Proposal of Intelligence Module Type Robot that can Exchange It in Seamless

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Abstract: Although industrial robot has been developed well from the end of the last century, and has been well used in various fields, robotics is still being actively researched in Japan now. Chasing after national research institute, the educational institution and robot manufacturer also cost a lot of resource to develop a new generation robot. Moreover, the society gives a high expectation to robot. To provide a low price robot that can be widely used in home, in medical treatment, in welfare, and in disaster relief, etc., a high function, low cost module that can be easy exchanged for maintenance is very necessary. To achieve this aim, it is undesirable to develop the robot based on an original standard in the research institute, in the educational institution, and in the robot manufacturer, etc. separately. Therefore, a common standard in the robotic development needs to be established, and develop the robot based on the common standard. In this research, a new concept for next generation robot development is proposed. This concept contributes a higher intelligence to module, a lower manufacture cost and an easy exchange operation.

Keywords: Robot, Module, Concept, Command, Communication, Intelligence.

I. INTRODUCTION

Japan is leading the world as a country where robot is actively researched now. Robot is researched and developed in various fields such as national research institute, the educational institution and robot manufacturer now. Many of robots that has been researched and developed in Japan are industrial robots. These are still active around the manufacturing industry now[1]. Moreover, the society gives a high expectation to robot day by day, that the robot should active in these fields which are close to our daily life such as home help, medical treatment, welfare, and disaster relief, etc, in the future. It is required that the robot composition module should be a high function, low cost, and be easily exchanged for a good maintenance ability so that it can expand the application field with a low restriction. And, to realize this aim, it is undesirable to develop the robot based on an original standard in the research institute, in the educational institution, and in the robot manufacturer, etc. separately. Therefore, a common standard in the robotic development needs to be established, and develop the robot based on the common standard[2].

Then, as a typical research example concerning sharing the standard in the robotic development, New Energy and Industrial Technology Development Organization (NEDO)[3] executed the project of next generation's robotic development aiming at sharing the standard in the robotic development in 2005. The specification of the project is shown as follows.

- Robot is equipped high functional Central Processing Unit (CPU) in it and works with depending on Operating System (OS) such as Windows and Linux, etc.
- The command of the communication between robot body and module is made at the level of signal.
- Module need to be installed the middleware for the module when module is exchanged.
- Module need to be wire physically between robot body and module when module is connected.
- Module works with depending on the command of robot body.

Here, a signal-level command indicates the physical values of the distance, the speed, and weight, etc.

In this research, a new concept for next generation robot development is proposed. This concept contributes a higher intelligence to module, a lower manufacture cost and an easy exchange operation. The specification of the concept is shown as follows.

1. The robot works without depending on Operating System (OS).
2. The command of the communication between robot body and module is made at the level that human perceives and works.
3. Module has its own intelligence by equipping the microcomputer in it.

4. The communication between the robot body and the module is made wireless.
5. The module works by the unit even if it separates from the robot body.
6. The brain of the robot can be dispersed from the robot body to each module[4] ~[6].

Moreover we produced a prototype robot that works simply based on the concept of 2, 3, 4, 5. As a verification experiment result, the robot worked correctly. Therefore, validity and the effectiveness of this concept were confirmed, then we described the detail following.

II. OUTLINE OF CONCEPT

This section explains the specification of the proposal concept.

A. Proposal concept 1

Because of robot body is not depending on Operating System (OS), it is possible to make the robot work even if a high-end Central Processing Unit (CPU) is not installed in the robot body. According to circumstances, it is possible to make the robot work with the one-chip microcomputer.

B. Proposal concept 2

The human perceive/act-level command is a command that uses the language, which just shows recognition and action by the robot and the module. In the communication between the robot body and the module, it is possible to correspond to a different module that has the same function by sending and receiving the human perceive-level command. Moreover, because the command is easy, the driver software need not be installed in the module.

C. Proposal concept 3

It is possible to convert the human perceive/act-level command into the signal level command by installing the microcomputer in the module.

D. Proposal concept 4

By using the wireless communication between robot body and module, it is possible to connect easily the module to the robot body by putting and changing it only.

E. Proposal concept 5

It is possible to use the module individually by separating the module from the robot body. Moreover, if necessarily, it is possible to use the module that is connected to the robot body as robot.

F. Proposal concept 6

Because the communication between the robot body and the module is at human perceive/act-level command, the program of robot body is simple. Therefore, even if the robot body break down, it is possible to take a backup operation by using the module.

III. INTELLIGENCE MODULE TYPE ROBOT THAT CAN EXCHANGE IT IN SEAMLESS

1. Outline of intelligence module type robot that can exchange it in seamless

To be realized the concept of 2, 3, 4, 5, we produced a prototype robot that move on the line, and recognizing the object that is on the line experimentally. This robot can work correctly with depending on the same command even when we put and change the different module that has the same function on the robot body.

2. Composition of intelligence module type robot that can exchange it in seamless

The prototype robot that we produced experimentally this time is composed of the robot body, distance measurement module and movement module. As the robot body, we used small note computer. As distance measurement module, we used PSD module that is composed of infrared LED and Position Sensitive Detector (PSD) and ultrasonic module that is used ultrasonic sensor. As movement module, we used tire type line tracer and caterpillar type line tracer. The composition of the robot is shown as Fig.1. The robot body (Refer to Fig.2 (a)), distance measurement module (Refer to Fig.2 (b), (c)) and movement module (Refer to Fig.2 (d), (e)) is shown as Fig.2.

3. Communication between robot body and module

The state of the communication between robot body and module is shown as Fig.3. The communication is serial communication. The command that is the level that human perceives and works is send and received periodically. About the communication between the robot body and the distance measurement module, when robot body send the command "Measure the distance between the robot and the object" to the module, the module understand the command and measure the distance with the microcomputer that is installed in the module. After the module measure the distance, it recognizes the distance as "Near" or "Far". The result of the recognition is send to the robot body as character string. About the communication between the robot body and movement module, when the robot body send

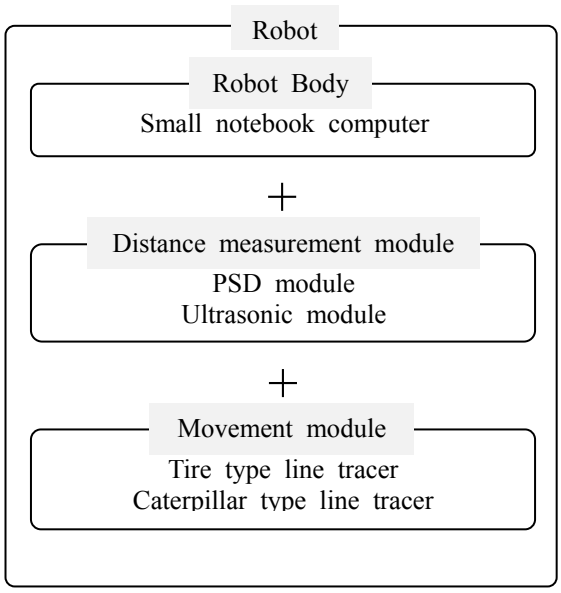

Fig.1. Composition of robot

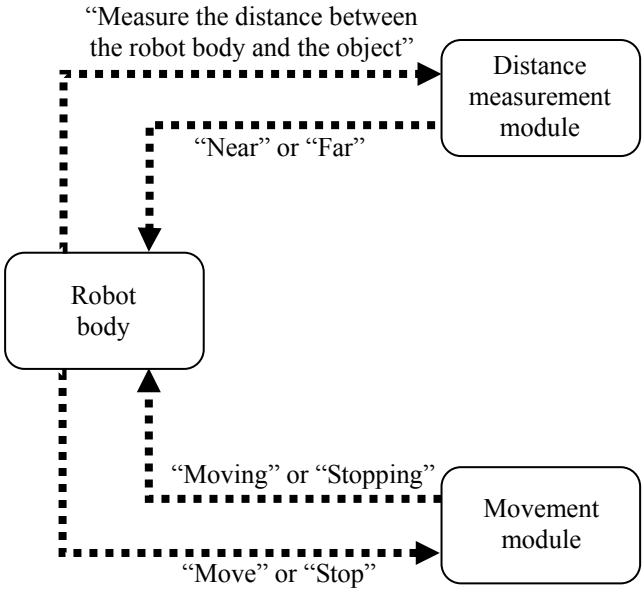

Fig.3. Communication between robot body and module

(a)Robot body

(b)PSD module

(c)Ultrasonic module

(d)Tire type line tracer

(e)Caterpillar type line tracer

Fig.2. Picture of Robot body and module

the command "Move" to the module, the module understand the command as well as distance measurement module and move on the line by the microcomputer that is installed in the module. Moreover, the module sends the state of working of the module to the robot body at the same time.

IV. EXPERIMENTS

For verification of working for the robot, a small notebook computer was equipped on the robot body to control the robot and to send the human perceive/act-level command to each module. Moreover, distance measurement module and movement module was docked to the robot body separately for the robot moving on the line.

First, the line was drawn like circle on the floor and the object was put on the line. The robot move on the line while measuring the distance with the object. After it approaches the object, it recognized the distance as "Near" and stopped on the line.

Second, the object was removed on the line. The robot recognized the distance as "Far" and moved on the line again.

Four kinds of module groups that change combination of modules (Refer to Fig.4 (A), (B), (C), (D)) are shown as Fig.4. About validation methodology of robot, the robot was worked by putting and changing the robot body into four kinds of module groups that is change combination of the distance measurement module and the movement module. Putting and changing four kinds of module groups on the robot body (Refer to Fig.4 (A), (B), (C), (D)), using the exactly same human perceive/act-level command, the robot worked correctly.

(a)PSD module and
Tire type line tracer (A)

(b)Ultrasonic module and
Tire type line tracer (B)

(c)PSD module and
Caterpillar type line tracer (C)

(d)Ultrasonic module and
Caterpillar type line tracer (D)

Fig.4. Four kinds of module groups

As a result, the robot worked correctly according to the same human perceive/act-level command even use the different module group.

V. CONCLUSIONS

In this research, a new concept for next generation robot development is proposed. Moreover, we could experimentally produce robot that works easily based on the concept of 2, 3, 4, 5. And we could confirm that the concept of 2, 3, 4, 5 was effective.

In the future, we are going to produce robot that works easily based on the concept of 1, 2, 3, 4, 5, 6 experimentally and confirm that the concept of 1, 2, 3, 4, 5, 6 was effective.

REFERENCES

[1] H. Asoh, et al: Jijo-2:"An office robot that communicates and learns", IEEE Intelligent System, Vol.16, No.5, pp.46-55, SEPTEMBER/OCTOBER (2001)

[2] Fumio Kanehiro, Kiyoshi Fujiwara, Shuuji Kajita, Kazuhito Yokoi, Kenji Kaneko, Hirohisa Hirukawa, Yoshihiko Nakamura and Katsu Yamane: "Open Architecture Humanoid Robotics Platform: OpenHRP" Journal of the Robotics Society of Japan, vol.21, No.7, pp.785-793, (2003)

[3] NEDO, http://www.nedo.go.jp/english/index.html

[4] Kenji Kaneko, Fumio Kanehiro, Shuuji Kajita, Kazuhiko Yokoyama, Kazuhiko Akachi, Toshikazu Kawasaki, Shigehiko Ota, and Takakatsu Isozumi: "Design of Prototype Humanoid Robotics Platform for HRP", In IEEE/RSJ International Conference on Intelligent Robots and Systems, pp. 2431-2436, (2002)

[5] R. Bischoff and V. Graefe: "Integrating, Vision, Touch and Natural Language in the Control of a Situation-Oriented Behavior-Based Humanoid Robot", In IEEE International Conference on Systems, Man, and Cybernetics, pp. 999- 1004, (1999)

[6] Fumio Kanehiro, Ikuo Mizuuchi, Kotaro Koyasako, Youhei Kakiuchi, Masayuki Inaba, and Hirochika Inoue: "Development of a Remote-Brained Humanoid for Research on Whole Body Action" In IEEE International Conference on Robotics and Automation, pp. 1302-1307, (1998)