

N95-14025

## TELE-EXISTENCE AND/OR CYBERNETIC INTERFACE STUDIES IN JAPAN

Susumu Tachi

Mechanical Engineering Laboratory, MITI  
Tsukuba Science City, Ibaraki, JAPAN

2-2  
1

Tele-existence aims at a natural and efficient remote control of robots by providing the operator with a real time sensation of presence. It is an advanced type of teleoperation system which enables a human operator at the controls to perform remote manipulation tasks dexterously with the feeling that he or she exists in one of the remote anthropomorphic robots in the remote environment, e.g., in a hostile environment such as those of nuclear radiation, high temperature, and deep space.

Systematic research for the development of tele-existence has been conducted at MEL by feeding back rich sensory information which the remote robot has acquired to provide the operator with a real-time sensation of presence.

With the advent of science and technology, it has become possible to envision teleoperation with a sensation of presence. The concept of projecting ourselves by using robots, computers and cybernetic human interfaces is called Tele-Existence, and a lot of effort has been made for the realization of this concept. This concept also provides an extension of human sensing and muscular capabilities.

The tele-existence system consists of intelligent mobile robots, their supervisory subsystem, a remote-presence subsystem and a sensory augmentation subsystem, which allows an operator to use the robot's ultrasonic, infrared and other, otherwise invisible, sensory information with the computer graphics-generated pseudo-realistic sensation of presence. In the remote-presence subsystem, realistic visual, auditory, tactile, kinesthetic and vibratory displays will be realized (ref. 1).

Using this system, a human operator can be in a safe and comfortable environment and, at the same time, be present or exist at other environments where the robots are working. He or she will monitor the work through the robot's sensors, and, if necessary, conduct the task on behalf of the robot as if he was doing the work himself (ideally) or as if he was working inside the robot (practically).

The principle of the tele-existence sensory display has been proposed. Its design procedure has been explicitly defined. Experimental visual display hardware has been built, and the feasibility of the visual display with the sensation of presence has been demonstrated by psychophysical experiments using the test hardware (refs. 1,2).

A method has also been proposed to develop a mobile tele-existence system, which can be remotely driven with the auditory and visual sensation of presence (ref. 3). A prototype mobile tele-vehicle system has been constructed and the feasibility of the method has been evaluated.

In order to study the use of the tele-existence system in the artificially constructed environment, the visual tele-existence simulator has been designed, a pseudo-real-time binocular solid model robot simulator has been made, and its feasibility has been experimentally evaluated (ref. 4).

An anthropomorphic robot mechanism with an arm having seven degrees of freedom has been designed and developed as a slave robot for feasibility experiments of teleoperation using the tele-existence method. An impedance controlled active display mechanism and a head mounted display have also been designed and developed as the display sub-system for the master. The robot's structural dimensions are set very close to those of humans, and it is designed to mimic the movement of humans (ref. 5). By using this tele-existence master slave system, the feasibility of the tele-existence master slave system has been demonstrated.

## REFERENCES

1. S. Tachi et al., "Tele-existence (I) – Design and evaluation of a visual display with sensation of presence-," Proceedings of the 5th Symposium on Theory and Practice of Robots and Manipulators (RoManSy84), pp. 245-254, CISM-IFTOMM, Udine, Italy, June 1984.
2. S. Tachi and H. Arai, "Study on tele-existence (II) – Three dimensional color display with sensation of presence – ," Proceedings of the "85 International Conference on Advanced Robotics (ICAR), pp. 345-352, Tokyo, Japan, Sept. 1985.
3. S. Tachi, H. Arai, I. Morimoto, and G. Seet, "Feasibility experiments on a mobile tele-existence system," The International Symposium and Exposition on Robots (19th ISIR), Sydney, Australia, November 1988.
4. S. Tachi, H. Arai, and T. Maeda, "Tele-existence simulator with artificial reality (1), – Design and evaluation of a binocular visual display using solid models-," Proceedings of the IEEE International Workshop on Intelligent Robots and Systems, pp. 719-724, 1988.
5. S. Tachi, H. Arai, and T. Maeda, "Development of an anthropomorphic tele-existence slave robot," Proceedings of the International Conference on Advanced Mechatronics (ICAM), pp. 385-390, Tokyo, Japan, May 1989.