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Cooperative Robot and User Friendly Robot- New Challenge in Robotics

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ABSTRACT

In the near future many aspect of our life will be encompassed by tasks performing in cooperation with robot. The application of robot in home automation, agriculture production and medical operations etc will indispensable. As a result robot needs to be made human-friendly and to execute tasks in cooperation with human. Researchers proposed many new field of research in Robotics. Cooperative robotics and User friendly robotics are two new area of robotics research. Some researcher is trying to make human like robot. Robots that will be imitate human characteristics in movement, learning etc. Other researchers trying to develop robots which will be entertain human. Another group trying to develop robots and/or control system or robots those will be work cooperatively. In this paper it is tried to gather information regarding these two fields in brief.

1. INTRODUCTION

Human being is the best creature of this universe. In comparison to other creatures, the size and shape of the human body is most favorable in all respect and every movement of the human body is smooth and perfect. From the past, scientists have tried to build mechanism that imitates parts of the human body to perform task for the mankind. Development of robots during the latter half of the twentieth century is its burning example.

Robot is defined as 'any device, which replaces human labor' [1], and up to now most of the robots have been used as industrial robots. These robots have been isolated from human and performed various tasks, which human do not want to do or con not do. The social demand and the technological development of the last decade in robotics, computing and communications have led to envisage the design of robotic and automation systems consisting of networked vehicles, sensors, actuators and communication devices. These developments enable researches and engineers to design new robotic systems that can interact with human beings and other robots in a cooperative and friendly way [2]. These robots should be operated effectively in a human environment i.e., the movements should be smooth, safe and comfortable for the humans use or cooperate with. Control systems for such robots should be designed to work a better context to decipher and imitate the human characteristics.

Human/robot cooperation is an emerging research area in robotics and machine intelligence. A truly intelligent system should be able to work in conjunction with people. However, the key issues are how to define the human and robot functionalities and how to design sensing, planning and control systems such that humans and robots can cooperate in a complementary fashion to perform a task which could be difficult or impossible for a human or a robot working alone. Obviously this could significantly increase the safety, efficiency and effectiveness of robotic operations. In the past the human aspect of machine intelligence in robotics had been focused mainly on human knowledge acquisition and representation [3-6]. Therefore, the research in this area has concentrated on (i) robot programming which deals with the issue of how to pass a human command to a robotic system [7–9]. This process usually happens off-line, i.e. before the task execution. But humans have no real role during a task execution; (ii) teleoperation in which a human operator can pass action commands to a robotic system on-line [10-11]. In a telerobotic system, the human plays the role of a command generator, and the function of a robot is simply to enhance the mechanical power of humans and their ability to work remotely. In the above two cases, the human operator has a deictic role and the robot is a slave system which executes the human program/command received either off-line or on-line. Recently, there is ongoing research on involving humans in the autonomous control process, such as human/robot coordinated control [12–14]. The human, however, is introduced to the system in a similar role as a robot. The human has been represented by a simple mathematical model which usually describes only the mechanical effect of the human factor. Moreover, the human and the robot have a homogeneous functionality in a task execution. For instance, in the task of object handling by a human and a robot, the human is only involved in the low level task execution to perform the predefined functionalities, and has no role in the task scheduling and action planning during the real-time process. The ultimate goal of this paper is to explore the two new areas of robotics.

2. COOPERATIVE ROBOTS

Most operating robots today are stand-alone industrial robots that carry out single tasks such as cutting, bending, or welding metal for automobiles. But future intelligent machine in factories and other environments are likely to include cooperative robots. Robots, those are work cooperatively with other robots or human are considered as cooperative robots.

A team of robots can accomplish more complex tasks than a single robot can working alone. The team is more reliable and robust; if one robot fails, the other robots can take over and continue the mission. By working in parallel, the team can complete the task much faster than one robot. Because the individual robots will have a simpler design, a team of robots may cost less to construct and maintain then one robot built to carry out a complex task [15].

Two robots could be used to perform simple tasks like carrying, lifting or manipulate an object. They can also perform same task in certain order. In Fig. 1, two robots serve coffee to the customer.

Fig. 1. Two robots work together in cooperation.
(Courtesy: Honda Motor Co. Ltd. Japan)

Team of robots could be used to perform complex tasks in areas too dangerous or otherwise undesirable for humans. Such tasks could include cleaning up hazardous waste sites, exploring planets mining in unpopulated areas, participating in search and rescue missions, and decommissioning nuclear power plants, as well as taking part in such activities as automated manufacturing, industrial maintenance, and surveillance for threats such as biological and chemical warfare weapons. Robots are playing football cooperatively shown in Fig. 2.

Fig. 2. Cooperation between multiple robots.

In 1994, Ikeura et al. proposed the human-robot cooperation as shown in Fig. 3. They have considered the task of carrying and lifting an object by a robot and a human cooperatively [16-17]. There are two types of human robot cooperation; master-stave cooperation and human assists robot.

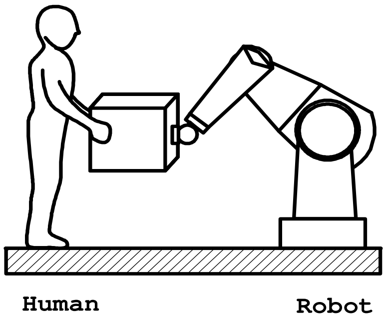

Fig. 3. Human-Robot Cooperation.

In conventional research on intelligent robot systems, many autonomous robots were made for carrying out all tasks automatically by themselves. These robot systems do not include a person as an operator. In some applications such as surgery, agriculture, factories robot motion depend direct or indirect cooperation of human as shown in Fig. 4. These systems are proposed as master-slave type robot systems.

Fig. 4. Master-slave cooperation

In some application, human power needs to amplify for performing bulky task. Human assisting robot, HARO (Fig. 5) [18] and nursing robot, Regina (Fig. 6) [19] are the two examples of many of such robots.

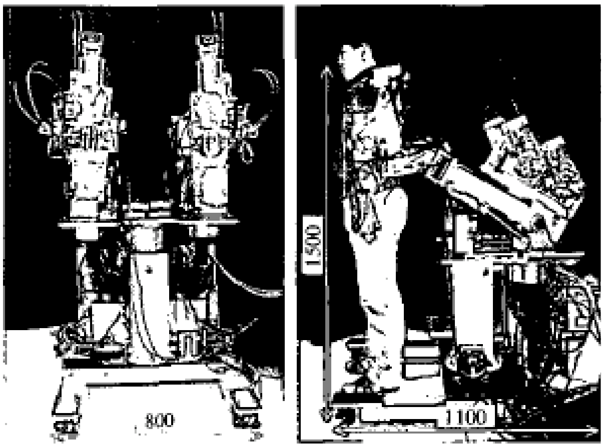

Fig.5. Human Assisting Robot (HARO).
(Courtesy: Department of Mechanical and Control Enginccring,
Graduate School of Electro-Communications,
University of Electro-Communications, Tokyo, Japan)

Fig. 6. Nursing Robot Regina.
(Courtesy: Japan Logic Machine (JLM) Co. Ltd.)

3. USER FRIENDLY ROBOTS

Progresses in modern technologies as well as growing social demands require user friendly robots. A user friendly robot can carry orders efficiently, reliably, and reasonably fast. Ideally, a human operator can say something like, "Go to the kitchen and get me an apple" and (assuming there are any apples in the kitchen) the robot will return in a minute or two, holding an apple. A seemingly simple task like this is difficult to program into a machine, as researcher have found out. Even the most basic tasks are complex in terms of number and combination of digital logic operations.

One of the most important considerations in human engineering is Artificial Intelligence (AI). It is much easier to communicate with a machine that is 'smart' compared with one that is 'stupid'. It is especially enjoyable if the machine can learn from its mistakes, or show ability to reason. Speech recognition and speech synthesis also help make computer and robot user-friendly [20].

User-friendly communication between man and those machines is very important for a human-robot cooperative system that utilizes their features and abilities in order to accomplish their common operational tasks. Realization of such a cooperative system is eagerly anticipated for future robot systems. In this system, various communicating functions between the human and the robot system are necessary for exchanging their commands, advice, and comments about their common operational goals with user-friendly interfaces.

4. CONCLUSION

The cooperative robots and user friendly robots are directly or/and indirectly interact with human. Therefore, human characteristics such as faces, voices, gesture, and movements play an important role in design and control of such robots. The more human-like the robot appears, the higher the expectations of people interacting with it are. All the aspects of human, physical, movements and sensing ability, interacting with environment must be considered to design user friendly and cooperative robots.

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