Robotics for Health and Well-Being

By Mihoko Otake

Have you ever seen a person with dementia? My first contact with a dementia patient was in the 1990s when I was a student. My grandmother got dementia. This personal experience combined with the strong social need led me in the direction of robotics: robotics for health and well-being and, above all, robotics for the prevention of dementia.

There are 44 million people suffering with dementia worldwide. With this number increasing every year, it is expected to be 135 million by 2050, which is three times the current rate. There is a serious need to develop technologies to prevent cognitive decline and dementia since the current pharmacological therapies do not suppress the disease process. It looks as if a medical solution, nonpharmacological intervention to cognitive systems based on its embedded algorithm, should be possible since humans can be viewed as intelligent machines and dementia is a breakdown of the machine.

This article describes the holistic and exploratory efforts to develop effective treatments for the prevention of dementia, starting from and partially coming back to the robotics and automation discipline. This proposal was originally presented at an invited talk during the IEEE Robotics and Automation Society (RAS) Women in Engineering (WIE) Luncheon at the 2013 IEEE/Robotics Society of Japan International Conference on Intelligent Robots and Systems (IROS) in Tokyo, Japan (Figure 1). Xiaorui Zhu, the WIE liaison coordinator of RAS gave me the opportunity to present the information. I formerly served as the WIE liaison coordinator of RAS in 2010–2011.

Figure 1. (a) The author speaking and (b) the audience at the WIE Luncheon at IROS 2013.

Here is an anecdote to describe a typical conversation with a patient with dementia. When I visited my grandmother in the nursing home, we always had the following conversation. "G" refers to my grandmother, and "M" refers to me.

G: How is Mihoko doing?
M: This is Mihoko.
G: Oh, you are Mihoko! You grew up so much. Where are you from?
M: We came from Tokyo.
G: Such a long way! Thanks for coming.

A few minutes later, she started asking me "How is Mihoko doing?" again. She was eager to talk to people in front of her and could give comments or ask questions about very recently discussed topics. However, her working memory of these topics cleared in a few moments. It was difficult for her to find new topics from scratch, but she could give comments on very recent topics. In addition, she was trapped by what she really saw, in this case, her granddaughter.

To test whether other visual input might trigger different memories, I brought some photos of my grandmother and her family and showed them to her [Figure 2(a)]. She then started talking about totally different things that were

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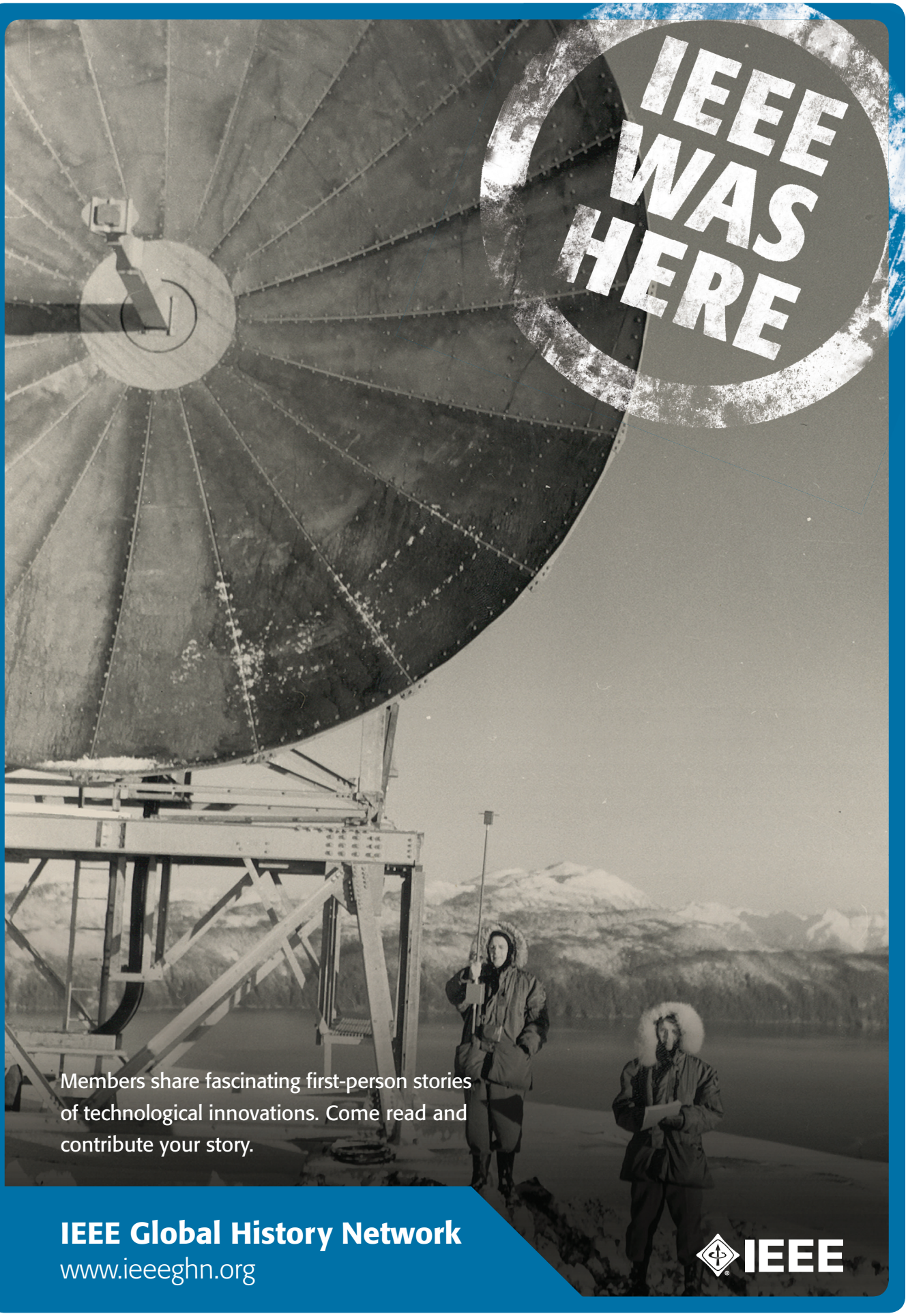
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(a) (b)

Figure 2. (a) The author and her grandmother talking while watching photos on the screen. (b) The coimagination method being applied on a group of older individuals in a nursing home.

new to us. The photos were black and white, but she mentioned the color of certain objects.

M: Tell me about this picture.

G: This is a picture taken at the photo studio in the department store in Tokyo.

M: You look so nice.

G: This clothing was tailored at the same department store. It was in stripe patterns of orange and silver.

The photos triggered something, and she was able to recall. My comments and reactions also helped her talk about them. The cognitive systems of dementia patients operate by assistance. It is known that visual aids and semantic and phonological priming help when communicating with older adults both healthy and suffering with dementia. The ideal activities for intervention use simultaneously as many of the individual's resources as possible to maintain their cognitive functions for better quality of life. Ideally, those activities are either everyday activities that serve as training or those that stimulate individuals' cognitive or social abilities. Our hypothesis, which is based on cognitive mechanism and observation, is that an interactive group conversation, including information input, processing, memorizing, and output processes, serves as a cognitive task that prevents cognitive decline and dementia caused by disuse in older adults. In conversations, turn taking occurs frequently, which requires divided attention as well as discourse skill. Therefore, we developed a conversation support method called *coimagination*, using photos brought by the participants and giving equal turns to all participants to listen, ask questions, and give comments and answers.

We applied the method to older adults in various conditions: from older adults with dementia to those who enjoy healthy longevity. We founded a research institute collaborating with older adults, local governments, and industries for collecting large-scale conversation data of various older adults to investigate effective intervention. We have been collaborating with and providing services for nursing homes, hospitals, and other nonprofit organizations [Figure 2(b)].

Recently, we got to know the older sisters, whose average age is 94, who enjoy healthy longevity by having energetic group conversations on a daily basis. Their mother was one of the famous twins who lived for 108 years old. We found that their group conversations have the characteristics of cognitive training and that they are good role models for participants. The following is a typical script in which they discuss who will die first. The sisters are referred to as A98, B94, C91, D89, from older to younger. The numbers are their ages. Their positive mindsets allow them to talk about their own deaths with bursts of laughter.

Figure 3. The robot with the older sisters making them laugh.

B94: When I think about us, I would like to be the first to go.

C91: No way.

B94: I want to be the first.

D89: It goes in order of age.

A98: Oh, no, no, then I'm first.

All: Ha, ha, ha, ha, ha.

We observed that the sisters' conversation bounced from one person to another without a pause. Words, nodding, and laughter animated all but 52 s of their 20-min chat. We also noticed that when one was speaking, the others were thinking about what they would say next. Divided attention should be used for thinking while talking. No one dominated the conversation although it was a free conversation without rules. They all spoke in equal turns and gave each other the opportunity to speak. In addition, they visualized the scenes in detail by words as if they were looking at that scene. Their conversational style is similar to that of the coimagination method.

Inspired by the sisters, we implemented robots that react with interjections and laughter since these reactions make the other participants feel free to talk and trigger turn taking. The robot observes the facial expressions of the participants. If the average smile rate exceeds a certain threshold, the robot starts to laugh (Figure 3). The robot triggered the older sisters' laughter successfully through its own laughter. Here is the example:

B94: I don't know the pain of my shoulder.
M: Have you ever had frozen shoulder before?
C91: No, we haven't.
Robot: Ha ha ha ha.
All: Ha ha ha ha.
C91: We don't have any difficulties raising our arms. It is not painful. If we keep that posture, it may become painful.
Robot: Ha ha ha ha.
All: Ha ha ha ha.

The robot may enliven people's minds and spirits for health and well-being. We are investigating the effects of lively conversations and conversational support robots on cognitive systems. From this, we can determine what stimulates older adults who enjoy healthy longevity and implement these conversational tools in the robots.