The 18th IEEE International Symposium on
Robot and Human Interactive Communication
Toyama, Japan, Sept. 27-Oct. 2, 2009

The Use of Robots in Early Education: A Scenario Based on Ethical Consideration

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***Abstract*— In this position paper, we will raise some critical issues on applying robotics technologies into the educational environment. The series of discussions are based on our previous study on toddlers - robots interaction at a nursery school. In reaction to the notice warning of its potential risk, we will present a scenario in which robots are employed with less ethical concern and more educational contribution.**

I. Introduction

Between year 2004 and 2007, Tanaka and his colleagues conducted a long-term field study on toddlers - robots interaction at a classroom in the Early Childhood Education Center in the University of California, San Diego [1]. The study was a part of the RUBI project [2] whose goal was to investigate the potential of robotics technologies at the educational environment. A small humanoid robot was immersed into a classroom where there were children less than 24 months old, and the interaction between them had been observed on daily basis for more than 5 months (Fig. 1). Through the observational study, the socialization process was recognized where children were getting to accept the robot as if it was a peer to them, and also it was foreseen the potential benefit of introducing robotics technologies as a supporting tool of teachers engaging educational activities.

The trial was very well-received by teachers and parents at the nursery school, but on the other hand it evoked some critical reactions on some media warning the potential risk of childcare-robots. Noel Sharkey pointed out at *Science* magazine [3] that few is known about the long-term effect of children interacting with a robotic caregiver, and it might lead to the lack of human attachment for the children. Then he also emphasized the vital need for public discussion and legislation to decide the limits of robot use before the industry and busy parents made the decision themselves. In the experiment mentioned above, actually the robot did not function as a care-giver, but rather served as a care-receiver by children. The Roboethics community [4], [5] has been discussing wide range of ethical issues surrounding robotics. Ronald Arkin speculated the use of entertainment robots might provide an artifact displaying an illusion of life, thus encouraging a further loss of contact with reality by the elderly [6].

Fig. 1. A long-term ($>$ 5 months) field trial of immersing a small humanoid robot into a classroom of children less than 24 months old. [1] PNAS/National Academy of Sciences (Copyright 2007)

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These critical comments need to be located in a context of the long history of human-technology relationship. For example, after the WWW was introduced not only to the workplace but also to our home, what have happened to the family relationship? When an automobile was accepted as the major transportation vehicle, what happened to the communities? Human-robot interaction is not a separate case, but a part of the long and complicated relationship between humans and technologies with some local and unique problems.

Most technologies have upsides and downsides. Therefore it is crucial for engineers and users to recognize the both properties well and consider the better use. The authors of this paper and their colleagues formed a Roboethics task force to examine various ethical issues related to the introduction of robots into the various aspects of the daily life. The purpose of this paper is to sort out the potential benefit and risk of introducing robots into the educational environment such as a classroom from the experience of being immersed with the long-term field trial mentioned above. We will also explore the better form of robot-use considering the ethical discussions made so far.

II. Robots in Education: Potential Benefit and Risk

As far as Tanaka and his colleagues had observed, children were very motivated to interact with robots - particularly the ones which were in some sense ‘weaker’ than the children. They tried introducing a small humanoid robot (58cm height) which functioned much higher than other conventional toys but not as high as children (for instance, the robot could do biped walking but the speed was much lower compared

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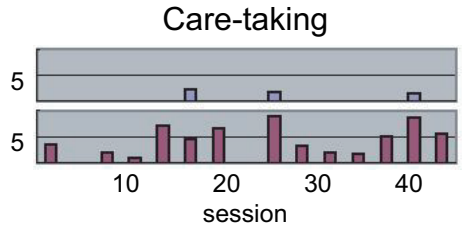

Fig. 2. Histograms as to children's care-taking behaviors towards a robotic toy (upper) and a humanoid robot (lower). [1] PNAS/National Academy of Sciences (Copyright 2007)

with children). It turned out that through the daily classroom activity over more than a 5 months period, children had taken care of the robot much more times than other similar objects such as an immobile robotic toy (Fig. 2).

The robot also worked very well as a tool to get and keep children's attention. In the classroom where the study was conducted, every morning there was time reserved for children's physical exercise such as dancing. Normally it is not always easy to keep the interests of children on a specific task, but it had been observed that children were more engaged in the dancing activity when the robot was present than was absent [7].

Regarding the risk side, the developers of robots and policy makers so far have been mainly paying attentions to the safety issues such as the malfunction detection inside servomotors or the pinch detection of user fingers. But, recently, people are starting to discuss the psychological effect accompanying with the introduction of robots into the society. In case of the early educational domain, as was mentioned before, still we don't know much about the long-term psychological effect on children, some of which seem to be common with the debates related to TV programs or video-games. There was also concern for the care-giver side, worrying about the situation where those convenient technologies might promote the laziness of people, leading to the lack of real attachment by human care-givers to the children.

Another type of concern, which probably is more fundamental and thus is spread over the broad robotics field, is about the debate of robots replacing humans (jobs). It seems that still the capability of the latest robots is very limited and they cannot function as nowhere near humans. But we consider it very important to keep the fundamental idea in our mind that those technologies are to help and support humans, and they do not exist by themselves. In case of robots for educational purposes, they should be designed to assist and support teachers' educational activities together with them and under the control of them. In other words, the robot is a tool of care-givers to enrich the educational environment.

III. A Promising Scenario

Based on the consideration so far, in this section we will explore the better use of robots at the educational environment such as the classroom for children.

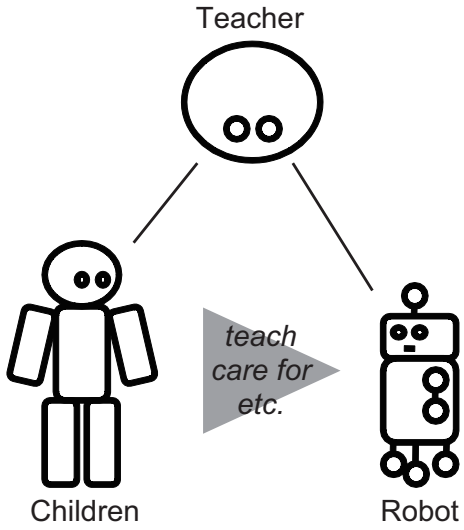

Fig. 3. Robot as a care-receiver: In this scenario, children teach the robot (ex.) how to express greetings when he/she encounters other people, which actually turns into a practice for the children. Teachers design the learning topic depending on the children group. Therefore the function of the robot is supposed to be easily configurable/controllable by the teachers.

In contrast to the conventional stereotype where a robot is going to serve as a childcare machine or a teaching computer, here we consider a reverse-scenario where a robot is supposed to be a care-receiver by children (Fig. 3). In a sense this is a snapshot from the observation we had made, but here we consider designing the situation under the purpose of early education by teachers in the classroom.

First, teachers decide the educational topic depending on the children group in the classroom. Examples include child disciplines such as expressing greetings or the words of appreciation. Then, teachers ask the children to teach the topic to the robot. The robot is equipped with the basic functions of making dialogues although it is not perfect and often the robot makes a mistake at beginning. As the instruction of children increases, the robot is going to learn the task even slowly, expecting for the children to be motivated with the task itself as a result. Thus, the whole process can be viewed as an indirect practice for the children.

Again, the scenario is based on our assumption that a 'weaker' robot is going to attract children's interests well, and also it motivates their will to take care of it. In case it is true, we predict it will be a scenario where robotics contributes enriching the educational environment, with offering a useful tool of teachers on less ethical concern.

It might be useful to stop here to consider and compare our case to the situation in which children interact with pet animals. It is often encouraged that children have interactions with animals especially for the sake of emotional development. It might be tricky to compare animals with robots, but it must be aware that some scientists deny any emotional and intellectual traits in animals on which they argue that we just project our emotions. In the meantime, we know that robots have not yet acquire any truly intellectual and emotional abilities, but some people, including robotics

engineers, project their emotions and develop emotional attachment. We also know that many children have emotional interactions with dolls and stuffed toys.

IV. Open Issues

We are still in a stage to develop and design ways to examine, analyze, and assess the intellectual, psychological, and social impacts in bringing children into the long-term relationship with a variety of robots. We also need to take into consideration cultural influences. In some cultural domains, there is a kind of discipline where we are supposed to treat (non-living) objects with due respect. Behind the discipline, there might have been an expectation that people who treat non-living objects with respect naturally act in the same way towards living things, too. The scenario presented in the previous section still includes open issues, some of which seem to be related with this discipline.

First, practically we have no idea to what extent the effect of children's active teaching is going to result in their own learning. Here there could be another assumption that a robot is an object which children can easily feel empathy with, and care-taking behaviors towards the robot can easily be regarded as their own behaviors towards other people.

There are also difficulties in analyzing and assessing the impact of interacting with robots upon children's personal development because there is no way to know whether or not it is personal genetic traits or social impacts which contribute to form the child's personality, cognitive capacity, and emotional growth.

Kimura, one of the authors of this paper, has begun to introduce and explore the issue of Roboethics in Japan recently. With a background of humanities and social sciences, his approach to Roboethics is somewhat different from those by robotics engineers. Robotics engineers tend to forget the fact that everyone including scientists and engineers whose works are directed toward universal knowledge and universal applicability is unconsciously engaged and circumscribed in the cultural, social and philosophical framework. When it comes to assess and examine roboethical issues, it is required to analyze various dimensions regarding introducing and employing different kinds of robots. For example, if a robotics engineer whose social culture has not yet developed any sub-culture of robot such as robot animation and robot figures might not be so familiar to a situation in which children enjoy interacting with certain kinds of robot images and robot figures. Those who are dwelling in this sort of social culture might not be psychologically ready to see children enjoy playing with robots. In Japan, many prominent robotics engineers confessed that they were very much interested in watching robot animations during their childhood. There are certain kinds of sub-culture that provide some intellectual framework to robotics engineer in creating a human-interactive robot. In Japan, several kinds of educational and entertainment robots have been developed and marketed recently. Yet, this does not automatically justify introducing robots into every social arena. It is necessary to analyze and examine the social situations and the kinds of robot to be introduced to [8], [9], [10]. As far as Kimura has observed, robotics engineers have good intents of their own in exploring and developing many kinds of robot, though their good intentions have to be examined, too.

V. Acknowledgments

This study was supported in part by the Grant-in-Aid for the Global COE Program on "Cybernics: fusion of human, machine, and information systems" at the University of Tsukuba.

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