Using Androids to Provide Communication Support for the Elderly

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1. Introduction

These days, the social ties of family, neighbors and work colleagues do not bond people together as closely as they used to, and as a result, the elderly are becoming increasingly isolated from the rest of society. When elderly people become isolated, they can lose their sense of purpose, become more susceptible to crime, and may even end up dying alone. Preventing isolation is essential if we are to create a safe and secure environment in the super-ageing society that Japan is having to confront ahead of any other country. It is also important to give the elderly more opportunities to interact with other people because (a) these interactions facilitate the prompt detection and treatment of dementia and mild cognitive impairment (MCI), which are reckoned to affect over 4.5 million people and are predicted to affect even more people in the future, and (b) they are also essential for extending the healthy life expectancy of the elderly. Efforts to achieve this have included the regional watch initiative of the Ministry of Health, Labor and Welfare, but have been hampered by structural shifts in society that have resulted in regional societies becoming increasingly hollow.

Even when elderly people live with family members or in care facilities, they can still find it difficult to communicate adequately with other people due to staff shortages and the like. Although listening volunteers sometimes visit care facilities to interact with their residents, it may be difficult for them to visit frequently, or to spend ample time on each visit. In some cases, it may even be impossible for volunteers to engage with the elderly due to physical constraints such as time limits or a lack of facilities nearby. If their interactions with other people are impoverished, elderly people are liable to suffer from declining social skills and advancing dementia, making social interaction even more difficult for them. When elderly people become unable to communicate, other people will be oblivious to their situation, and their caregivers can become demotivated. This may result in a vicious cycle that degrades the quality of life of both elderly people and their caregivers.

We believe that breaking this cycle requires not only conventional support from people who live nearby, but also communication-based support that is unbounded by geographical constraints, and new forms of communication support involving the use of artificial intelligence. This article shows how communication support for the elderly can be provided by the Telenoid® remote operated android robot, and introduces our research of autonomous interactive androids.

2. Communication support by a teleoperated android

The Telenoid has a human-like appearance and is covered with a soft skin made of materials such as silicone and soft vinyl. It is 80 cm long and weighs 3 kg (Figure 1(a)), and can be operated by a person at a remote location. When hugged by the user, it enables them to feel close to the presence of a person at a remote location through physical and non-verbal communication. It can thus provide large numbers of people with the opportunity to participate in volunteering from home even for a short time. In this way, it provides the elderly with greater opportunities for engaging in communication, and can reduce the burden on local helpers such as caregivers and family members.

A Telenoid can communicate using a minimal set of actions such as nodding and moving its mouth in sync with speech. It can be remotely operated by a system that uses technologies such as communication and speech processing, and is simple enough for anyone to use without having prior experience of robots or computers. This simple configuration allows people to convey their intentions effectively with simple operations via a robot that is lighter, more affordable, and easier to operate. The operator simply needs to wear a headset and talk to the screen of a notebook PC. The Telenoid's head and lips will then move according to what the operator is saying. As long as an Internet connection is available, this system can be used anywhere, and at any time.

Figure 1: Remotely operated Telenoid and interactions with it

(a) Telenoid

(b) Interacting with a Telenoid

(c) A Telenoid being used in Denmark

Although many people are initially disconcerted by its unusual appearance, we have found that they can soon adapt to it when they hold a conversation through the Telenoid[1]. For elderly people, this tendency is even more pronounced, and we have found that they show a strong affinity to the Telenoid from the outset. Elderly people afflicted with Alzheimer's disease often show a particularly strong attachment to the Telenoid: they want to hug it straight away, become absorbed in conversation, and are reluctant to relinquish it when their allotted time has expired. In earlier tests at Japanese facilities for the elderly, we saw many cases where people's attitudes changed through interaction with the Telenoid. Residents with a depressive tendency who did not respond when addressed directly by care staff were much more willing to talk to a Telenoid. Some people who were exhibiting behavioral and psychological symptoms of dementia (BPSD) such as abusive language and resistance to caregivers were found to make progress when interacting with a Telenoid, and gradually became calmer as they became more interested in it.

These effects of the Telenoid have been confirmed in Europe as well as in Japan. In Denmark, where the increasing medical and nursing costs of the elderly are similar to the problems being experienced in Japan, many advanced welfare policies are being implemented from the viewpoint of improving the quality of life of the elderly while keeping down the cost of doing so. Their impact on Japan's welfare policy is also large. Isolation of the elderly is also becoming a problem in Denmark. Although the transition away from large-scale facilities is also said to be part of the cause, it is considered that modernizations such as the concentration of populations in large cities and cultural tendencies such as the strongly independent nature of individuals are in the background of this trend.

We have also set up Telenoids at multiple care facilities in Denmark and have performed tests with the cooperation of care staff, but the reactions of the elderly people were almost identical to those obtained in Japan, and they enjoyed having conversations while holding the Telenoid[2]. For example, Mr. P (75 years old), a former Danish language teacher living alone in an apartment annexed to the care facility, responded enthusiastically to the Telenoid, read books and poetry to it, and watched television with it. Mr. V, a 90-year-old without dementia, talked to the Telenoid, played piano to it, and showed it some flowers in a vase (Figure 1(c)). In each case, when living independently, the conversations can last for several tens of minutes, and it sometimes seemed as if they could carry on talking forever if the operator hadn't needed to take a break.

3. Towards an autonomous talking android

As discussed above, it is clear that a remote-operated android is a communication medium to which people have a strong affinity. Since people are able to accept an android as a conversation partner, if the words spoken by the robot have no distinction between words spoken by an operator and words generated autonomously, then it should be possible to accept an android with autonomous speech functions as a conversation partner. A remote controlled android is more effective than existing media at getting people to engage in dialogue, but human resources are always needed to perform remote operation. If an android can talk with people all by itself, then it would be an even more effective form of media in terms of human resources.

Therefore, the next challenge is to realize a humanoid robot that is capable of conversing with people autonomously. Although there are now humanoid robots that are capable of walking and performing various actions, talking with humans is still a major challenge. Research into agent systems that interact linguistically with people have already produced interactive systems that use big data, such as IBM's Watson[3]. However, these are generally only capable of providing a single answer to a single question at a time, and even systems that can hold conversations with multiple turns are almost entirely restricted to task-based dialogue with a particular goal such as bus travel guidance[4]. As yet, there are still no systems capable of carrying on the sort of complex open dialogue needed for interactions between elderly people and Telenoids. More recently, systems have been implemented that use big data to engage in complex dialogues, such as NTT Docomo's Shabette Concier[5]. However, to achieve natural communication between humans and robots, it is essential to develop multimodal systems that use both verbal and non-verbal information. For example, if the output of an existing chat system were to be converted into speech and simply read out by a robot, it would not create the impression of having a free conversation or of interacting with a robot. A benefit of implementing dialogue functions in humanoid robots is that it is possible to use diverse non-verbal information such as the robot's gestures and expressions, but this raises the challenging issue of implementing an autonomous robot that can interact with people in a human-like way, including the expression of diverse non-verbal information.

At present, the authors' research group is working on the implementation of robots that are capable of autonomous dialogue by using android robots that are similar to humans. We are working on various issues, including the development of actuators that make it possible to perform human-like flexible movements, and the development of systems for implementing human-like dialogue. For the dialogue functions, we are studying how to achieve a natural dialogue in (a) interpersonal situations, and (b) social situations.

3.1 A hierarchical model of dialogue generation

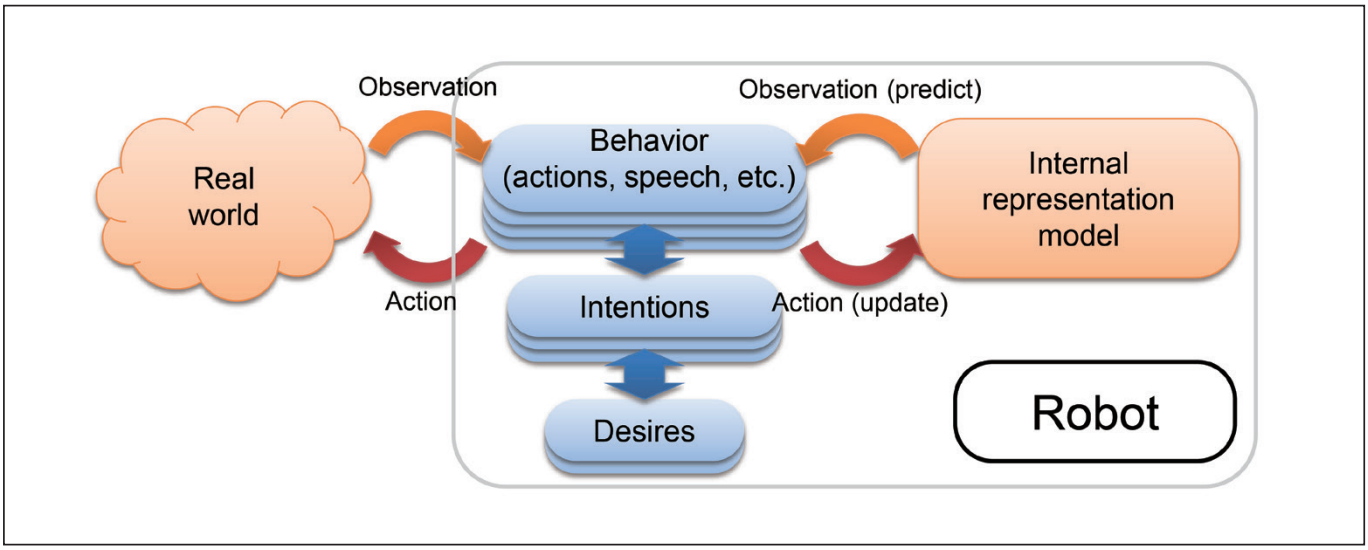
One of the difficult issues in the realization of natural dialogue in interpersonal situations is using natural language to achieve a natural dialogue that follows multiple turns, including non-verbal information as discussed above. For this purpose, we are collecting the dialogue patterns of natural behavior exhibited by humans when operating an android remotely. This includes non-verbal information such as facial expressions, gaze behavior and gestures, resulting in a huge amount of data that we hope can be used as a basis for dialogue creation. Since it is difficult to implement a completely open chat-type dialogue, we first aim to implement an android that can engage in human-like verbal and non-verbal dialogue by limiting the situations (dialogue content). However, when dialogue is simply generated based on big data, it is thought to be impossible to generate more complex and human-like actions and utterances that would occur when conversing with a human. To achieve more human-like behavior, we introduced a hierarchical model of decision-making that has been used for dialogue generation in previous mobile robot studies. This model consists of basic desires, intentions generated from these desires, and then words and actions that are generated from these intentions (Figure 2). Using this hierarchical model, we will implement an autonomous robot that classifies the collected data by machine learning to solve the problem of language generation, and can produce human-like dialogue to voice its intentions.

3.2 Social dialogue using a model of desires and intentions

Just to hold a dialogue in interpersonal situations, a robot has to be very human-like. People become more human-like in social situations where there are many people interacting. The biggest difference between interpersonal situations and social situations is that for the formation of stable relationships, it is necessary to estimate the other person's intentions and desires. In interpersonal situations, to create smooth dialogue using language, it is necessary to have a hierarchical model that generates dialogue based on one's own intentions, but in social situations, it is necessary to infer the intentions and desires of others from their behavior, as expressed by their own hierarchical models. In this study, we aim to implement a function that estimates the other person's intentions and desires from the robot's own hierarchical model and the behavior of the other person.

Once a stable relationship has been formed, a dialogue can proceed smoothly even if there is ambiguity in the speech or behavior. For example, if a third party that shares my opinion agrees with the other person, then I will proceed with the dialog with the feeling that I am also in agreement. By skillfully manipulating the relationships between multiple robots, it should be possible to achieve a smooth dialogue between people and multiple robots. We are also studying how the principles of social

Figure 2: Model of desires, intentions and actions in the generation of dialogue by androids



characteristics can be exploited to achieve smooth dialogue.

4. Conclusion

In this article, we have introduced our research of the teleoperated android Telenoid and the possibility of implementing autonomous dialogue capabilities in androids in order to provide communication support for the elderly. The Telenoid has already been publicized as a commercial communication service, and will be launched in Japan in the near future. The provision of a service in Denmark is also being considered.

Since the Telenoid currently needs to be remotely operated, it is not able to interact with people for 24 hours a day. Its main purpose is to give the elderly a chance to engage in dialogue and improve their willingness to interact. On the other hand, advances in the study of androids capable of autonomous dialogue will allow the elderly to converse with androids at any time, and may also help to mediate their communication with other people. If androids can not only be made to look like human but also have human-like desires, intentions, feelings, intelligence and social skills, then we can expect them to contribute to true human-like communication instead of simply conveying information.

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＊“Telenoid” is a registered trademark of Advanced Telecommunications Research Institute International Corporation.

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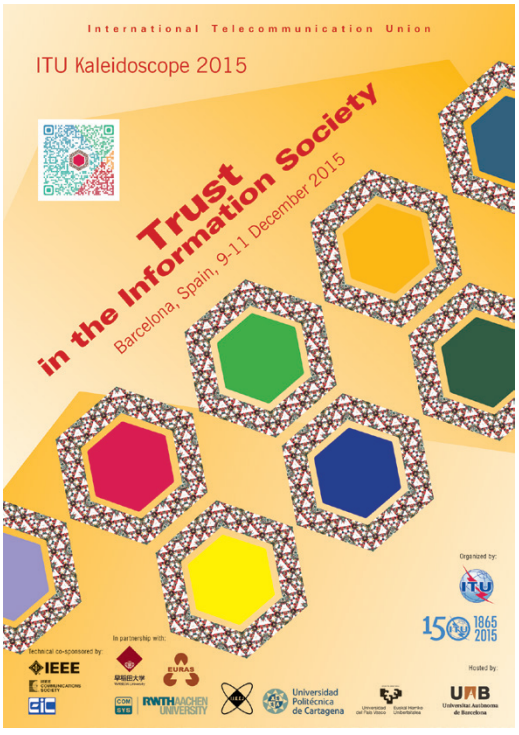

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