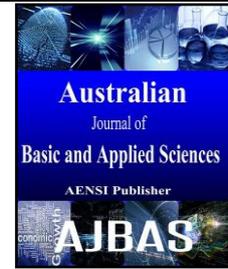




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Effect of a New Emotional Robot Therapy for Demented Elderly Patients -Using the Automatic Generation of Face Movie

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ABSTRACT

This paper describes the effect of a new robot therapy for elderly dementia. Dementias are increasing rapidly, and the rate of elderly dementia is increasing in the world. The care facility has big problems. In these situations, Non-drug therapy (Life review, Music, Pet Robot, TV monitor care) is attracted a lot of attentions. These therapies arouse the feelings of dementia. By using a new therapy robot included next 2 functions for a video call, the automatic generation of their family's emotional face movie and moving the body in synchronization with their family's and pet's face and voice, and the elderly dementia's feelings will be aroused and their behaviors will be activated. These have effects on inhibiting their advance of dementia. We built a new therapy robot, and we had experiments for elderly dementias in care facility. All subjects enjoyed them and their behaviors were activating. And the almost results of measuring their brains were activating. These results suggest that this new robot therapy is useful for elderly dementia, especially the video call with family by the automatic generation of family's face movie was an effectual therapy.

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INTRODUCTION

Situation of patient therapy and Non-drug therapy:

At present, elderly patients with senile dementia are increasing rapidly in Japan, and the rate of elderly people is highest in the world. It is a big social problem that the lack of care facilities of the elderly people and the care of demented elderly patients by the old family is serious. There are many therapies for patients, but there is no effective rules for mechanism of developing dementia.

In this situation, some caregivers recognize that the therapy of recollections (life review) and music therapy are effective and work for them. So many care facilities use these methods. Otake provides "Kyousohou", which is gathering attention as a new dialog therapy. It provides delaying progression of dementia. However, these therapies need many caregivers and a lot of times to prepare, and it is difficult for most nursing home, and there are many robot therapies, exercise and rehabilitation and healthcare for dementia, and supporting for caregivers. Among

Pet Robot for dementia, therapy seal Robot "Paro" is attracted a lot of attentions, it is more sanitary than animal pet therapy.

And using TV monitor care and 3D avatars (virtual robot) as dementia caregivers increased.

Primary factors of dementia are caused by the lack and the aging of emotions. The aging of amygdala, which is known to regulate human emotion in the brain, make dementia worse. Hasegawa, a medical specialist for dementia had been advocating this theory in his book. Recently Rivastigmine (dementia medicine) is used for many dementias. This medicine works the amygdala for emotions.

In the present, there are many therapy robots for dementia, and preliminary experiments had been done to verify the effects of these Care Robots for serious demented elderly patient (age 93 female).

Through my visiting care facility more than 30 times for preliminary experiment, a site of care service was more tragic and painful than the situation I had imagined.

The care facility has big problems. Especially

demented elderly patients in care facility feel sadness and lonely, so conversations with their family are their desire. Nevertheless, their family cannot visit many times. And caregivers are too busy to care for each elderly patient kindly.

From these various observations for dementia and real problems, I make a hypothesis, that is, many dialogs between the therapy robot and demented elderly patients is useful to restrain progress of the dementia.

Related research:

We want to design a new style therapy robot system for serious dementia patients. The system has two functions. First function is the conversation between these demented elderly patients and their family on new video call system. Second function is a pet function by the proposed therapy robot system.

Preliminary experiment 1:

There are many therapies by using a video call system. Clinical use of Skype and living experiences from past memories on it are used effectively.

Especially, serious demented elderly patient (age 93 female) in care facility feels sadness and loneliness, so that conversation with their family will be very useful.

So, using skype for this dementia, but she could not recognized her family by the family's face on the PC monitor.

However, there is a new technology for game by using automatically creating 3D face motion from 2D picture. In order to explore this possibility, we recorded only family's voice from the telephone call conversation between a demented elderly patient and her family. By using this recorded family's voice conversation and the face video of animation, artificial conversation experiment had been done many times for demented elderly patient using the smart phone. She was enjoying this recorded conversation every time, as if it was the first time.

Preliminary experiment 2:

Preliminary experiment 2 had been done to verify the effects of these Care Robots for serious demented elderly patient (age 93 female) using the following devices.

- 1) Emotional computer graphics (CG) animation robot on notebook personal computer (PC).
- 2) Therapy seal robot "Paro".
- 3) Therapy baby robot "Kabochan".
- 4) Teddy bear (doll).

These experiments clarified the next key-points, that is,

- 1) Conversation with family (recording possible),
- 2) Emotional big motion of therapy Robot,
- 3) Touch feedback from therapy Robot "Paro",

4) Appearance.

I interviewed the patient about these experiments, and the highest evaluation for the patient was "Paro". However it has two problems, that is, this size (the height) is 57cm, and the weight is 2.55kg. The size is too large, and the weight is too heavy for the patient. So she could not carry it and could not put it on her knee.

Policy to develop our therapy robot:

Above mentioned two functions were important. First function is a recorded video call conversation with family, and second function is an emotional robot. These will make stimulate emotion of amygdala in the brain of dementia elderly patients, so that we planned to develop our therapy robot to restrain progress of dementia.

We had been making a study of Robotics Design for 10 years, and the recent research is that the emotional communicating of the robot to human solve many problems between human and robot. In this research, we wanted to reflect these experiments to practical robot.



Fig.1: Dementia patient and "Facestand" used a smart phone call from family to demented elderly patient.

Therapy effect of emotional robot:

Outline and method:

Commercial toy "Facestand" in Fig.1 was used for this experiment, which showed her family's face on 4 inch LCD screen, and dances along voice sound. Especially, application software "Facing" technology is automatically creating 3D face motion from 2D still image, and creating the natural motion such as lip-synching to communicate with the peoples.

- (1) Object: To verify the effects of this new therapy which uses a recorded telephone call conversation included memorial topics and nostalgic music with family and an emotional simple moving robot by using commercial toy "Facestand", which can move meaningless two arm, two feet and the recorded face on display by the voice of a smart phone.
- (2) Hypothesis: These two stimulating emotions of amygdala in brain are effective to restrain progress of dementia for dementia elderly patients.

(3) Experimental unit: We used mobile information terminal "iPod touch" with 4 inch screen, commercial toy "Facestand". The moving face was generated from the still picture of the family by application software "Face Sing" by Takaratomy-Entamedia, and the family's voice recorded by the voice recorder was used.

(4) Method: Followed rules of procedure for ethics committee and care facility and family of subject. And when the subjects were good situation, experiments had been done them.

(5) Three subjects have serious senile dementia in acare facility.

RESULT AND DISCUSSION

Three subjects were experimented to verify the effects of this new therapy Robot "Facestand". After these experiments, some subjects moved to tears, sang with the voice of family singing, regained their past memories and kept talking memory. Their memories came rushing back, and continued talking about recollections. Their emotions were aroused, and their behavior is activated. Caregivers were surprised too.

For serious demented elderly patients, even if the video scene of telephone calls from their family were recorded and the system repeated the playback of the same scene of the family, they recognized the video scene as the first call for each times. This finding is important in this research, because this can reduce the times of visiting and telephone call by family.

Result of brain wave measurement:

(1) Object: To verify the effects of this new therapy. Brain wave was activating, which presented the activation of other emotions. It means stimulating by the emotion of amygdala in brain.

θ wave: 4-7Hz light sleep state,

α wave: 8-13Hz relax state,

β wave: 14-40Hz brain is strained and excited.

(2) Hypothesis: These two therapies make their emotions arouse positively. Their brain waves of all patients were activated.

(3) Experimental device is brain wave measuring support tool "BrainPro FM-929" made by FUTEK ELECTRONICS. One subject was measured her brain wave tentatively. Experimental device was Brain wave measuring support tool "BrainPro FM-929" made by FUTEK ELECTRONICS.

(4) Method: When the subjects were good situation, the brain wave of subjects is measured.

(5) Subject 1: serious dementia

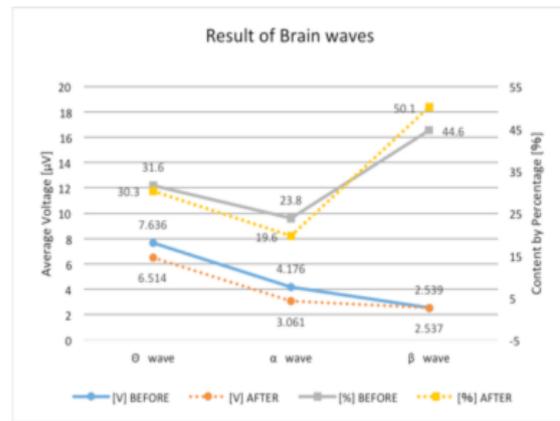


Fig. 2: Brain wave of subject 1 in preliminary experiment.

Fig.2 shows the result of this experiment for brain wave measurement, θ wave and α wave (of average voltage) were lower than before experiment, and β wave (of percentage) was higher. It was a typical activating of brain, which presented the activation of her emotions. In this case, her emotions were positively, happy and joyful. By all results of the brain wave measurement, we confirmed the following effective functions of this therapy robot.

1. Conversation with watching the recorded family's face on screen.
2. Large emotional behavior of the family's face on screen synchronized with the motion of therapy robot.
3. Conversation included memorial topics and nostalgic music.

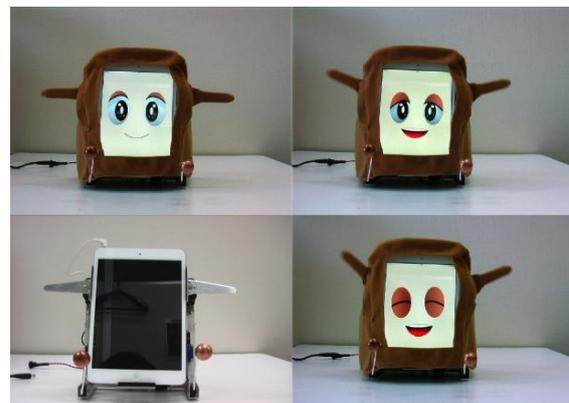


Fig. 3: Three motions and structure of therapy robot, Upper left : normal emotion, upper right : joy emotion Lower left :structure, two balls connected with touch sensors, Lower right : great joy emotion

Therapy effect of care robot system for dementia:

Summary and method:

Through these preliminary experiments, we propose a new therapy robot system for demented elderly patients. The therapy robot has two functions.

First function is the conversation with family using the recorded voice included memorial topics and nostalgic music and the still picture of the family.

Second function is the emotional big motion of a therapy robot. The experiment had been done for 10 serious demented elderly patients. So that the emotions of them such as seeing, hearing and touching are stimulated by these functions. After these experiment, their brain waves were measured.

This system was used tablet PC (Apple iPad mini) with 7.9 inch monitor. The application software "Face Sing" was built in this system, automatically generated movie from a still picture along the recorded family's voice. By this software, demented elderly patients had a video call with their family in the 7.9 inch monitor. Two arms swinging in synchronization with their family's face were built in this, too.

In the mode of emotional pet robot, on the screen, cartoon faces expressions with exaggeratingly emotional expressions which are three feelings: smile, joy, and great joy. The speed of swinging two small arms is synchronized for each emotional expression. Touch sensor function by metal ball was built, and when the metal ball would be touched, it occurred the reaction of the head and arms. The exterior of this was covered with soft cloth like stuffed toy. This emotional pet robot is like Paro, however the size and weight is smaller.

Specification and control method of this care robot system:

(1) Specification: 2 flexibilities for motion of arms, 1 flexibility for tilting iPad mini, totally 3 flexibilities designed. Range of movement this arm 2 flexibilities $\pm 90^\circ$ (up and down motion), 1 flexibility $\pm 5^\circ$ (forward and rearward movement), Motor is Dynamixel MX-28R made by ROBOTIS company, Touch sensor is AT42QT1010 (capacitance) made by Adafruit company, Program creation by Linux (Raspberry Pi).

(2) Control method Event for voice input: By detecting the voice level (3 level), recognized the motion, and move this care robot by transmitting the signal. Event by touching the legs: when touched, response of the touch sensor, so that detecting the signal, make the motion (up and down the arms) by sending the signal to the motor.

Experiment method:

Subjects were 10 demented elderly patients (serious patients). At the beginning of this experiment, subjects were enjoying the emotional pet robot. They enjoyed the emotional reaction of this robot by touching the sensor legs, exaggeratingly emotional expressions and swinging arms.

After that, they had a time of video call. In this main experiment, we had 2 kinds of experiments. One is video call. at 1 time they had, another is video

call 3 times with interval over 1 hour each. Their brain wave were measured before and after 1 time experiment, and before and after 3 time experiment.

Our hypothesis was that many stimulations made their brain activate than one stimulation, because new synaptic connection occurred. The contents of video call were recorded. And making the animation of their family's face were made by the application system same as "Face Sing".

All 10 Subjects had enjoyed the video call as if it had been the first time, even if it was recorded.



Fig. 4: Dementia patient and therapy robot.

Their family was selected by caregiver not only their child but also wife and grandchild. After these experiments, many subjects moved to tears, especially subjects with grandchild were enjoying it.

Special episodes we had, one of episodes was next. One subject had refused singing in the care facility absolutely, but she was singing 「Hurusato」 3 times with her family in video call. All caregivers were surprised this singing, this communication with family were important to restrain the progress dementia for them.

The result of measuring brain wave:

Brain wave measuring support tool was "Brain-Pro FM-929" made by FUTEK ELECTRONICS. When the subjects were comfortable time, we measured their brain wave before and after experiment (1 time and 3 times).

Fig.5 shows the result of average voltage before and after 1st time of 10 subjects. All average voltage of brain wave decreased, this result shows the activation of brain. Fig.6 shows the result of average voltage of a wave before and after 1st time of each 10 subjects. From this result, average voltage of brain wave of most subjects decreased, this result shows the activation of brain too.

Especially 2 subjects who moved to tears loudly for joy were subject 3 and subject 4. Their results are appeared in Fig.7 and Fig.8. Both shows great activation of brain, because θ brain wave and δ brain wave were decreased greatly. It was typical case to be acti-

vation of brain. However both percentage of β brain wave decreased.

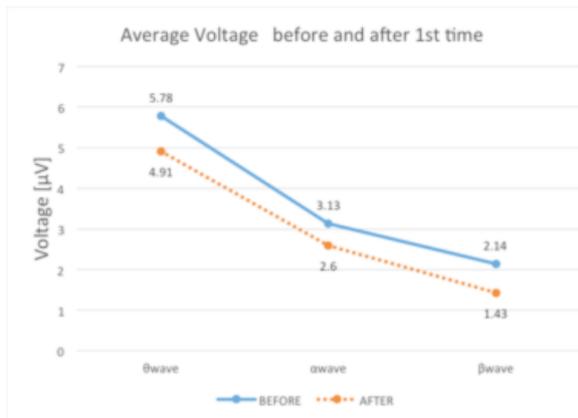


Fig. 5: Average Voltage before and after 1st time of 10 subjects.

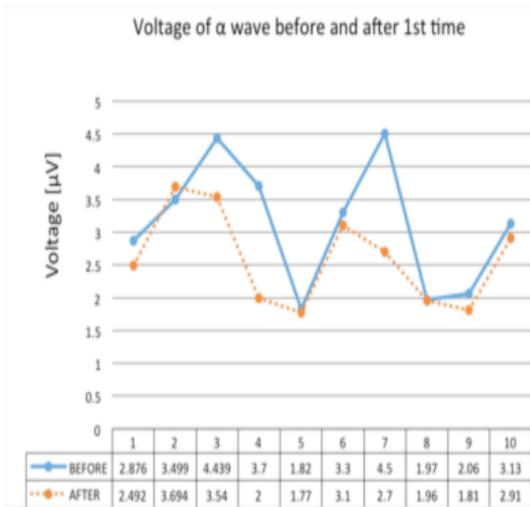


Fig. 6: Average Voltage of α brain wave before and after 1st time of each 10 subject.

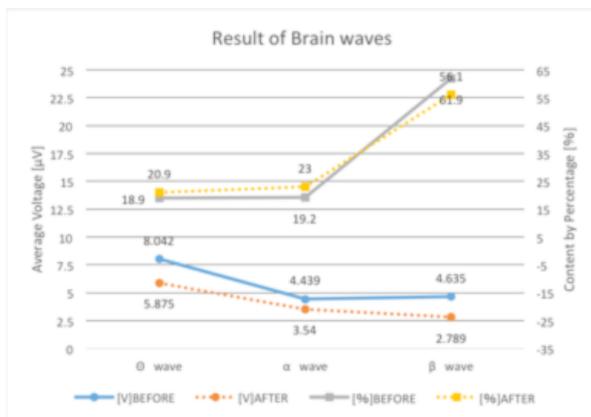


Fig.7 Brain wave of Subject 3 in main experiment

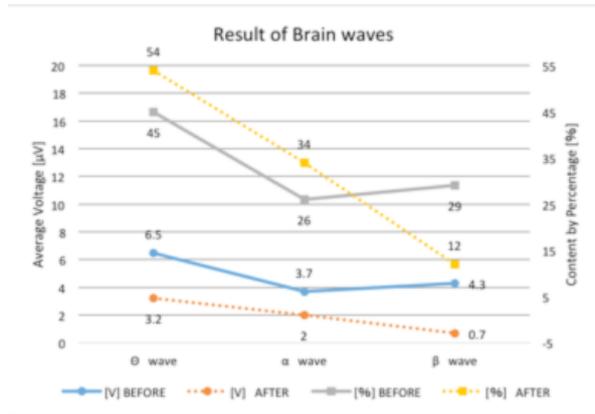


Fig. 8: Brain wave of Subject 4 in main experiment

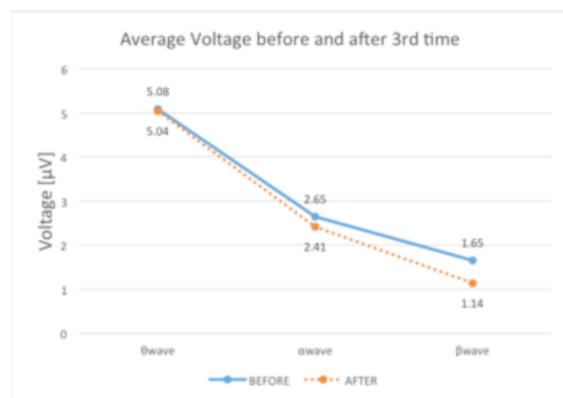


Fig. 9: Average Voltage before and after 3rd time of 10 subjects

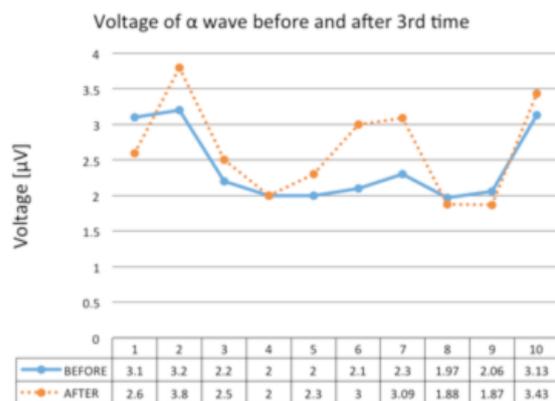


Fig. 10: Average Voltage of α brain wave before and after 3rd time of each 10 subject

By the way, from the result of 3rd time brains of 6 subjects were activation. Fig.9 shows the result of average voltage before and after 3rd time of 10 subjects. All average voltage of brain wave decreased, this result shows the activation of brain too. But the amount of decreasing average voltage of all brain waves was small than 1st time. This means that many

therapy (video call and so on) a day is not good for demented elderly patients.

RESULTS AND DISCUSSIONS

A new therapy for dementia is useful:

In this experiment, all serious demented elderly patients had enjoyed this new therapy, joyful and lively. After that, most results of measuring their brain waves show the activation of brain. It was confirmed the effectiveness of this new therapy for dementia.

Especially, the vital point is natural moving family's face along her voice recorded. So, their family uses this by making a call on a cellular phone only without using the complicated internet machine. This technology is automatically creating 3D facemotion from 2D still picture along their recorded voice. This virtual robot on this video call system is key function in this new therapy.

Next, the crucial point is nostalgic music and memorial topics included in the contents of their conversation. One subject were always singing the song which they had been singing with family on this video call in main experiment, and another subject's pronunciation were sounded clear by this. This therapy is effective and work for restraining progress of their dementia.

A new therapy with only tablet PC:

By producing integrated application software which includes "WebRTC technique"[30] and "Motion Portorate"(master of "Facesing"), this useful video call system will be completed. This application will be loaded on tablet PC, the new therapy shown in the following Fig.11 will be possible. The families of serious demented elderly patients will use this new therapy by their cellular phone only. The caregivers will support to receive a telephone from dementia's family, or their supports will be unnecessary by making these system automatically.

If this system stored the motion video scene on their family's call, the patients always enjoyed the conversation as if it was the first time. Their emotions were aroused, and their behavior is activated.

And, when recorded video call will be used, caregivers will put the button on the tablet PC during the daily care, or the video call will be automatically reproduced. By this easy way, their mental and physical burdens of their family and caregiver will be decreased.

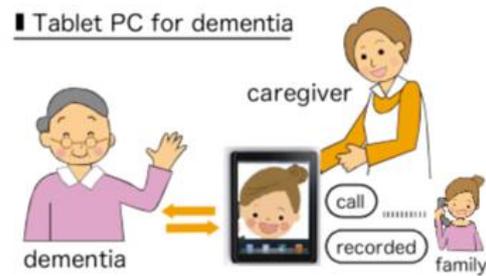


Fig. 11: A new robot therapy using tablet PC only.

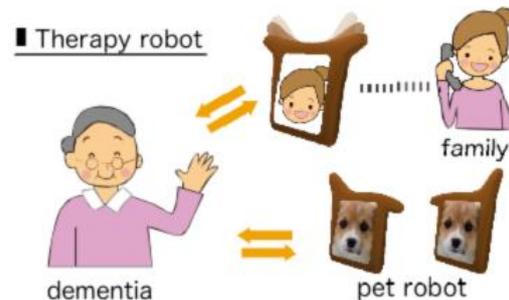


Fig. 12: A new robot therapy using two-mode robot.

A new therapy with emotional pet robot system:

These moving arms synchronized family's video call (moving face and voice) were effective. This function exaggerated or made bigger the family's emotions conveyed from the video call.

However, this cartoon faces expressions must be changed to familiar child animals, like kitten and puppy.

Because elderly patients had lacking affinity for this cartoon faces.

And, some patients poked with their fingertip the cartoon face on the monitor. In addition, by loading display device with touch sensor on the monitor, and by the application of child animal's face reacted by dementia's poking, the dementia's touch sensor will be stimulated. Like the following Fig.12, dementia will be received family's video call therapy and pet robot therapy automatically all of days.

Conclusion:

In this paper, for serious demented elderly patients in care facility, we proposed a new robot therapy used next information communication technology. We confirmed the effectiveness of a new robot therapy by measuring brain waves of subjects.

(1) Emotional robot: 3 subjects were verified the effects of this new therapy by using Commercial toy "Facestand". It was an emotional robot which arms and body dance along family's voice sound (a recorded video call conversation with family). It showed her family's face on the 4inch LCD screen. That application software "Facesing" technology in "Faces-

tand” was automatically creating 3D face motion from 2D still image, and creating the natural motion of it (like lip-synching) to communicate others. 3 subjects related this emotional therapy robot and they always enjoyed the video call as if it was the first time. We confirmed this new robot therapy was useful. The result of measuring brain wave of 1 subject was a typical activating of brain. θ wave and α wave (of average voltage) were lower than before experiment, and β wave (of percentage) was upper.

(2) This new therapy robot system for dementia: 10 subjects were verified the effects of this in same way as emotional robot. This system was used iPad mini with 7.9 inch monitor (tablet PC). 2 arms swinging in synchronization with their family’s face were built in this, too. All 10 Subjects had enjoyed the video call system as if it was the first time, even if it was recorded. From the result of measuring subject’s brain, all average voltage of brain wave decreased, this result shows the activation of brain. This way of using tablet PC (simple ICT technique) and robot, is expected as a new therapy for dementia. Specifically automatically creating 3D face motion technique will be applied Karaoke image. By using family’s face date to this motion technique, patient sings a song as if family sings together. By using it to Game image, patient plays Majyan game as if family plays together.

REFERENCES

- Ministry of Health, 2014. Labour and Welfare, Care Benefit Expenses subcommittee No.115 background information 2014.11.19.
- Keiko Koyama, 2014. “Nazekaisouryouhouganintisyouni kikunoka” (in Japanese), P.92, Syoudennsinnyo.
- Aeka Sasaki, 2013. “Nintisyo kea to yobou no onngakuryouhou” (in Japanese), P.25, Syuujuunnsya.
- Mihoko Otake, 2012. “Kaigoni Yakudatu Kyousouhou” (in Japanese), P.131, Tyuouhouki.
- Mihoko Otake, 2013. “Grupukaiwasokusin robot no kaihatuwomokutekitosurkennkoutyoujyukoureisya no hatuwabunnrui” (in Japanese), The 31th Annual Conference of the Robotics.
- Masataka Hirano, Naohiko Hanajima, Keigo Urata, Satoru Muto, Yohei Muraoka and Makoto Ohata, 2013. Development of an Exercise Support System for the Elderly Which Uses a Small Humanoid Robot, *Journal of Robotics and Mechatronics*, Vol.25, No.6.
- Wataru Hashimoto and Fumitaka Nakaizumi, Mieko Ohsuga, Yumiko Inoue, 2007. VR Applied Asobi-Litiation System for Demential Elderly in Group Homes, *Journal of Robotics and Mechatronics*, Vol.19, No.6.
- Kengo Toda, Mutsuhisa Fujioka, Atsuhiko Fujii, Shigeki Okawa, Junri Shinohara, Shinji Tanaka, Takayuki Nakamura, and Takayuki Furuta, 2011. A Home Healthcare System with Communication Robot Technologies-Development of Experimental Systems and in-Home Verification Experiments by Older Persons, *Journal of Robotics and Mechatronics*, Vol.23, No.6.
- Yutaka Miyaji and Ken Tomiyama, 2013. Implement Approach of Affective Interaction for Care giver Support Robot, *Journal of Robotics and Mechatronics*, Vol.25, No.6.
- Marcel Heerink, Jordi Albo-Canals, Meritxell Valenti-Soler, Pablo Martinez-Martin, Jordi Zondag, Carolien Smits, Stefanie Anisuzzaman, 2013. Exploring requirements and alternative pet robots for robot assisted therapy with older adults with dementia, *Lecture Notes in Computer Science*, 8239: 104-115.
- Masayoshi Kanoh, Babyloid, 2011. *Journal of Robotics and Mechatronics*, Vol.26, No.4.
- Hiroshi Yamamoto, Hiroyuki Miyazaki, 2002. Takashi Tsuzuki and Yoshihiro Kojima, Spoken Dialog robot, Named Wonder, to Aid Senior Citizens Who living Alone with Communication, *Journal of Robotics and Mechatronics*, Vol.14, No.1.
- Robinson, H., B. MacDonald, N. Kerse, E. Broadbent, 2013. Suitability of healthcare robots for a dementia unit and suggested improvements, *Journal of the American Medical Directors Association*, 14(1): 34-40.
- Kazuyoshi Wada and Takanori Shibata, 2006. Robot Therapy in Care House, *SCIS&ISIS*.
- Kazuyoshi Wada and Takanori Shibata, 2009. Social Effects of Robot Therapy in a Care House, *Journal of Advanced Computational Intelligence and Intelligent Informatics*, Vol.13, No.4.
- Comparison of Verbal and Emotional Responses of Elderly People with Mild/Moderate Dementia and Those with Severe Dementia in Responses to Seal Robot, PARO, Kazue Takayanagi, 2014. Takahiro Kirita, Takahiro Shibata, *Frontiers in Aging Neuroscience*.
- Satomura Hiroaki, Tanaka Takehiko, Yoshihiro Takuya, Nakagawa Masaru, 2006. Healthcare Supporting Systems over the Internet, *Journal of Japan Society of Information and Knowledge*, Vol.16, No.2.
- Kazuki Nakajima, Akinori Kamiya, Hiroyuki Matsui, Daisuke Oikawa, Kentaro Fujita, Yuji Higashi, Toshiyo
- Tamura, Toshiro Fujimoto and Kazuo Sasaki, 2007. Development of a Television-Use Telemonitoring System for Elderly Daycare-Recipients Living Alone, *Journal of Robotics and Mechatronics*, Vol.19, No.6.
- Nigei Armfield, R., C. Leonard Gray, C. Antony Smith, 2012. Clinical use of Skype: a review of the evidence base, *J Telemed Telecare*, 18(3): 125-127.
- Marry Frances O’Connor, J. Brian Arizmend,

W. Alfred Kasznak, 2014. Virtually supportive: A feasibility pilot study of an online support group for dementia caregivers in a 3D virtual environment, *Journal of aging studies*, 30: 87-93.

Wada Hito ha kanjyokararoukasuru, H., 2013.” (in Japanese), P.16, *Syoudensya 2006*. K.Hasegawa “Koumuin ha nintisyouninariyasuinoka” (in Japanese), P.6, *Gentousyasinsyo*.

Yoriso Smile Supplement Robot “UnazukiKabochohan” (in Japanese), <http://www.pip-club.com/kabo/> 「if bot」 (in Japanese), <http://ja.wikipedia.org/wiki/イフボット>

Armfield, NR., LC. Gray, AC. Smith, 2012. Clinical use of Skype: a review of the evidence base, *J TelemedTelecare*, 18(3): 125-127.

Panote Siriraya, Chee Siang Ang, 2014. Recreating living experiences from past memories through virtual worlds for people with dementia, CHI'14 Pro-

ceedings of the SIGCHI Conference on Human Factors in Computing Systems, pp: 3977-3986.

Motionportraite company, “Face Sing”, <https://www.motionportrait.com/solutions/TakaraTomyFacestand> ,<http://www.takaratomy.co.jp/products/dancingfacestand/>

Shinobu Nakagawa, 2014. “A new robot therapy to delay progression of dementia for elderly patients by arousing emotions of them.” *Japan Ergonomics Res. Soc*, 55:162,163.

WebRTCtechnique<http://www.webrtc.org>
Motionportraitecompany
<http://www.motionportrait.com/indexj.php>

Shinobu Nakagawa, 2014. Device supporting for dementia No.51407869 Japanese Patent application 2014-068874 2014.3.28 (in Japanese).