Next Generation Communication with a "Telecommunication Robot"

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Abstract

NEC has been providing an enterprise oriented rental service featuring a "Communication Robot, PaPeRo." As a part of this service, we have produced a prototype of a "telecommunication robot (a mobile robot performing telecommunication)" that is capable of communicating with people while being operated from remote locations and we are currently undertaking further research and evaluation.

A user remotely controls the robot via a PC by watching the images that the robot captures with its camera eyes. This enables smooth communication between a person remotely operating the PaPeRo and those sitting in front of it. The history of communication tools has been progressed via telephone and videophone. The "telecommunication robot" suggests a new possibility of a communication tool in next generation.

Keywords

robot, telepresence, video conference, remote telecommunications, remote communication surrogate robot, communication robot

1. Introduction

As one of Japan's main industries, the robot industry has been increasingly drawing attention in the market. According to the announcement of April, 2010 by METI (Ministry of Economy, Trade and Industry) and NEDO (New Energy and Industrial Technology Development Organization), the growth of the robot market will reach 2.9 trillion yen by 2020, and 9.7 trillion yen by 2035. Although a manufacturing based market in industrial robots already exists, dissemination of a service providing market is considered as a new trend in cultivating markets that are likely to accelerate growth in the robot industry.

As a project aimed at testing the market, NEC has been leasing the "Communication robot, PaPeRo R500" (**Photo 1**) for enterprises since 2009. As a result of these test marketing activities, we expect that a telecommunications robot will become a product that will potentially have strong appeal in the service providing market. A user will be able to communicate with people via the robot by operating it from remote locations. This paper introduces details of NEC's telecommunication robots.

Photo 1 The communication robot "PaPeRo R500."

2. The Communication Robot "PaPeRo"

The communication robot PaPeRo can enhance its features by installing additional software. The telecommunication robot is an enhanced model of PaPeRo, which has software installed to enable remote communication. Before explaining what a telecommunication robot does, the standard functions of PaPeRo will be described.

NEC started robot research and development in 1997. Since then, we marketed "R100," which is our first generation ro-

bot, in 1999, and "PaPeRo (PaPeRo2001)" in 2001. In 2009, we started leasing the latest "Communication Robot PaPeRo R500."

Its innovative features are:

- Communication functions including a speech recognition technology that enables greetings and responses, etc.
- Cutting edge technologies such as NEC's original voice recognition technology and also face detection technology may also be mounted.
- The optimal use of various sensors (**Fig. 1**), autonomous walking, playing games by using touch sensors, etc. are also available.

NEC's original robot platform software is installed in Windows. A development tool, PaPeRoCreator (**Fig. 2**) is provided for user customization, so that users can adapt PaPeRo to be suitable for a variety of scenarios that are able to fulfill different purposes.

At the moment, PaPeRo R500 is mostly being used at universities and research laboratories. However, it is used not only for industrial research but also in support of cultural studies. For example, in cooperation with the Research Institute of National Rehabilitation Center for Persons with Disabilities, an assessment of PaPeRo is in progress for adoption in a nursing care role. Research is being conducted to find out how to guide the behavior of dementia patients.

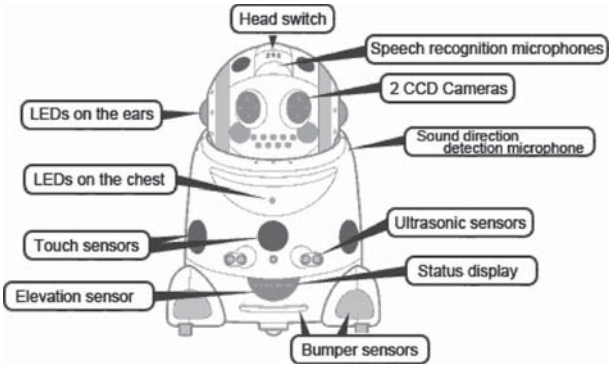

Fig. 1 Sensors mounted on PaPeRo.

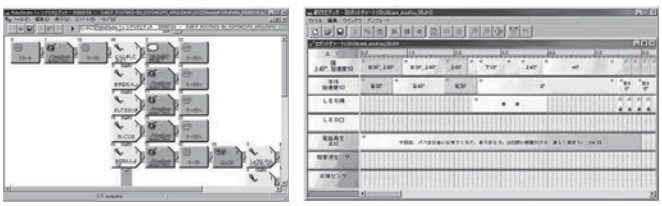

Fig. 2 Development tool "PaPeRoCreator."

3. What is a Telecommunication Robot (Surrogate Robot)?

There are two types of robots: one mounts an AI (artificial intelligence) and moves autonomously, and another is developed to help people to extend human ability by being worn or operated. The latter is called a capability expansion model. The telecommunication robot is an example of this type. A user sends the robot as a surrogate to a chosen venue and remotely controls it via a network. This procedure enables smooth communication with others in remote places as if the user were actually attending the meeting etc. (**Fig. 3**). In employing this robot, we aim to eliminate the distance between places and to reduce transportation hours and loads. We also expect that this robot will contribute to reducing CO_2, which is currently a serious social issue, providing effective countermeasures against pandemics and solving issues of elderly persons living alone.

NEC exhibited a "PaPe Telephone" at the 2005 World Exposition, Aichi, Japan. By using video telephony implemented in a mobile phone, a user operates the "PaPe Telephone" while at the same watching images via PaPeRo's eyes. Recently, a suitable environment for increasing the possibility of a telecommunication robot has been prepared due to the dissemination of high-speed broadband networks such as NGN (Next Generation Network) and LTE (Long Term Evolution) as well as improvement of the network circuit quality. The release of similar robots is also being announced in the overseas markets.

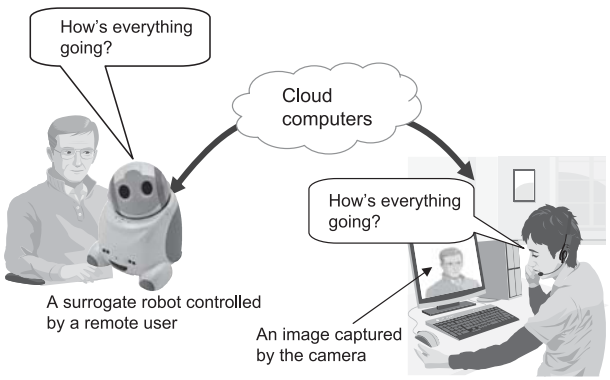

Fig. 3 A diagram illustrating telecommunication robot usage.

4. Focusing on Issues of the Telecommunication Robot

Now we will review the telecommunication robot and focus on its functions as a communication tool. Nowadays, there are many tools that conveniently enable remote communication, such as email, video phone, etc. However, many people still prefer face to face communication when discussing important subjects. Why is this so? One of the possible reasons is that verbal language alone (text information) cannot convey information as adequately as is expected to be gained from an intimate communication. They also expect to communicate non-verbally such as by body language, gestures, voice sounds, and to thereby establish some kind of rapport with the other person, etc. (see **Table**), real time communication is also expected.

For example, instead of sending a text saying only "I feel sad," adding non-verbal language such as a sad voice (Paralanguage) and body language may convey feelings more precisely as well as instantaneously. A researcher says that the percentage of effective message conveyance in human communication when using non-verbal language is generally 65 to 90%. This shows how important a role is taken by non-verbal language in communicating with each other. Moreover, real-time feedback enables more effective communication while enabling clarity. **Fig. 4** is a chart illustrating communication tools by classification as "verbal language only," "verbal language + non-verbal language," "real time" and "non real time."

The telecommunication robot uses tools classified as "verbal + non-verbal." Additionally, its real-time capability shows a similar communication method to that of a video phone. However, while a video phone uses video images to improve communication quality, the robot is able to use its body language capabilities.

Table Major non-verbal languages.

KINESICS (Interpretation of body language)	Facial expressions, eyes (eye contact, eye expressions, pupil size), body language or gestures, posture, etc.
Paralanguage (Non-verbal elements of communication)	Voice quality, Vocalizations: vocal characterizers (laughing, crying, moaning, whining, yawning), vocal qualifiers (volume, pitch, tempo, resonance, tone), vocal segregates
Tacesics and Stroking (Physical contact)	Physical contact with the other person to aid communication
Proxemics	Personal space, measurable distance between people as they interact
Human characteristics	Sex, age, physical features etc.
Choice of clothing	Hats, jackets, underwear, uniforms etc.

5. The Differences from Telephones and Videophones

Why does a telecommunication robot have the ability to feature different market values from those of telephones and videophones? For example, the book "The Cognitive Science of Usability" written and edited by Etsuko T. Harada introduces research results by Dr. Christian Heath and Dr. Paul Luff of EuroPARK. These research results indicate that the communication effectiveness that eye contacts or gestures should have, may be significantly decreased in a communication that uses video images. It also indicates that this disadvantage could be amplified when the communication is of long duration. This means that a wrong message conveyed via non-verbal language contained in the video images may raise issues in the communication.

Non-verbal language such as body language and eye contact are very important elements of a communication. The

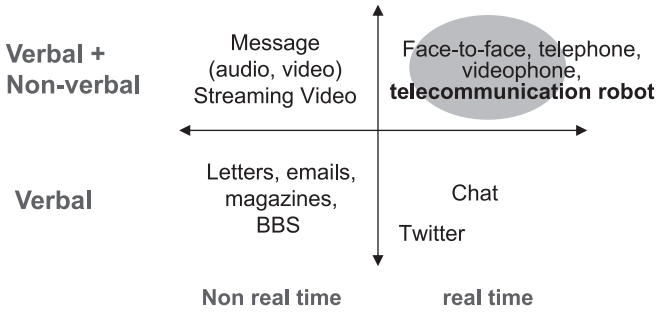

Fig. 4 Communication tools chart.

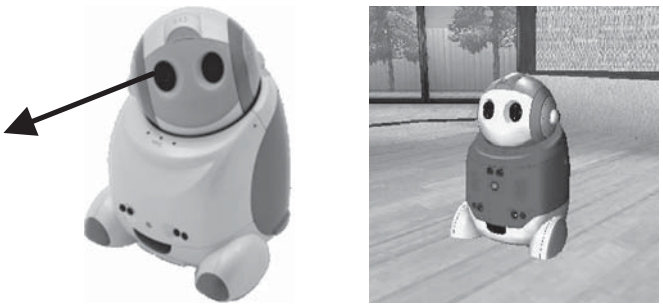

Photo 2 3D robot (Left) and 2D CG robot (Right).

telecommunication robot may be able to convey these messages more precisely than a video conference system. Because the telecommunication robot is an entity that actually exists in the same environment as those to be communicated with, it can communicate more effectively and it also features a personal space that can influence the level of mutual interaction (**Photo 2**).

6. Outline of the Telecommunication Robot Prototype

NEC has been conducting prototype developments and experiments to demonstrate the possibilities of the telecommunication robot as a new communication tool.

PaPeRo mounts a CCD camera and a microphone to communicate image and voice messages with distant locations. A remote user operates PaPeRo via the operation console panel on the PC screen using a mouse (input with a keyboard or a game pad is also possible). The targeted scene that the user wants to access or the body language of PaPeRo such as nodding, can be operated while watching images sent from PaPeRo via its eyes. By connecting a microphone to a PC, the user's voice can be sent to the robot. In this way, a user can remotely control the visual/hearing senses and body language of a robot located at a distant place (**Fig. 5**).

PaPeRo employs a speech synthesis technology and a sensor to detect sound source directions. A user sends a text message to PaPeRo, it speaks out the message with its cute voice. With the sound source detection function, PaPeRo turns automatically towards the direction where the sound comes from. **Photo 3** illustrates scenes of the experiments.

Following the experiments, we received comments from people who spent time with PaPeRo such as "I felt eye contact with this robot.", "I felt as though the speaker were with us." etc. The person who operated PaPeRo at the distant location commented "I felt like I were inside the robot." We consider that such comments confirm the hypothesis that robot communication differs from that of conventional communication devices.

Moreover, NEC Facilities, Ltd. is experimentally operating PaPeRos in order to employ this technology in practical business situations. For example, multiple PaPeRos can be controlled from a single operation console panel of a PC. This

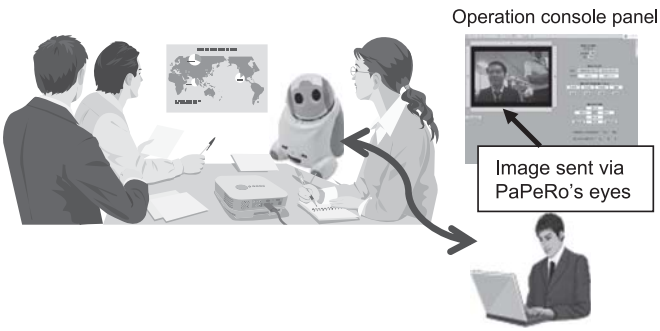

Fig. 5 Image of an office usage situation.

Photo 3 Usage experiments at meeting room (Left) and at home (Right).

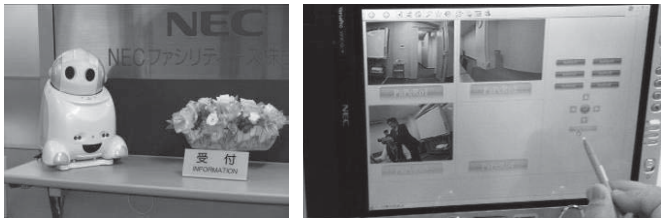

Photo 4 PaPeRo at a reception counter/A console panel for multiple PaPeRos.

Photo 5 Operation panel using LifeTouch software.

means that a person can operate multiple PaPeRos located in distant places and to use them for monitoring and remote handling (**Photo 4**). We aim thereby to remotely provide our services.

In cooperation with NEC Software HOKURIKU, Ltd., we have developed a prototype robot that can be remotely operated via LifeTouch for mobile use (**Photo 5**).

7. Conclusion

The results of these activities are:

- A telecommunication robot has the possibility of becoming a next generation communication tool due to its features such as an ability to command presence and sight lines that cannot normally be equipped with a video phone or a video conference system.
- As experimental results, we have received the comments of those that have spent time with PaPeRo such as “I experienced eye contact with this robot.”, “I felt as though the speaker were with us.” A remote user that had operated PaPeRo commented “I felt like I were inside the robot.”
- With optimal use of PaPeRo a user is made to feel like there is no distance between locations. PaPeRo possesses the possibility of being employed in various practical business scenarios, such as those enabling one person to remotely operate multiple robots in different places.

When considering reducing CO_2 , providing countermeasures against pandemics and solving issues of elderly people living alone, communication with distant places becomes more and more important. We aim to continue to develop and improve the telecommunication robot so that it will become a new communications tool that admirably meets the needs of the market.

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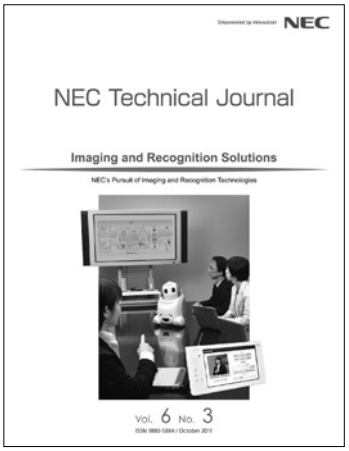

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Special Issue TOP