the scheme of dialogue agent, which is equivalent to the dialogue module necessary to develop the knowledge-evolutionary intelligent machine-tools in M2M environment, was presented. The knowledge-evolutionary intelligent machine-tools has three mechanisms. First, it has the sensory function similar to that of humans. Secondly, it has communicational function. Namely, it acquires the knowledge based on indirect experiences from other experts, using the human-dominated linguistic ability. Lastly, it has reasoning function. The sensory function, communicational function and reasoning function can be performed by sensory module, dialogue module and expert system as shown in Fig. 1.

In this study, the agential concept of the dialogue module, which is necessary for inter-machine cooperation, was presented among the three modules. In line with this object, FIPA-OS, a framework based on agent, and a related simple agent were presented and also a dialogue agent advanced from it was presented. The dialogue agent that functions as a dialogue module communicates with other machinery, using communication agent. Namely, it acquires the knowledge based on indirect experiences by communicating with other machinery having the relevant knowledge in case a task is assigned. The designed dialogue agent is applied for the recommendation of cutting conditions and thermal error compensation in tapping machine. Through this study, the knowledge-evolutionary machine-tools is expected to be hereafter more easily implemented with the assistance of the study on sensory agent and decision support agent.

II. DESIGN OF KNOWLEDGE-EVOLUTION MACHINE-TOOLS

Machine-tools have been regarded as integration the object of integration, but it is expected that those may be the subject of cooperation if intelligence technologies for knowledge evolution are developed. Figure 2 shows the outline of M2M (Machine to Machine) environment that is expected to minimize the roles of human experts and to substitute mechanical experts. As regards the information exchangeable through M2M environment, machine-dependent knowledge and machine-independent knowledge are representative. The information may make it possible to evolve knowledge, exchanging information in real time with computer-aided manufacturers, tool makers and marketers, material producers and marketers, and remote service distributors not to mention e-machine. Figure 3 shows the outline of intelligent machine-tools of which knowledge can be evolved in the M2M manufacturing system. As previously stated, it has three agents such as sensory function, communicational function and reasoning function.

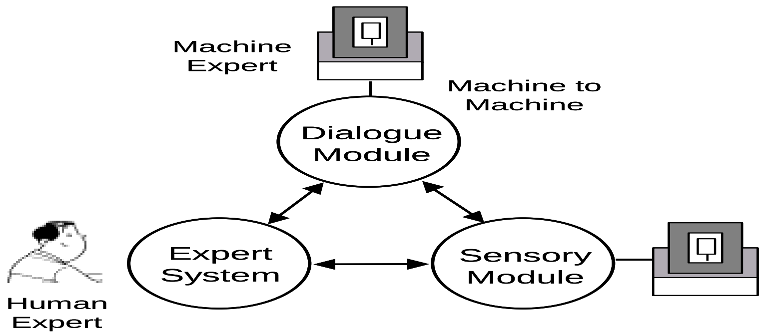


Fig. 1 Three Object Modules

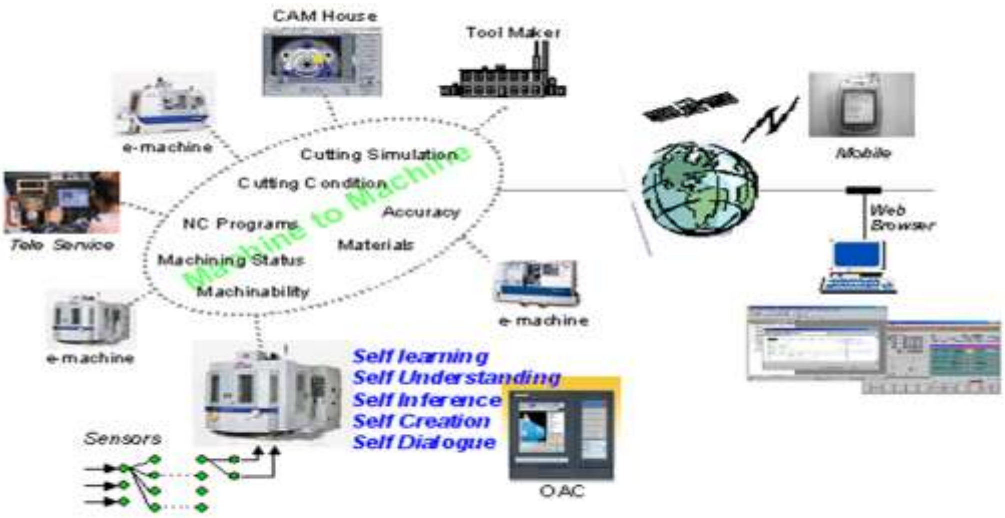


Fig. 2 M2M Manufacturing Systems

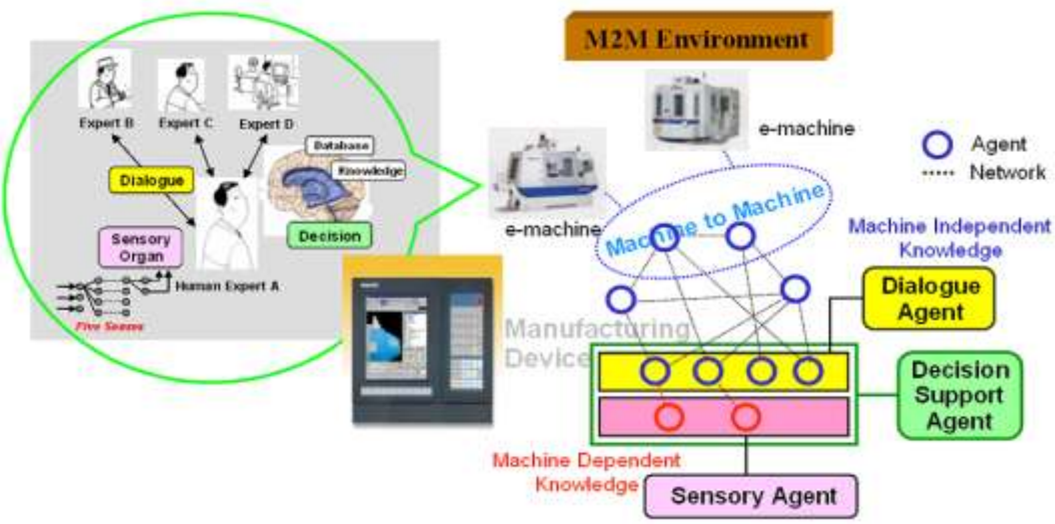


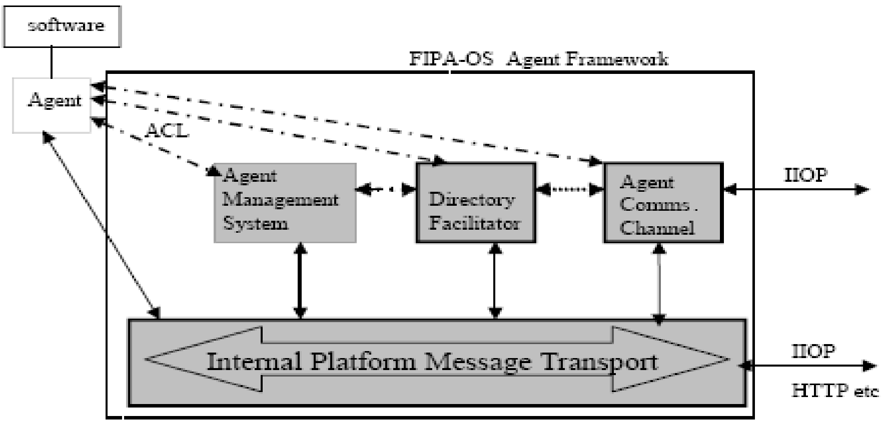
Fig. 3 Knowledge-Evolutionary Intelligent Machine-tools in M2M

III. AGENT PLATFORM AND COMMUNICATION

The dialogue agent acquires the knowledge based on indirect experiences by communicating with other machinery and manages windows. The dialogue agent or the communication agent are constructed on the basis of FIPA-OS (Open Source) or JADE (Java Agent Development Framework), the software agent platform that implemented FIPA agent standard presented in Fig. 4. Italy's JADET, Japan's Comtec, USA's AAP and UK's Notel Network are included in the agent standard-oriented platform. In particular, it is evaluated that FIPA is most suitable to multi agent standard (Poslad et al., 2000). FIPA-OS has several basic agents and factors, such as DF (Directory Facilitator), agent management system, agent communication system, IPMT (Internal Platform Message Transport), agent shell, etc., in order to terminate and generate agents and to provide ACL (Agent Communication Language) message. DF service makes it possible to retrieve specific agents, the agent management system lists agents or cancels the registration, the agent communication channel (ACC) supports inter-agent communication and the agent shell provides the basic framework so that agents may be generated. The agent shell is based on Java class, and new agents are produced by inheriting from the basic class. Likewise, the agent shell manages ACL message and contains the class pertaining to protocol standard. IMPT provides message routing service for the agents produced on the basis of a specific agent shell. FIPA-OS, the software agent platform that implemented FIPA agent standard, was analyzed to implement dialogue agent as well as to present inter-agent communication and the scheme of dialogue agent.

This chapter also deals with the program, which is necessary to implement a demo program for transmitting and receiving string in agent operation, and its application. Above all, JVM, JDK and FIPA-OS should be operated after matching their versions with each other. The agent loader should be analyzed and GUI Window should be generated so that ping agent may be implemented and messages may be mutually exchanged, and the analyzed ping agent should be registered on the agent loader. The GUI, form and dialog file in the agent loader were analyzed and the dialog usable in text-transmitting and receiving program was constructed. Message transmitting and receiving was appositely corrected by analyzing ping agent. The Fig. 5 shows the agent modeled so. As regards the communication between FIPA-based agents, ACL is most important. The agent using ping in DF is retrieved and service interface is implemented by the query through ACL envelope. The followings concretely show M2M interface and the relativity between agent and component for the basic studies on internet/agent application.

The Fig. 6 shows a pattern of the interface between FIPA-based agents that is shown in M2M environment. The figure shows the outline of agents necessary for the knowledge-evolutionary intelligent machine-tools in M2M environment. Also, the it shows the machinery, which is broadly classified into the container, and shows the pattern of inter-machine or inter-agent interfaces. Such designs and illustrations make it possible to study the multi-agent application.



ACL : Agent Communication Language
IIOP : Internet Inter-ORB Protocol

Fig. 4 FIPA Based Agent Standard Platform

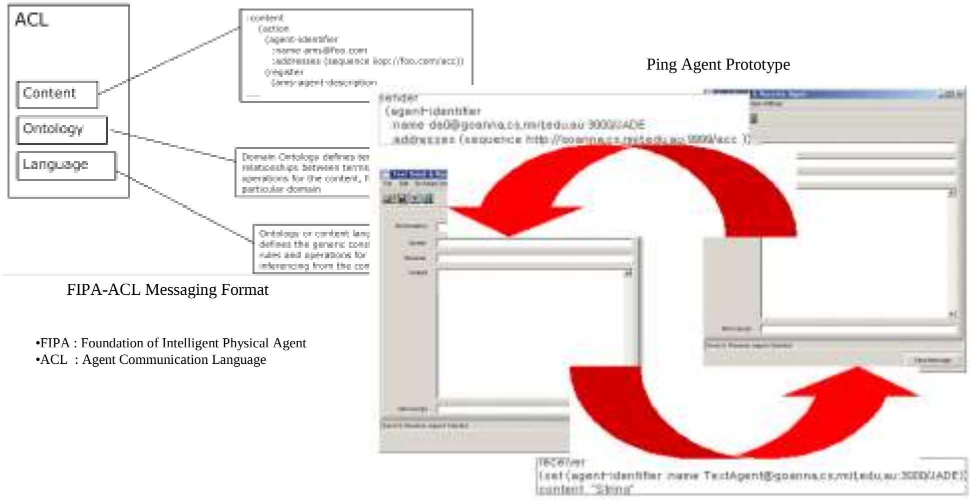


Fig. 5 FIPA-ACL based Ping Agent Prototype

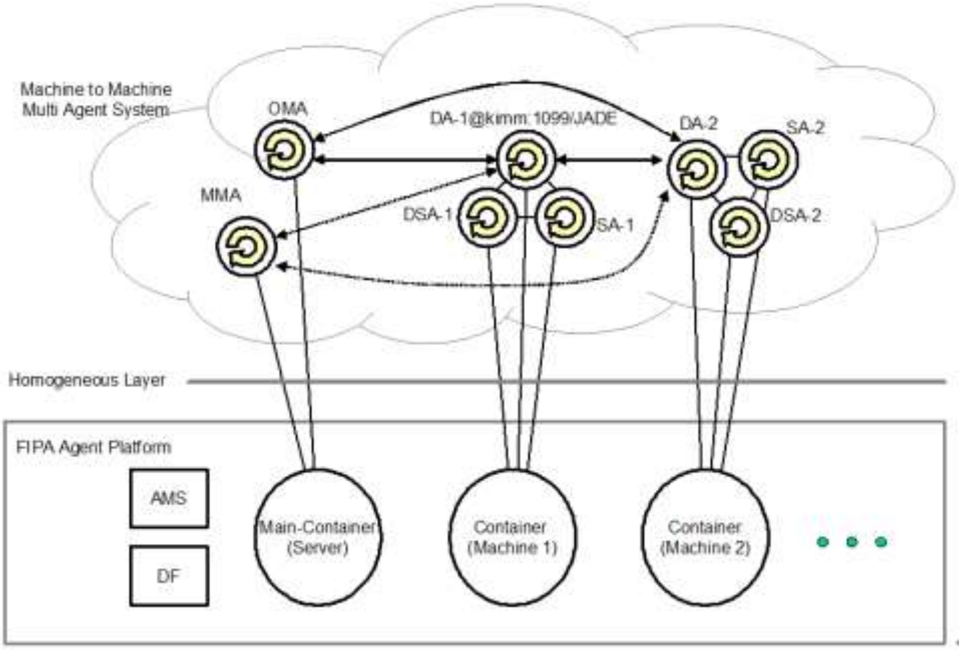


Fig. 6 Communication and Interface of Agents in M2M

IV. APPLICATION BY USING DIALOGUE AGENT

To derive actual data from the sensor, thermal change and deformation-measuring experiment was applied to the tapping machine. The tapping machine is to make female screws that are used for automobile parts, electronic parts, mechanical parts, etc. In a word, it is a core machine necessary for almost all the industries. The Fig. 7 shows the outline of thermal change and deformation-measuring experiment. The thermal signal of respective axes (X, Y and Z) is amplified by the amplifier (ADAMS 3000) and is digitalized and stored by an A/D converter. The deformation of respective axes is fixed by using an eddy current-type cap sensor, and is measured at the position where thermal change was measured and is stored after amplification and conversion. Atmospheric temperature was between about 3.2 and 5.2 degrees centigrade, that is, shows the variation of 3 degrees centigrade.

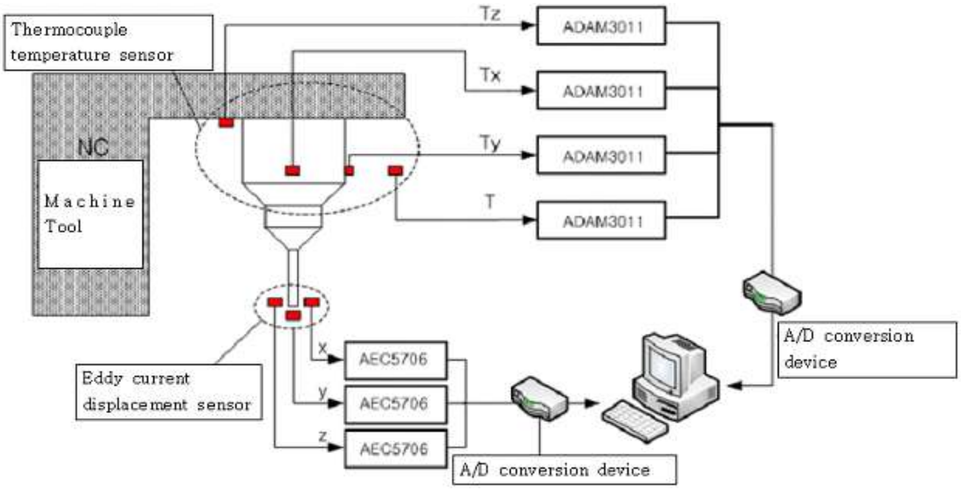


Fig. 7 Data Acquisition for Thermal Error Compensation

As shown in Fig. 8, the dialogue agent generally manages the sensory agent, the decision support agent and interface, to process an enormous amount of knowledge including the knowledge concerning the machine-dependent thermal deformation and the machine-independent cutting condition. For instance, an interrogatory knowledge is regularly applied to the case of the ball-end mill, which is used most in mold processing, in case a cutting condition is given in the dialogue agent. To be exact, the cutting condition necessary for processing work such as RPM, feed rate, feed/tooth, main speed, etc. is given in case of inputting the information of workpiece such as materials, hardness, necessary tools, etc., same as thermal deformation. The Fig. 9 shows a sample of thermal compensation and the Fig. 10 shows a sample of cutting condition. In case of a machine in which the knowledge concerning cutting condition is not inputted, it receives the related knowledge from other machines in which such was already inputted. This system makes evolution possible. Actually, the machine-independent knowledge like cutting condition could be applied as it is. On the other hand, the machine-dependent knowledge received from other machines, like thermal compensation, was unsuitable, because the temperature around machine had influence on the application despite the same machine and the same position. This problem should be gradually solved in consideration of such conditions. As the intelligent application case, fig. 11 shows the autonomous compensation results of machining error occurred by thermal change in M2M machine-tools.

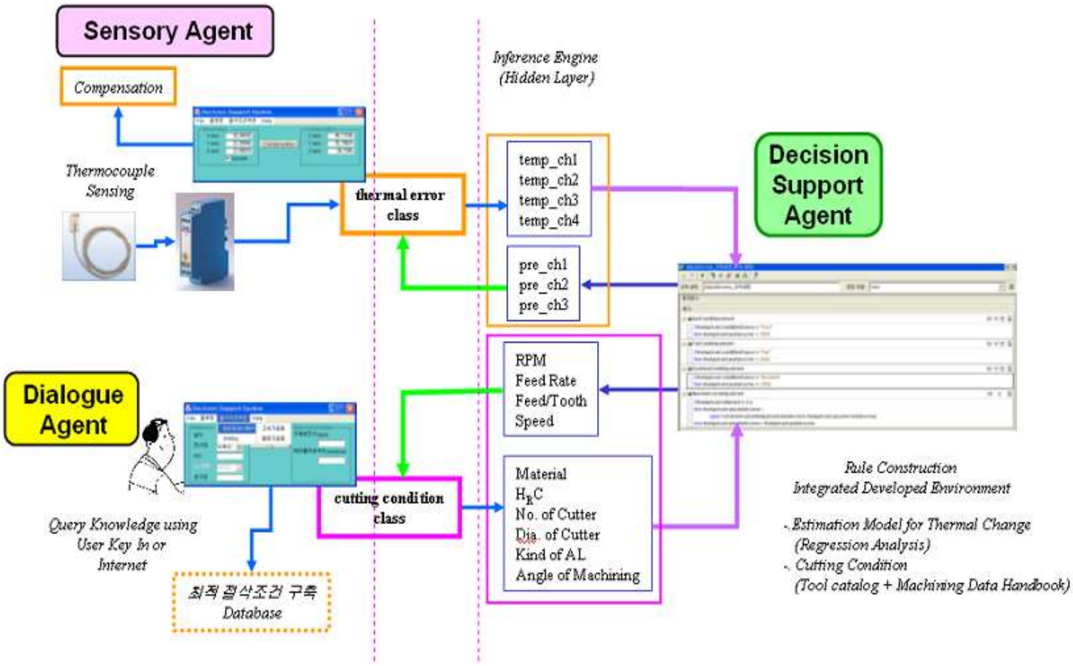


Fig. 8 Data Interface by Dialogue Agent

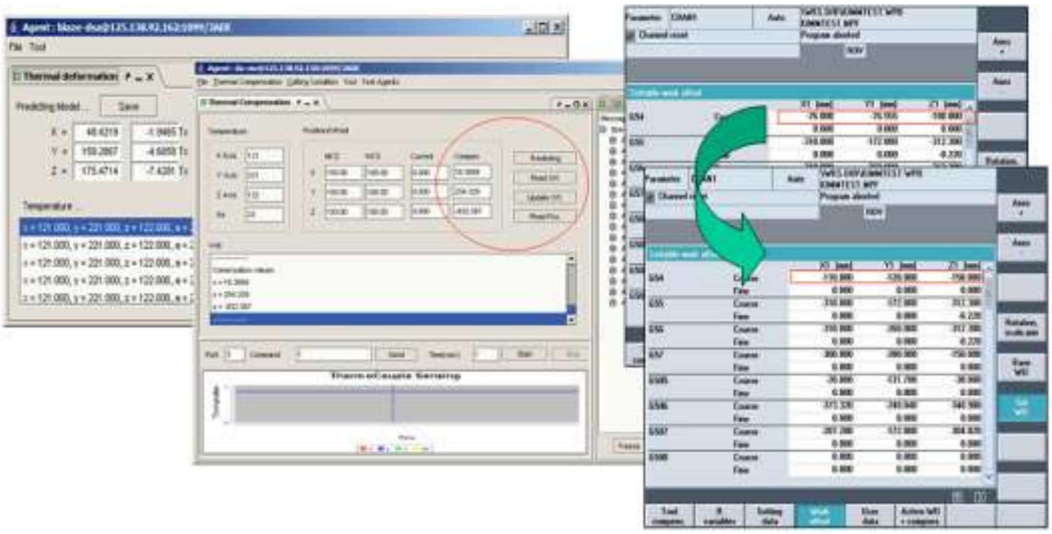


Fig. 9 Thermal Error Compensation through Dialogue Agent

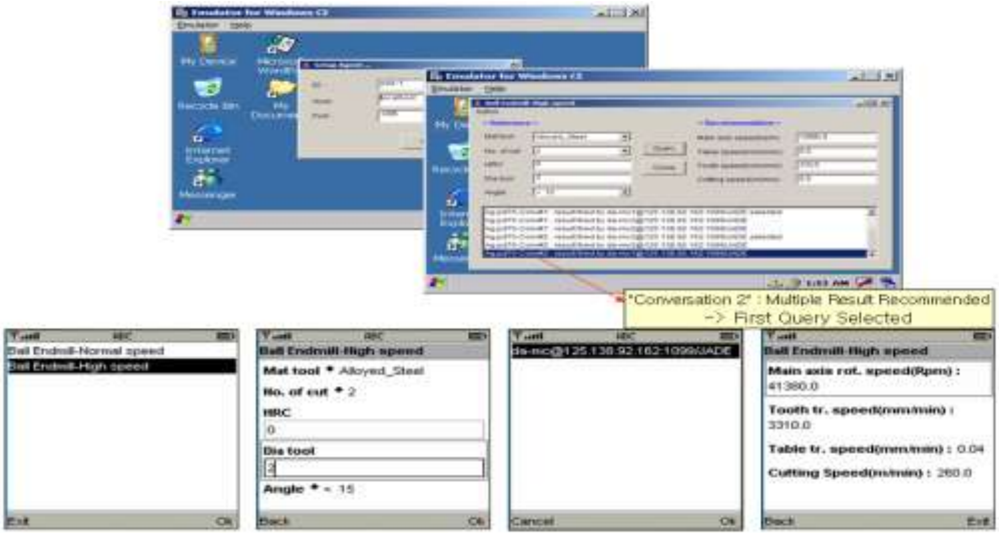


Fig. 10. Cutting Condition Recommendation through Dialogue

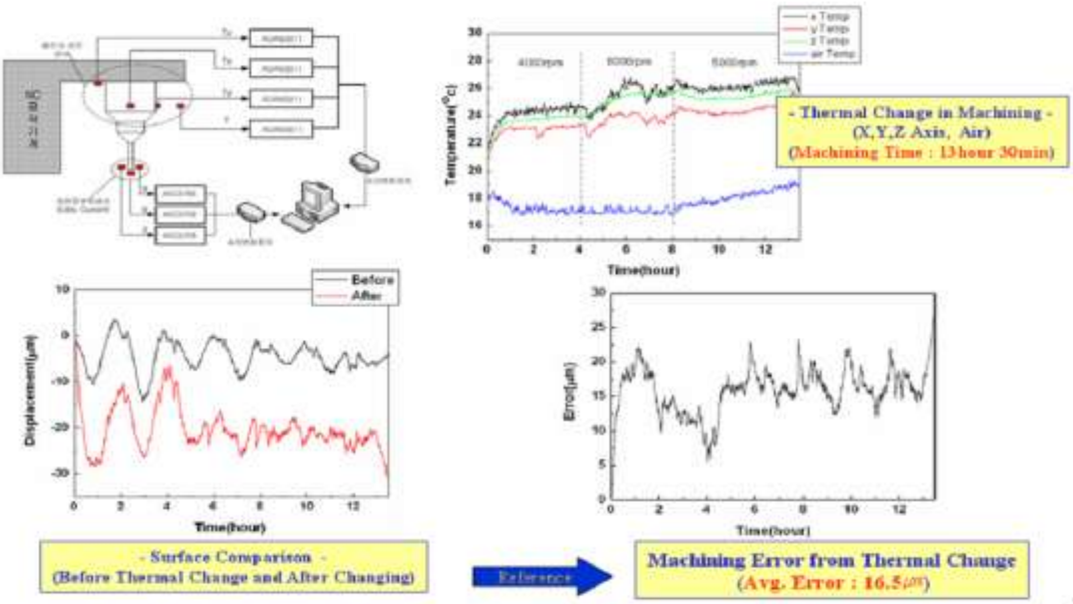


Fig. 11: Analysis of Machining Error by Thermal Change

V. CONCLUSION

This study was performed with intent to design the dialogue agent among the sensory agent, the dialogue agent and the decision support agent necessary to develop the knowledge-evolutionary intelligent machine tool. FIPA platform, a standard operative environment, and the ping agent were analyzed and implemented as well as the studies on effective dialogue agent were performed. In this study, the function of dialogue agent in the M2M environment, suitable to the development of knowledge-evolutionary intelligent machines, was presented in consideration of inter-machine cooperation. Namely, the concept of agent-based dialogue module was presented between the pattern of knowledge-evolutionary intelligent machines and the objective models of knowledge. In particular, the dialogue agent was designed by centering on FIPA-based message interface after the basic analysis of ping agent in M2M environment, and actual application was performed. In the actual machine application, work-offset compensation from thermal change and recommendation of cutting condition are on-line performed for knowledge-evolution verification.

REFERENCES

[1]. Kim, D. H., & Kim, S. H., A scheme for an Internet-based checking method of machine-tools with variant CNC architecture, Journal of Mechanical Science and Technology, 19(1), 2005, 97-105.

[2]. Kim, D. H., & Koh, K. S., CNC-implemented fault diagnosis and web-based remote services, Journal of Mechanical Science and Technology, 19(5), 2005, 1095-1106.

[3]. Kim, S. H., Basic Concept of Ubiquitous - machine, Proceedings of the KSPE Spring Annual Meeting Korea, 2004, 742-745.

[4]. Cantamessa, M., Agent-based Modeling and Management of Manufacturing Systems, Computers in industry, 34(1), 1997, 173-186.

[5]. Poslad, S. & Buckle P. The FIPA-OS Agent Platform: Open Source for Open Standards, Proceedings of PAAM Manchester UK, 2000, 170-184.

[6]. Erol, N. A. & Ito, M. R., Open system architecture modular tool kit for motion and machining process control, IEEE/ASME Transactions on Mechatronics, 5(3), 2000, 281-291.

Dong-Hoon Kim "Smart Machine-Tools based on Knowledge-Evolution " International Refereed Journal of Engineering and Science (IRJES), vol. 07, no. 07, 2018, pp. 11-17