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Field Trial of Asynchronous Communication Using Network-Based Interactive Child Watch System for the Participation of Parents in Day-Care Activities

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Abstract— **A recent trend in society is for young parents to ask for support in performing their childcare duties. Against this background and to promote the intermixing of parents and children and support information exchange between parents and nursery teachers, we developed the network-based interactive child-watch system called "Meru-robo Digital Log system". It is composed of the "Action Switch Platform (AcSP)" (developed by NTT Laboratories) for exchanging dialog with a "personal robot" (called "PaPeRo") (developed by NEC Corporation) by using cellular phone text messaging. A field trial showed that parents could send their intentions and receive information in a schedule-flexible manner via cellular phone text messaging. Since the robot in the nursery linked the parents to the teacher, their information exchanges did not interfere with the activities of the children. We report results of information exchanges using this system in two situations: parents are the same building (but not the same room as the children) and parents are in other locations going about their daily life. In the limited situation of children playing in a nursery, we found that parents in remote locations could get detailed information about their children's activities and expressions when desired via asynchronous communication.**

Index Terms - child-watch system, nursery facility, cellular phone, asynchronous communication

1. INTRODUCTION

More and more people are recently changing their lifestyle by having both parents working. Families now need to collaborate with the service providers taking care of their pre-school children and aged parents. To better support working parents, nursery facilities are offering extended opening hours. To encourage the elderly to lead a self-supporting life, more day service centers are offering home visit nursing. As implied, it will be more important to support collaboration between the family and the service providers.

The functionality offered by modern robots has advanced to the point that many of societies needs can be fulfilled by using these technologies. Several recent studies have targeted the effective support of the elderly and children through the use of robots. Experiments have been conducted on robots providing therapy services to elderly people and child-care in nurseries[1][2][3][4]. Several studies have been made on robotic systems and the remote control of robots for remote collaboration[5][6][7]. As mentioned above, several studies have been made on the use of robots to provide effective support for elderly people and children. However, no study has examined using robots to allow the parents to collaborate with service providers as well as their aged parents and children.

Higher levels of "safety" and "security" are being demanded, and expectations for services that allow parents to watch over children from a remote location and services that activate communication between parents and children are growing. We introduce here our concept of a robot system that establishes asynchronous communication between remote parents, teachers, and children.

We developed "Meru-robo Digital Log system", a network-based interactive child watch system for the participation of parents in day-care activities as a prototype of our concept. This system is composed of "Action Switch Platform (AcSP)" (developed by NTT Laboratory) for exchanging dialog with "PaPeRo", a personal robot developed by NEC Corporation. A key feature is that it is based on cellular-phone text messaging. The parent writes an e-mail message describing the parent's wishes and sends it to the system. PaPeRo receives the message which is passed to

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AcSP and converted into an action command acceptable to PaPeRo. The teacher, at the appropriate time, triggers PaPeRo to process the command. PaPeRo follows the parent's instructions and collects video images of the child's response to the parent's message. The collected video data is returned to the parent.

An experiment was conducted at two child care facilities to validate our concept; 12 families participated. We report trial results and interview data collected from the families and the teachers.

We describe our concept in the second chapter. Next, we describe the"Meru-robo Digital Log system," the prototype system used to validate our concept. We report the results of the experiment in the fourth chapter; our conclusions are given in the fifth chapter.

2. Robot System with Asynchronous Communication

2.1. Problem of nursery facilities for parents

Given the background of working parents utilizing child-care services, parents and teachers are sharing roles for child development. Parents can watch their child activities and can listen to the voice of their child at home. This is not possible while the parents are working. If the parents have a spare moment such as a coffee break, there is no direct way of getting detailed information about their child's activities. The parents are limited to second-hand information about their children provided by their child's teacher. Since working parents are very busy, their communication time is generally short. Therefore, parents cannot learn of their children's activities in any detail. Moreover, the parents and teachers have insufficient face time to be able to share the parent's policies and requests about day-care activities, as well as learning the teacher's advice about day-care activities.

Trials have been conducted in which parents could get information about their child's activities in Japanese nursery facilities[8][9]. Past trials set a Web-camera in the play room to deliver video of the children's activities to the remote parent's PC. This arrangement is effective in providing a parent with a general sense of reassurance about the day-care activities. Such Web-cameras, however, have a fixed position (usually on the ceiling) and are wide angle. The parent may have to wait for some time to see their child actually doing anything. This can be a serious problem since working parents have so little free time. Working parents are constrained and can only peruse web-cam feeds at particular periods such as a coffee break.

Our solution is to realize a system that permits the parent to establish an immediate link with their child whenever possible and interact with the child as needed.

2.2. Our concept

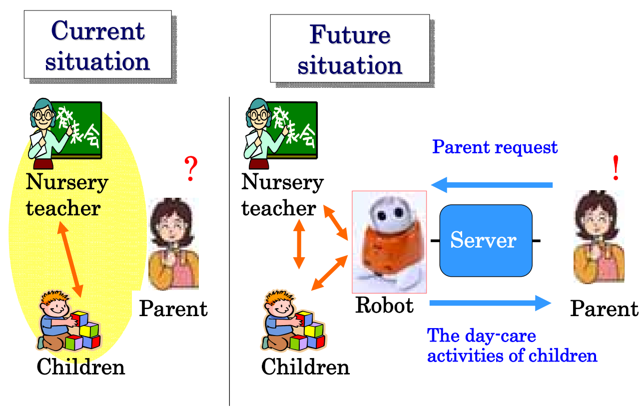

Fig. 1 Future situation in nursery facility.

Fig. 1 show the Future situation in nursery facility which we image. We think that the problems can be effectively resolved by using a robot system to link parents to the nursery teacher and child. In order to realize the proposed system, we first considered the robotic systems on remote collaboration model used to pass the information provided by a remote expert to an on-site worker and observe the results of the worker's actions.

The goal of these robotic systems are to realize an environment in which the remote expert can get feed back and so correct the worker's mistakes and the worker can get the information needed to finish the maintenance or repair actions scheduled. The remote expert and worker use video communication to share the condition of the work site in real time; a remote control robot is placed at the worker's site. The expert remotely controls the robot to assist the worker in understanding the operations needed. For example, the robot can highlight the part piece of equipment that must be tested next. This establishes intuitive communication between the remote parties.

To realize our proposed environment, a robot system is effective as the instruction medium to link remote parents with the teachers and children. But, as mentioned in the previous section, it is difficult for remote parents and nursery teacher, child in nursery facility to conduct synchronous communication. Because the parents, teacher, and child have different daily schedules.

A robot system using on asynchronous communication between parents and the teacher and child, allows us to develop new robot functionality to provide instruction channels that allow all parties to conduct comfortable communication. Our developed robot system needs to have the following capabilities.

- Make it easy for parents and teachers to asynchronously input instructions to the robot system.
- Interact with child and collect information from the child in response to the asynchronous instructions from remote parents and teachers.
- Display the information collected to remote parents and teachers via asynchronous communication.

To validate our robot system, we developed Meru-robo Digital Log system, a network-based prototype system. It is composed of the "Action Switch Platform (AcSP)" (developed by NTT Laboratories) and the personal robot "PaPeRo" (developed by NEC Corporation).

3. OUR PROTOTYPE SYSTEM : MERU-ROBO DIGITAL LOG SYSTEM

3.1. Overview of Meru-robo Digital Log system

We describe here our network-based interactive child watch system for the participation of parents in the day-care activities of their children : Meru-robo Digital Log system. Figure 2 shows overview of "Meru-robo Digital Log system". In this system, the remote parent uses his/her cellular phone as the interface device, because it is used on a routine basis and can be used anywhere at anytime. The teacher and children use the personal robot "PaPeRo" as the interface device, because it was designed to be perfectly safe for children and provides the interfaces needed. In this system, the "Action Switch Platform (AcSP)" on the network links PaPeRo to the cellular phone of the parent.

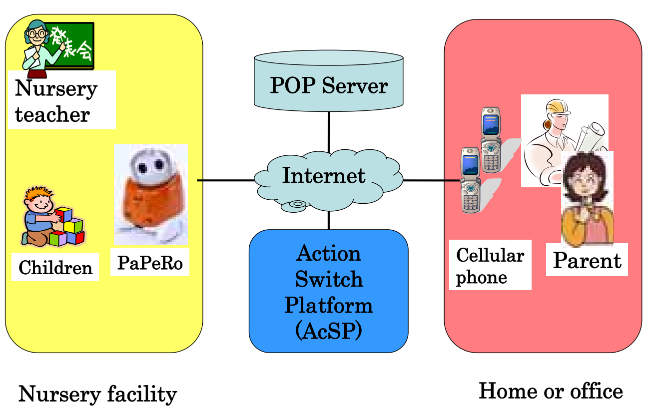

Fig. 2 Overview of "Meru-robo Digital Log system".

3.1.1 Meru-robo Function

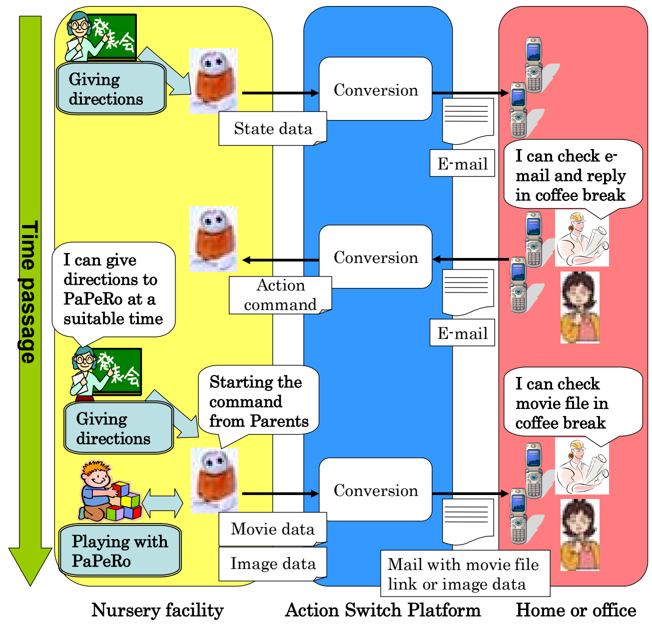

Fig.3 Overview of "Meru-robo Function".

This system has two functions but in this paper we explain only the "Meru-robo Function", an overview of which is given in Figure 3. The parent sends e-mail or reply to AcSP to access the Meru-robo Function. Using the Meru-robo function provided by this system, the parent can indicate to AcSP via cellular phone text messaging the action that their child should perform (play). The teacher gives directions to PaPeRo via touch control. When PaPeRo is triggered by the nursery teacher, PaPeRo starts the command received from AcSP and plays with the children. At the same time, PaPeRo take a movie of the child with its eye camera. The movie will include the child's facial expression, because PePeRo's eye camera is level with the child's eyes. The movie taken by PaPeRo is sent to the parent's cellular phone by Mail as a movie file link.

By using e-mail(cellular phone text messaging) as the communication tool, the parent can create and send messages when suitable for the parent and get, in return, the information desired. The parents have a direct way of getting detailed information about their child's activities. The response of the child is captured on video by PaPeRo and replayed asynchronously to the parent.

The teacher can decide what time is appropriate given the day-care schedule in the facility for starting robot activities or sending the information to remote parents.

In this way, through the robot, the parent can send a request and message to their child and the teacher, and the teacher can send details of the activities of the children to their parents at times suitable for each other.

3.2. System constitution

Meru-robo Digital Log system is composed of AcSP, PaPeRo, Cellular Phone and POP server. We describe each part as below.

3.2.1Action Switch Platform (AcSP)

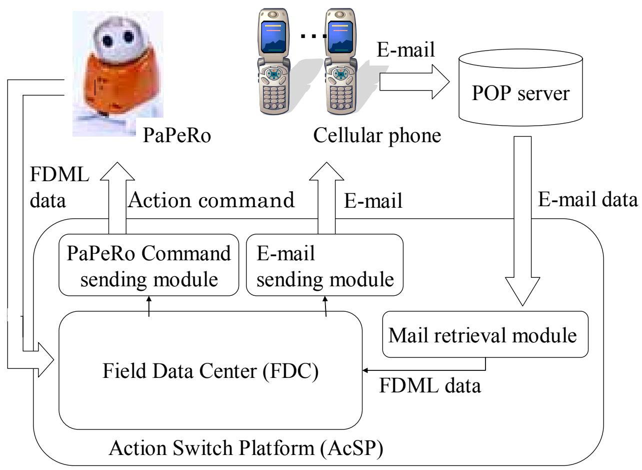

Fig.4 Outline of Action Switch Platform (AcSP).

AcSP is based on the information distribution platform "Field Data Center(FDC) " and some other modules. Figure 4 outlines AcSP. For realizing the asynchronous communication between FDC and the Personal robot, we developed a Mail retrieval module, a PaPeRo command sending module, and an E-mail sending module.

FDC was developed by other members of our laboratory[10]. The information distribution data format "Field Data markup Language(FDML) " , which is based on XML, is used to link the various devices across the network and pass information between them[11]. FDC stores and manages data in FDML format; it can check the conditions of events through the application of IF-THEN rules. FDC makes it easy to realize the functions needed for realizing link event processing with external applications. Therefore, desired events can be registered with FDC ahead of time and services and external applications can be triggered as desired by checking the conditions of events.

The Mail retrieval module converts the cellular phone text message into FDML data. It acquires e-mails from the mail server (POP server) at regular intervals. If a new e-mail is found, it extracts the body of the e-mail. This module holds pairs of keywords and FDML data. If a keyword registered in it is found in the message body, it sends the FDML data that matches the keyword to FDC.

The PaPeRo command sending module and E-mail sending module are external applications that are triggered as desired by checking the conditions of events on FDC. The PaPeRo command sending module can send an action command over HTTP protocol to PaPeRo to control its speaking function and actuators. The E-mail sending module can send one of several standard e-mails to parents.

3.2.2Personal robot "PaPeRo"

PaPeRo has several default scenarios written in a scripting language that describe basic behaviors and actions. PaPeRo's basic functions include a speaking function and an actuator control function. The software platform "robot virtual machine" in PaPeRo interprets these scenarios, and triggers the PaPeRo's functions as performance flow. This platform can switch these scenarios, received an action command over HTTP protocol, from other devices on the network. PaPeRo is able to run several scenarios in parallel such as one to interact with the child and another for receiving commands from the network. Therefore, while PaPeRo is playing with a child, PaPeRo's action and speech changed by the server. The child is unaware of any switching or activation of different scenarios.

3.2.3Processing of Meru-robo function in Meru-robo Digital Log system

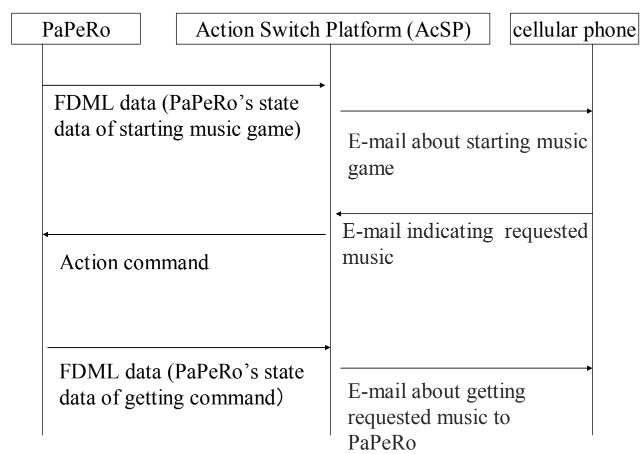

Fig.5 The example of processing flow of Meru-robo function.

We explain the key processing flow of the Meru-robo function on AcSP and PaPeRo, and the cellular phone below. Figure 5 shows an example of the processing flow of the Meru-robo function.

When the teacher triggers PaPeRo to start the music game via touch control, PaPeRo sends its FDML data to AcSP as state data corresponding to the touch command. Upon receiving the FDML data, AcSP checks the conditions of events associated with the FDML data received. If the conditions of events of "sending e-mail about starting music game to parents" are TRUE, AcSP initiates the action. After the parent's e-mail reply is received by AcSP, if the body of the e-mail contains keywords registered with AcSP, AcSP receives the FDML statements that match the keywords. Upon receiving the FDML data, AcSP checks the conditions of events associated with the FDML data received. If the conditions of events of "an action command over HTTP protocol to PaPeRo " are TRUE, AcSP does the actions.

Through this processing flow the system establishes asynchronous communication between remote parents, teachers, and children.

4. Experiment

The experiment was designed to encourage parents to communicate asynchronously with the teachers and the children by using the Meru-robo function, and to verify whether the parents could acquire useful information.

4.1. Outline of experiment

We conducted trials in two nursery facilities, Maito-project (infant education facility,Tokyo) and Makoto-aijien (day nursery, Yamanashi Prefecture). At the Maito-project site, we examined 6 infants from 5 to 9 years old and their parents while 6 infants from 5 to 6 years old and their parents in participated in the experiment at Makoto-aijien. Trials were executed for about 2 hours on selected days at each location. Each parent was assumed to have a different situation as regards the children in the facilities. At the Makoto-aijen site, parents stood around in a room apart from their children after they received an outline of the experiment; all parents shared a cellular phone provided by us. At the Maito-project site, on the other hand, parents left the site after receiving an outline of the experiment; each were given a cellular phone (same model as above). The actual experiment used the flow in which the parent's demands were collected over a certain period and presented to the children over a 2 hour period. The period when the child care was smoothly advanced to the nursery teachers was selected. The parents answered a questionnaire after the experiment. Moreover, we collected verbal comments from the parents and the teachers.

4.2. Flows of teachers and parents during the experiment

We now explain the flow of play actions observed during the trials. Figure 6 shows the example of paying attention to the behavior of the children and parents. In this experiment, we provide four pairs of keywords and FDML data as music type requests, and five pairs of keywords and FDML data to represent the types of impression from parents.

Each PaPeRo trial began with the children receiving some instruction from the teacher. When PaPeRo was turned on, it sent an FDML statement containing its state. Figure 7 shows children with PaPeRo. AcSP then sent e-mails to the parents asking them to nominate the tune to be played. The parent replied with an e-mail containing the name of the tune. Figure 8 shows a typical e-mail from a parent and display of a movie file on the cellular phone. When the parent's e-mail was received at AcSP, AcSP sent an action command over HTTP protocol to PaPeRo.

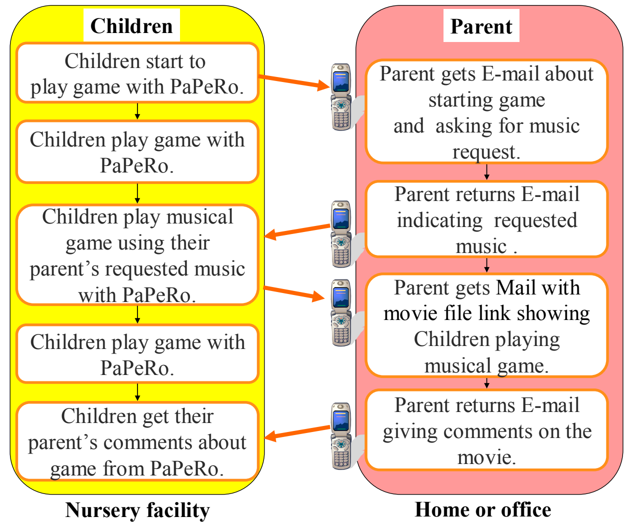

Fig.6 The example of user's flow chart.

Fig.7 Children playing with PaPeRo.

Fig. 8 Example of e-mail from parent and movie file displayed on a cellular phone. The e-mail states "To PaPeRo. my request is for the song of frogs to played in the musical game of the children with PaPeRo".

Upon receiving this instruction, PaPeRo played the tune and invited the child to sing along. While PaPeRo sang to the child, PaPeRo took a movie of the child with its eye camera. The video captured at this time was transmitted to the parents as mail with a movie file link.

In each trial, the teacher let the children play with the robot for about 20 minutes. This gave the system enough time to send the requests and collect and process the parents' requests. Afterwards, after the impression from parents is sent via mail to AcSP, the impression from parents is presented to children by PaPeRo after the teacher's approval.

4.3. Trial results

TABLE 1
QUESTIONNIRE RESULTS FROM PARENTS

Questionnaire Items	Answer	total
Could you operate the cellular phone and make e-mail with keywords ?	YES	11
	NO	1
Could you understand the appearance of your child from the movie on e-mail link ?	YES	9
	NO	3

Of the twelve parents who used the Meru-robo function, eleven were able to acquire useful information about their child. One parent was unable to reply to a teacher's e-mail asking for the parent's request. Since this parent was in a subway train, the cellular phone connection was poor which lead to a failure to receive the e-mail.

Table 1 shows the questionnaire responses collected from the parents. From the responses, the following comments were obtained. Eleven of them could operate the cellular phone and make e-mail containing the desired keywords easily, because they often wrote e-mails of the same length. Nine of them were glad to be able to visually confirm their child's play and expression and the work performed in response to their requests by watching the movie accessed via the e-mail link. Most watched their child's appearance during spare moments such as a coffee break. Three parents indicated that they wanted to confirm not only their child's play and expression, but also their child's play with other children, an overall view. With regard to the impressions of the children, gathered from the parents, the children were very glad to receive their parents' requests and comments. In the limited situation of children playing in a nursery for this experiment, this system did not hinder the activities of the nursery teachers in terms of starting commands from parents in compliance with directions given from the teacher.

In future work, we need to improve the method of making the movie contents available to the parents and the method used by the teacher in giving directions to PaPeRo. We also need to extend the kinds of requests that the parents can issue for using this system.

5. CONCLUSON

In this paper, we proposed the concept of a robotic system that offers asynchronous communication between remote parents, nursery teachers, and the children themselves. To confirm our concept, we developed Meru-robo Digital Log system, a prototype network-based interactive child watch system that lets parents participate in day-care activities. We implemented this system in two childcare facilities and conducted a trial with the cooperation of 12 families. In the limited situation of children playing in a nursery, we found that parents in remote locations could get detailed information about their children's activities and expressions, when desired, via asynchronous communication.

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