On a Multi-Agent System for Assisting Human Intention

Hajime Tawaki*, Joo Kooi Tan*, Hyoung Seop Kim*, Seiji Ishikawa*
* Department of Mechanical and Control Engineering
Kyushu Institute of Technology
Sensuicho 1-1, Tobata, Kitakyushu 804-8550, Japan
(email: tawaki@is.cntl.kyutech.ac.jp)

Abstract: In this paper, we propose a multi-agent system for assisting those who need help in taking objects around him/her. One may imagine this kind of situation when a person is lying in bed and wishes to take an object on a distant table that cannot be reached only by stretching his/her hand. The proposed multi-agent system is composed of three main independent agents; a vision agent, a robot agent, and a pass agent. Once a human expresses his/her intention by pointing to a particular object using his/her hand and a finger, these agents cooperatively bring the object to him/her. Natural communication between a human and the multi-agent system is realized in this way. Performance of the proposed system is demonstrated in an experiment, in which a human intends to take one of the four objects on the floor and the three agents successfully cooperate to find out the object and to bring it to the human.

Keywords: Multi-agent systems, Autonomous robots, Man-machines communication, Robot vision

1. INTRODUCTION

Mobile robots have been developed initially for industrial use. Recently they have become much more popular than ever by the request of possible employment in various fields. For example, a walking robot with legs like a human or an animal, a rescue robot which can work in dangerous zones such as disaster areas, an exploring robot in space, a cleaning robot in an office, *etc*., are eagerly requested in respective areas. A mobile robot that supports people's life is also demanded increasingly due to the forthcoming aging society.

The necessary functions such a mobile robot should be equipped with include an autonomous nature by which it can recognize its environments, judge what to do next, and make an action by itself. Moreover, if one intends to employ it for the purpose of welfare, communication between a human and a robot is indeed necessary. For this purpose, the mobile robot should act based on simple instructions by a human. It is therefore important to design a man-machines interface that realizes such simple and easy instructions to robots [1].

In this paper, we propose a multi-agent system for assisting those who need help in taking objects around him/her. Man-machine communication is realized employing visual information processing.

2. SYSTEM OVERVIEW

2.1 Composing a Multi-agent System

Suppose that a person is lying in bed and wishes to take an object on a distant table without getting up. A robotic function expected in this situation first of all is transport of a requested object in the distant place. In another word, a mobile robot is needed. One may think of making a single mobile robot having high performance to achieve this kind of service. This kind of service should include a function of finding out a requested object (FIND), a function of transporting the object (TRANSPORT), and passing the object to the requested person (PASS). If these three functions are integrated into a single mobile robot, it is not efficient, however, since, when one function is employed, the other functions are not used. When FIND runs, TRANSPORT and PASS are on standby, for example. This fact leads to the employment of a multi-agent system. In the system, the services are done through independent work by multi-agent robots. In this situation, when TRANSPORT runs, FIND can devote itself into another service for another person, *e.g.*, in the next bed. However, to measure own position in the world coordinate only with the mobile robot, enlargement or making the robot large amount of money is demanded. Then, we think the function is distributed by the idea of the multi-agent system. Then, to measure the position of the robot, the system which seizes in the work region is needed. Moreover, if the user does not bend the waist because the demand object is on the floor even if the mobile robot transports the demand object to user's origin, the demand object cannot be obtained. In a word, the demand object is picked up, and the system which passes the demand object to the user is needed. In addition, because the multi-agent system is used, the communication function between agents is needed.

The proposed system is composed of three main agents.
The first agent seizes information in the work region. We call this agent a Vision Agent (VA).
This system which bases the above is composed by four agent. The second agent captures and transports the object in the distant place. We call this agent a Robot Agent (RA).
The third agent passes the requested object to the user. We call this agent a Pass Agent (PA). In addition, the user is considered to be one agent. We call this agent a Human Agent (HA). Information is exchanged according to the TCP/IP communication among agents.
A VA and a RA can proceed to the next service while a PA concentrates in its present job in the proposed multi-agent system, which was not the case with the former version. In this

way, the agents realize mutual independence [2] .

Figure 1 shows the system configuration.

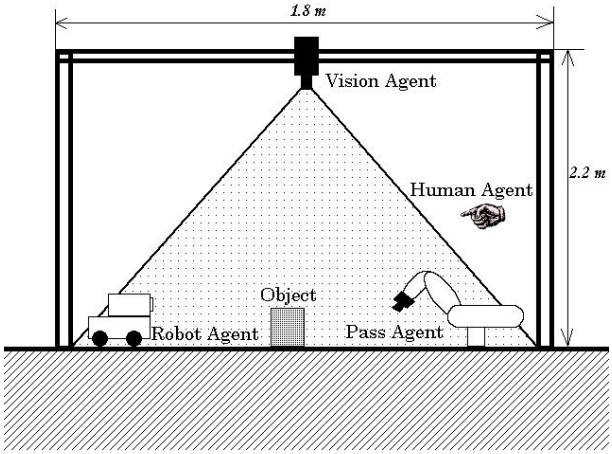


Fig. 1. System configuration.

2.2 Vision Agent

Vision Agent is composed of a video camera and PC. As a result, VA has the function to seize information in the work region. VA's role is object recognition, detection of direction of the tip of a finger, selection of a requested object, and positional seat table detection of agent robots.

2.3 Robot Agent

Robot Agent is composed of a video camera, a mobile part and PC. As a result, the RA has the function to capture and transport the object.

Figure 2 shows the mobile robot.

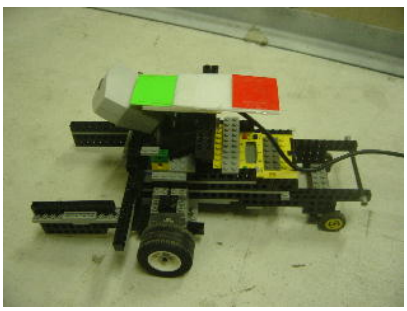


Fig. 2. Mobile robot.

2.4 Pass Agent

Pass Agent is composed of a video camera, manipulator and PC. As a result, PA has the function to capture and pass the object to HA.

Figure 3 shows the PA containing a manipulator.

Fig. 3. PA containing a manipulator.

3. ALGORITHM

When the instruction enters form HA, VA detects the direction of the tip of a finger of HA, and selects the requested object. VA and RA communicate when the selection of the requested object ends, and RA arrives at the object. Then VA does judgment whether or not the selected object is a right object by recognizing existence of the HA's hand at a specified place. VA transmits the judgment result to RA and, if it is a right object, RA captures the object. If it is not a right object, RA moves to the next candidate object. After RA has captured the requested object, RA transports it to the vicinity of PA by communicating with VA. RA transmits the arrival notification to PA when it arrives near PA, and PA captures the transported object. At this time, RA can accept the next service, if an instruction enters from another HA. After having captured the transported object, PA passes HA the object by communicating with VA.

Figure 6 shows flow chart of this system.

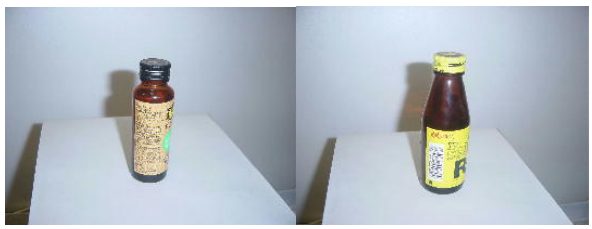
4.EXPERIMENT

In the performed experiment, four objects were used. It is possible for both the RA and the PA to capture and transport the objects used here.

Table 1 shows the size of the objects. **Figure 4** shows these objects.

Table 1. Size of the employed objects.

	Height (mm)	Width (mm)
Bottle 1	110	30
Bottle 2	130	45
Cigarette Box	65	60
Doll	115	60



(a) Bottle 1 (b) Bottle 2

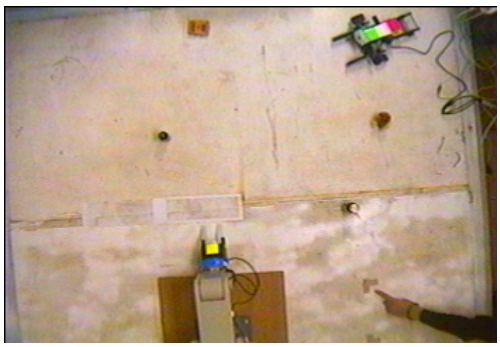
(c) Cigarette Box (d) Doll

Fig. 4. Photos of employed objects.

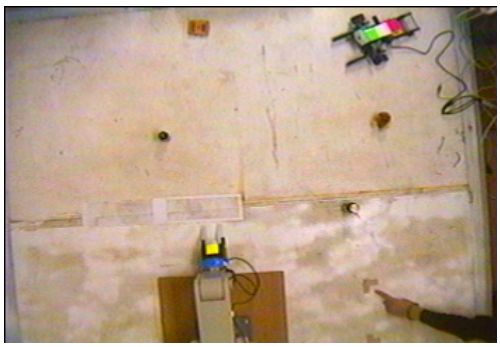
5. RESULTS

Figure 5 shows the movement of this system. HA decides an object from the four objects. (a) When the instruction enters from HA, VA detects the direction of the tip of a finger of HA, and selects the requested object. Afterwards, RA moves to the requested object. (b) Because the judgment result is "Yes" in this case, RA captures the object, and transports it to the vicinity of PA. (c) Because PA has received the arrival notification from RA, the transported object is captured. (d) PA passes HA the object.

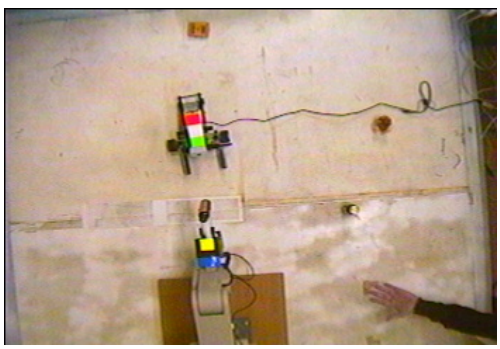
Only because HA pointed at the demand object in the distance by this system, not voluntarily moving and nor taking the demand object while having slept in the bed with sitting became possible HA.



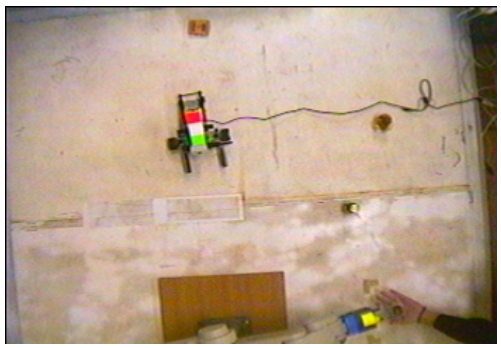
(a)



(b)



(c)



(d)

Fig. 5. Photo of the results.

6. DISCUSSION AND CONCLUSIONS

A multi-agent system was proposed for assisting human intention. When VA and RA find out the right object HA is requesting soon by RA's first move, the entire process time is fast. On the other hand, if the system selects the right object after the second or more move of RA, system performance becomes worse in the present system. Further refinement of the communication between HA and the system is necessary.

One way of realizing natural communication between a human and a machine system was presented in the paper. The idea is to understand human sign language using a hand by image processing of a VA. Alternatively one may employ voice/speech recognition into the present system. Both techniques are going to be employed in our future version in order to achieve more natural man-machines communication.

The importance in this system is "Very, does the robot take communications with the person?". The solution of this problem was attempted by three kinds of agents' cooperative works by this system's using the multiagent system and utility was shown. The speech recognition function is added to talk about HA and the robot to achieve a comprehensible, friendly system in the future, and the word is scheduled to be given to the work of each agent with a voice synthesizer.

REFERENCES

[1] Ishikawa S., Kim H.S., Inoue F., Shimamura S.: "Man-machine collaborative work based on visual communication," *Proc. TENCON2000,* Ⅱ -321-325, 2000.

[2] Ishikawa S., Kim H.S., Igawa S.: "Development of a Mobile Robot for Handicapped People," *Proc .ICCAS2001*, 59-62, Unknown, 2001.

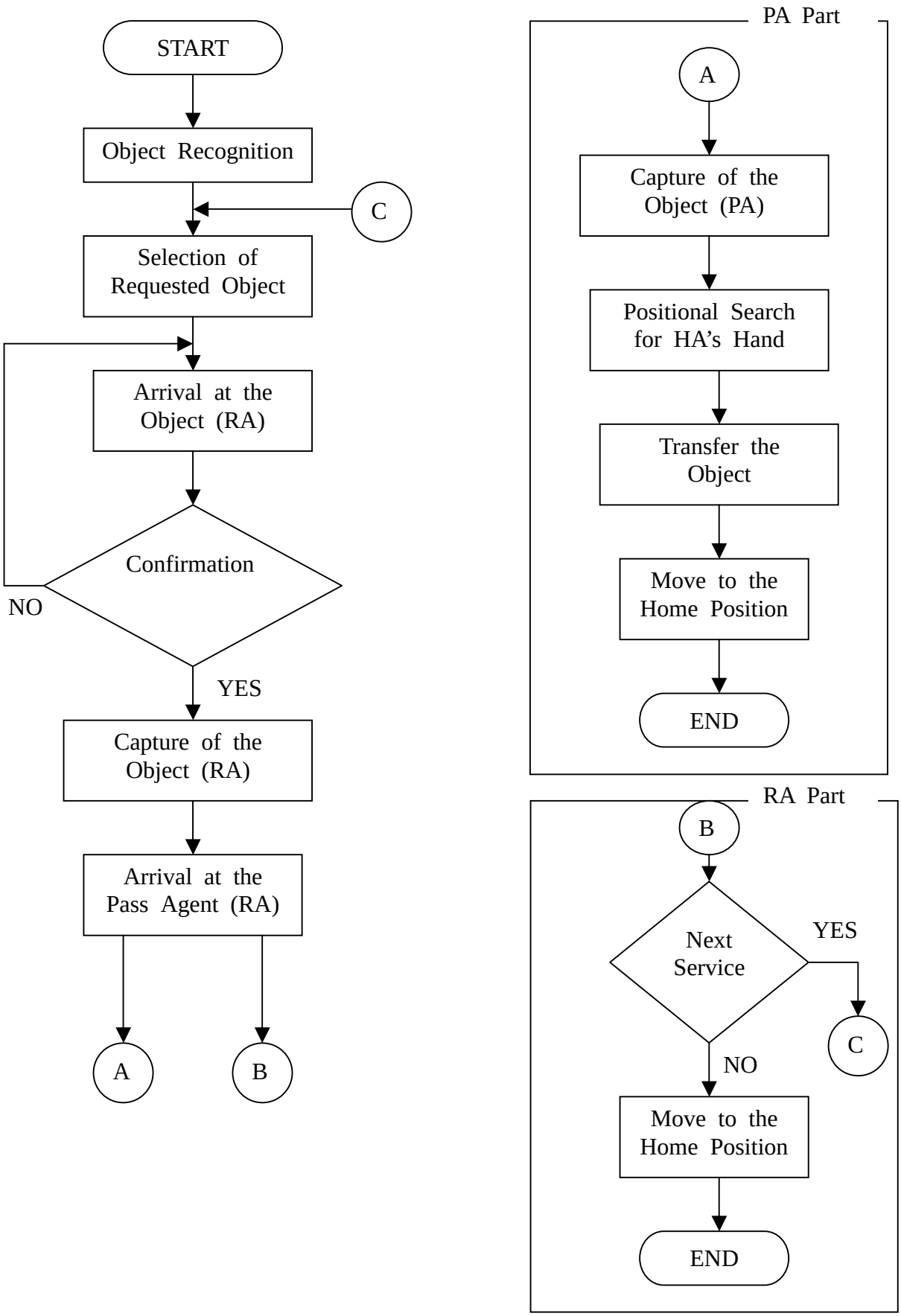


Fig. 6. Flow chart of the system.