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Generating Robot Arm motion by Using Generalized Environmental Information

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Abstract: In this paper, the authors establish a structured environment, in which environment knowledge is not only given to the visible robot that serves to people but also to the environment itself. It aims to provide services efficiently by using the visible robot and to construct a general system that information can be shared with the other robots. Through the experiment, it succeeded in constructing a robot arm motion generation system by generalizing environmental information under a structured environment. In the future, it comes to be able to provide more services by increasing other robot components that can cooperate with robot arm and the accuracy of robot's motion will be improved.

1. INTRODUCTION

In recent years it can be expected that the work force will keep on decreasing in the developed countries in the near future as the aging society with the declining birth rate advances rapidly. There will be much demand for nursing of aging people and the disabled. In that case, it becomes difficult to supply aging people with enough care. Therefore a nursing support robot with high-tech attracts more attention now.

Most information about the service that the visible robot supplied has been given to the robots themselves in the old method. However, it is not possible to provide services efficiently sometimes.

If we make an intelligent space in which the function of the robot is built in the environment. This means to distribute the functional element of the robot in an external environment. The robot with low intelligence comes to be able to provide service by supporting information from the environment to the robot.

Therefore, by reducing the knowledge that has been embedded in the robot and distributing intelligence to environment. We can make the development of robot system simply and efficiently.

In this paper, we are aiming to construct an intelligent robot arm system to carry various objects like human beings performed every day by generalizing environmental information under a structured environment.

2. STRUCTURED ENVIRONMENT

When a visible type robot provides the person with service, the robot carries out various activities. However, it is difficult to do those all by just one robot, and the load of the robot will grow.

By distributing intelligence to the other robots existing in the same environment and the environment itself, therefore the intelligence of each individual robot could be decreased. So the structured environmental means distributed intelligence within an environment. It comes to be able to take flexible correspondence to the environmental changes.

It shows great facility in recognizing object by obtaining information about target object from the outside. Moreover, the intelligence of the robot system is also simplified by obtaining the ordered operation information from the structured environment.

By the robot control such as artificial intelligence or the image processing technology, it is insufficient to support human's daily life in a changing environment. To solve such condition, we suggest a method that attaching RFID (Radio Frequency Identification) tags with standard identification information to all objects. As a result the robot can read it and the object can be recognized without any advanced object recognition technology.

By giving the idea of setting marks in the environment by using RFID tags and tracing their changes, if we present an RFID-sensing robot which cruises in the environment and checks changes occurred in the environment by using the records in RFID tags; through this we can cope with the dynamic changes of the environment for information ensuring for the operating objects [1].

It is assumed that the RFID tags have already been set up in this research, and the robot performs actions on an object by acquiring the necessary information that has been stored in a server [2].

3. GENERALIZING ENVIRONMENTAL INFORMATION

The notion of state transition is used here as a method of obtaining environmental information and generating the operation of the robot arm. We define the detailed basic motions of the robot arm, and make each of them as an object. On the side where environmental information is given, we know executable operation of the robot arm. The order of executing object, and the necessary information of the execution are matched with the environmental information.

Our research is particularly interested in how these intelligent spaces cooperate with robots that move in them. One interesting application here is how the environment can serve as a high level, context sensitive interface to robots. The other target is on how the space and the robot can share information on the geometry and semantics of the environment. Classically a robot has a representation of its environment in a world model he uses alone. In an intelligent environment the world model becomes a service that is offered by the environment, in which the robot participates and eventually contributes to [3].

The movement of robot arm can be generated by state transition with the notion of make each object as a state. Thereby, it comes to be able to carry an object by obtaining information from environment even without giving the knowledge about objects to the robot arm beforehand.

Furthermore, it is made to use for plural robot arms effectively by abstracting environmental information with the method mentioned above, and the environmental information is generalized. It is thought that the convenience of environmental information improves according to generalized information can be shared with different kind of robot arms which existing in a same environment. Figure 1 shows a global image of this research.

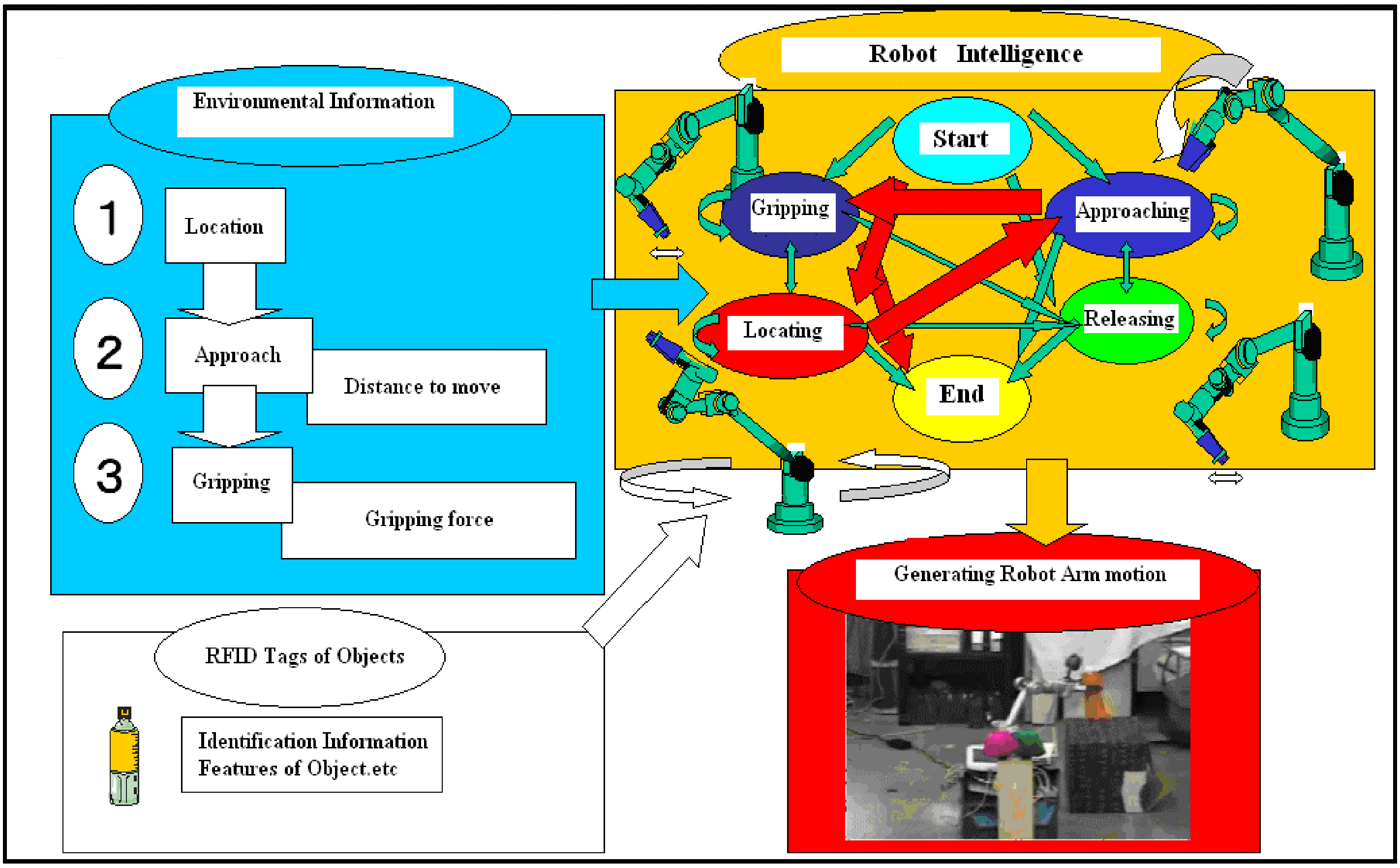

Fig 1: Concept of this research: the robot provides a service using environmental information with the data obtained from RFID tags

4. EXPERIMENT

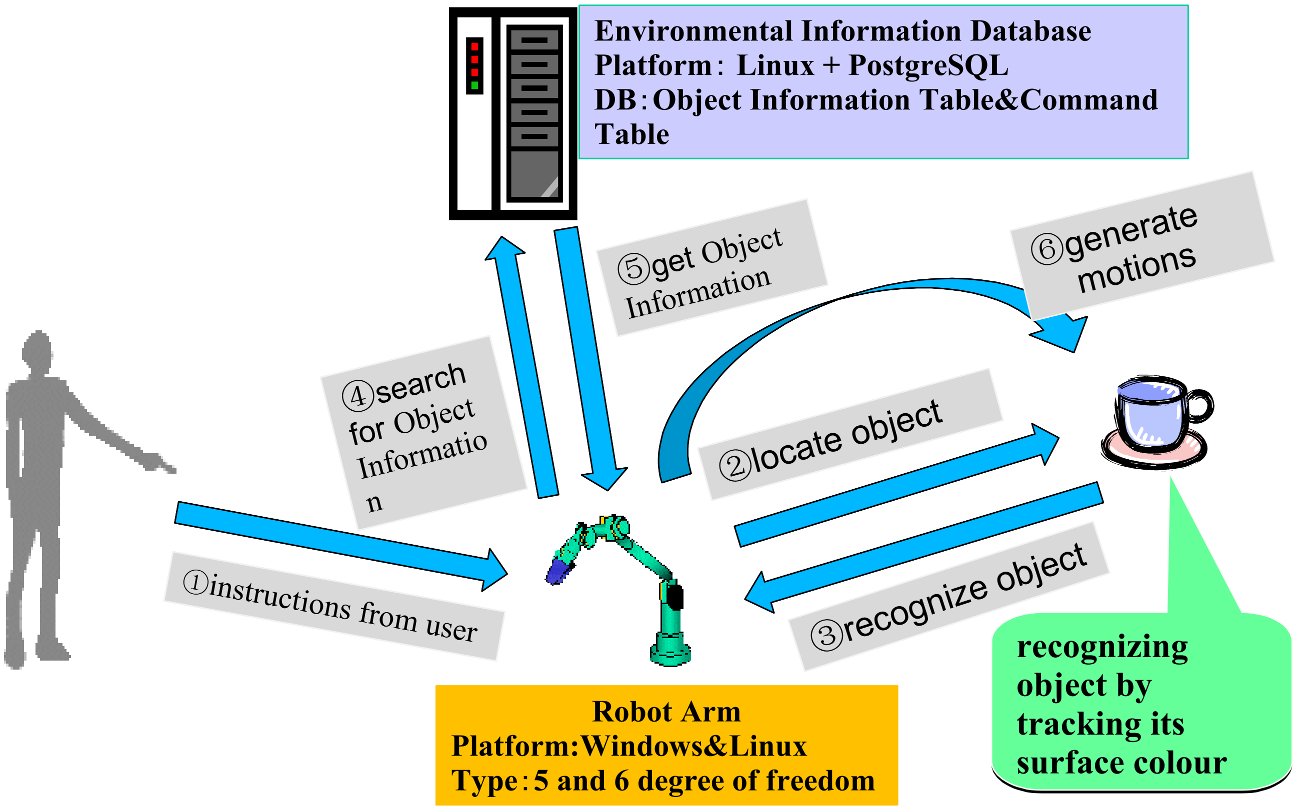

Fig 2: Structure image of this system and flowchart of experiment

In this research, the robot system obtains information from the environment, and generates robot arm motions. At first, we show that how to share the environmental information with different robot arms by doing a same service. Secondly, it shows how the robot recognizes information if the object was changed. Figure 2 shows a global image of this experiment.

4.1 Experiment Outline

A. Experiment Procedure

Step.1: The robot receives instructions from user.

Step.2: Searching for object and lead robot arm to get close to it by camera, the robot doesn't stop until it gets in the operating area.

Step.3: The robot recognizes the identification information of the object by tracking its surface colour.

Step 4:Robot searches for the object's information from server by using 'colour' and 'instruction' as primary key.

Step 5: Robot gets the object's information from server by querying two tables of database. (shows in Fig.2.1 and Fig 2.2)

Step 6: Robot arm generates the appropriate motions according to the parameter form of database, and performs operations by tracking the object with camera under control of laptop.

ID	Object	Colour	Sensor value	Grip mode
N001	cup	red	160	1
N002	bottle	orange	220	1

Fig 2.1: Object Information Table

ID	Instruction	Step	Operation (1…..n)
S001	catch	7	1 or 0
S002	clean up	9	1 or 0

Fig 2.2: command Table

The primary key is red.

B. Experiment Devices

Server: Keeping and updating the environmental information database, communicate with Laptop via socket;

Laptop: Located on the mobile robot to control robots and cameras, communicate with Server via socket;

Camera: To locate the position of objects as the eyes of the robot system, camera works under an image processing software named I-Space. We recognize object by tracking its surface colour, this shows in Figure 3.1;

RFID Tag: Although we did not use them in this research owing to lack of RFID devices right now, we are going to be incorporated it with object as an automatic identification method in further experiment;

Robot Arm: KATANA5M180 (five degree of freedom version, shown in Figure 3.2) & KATANA6M180 (six degree of freedom version, shown in Figure 3.3) manufactured by Neuronics AG, to find the object and get them as the hands of the robot system;

Mobile Robot: PIONEER3-DX manufactured by MobileRobots Inc, to approach object as the foot of the robot system.

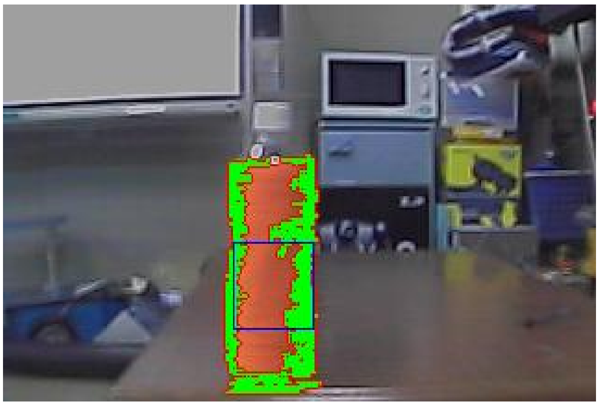

Fig 3.1: Tracking object's colour

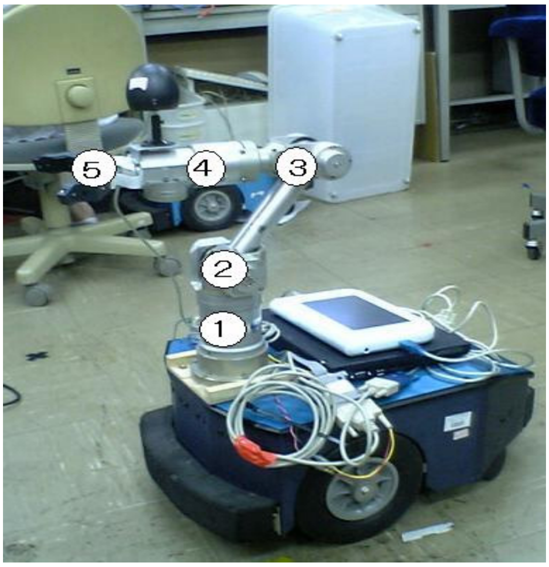

Fig 3.2: KATANA5M180 robot arm (1-4: four motors; 5: the gripper)

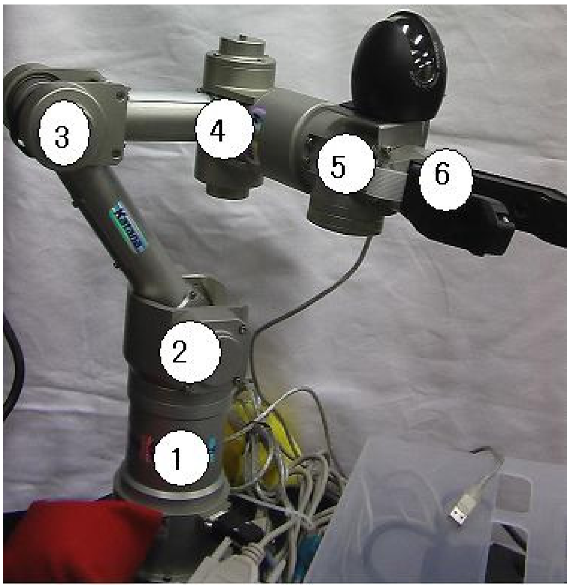

Fig 3.3: KATANA6M180 robot arm (1-5: five motors; 6: the gripper)

4.2 Generating motions with Different Kind of Robot Arms

In this part, we used two kinds of robot arms: five degree of freedom version and six degree of freedom version. Environmental information is generalized by performing the same operation with both two types of robot arms sharing the same information that has been embedded within the environment. The robot arm selects appropriate environmental information from the server by judging objects. So that any type of robot arm can recognize the correct object that should be operated by this way. Figure 4 shows how the two different robot arms grip the PET bottle.

Fig 4.1: Five degree of freedom version arm

Fig 4.2: Six degree of freedom version arm

4.3 Generating motions from Different Environmental Information

According to the different object, Obtained environmental information will be changed. For instance, there is no big difference when the robot arm performing the actions until gripping a paper cup or a PET bottle. However, the paper cup is very soft in comparison with the PET bottle. It will collapse if you grip it with the same force as well as gripping a PET bottle. It is shown that the robot arm can understand different environmental information in this experiment. And the result is shown in Figure 5.

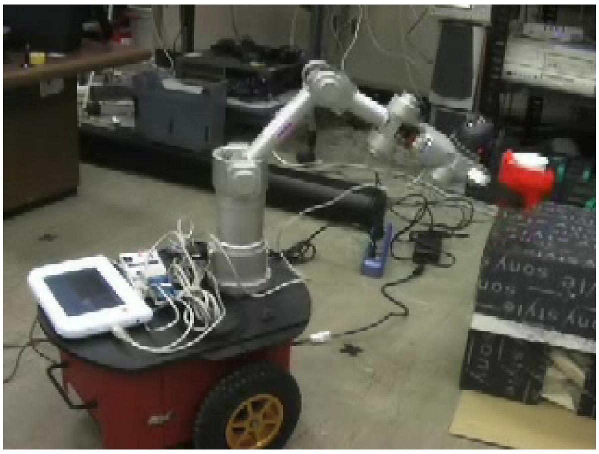

Fig 5.1: The robot arm is gripping a paper cup

Fig 5.2: The robot arm is gripping a PET bottle

Figure 6.1 shows traces of the robot arm's movement. We succeed in generating the same robot arm motion due to that two different robot arms acted in a same track by using the same environmental information. In addition, Figure 6.2 shows parameters of the force sensor that is attached to the robot arm. Horizontal axis is the frequency of the robot arm's movement, and the vertical axis means value of force.

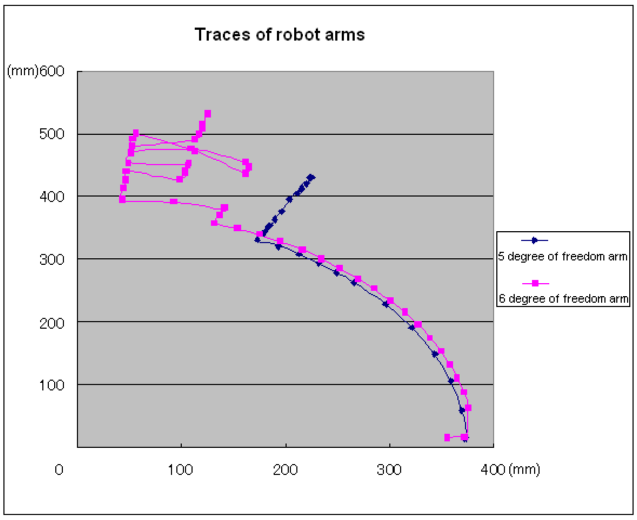

Figure 6.1: Traces of the robot arm's movement

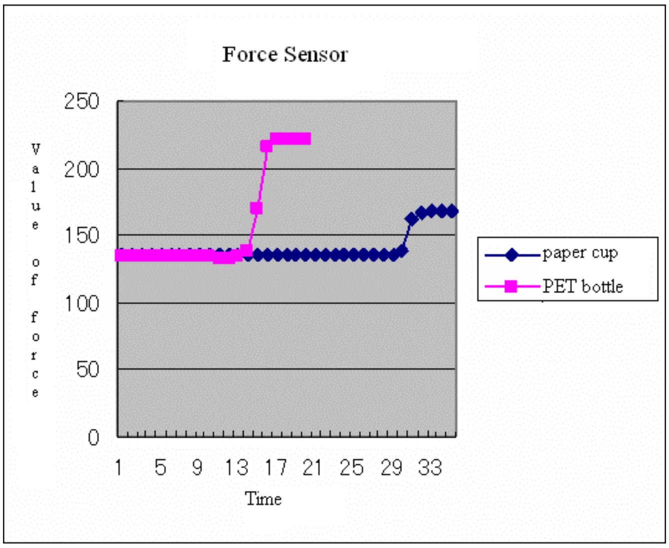

Figure 6.2: Values of the force sensor

4.4 Experimental Results

In experiment 4.2, the robot arm of five degree of freedom version and six degree of freedom version succeeded both in generating the same motion as shown in Figure 5, thus information was able to be generalized. No matter how many robot arms existed, information is always available for all the robot arms by updating one common informational source. As a result, an efficient robot system was constructed.

As the result of the experiment 4.3, the robot arm gripped the paper cup in a weak force compared with the PET bottle shown in Figure 6.2. In consequence, the robot arm can distinguish different objects and grip them in right way by using environmental information.

5. CONCLUSIONS

In this paper, we proposed the idea of generating plural robot arms motion by generalizing environmental information. The motions of two different robot arms were generated from same environmental information. And the different motions done by the same robot arm was generated from different environmental information. Therefore, the effectiveness of this method was verified.

Our experiment yields that it is advisable to make the environment more intelligent. Because it is simple to build a intelligent structured space and the environmental information can be shared, updated and reused easily. For this reason, we can cut down the cost on developing complex robotic technologies.

In future, we are planning to provide more service by increasing the other robot components that can cooperate with the robot arm and improve the accuracy of robot arm motion as well.

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