CATARO: A Robot that Tells Caregivers a Patient's Current Non-Critical Condition Indirectly

Patrick Hock
Graduate School of Science of Engineering, Saga University,
1 Honjo, Saga, Saga 840-8502, Japan
16233064@edu.cc.saga-u.ac.jp

Chika Oshima
Graduate School of Science of Engineering, Saga University,
1 Honjo, Saga, Saga 840-8502, Japan
karin27@sa3.so-net.ne.jp

Koichi Nakayama
Graduate School of Science of Engineering, Saga University,
1 Honjo, Saga, Saga 840-8502, Japan
knakayama@is.saga-u.ac.jp

ABSTRACT

Currently, a system is being developed that gathers information about a dementia patient's condition and sends it to a smartphone. Through this system, caregivers in a nursing facility could always check on their patients' current condition and act accordingly. However, they are generally too busy to constantly check their smartphones for "non-critical" information about patients. This research proposes putting a small robot in front of a patient to speak to the patient in a professional manner in reaction to his/her current condition. Caregivers nearby could hear the robot and then determine the patient's condition. When the caregiver is free, he/she could approach the patient and start talking to him/her in the same manner as the robot just did[1].

CCS CONCEPTS

• **Human-centered computing → Human computer interaction → Interactive systems and tools**

KEYWORDS

Dementia, BPSD, Occupational therapy

ACM Reference format:

H. Patrick, C. Oshima, and K. Nakayama. 2018. SIG Proceedings Paper in word Format. In *Proceedings of ACM GECCO conference, Kyoto, Japan, July 2018 (GECCO'18)*, 4 pages.
DOI: 10.1145/3205651.3208264

1 INTRODUCTION

Although the population aging rate exceeds 26.7% and the number of caregivers is not sufficient, high-quality nursing is requested more and more. The symptoms of dementia are divided into two major groups. The core symptom is the death of brain cells, which results in memory loss. Peripheral symptoms, behavioral and psychological symptoms of dementia (BPSDs), include the following:

- abusive language
- violence
- insomnia
- delusions, that things were stolen
- wandering around

BPSDs highly depend on how other people are treating or talking to a patient. This is a category of symptoms that caregivers struggle the most with to handle. It places a significant burden on them. To help in dealing with these symptoms, there are medications available, including antipsychotic drugs, antidepressants, and anti-anxiety drugs. However, as they have strong side effects, non-medication treatment is the standard [1].

When handling dementia patients without medication, the communication between a caregiver and a patient is critical. To communicate in an appropriate way, proper training for the caregiver is necessary. However, caregivers neither have the time nor motivation to undergo such training due to their day-to-day extremely stressful workload.

This paper introduces a system in which a robot recognizes a patient's current condition and starts talking to him/her in an appropriate way. While the robot is talking to the patient, a caregiver nearby might also hear the robot. This provides the caregiver with information about the patient's condition. It also indirectly teaches him/her how to talk to the patient appropriately—no separate training is necessary.

GECCO '18 Companion, July 15 -19, 2018, Kyoto, Japan

ACM ISBN 978-1-4503-5764-7/18/07…$15.00
https://doi.org/10.1145/3205651.3208264

2 BACKGROUND AND WORKING ENVIRONMENT FOR THE SYSTEM

Although this system might be useful in a variety of situations/diseases, we first assume that it is used in nursing facilities to operate on/with patients suffering from dementia. In settings with a high risk of injury, where someone must always keep an eye on patients, relying on this system is not recommended. It should be used in settings with a low risk of injury, where a patient tackles a work program—for example, coloring a sketch, collaging, making balls of paper, winding up cotton on old cupboard rolls of saran wrap, or making small balls of wetted tissue paper [2]. The system recognizes the patient's interest, motivation, fatigue, and work progress and reports it to the caregivers through the robot.

Instead of letting a robot verbally report a patient's current condition indirectly, a system in which the condition is directly transmitted to a smartphone might also be conceivable. However, caregivers are likely too busy to constantly check on their smartphones for "low-risk" information [3].

Compared to pure virtual characters, robots have a much stronger presence [4]. However, they also need to be given authority [5] and trust [6,7] of users around them (patients as well as caregivers). Otherwise, the users will not listen seriously to what the robot has to say.

Teaching new personnel which signs to watch out for and how to talk to patients is time consuming and thus hardly feasible. Therefore, it would be quite useful if the robot could teach new personnel when and how to talk to patients by simply demonstrating it. Regarding this field, Bandura [8] proposed "modeling" a process in which people observe the behavior of patients and find and model behavioral patterns. The proposed modeling is composed of four correlated constituent processes. The first step is the *attentional process*. If people do not focus on a specific task/ thing, they will not learn. As it will be challenging for the robot to gain authority and trust from caregivers, using it as a teacher seems difficult. But it might at least be charming and therefore might have a small effect. Further, talking to patients and encouraging them is a major factor for raising their self-efficacy [9,10].

Fig. 1 shows a robot initiating a discussion with a patient. Caregivers can hear the robot talking and eventually start talking to the patient in the same manner as the robot does. Ideally, there will be a robot like "Terapio" [11,12] that can freely move around, overcome small obstacles, carry things around that are placed inside the nursing facility, check up on all of a patient's conditions, and find, follow, and talk to specific people. However, a facility that is sufficiently large to have such a robot experimentally moving around is hard to find. Further, an ideal robot should also be easily extendable. This is also hard to achieve. Therefore, this research focuses only on building the foundation for the ideal robot using a stationary robot, which uses a smartphone with Android OS to accomplish its tasks.

To gather information about a patient, a scenario is used in this research in which the patient is sitting down while doing a certain task/work (e.g., sketch coloring). Fatigue could then be measured by wireless acceleration sensors [13] mounted onto the chair.

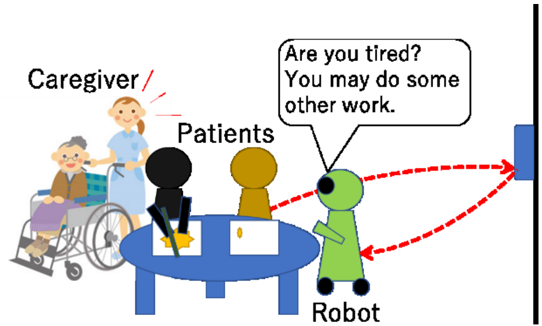

Figure 1: Caregivers become familiar with the patient's condition through the robot and eventually start talking to the patient.

3 REQUIREMENTS FOR THE ROBOT

We propose the following requirements with the aim of building a robot that can gather information about each patient, decide when and what to talk to a patient about, and can face the patient it is talking to.

(1) The robot must be based on Android OS to enable free application development.

We are constructing our application based on a finding from our research. However, we think that further functions are necessary to apply the robot to other people in the future. Therefore, Android is an ideal operating system. As a counterexample, "Smartpet" [14] is a robot that has a mount port for an iPhone, for which we cannot freely develop applications. There is also an Android solution called "Robophone" [15]. However, only 5000 units of this robot were produced and only Robophone specific applications can be installed on the device. Both examples do not offer free software development.

(2) The appearance of the robot must be freely changeable in favor of its user.

The robot's appearance is a key variable to ensure that it is liked by elderly patients. "Tapia" [16] is a counterexample that is basically sufficient but lacks the possibility of appearance changes. It is an approximately 25cm tall communication robot for home use. It has an integrated camera, speakers, a microphone, and a touch panel. It can talk to people and protect them. Developing for Tapia is even supported by a Software Development Kit (SDK). But it is not possible to freely change its appearance.

(3) The facial expressions (eyes) of the robots must be creatable through the screen of a smartphone.

The robot is expected to talk to each patient. Its facial expression can draw a patient's interest. E.g., "Smartpet" [14] shows a dog's face, which changes expressions in response to what the owner does.

(4) The direction of the face and body of the robot must be adjustable.

As mentioned above, because the robot is expected to talk to each patient, it needs to move in the direction of an intended patient.

(5) The robot must not harm/injure its user.

We believe the robot should not move its hands to avoid harming/injuring patients. Because the patients are doing work in our hypothetical scenario, they cannot pay attention to the robot's movement. Therefore, it is difficult for them to avoid its moving hands.

(6) The robot must be inexpensive to produce.

Nursing facilities do not have a large budget. It is necessary to make an inexpensive robot so many facilities can afford it.

As all the above-mentioned robots fail to meet all 6 requirements, they cannot be used for this research. Instead, we will create our own robot that meets all the above requirements.

4 SYSTEM SET-UP

We present a robot based on Android OS that enables free application development (Requirement (1)).

4.1 Appearance of the robot

As shown Fig. 2, we present the robot, "CATARO" (Care And Therapy Assistant RObot). We designed CATARO's appearance through "Fusion 360" [17], a 3D CAD/CAM/CAE software for product design. Then, we cut a plastic cardboard to construct the frame of CATARO. We covered its body with furry clothes. Through this, we can produce it at a low cost (Requirement (6)). The main body of CATARO is 391mm in height, 283mm in width, and 200mm in depth. The round stand that mounts CATARO is 6mm high and has a diameter of 290mm. Therefore, CATARO is unlikely to injure patients (Requirement (5)). We want the caregivers to pay attention to the robot and the patients to listen to it. Therefore, we do not aim to scale it down.

The first version of CATAROlooks like a cat. However, its appearance can be freely changed in favor of its user by modifying the design in Fusion 360 (Requirement (2)).

A smartphone is attached to CATARO's eyes. Its facial expressions (eyes) are created through the screen of the smartphone (Requirement (3)).

Table 1: Example of CATARO's utterances.

Category		Examples of utterances from CATARO
Preparation	1	Please sit down here.
	2	Let's get started!
	3	Preparing for work. Please wait a second.
	4	If you want to go to the restroom, please tell your caregivers.
	5	If you are thirsty, you should ask your caregivers for water.
Opening	1	I am CATARO. Nice to meet you.
	2	This is a calendar for June. Isn't the hydrangea beautiful?
	3	This is a calendar for July. You see a picture of the Star Festival.
	4	This is a calendar for August. The sunflower is beautiful, isn' t it?
	5	This is a calendar for September. The cosmos is beautiful, isn' t it?
	6	This is a calendar for October. The fruits look delicious.
	7	This is a calendar for November. The maple turns red.
	8	I want you to paint the calendar to make it look like the sample.
	9	Let's paint together!
	10	There is a sample, so painting it is not that difficult. You can do it!
Admiration	1	Hey, it looks good!
	2	You are painting with a delicate touch.
	3	Those things became lively.
	4	It' s hard to believe you did not do this for a long time.
	5	Awesome! You did not go over the borders.
	6	Good! you are really good at painting.
	7	The colors became quite dense. Good!
	8	You overpainted colors. This gives the picture more depth.
	9	You looked at the sample with a detailed eye.
	10	You like painting, do you?
Advice	1	You should paint more dense.
	2	You should overpaint colors to add depth to the picture.
	3	If you want, you can rotate or move the picture you draw.
	4	Didn' t you leave areas unpainted?
	5	You should add another color to the painted part.
Attention	1	Can you see the sample clearly?
	2	Are you OK? Are you tired?
	3	Are you tired of painting?
	4	Shall we do some other work?
	5	Shall we take a break?
	6	It is hard for you to paint with color pencils, isn't it?
	7	I think it is difficult to select a color.
	8	Do you feel uncomfortable in this chair?
	9	You will get tired if you work too hard.
	10	Shall we finish for today?
Small talk	1	Was the road crowded today?
	2	It's warm today, isn't it?
	3	It's cold today, isn't it?
	4	Many flowers are blooming in the garden.
	5	It's tea-picking season.
	6	It' s the season to hang carp flags high outside the house.
	7	The rainy season has set in.
	8	It's the season for rice planting.
	9	The Star Festival will start in a few days
	10	It's wheat harvesting season.
Ending	1	Thank you very much for your work.
	2	Fantastic work!
	3	You should take it home and show it to your family.
	4	Thank you. I' m waiting to see you again.
	5	We will hang your picture in this room.

4.2 Face recognition

CATARO can recognize patients' faces through the mounted smartphone if they have been learned beforehand. Further, the direction of the robot's face and body is adjustable (Requirement (4)). Therefore, CATARO can face a target patient and talk to him/her.

4.3 Utterance database

We collected the utterances of experienced caregivers in the patient's work program, sketch coloring. This study was approved by the Independent Ethics Committee of the Faculty of Medicine at Saga University. We also obtained the consent of the hospital director at the target hospital.

Table 1 shows some examples of what CATARO is able to say. We categorized the phrases into seven categories. One category for each situation where CATARO might talk. Further, we created some phrases according to the current season.

5 DEMONSTRATION

We will demonstrate CATARO during the workshop. The participants of the workshop will be assigned to take on the patient's or the caregiver's role. One of the authors will control the direction of CATARO's face and its utterances. We will experience the caregiver's feeling when the robot indicates the patient's current condition verbally.

6 CONCLUSION

We proposed a system that acquires information about the condition of each dementia patient. We also proposed a prototype robot, "CATARO," which talks to the patient in reaction to his/her current condition. We aim for caregivers nearby to listen to what the robot is saying, to become familiar with the patient's condition, and to be able to deal with the patient and/or talk to the patient in the same manner as the robot just did.

During the demonstration, we will show that CATARO talks to the patient (fake) in reaction to his/her current condition. The participants of the workshop have a simulated experience.

ACKNOWLEDGMENTS

This work was supported by JSPS KAKENHI Grant Number 17H01950.

REFERENCES

[1] R. C. Chen, C. L. Liu, M. H. Lin, L. N. Peng, L. Y. Chen, L. K. Liu, and L. K. Chen. 2014. Non-pharmacological treatment reducing not only behavioral symptoms, but also psychotic symptoms of older adults with dementia: A prospective cohort study in Taiwan. *Geriatrics & gerontology international*, 14, 2 (2014), 440-446.

[2] K. Machishima, Y. Ishii, C. Oshima, N. Hosoi, and K. Nakayama. 2016. The process of determining the occupational therapy program viable for users of severe dementia day care facility. The Japanese Society for Dementia Care, 15, 2 (2016), 503-512. (in Japanese)

[3] Y. Yamamoto, M. Sato, K. Hiraki, N. Yamasaki, and Y. Anzai, A request of the robot: an experiment with the human-robot interactive system HuRIS. *Robot and Human Communication, 1992 Proceedings.,* IEEE International Workshop on, 204-209.

[4] A. Powers, S. Kiesler, S. Fussell, and C. Torrey. 2007, March. Comparing a computer agent with a humanoid robot. *In Human-Robot Interaction (HRI) 2007*, 2nd ACM/IEEE International Conference on, 145-152.

[5] Marina Fridin. 2014. Kindergarten social assistive robot: First meeting and ethical issues. *Computers in Human Behavior*, 30 (2014), 262-272.

[6] Kristin E Schaefer. 2013. *The perception and measurement of human-robot trust.* Doctoral dissertation. University of Central Florida, Orlando.

[7] P. A. Hancock, D. R. Billings, and K. E. Schaefer. 2011. Can you trust your robot?. *Ergonomics in Design*, 19, 3 (2011), 24-29.

[8] Albert Bandura. 1989. Human agency in social cognitive theory. *American psychologist*, 44, 9 (1989), 1175-1184.

[9] Albert Bandura. 1977. Self-efficacy: toward a Unifying theory of behavioral change, *Psychological Review*, 84, 2 (1977), 191-215.

[10] L. L. Lee, A. Arthur, and M. Avis. 2008. Using self-efficacy theory to develop interventions that help older people overcome psychological barriers to physical activity: a discussion paper. *International journal of nursing studies*, 45, 11 (2008), 1690-1699.

[11] R. Tasaki, M. Kitazaki, J. Miura, and K. Terashima. (2015). Prototype design of medical round supporting robot "Terapio". *In Robotics and Automation (ICRA)*, 2015 IEEE International Conference on, 829-834.

[12] S. Iwamoto and R. Ohmura. 2015. Towards concurrent task verification in context-aware applications. *In Adjunct Proceedings of the 2015 ACM International Joint Conference on Pervasive and Ubiquitous Computing and Proceedings of the 2015 ACM International Symposium on Wearable Computers*, 1473-1477.

[13] R. Ohmura, F. Naya, H. Noma and K. Kogure. 2006. B-pack: a bluetooth-based wearable sensing device for nursing activity recognition. *In Wireless Pervasive Computing*, 2006 1st International Symposium on, IEEE, 6.

[14] Bandai. Smartpet, http://sp.asovision.com/

[15] Sharp. Robohon, https://robohon.com/global/index.php

[16] MJI. Tapia, https://mjirobotics.co.jp/en/

[17] Autodesk. Fusion 360, https://www.autodesk.com/products/fusion-360/overview