Using Observational Engagement Assessment Method VC-IOE for Evaluating an Interactive Table Designed for Seniors with Dementia

Yuan Feng[1,2(✉)], Ruud van Reijmersdal[1], Suihuai Yu[2(✉)], Jun Hu[1], Matthias Rauterberg[1], and Emilia Barakova[1]

[1] Department of Industrial Design, Eindhoven University of Technology, Eindhoven, The Netherlands
{Y.Feng, j.hu, G.W.M.Rauterberg, E.I.Barakova}@tue.nl, r.j.h.v.reijmersdal@student.tue.nl

[2] Department of Industrial Design, Northwestern Polytechnical University, Xi'an, People's Republic of China
ysuihuai@vip.sina.com

Abstract. Seniors with dementia living in residential nursing homes are often lack of meaningful engagement and keeping them engaged in meaningful activities can help reduce boredom and improve their well-being. This paper presents an Interactive Table Design (ITD) for providing seniors with dementia meaningful engagements. An observational engagement assessment method, Video Coding – Incorporating Observed Emotion (VC-IOE), was adopted to further study the effectiveness of the intervention design. Qualitative data such as video recordings of four participants engaged with the ITD and comparison intervention Pim Pam Pet (PPP) in Vitalis Kelinschalig Wonen, were then analyzed following the video analysis protocols of VC-IOE. The results from video coding analysis provided an overview of participants' emotional responses and engagement situations through six dimensions of engagement including emotional, verbal, visual, behavioral, collective engagement and agitation. The results showed sufficient positive impacts of ITD on participants which indicate that the ITD has the potential to be an effective intervention for providing seniors with dementia with meaningful engagement while keeping them socially connected in a nursing home.

Keywords: Dementia · Engagement · VC-IOE · Video analysis · Design

1 Introduction

Dementia is an umbrella term for multiple variant disorders which affects the brain, impairing the cognitive function, the executive function including planning and problem-solving, as well as the independent function for a job or personal care. It can be divided into further categories according to the stage of the disease and have varied etiologies. The life expectancy after being diagnosed with dementia is eight years on average and has no known cure. Besides cancer and cardiovascular diseases, dementia is one of the main causes of senior deaths within the Netherlands [1].

© Springer International Publishing AG 2017
H. Chen et al. (Eds.): ICSH 2017, LNCS 10347, pp. 26–37, 2017.
https://doi.org/10.1007/978-3-319-67964-8_3

In early stages, persons with dementia encounter problems such as inhibited memory, language deficiencies, and difficulties in novel tasks. With the progression of dementia, the number of complications becomes greater and the affected behaviors are further exaggerated. A decline in neurological functions due to the progression of dementia may lead to disorientation in time and place which often results in confusion and conflicts with others [2]. The loss of functional abilities ultimately leads to complications with daily tasks such as eating or getting dressed, or any other personal-care activities. Therefore, seniors with dementia often need specialized care in the form of nursing homes or professional caregivers.

1.1 Engaging Seniors with Dementia in Social Activities

Since dementia is an age-related disease, seniors with dementia are faced with not only the challenges of the disease itself but also a decrease in their physical health as well as other age-related declines. A decrease in physical health such as the deterioration of mobility, hearing, and visual functions may disorient seniors further, leaving them feeling vulnerable and more emotional. This leads to their search for reassurance and attention from others [2]. The transition into residential nursing homes brings forth a new set of challenges for seniors with dementia as they can lose a sense of familiarity which is punctuated by participating in unplanned activities. This results in an increase in boredom and loneliness [3]. The prolonged lack of engagement increases the risk of behavioral and psychological symptoms of dementia such as apathy, depression, aggression and agitation [4].

In addition, due to their compounding conditions, seniors with dementia spend less time than their peers engaging in social activities and communication is crucial in daily lives since it provides a means for people to express their needs and feelings. Without communication, unmet needs can result in aggression or other complicated behaviors, further resulting in social isolation [5]. Engagement in social activities can help seniors with dementia improve one aspect of their quality of life by mitigating boredom and decrease depression, agitation, and aggression [6]. Also, engagement in social activities is beneficial for social connectedness and increases autonomy, which improves an individual's well-being [7]. Research in engagement is crucial for determining individual-centered activities for the betterment of their quality of life.

2 Assessing Engagement of Seniors with Dementia

The analysis of different forms of engagement that expected to help to define suitable interventions for increasing interests and positive emotions of persons with dementia has been done by researchers [8]. However, analyzing and assessing engagement can be challenging since seniors with dementia often have inhibited memory, deteriorated cognitive functions and degenerated language skills, which makes the evaluation through self-reflecting very difficult. Additionally, some dementia-affected seniors also have reduced emotionality which means they cannot express their facial emotions properly [2, 9]. This makes the analysis of the facial expression even more difficult.

The most notable work within the dementia engagement study is Cohen-Mansfield and her colleagues. They utilized a comprehensive model of five dimensions of engagement known as the Observational Method of Engagement (OME) [8]. It measures engagement through the rate of refusal of the stimulus, duration of the time that resident involved with the stimulus, level of attention to the stimulus, attitude toward the stimulus, and actions toward the stimulus. Unlike earlier research about dementia engagement that emphases on the effect of reducing agitation or agitated behaviors, OME specifically addresses the experience of engagement with measurable aspects, which provide a more comprehensive overview based on direct observation of engagement experience than simply studying the positive effect on agitation [10].

Most recently, Jones [11] proposed a video analysis method called Video Coding Incorporating Observed Emotion (VC-IOE) for assessing engagement of persons with dementia. VC-IOE is a video coding scheme based on theory integration of the Dual-channel hypothesis and the Comprehensive Process Model of Engagement framework [8], which integrates emotional and social aspects of the engagement experience as well. It is designed based on the OME and Lawton's commonly adopted the Observed Emotion Rating Scale (OERS) for assessing engagement and emotions [12]. By combining existing methods and adding verbal, emotional and collective engagement, VC-IOE provides a more comprehensive understanding of the engagement of dementia in order to study the effectiveness of interventions.

3 Design of an Interactive Table for Dementia

An interactive table was designed intended to be used as an intervention for providing meaningful activity and improving engagement among seniors with dementia living in care facilities [13]. The table figure was chosen since residents in nursing homes are already familiar and can interact with things placing on it naturally, therefore enables a simple level interaction based on former experience and cognitive function. Additionally, the table is already a physical connecting object since people sitting around often form a sense of connectedness.

The Interactive Table Design (ITD) (Fig. 1) consists of two basic elements which are the interactive feather ball sets placing two on each long side of the table and four symmetric leaf shape patterns embedded in the center of the table. The positioning of the interactive ball sets is formed by their daily sitting habits. The table design can support at most four users interacting at the same time, with each user have one set of interactive balls and a hollowed route link to the center leaf shape pattern filled with colored liquid. Ball sets were chosen as related research indicated that ball figure shows appealing feature to all levels of cognitive impairment of dementia [14, 15]. Four different colors are used for distinguishing user characters, and the same color is applied on both interactive ball set and the liquid inside leaf pattern interface in order to build a logic link in between. Feather feature provides an inviting gesture for different ways of interactions, such as stroking, petting, holding squeezing or slapping.

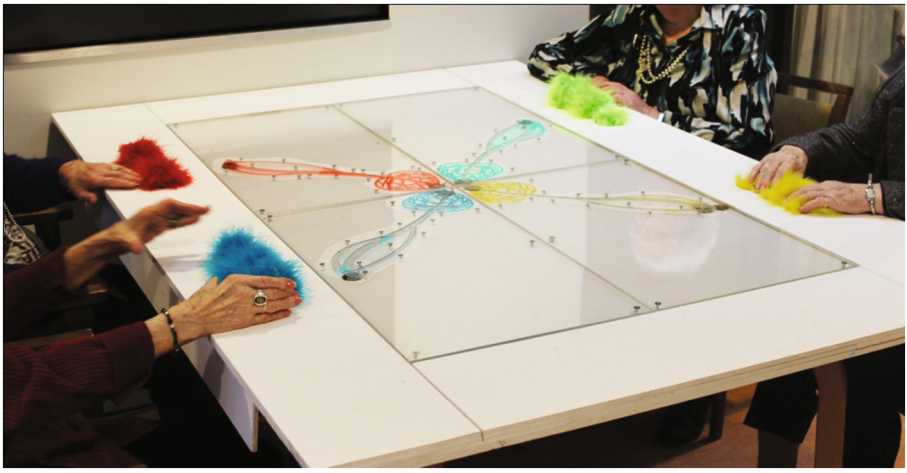

Fig. 1. The Interactive Table Design with four seniors with dementia from Vitalis Kelinschalig Wonen interacting with it (Color figure online)

Each ball set consists of three individual balls that are made of colored goose down with woven conductive wires, while still visually appears as an entity. Three separate balls are controlled by mechanics underneath the table individually so that together they can be programmed to mimic animal-like movements and respond to user gestures. For instance, when three balls are moving up and down gradually, they may appear like pulsing or alive and breathing in the perception of users. The conductive wires hidden in the feather are programmed for sensing different ways of contact, combining with force sensing in order to distinguish possible gestures. Different gestural interactions are defined so that ball set can respond correspondingly in order to provide an animal-like character. For example, when no engagement happens with the ball sets, they will show provoking reaction that is popping out the table surface now and then and acts like a curious and shy animal; when positive engaged such as stroking, holding, handling, or petting the feather balls, they will mimic a breath pattern by slowly moving; when negative engaged such as slapping or hitting, they will react hiding or diving back into the table to show a hurtful animal-like behavior.

Leaf shape patterns embedded in the center of the table were made of transparent acrylic-based resin plates. They are normally transparent and barely visible. When signals of continues positive interactions are detected from users' wrist by a pulse sensor installed near the ball sets on the table, a pump will start working to pump colored liquid towards the center along with the rhythm of users' heartbeat. The whole system consists of four sets of electronics. Each set of electronics contains one Arduino Uno board which controls all the sensors and actuators; three servomotors manipulate one interactive ball set through a motor controller; three groups of conductive wires that receive user's touch input through a breakout board; a pulse sensor for collecting pulse signals; a pump and a power converter. The ITD aims at providing meaningful

engagement for keeping dementia residents in nursing homes occupied, in order to further preventing social isolation, magnifying positive affective effects and social connectedness without interfering dementia residents' daily routines and adding extra burdens on caregivers.

4 Evaluation

In order to further study the effectiveness of this designed intervention, an observational engagement assessment method VC-IOE was then adopted for acquiring an overall experience of the engagement. The evaluation was conducted in Vitalis (Kleinschalig Wonen), which is a nursing home in Eindhoven (The Netherlands) that focuses on providing specialized care for seniors with various forms and conditions of dementia. Additionally, a game Pim Pam Pet (PPP) was used for comparison study, since the game has already been used as a daily activity in Vitalis and proved to have positive effects on seniors with dementia based on former experiences from caregivers.

4.1 Participants

A sample contains four participants with a formal diagnosis of dementia were recruited from Vitalis. Residents with a functioning level of auditory, visual abilities and physically able for sitting and interacting with different stimulus were eligible to participate. All four participants are female due to the majority population living in Vitalis are female, and with the average age of 85 and different levels of cognitive functioning according to a diagnostic four-stage rating scale used in Vitalis. The same group of participants participated in both PPP and ITD evaluations. Participant demographics are shown in Table 1.

Table 1. Participant demographics

Participant	P1	P2	P3	P4
Gender	Female	Female	Female	Female
Age	75	84	88	93
Stage	2	2-3	2-3	3
Form of dementia	Vascular dementia	Vascular dementia	Vascular dementia	Vascular dementia
Marriage status	Widowed	Married	Widowed	Widowed
Cognitive function according to staff	Mild cognitive decline	Confused at times	Confused at times	Constantly confused

4.2 Procedure

Evaluations were agreed ahead with Vitalis and performed in different days during non-planned activity time from 14:30 until 16:00 inside a unit within Vitalis. Four

participants were first invited to sit around a table in a living room formed by 7 residents of seniors with dementia and played with PPP for 20 min. The intervention session length was limited based on previous experience. The game PPP consists of a set of cards with questions and a turntable with letters from the alphabet. A registered nurse with extensive experience in dementia care as a facilitator to guide the game and read the questions on the cards, while participants take turns to roll the turntable then answer the questions on the cards start with the letter from the turntable. For instance, if the question is "what can you have on bread?" and if a participant rolls a letter "P", then "Peanut butter" should be one of the correct answers.

Participants were invited again another time for engaging with the ITD. As the intention of the design is to keep residents in nursing homes engaged with minimal involvement of caregivers, this evaluation was performed without a facilitator. Participants were first introduced to the table, then instructed to explore by themselves until loss of interest or left the table. Both evaluations were group sessions with the same four participants for better generating social connectedness and assessing collective engagement. Evaluations were documented using video cameras and cell phones for recording audios then transcribed into a manuscript and translated into English for further qualitative data analysis.

4.3 Assessing Engagement Using VC-IOE

A video coding protocol VC-IOE was used for video analysis according to the guidelines proposed by Jones [11]. The VC-IOE video coding protocol emphases on six dimensions of engagements, including emotional, verbal, visual, behavioral, collective engagement and signs of agitation. Each dimension will be assessed separately, and then considered jointly for providing a more comprehensive overview of the engagement experience.

The emotional engagement was assessed by observing facial responses and coded into three categories as pleasure, negative and neutral. The verbal engagement was assessed through conversations. It offers a context for understanding their engagement situations and behaviors toward stimulus. Visual engagement as an indicator of participants' non-verbal engagement was examined and coded according to the presence of the visual engagement, for instance, keeping eye contact with the stimulus, or no eye contact with the stimulus. Behavior engagement assessing was based on the relevant engagement study of Cohen-Mansfield et al. [16] and Kolanowski et al. [17]. Gestural interaction including petting, stroking, handling the stimulus properly were considered positive behavioral engagement, and hitting the table or pulling out the ball sets was considered negative behavioral engagement. The collective engagement was assessed when participants showed social connection such as introducing or instructing stimulus to others, encouraging others to interact with, or using stimulus as a communication tool for forming conversations. Agitation is coded based on Cohen-Mansfield's research on agitation and agitation behaviors (Cohen-Mansfield Agitation Inventory, CMAI) [18], both verbal and non-verbal aspects. The missing data was coded as no engagement. Table 2 presents and explains the video analysis protocols in details. Dedoose online platform (www.dedoose.com) was used for analyzing the qualitative data.

Table 2. Video coding protocols including six dimensions of engagement and observational signs used in evaluations

Engagement	Observation
Emotional engagement	
Positive emotions (Pleasure)	Smiling, laughing towards the stimulus
Negative emotions (Anger, Anxiety or fear, Sadness)	Physical aggression, yelling, cursing, drawing eyebrows together, clenching teeth, pursing lips, narrowing eyes; voice shaking, shrieking, repetitive calling out, line between eyebrows, lines across forehead, tight facial muscles; crying, frowning, eyes drooped, moaning, sighing, eyes/head turned down
Neutral	Relaxed or no sign of discrete facial expression
Verbal engagement	
Positive verbal engagement with stimulus or facilitator	Appreciating, praising the stimulus, making jokes, expressing happiness, fun experience, and participating and maintaining conversation, verbally responding to the stimulus
Negative verbal engagement	Verbalizes the desire to leave, refuses to participate in the activity anymore, makes repetitive generalized somatic complaints, cursing and swearing
No verbal engagement	Not participating and maintaining the conversation. Not responding or talking to the stimulus or facilitators
Visual engagement	
Visually engaged	Appears alerted and maintaining eye contact with the stimulus, including eyes following or looking at the stimulus
No visual engagement	Blank stare into space. Does not make eye contact with the stimulus
Behavioral engagement	
Positive behavioral engagement	Touching or attempting to touch the stimulus. Stroking, petting, holding and handling the stimulus appropriately
Negative behavioral engagement	Hitting, shaking and slapping the stimulus inappropriately, including Shoving it away and pulling it out
No behavioral engagement	No touching, physical contact and interacting with the stimulus
Collective engagement	
Evidence of collective engagement	Encouraging others to interact with the stimulus. Introducing stimulus to others. Using stimulus as a communication channel to interact and talk with others
No collective engagement	No sign of collective engagement
Agitation	
Evidence of agitation (verbal, vocal, motor activity)	Restlessness, repeated/agitated movement, picking and fiddling with clothes; repetitive rubbing own limbs or torso; appears anxious. Repeats words or phrases, abusive or aggressive toward self or other
No evidence of agitation	No sign of agitation as described above

5 Results

Coding result presented in Table 3 shows the duration of each participant engaged in six dimensions of engagement of two evaluations in seconds. The original coding results were converted and using 600 s as a unit of session duration of both evaluations for easier comparison purpose. Participants' emotional, verbal, behavioral responses to both PPP and ITD are summarized separately in Table 4.

Table 3. Session duration of each participant engaged in two evaluations in seconds

Evaluation	PPP				ITD			
Participant	P1	P2	P3	P4	P1	P2	P3	P4
Session duration	755	755	755	477	2832	1910	1399	1890

Table 4. Each participant's converted engagement duration using 600 s as a unit of both PPP and ITD evaluations in seconds

Evaluation	PPP				ITD			
Participant	P1	P2	P3	P4	P1	P2	P3	P4
Positive emotions	25.36	7.13	3.17	1.26	76.06	16.65	107.22	7.62
Negative emotions	1.59	0	0	0	5.08	13.19	2.14	11.11
Neutral	573.05	592.87	596.83	598.74	518.86	570.16	490.64	581.27
Visual engagement	529.46	397.09	493.79	435.22	261.86	394.87	208.00	330.16
Positive verbal engagement with stimulus or facilitator	88.77	40.42	9.51	5.03	323.31	37.70	258.18	54.29
Negative verbal engagement with stimulus or facilitator	0	4.76	0	0	22.46	0	14.15	8.89
Positive Behavioral engagement	3.17	9.51	0	0	167.80	385.13	88.78	203.17
Negative Behavioral engagement	0	0	0	0	0	0.63	2.14	0
Collective engagement	13.47	2.38	0	0	61.02	16.65	96.93	19.37
Agitation	3.17	5.55	0	40.25	0	6.28	4.29	38.41

5.1 Overall Observations in Six Dimensions of Engagement

It is obvious that the session duration of all participants when engaging with the ITD far surpasses the corresponding session duration of game PPP. They showed great interests towards the ITD. The attractiveness and aliveness of the design features, the inviting gesture for interacting, along with the calmness and connectedness brings by the ITD together shows a successful concept for residents with dementia in Vitalis. Longer positive emotional engagement towards the stimulus was also examined with the engagement of the ITD. Participants were found expressing emotions more often and with longer durations. Compared to the emotional engagement of PPP, ITD succeeded on provoking their emotional expressions. Both positive and negative emotional engagement experienced a rise, which suggested more brain activities regarding emotional expression were activated, and this may due to the rich multi-sensory stimulations and animal-like features of the ITD.

In addition, during evaluations, participants who expressed more verbally tend to have less behavioral and visual engagement. Their visual engagement is proportional to the behavioral engagement, as when they are behavioral engaged with the stimulus they usually also keep eye contact at the same time. Result also shows that seniors with advanced stage of dementia who have language deficiencies tend to be more engaged in behavioral engagement and find socially involved within collective engagement challenging.

Although evaluations of both evaluations are group sessions, engagement of all participants with the ITD shows much longer collective engagement duration. The results of qualitative video analysis present many clues on social inclusion. Participants helped each other on how to interact with the ball sets, how to make the liquid pumping works and guided each other's attention towards the stimulus. The interaction helped form conversations as well. Longer duration of verbal engagement was exhibited when engaged with the ITD. They were discussing the vibrant colored feather together and sharing past experiences. In addition, participants were found to be easily influenced by others during evaluations, for instance, petting behavior of one participant will trigger others' petting behaviors. No finding was found regarding the effect on ease of agitation.

5.2 Observations of Individual Cases

Results indicate that response varied between participants and overtime for each individual. Therefore, the below represents results of individual case studies, as case study method is advantageous for close inspection and exploration of the individual impacts when engaging with the stimulus.

Participant 1 (P1). Out of four participants, P1 attended the longest duration of both evaluations with PPP and the ITD and frequently showed positive expressions such as laughing and smiling. Also, longer positive emotional, verbal, behavioral engagement and collective engagement duration with the ITD was showed than with PPP. P1 verbally engaged well during both two evaluations. Her relatively high language skills, therefore, enabled more verbal expressions. The Result shows much more verbal engagement was provoked by ITD and both positive and negative verbal expressions

were used. P1 also showed signs of collective engagement, such as verbally instructing others and encouraging other participants playing with the stimulus.

Participant 2 (P2). During both two tests, P2 spent the majority of time on behavioral engagement and visually focused with the stimulus instead of expressing herself verbally or emotionally. The highest positive behavioral engagement was exhibited that other participants, while few verbal languages and emotional changes were captured. She was very curious towards the stimulus distributed in front of her and connecting every element of the environment through touching, handling, stroking the stimulus, which created a profile that likely her way of expressing engagement is more through behavioral engaged than other sensory channels. About two-thirds of the time when interacting with the ITD was positively behavioral engaged and almost no negative engagement showed during the whole period. Improved collective engagement was found compared to engagement with PPP.

Participant 3 (P3). Different engagement situations were found when P3 playing with PPP and interacting with the ITD. When engaged with PPP, few emotional changes were showed and no behavioral engagement including positive and negative, no collective engagement or agitation was examined. The game almost didn't trigger any emotional and behavioral expressions. Although session duration with the ITD was the shortest compared to others, however a high level of positive emotions, positive verbal engagement, and collective engagement was exhibited. What notable is that among all participants P3 showed most signs of collective engagement.

Participant 4 (P4). The game session of PPP was planned for 20 min while participants' interests towards the game only last for about 12 min. P4 lost interests and left the table at about 8 min after the game started and began pacing in the room. During the whole session when engaged with PPP, P4 showed almost no positive or negative emotion but the neutral facial expression, which indicated that the game almost did not provoke any emotional engagement in general. While during the evaluation of the ITD, both positive and negative emotions were examined, and the participant can verbally respond to the design positively and negatively. Duration of verbal engagement, positive behavioral engagement, and collective engagement experienced a rise than with PPP. Besides, P4 also showed most of the agitated behaviors among all participants.

6 Concluding Remarks

We presented the design of an interactive table for providing dementia-affected seniors living in specialized nursing homes with meaningful social activities and leveled stimulations. The aim of the evaluation was intended to study the effectiveness of the ITD as an intervention. Cutting edge observational engagement assessment method, VC-IOE, was used for assessing engagement of seniors with dementia to provide critical analysis of the effectiveness of the intervention. Qualitative data such as video recordings of four participants engaged with two evaluations with the ITD and PPP in Vitalis were then analyzed following the video analysis protocols proposed by Jones.

The results from video coding analysis provided an overview of participants' emotional responses and engagement situations through six dimensions of engagement including emotional, verbal, visual, behavioral, collective engagement and agitation. The analysis of engagement with the ITD showed significant positive impacts such as improved emotional state of participants, activated behavioral engagement, and increased positive connections. These resulted in a reduction of boredom and loneliness, further improving well-being. All facts indicate that the ITD has the potential to be a more suitable and attractive intervention for improving the quality of life of seniors with dementia including their social interaction in nursing homes.

While Further evaluation of the ITD is needed and more research is required for its improvement. Also, a second coder is needed for enhancing the reliability and validity of the qualitative video data analysis. Long-term engagement with more participants should be considered for a more comprehensive investigation of the effectiveness of the ITD. A greater number of sessions are needed to obtain the average duration of the engagement. Furthermore, automatic interpretation of affective facial expression [19], qualitative measures of connectedness, and social inclusion should be included [20]. In addition, for studying effectiveness on agitation, participants' normal agitation state is needed in order to provide a baseline. As for the ITD, further design improvements based on evaluation feedbacks are necessary, and practical use scenarios should be taken into consideration as well.

Acknowledgments. The author would like to thank the Chinese Scholarship Council, T. Zuo from Jiangnan University, and Sylvia van Aggel, Helma Verstappel from Vitalis for their support on the study.

References

1. Alzheimer Netherland, Fact sheet about dementia, http://alzheimer.vps9.dolphiq.nl/media/30329/Factsheet%20dementie%20algemeen%20-%20publieksversie%2003-10-2016.pdf
2. James, I.A.: Understanding Behaviour in Dementia that Challenges: A Guide to Assessment and Treatment. Jessica Kingsley Publishers, London (2011)
3. von Kutzleben, M., Schmid, W., Halek, M., et al.: Community-dwelling persons with dementia: what do they need? what do they demand? what do they do? a systematic review on the subjective experiences of persons with dementia. Aging Ment. Health **16**(3), 378–390 (2012)
4. Moyle, W., Venturto, L., Griffiths, S., et al.: Factors influencing quality of life for people with dementia: a qualitative perspective. Aging Ment. Health **15**(8), 970–977 (2011)
5. Scherder, E.J., Bogen, T., Eggermont, L.H., et al.: The more physical inactivity, the more agitation in dementia. Int. Psychogeriatr. **22**(08), 1203–1208 (2010)
6. Cohen-Mansfield, J., Dakheel-Ali, M., Marx, M.S.: Engagement in persons with dementia: the concept and its measurement. Am. J. Geria. Psychiatry. **17**(4), 299–307 (2009)
7. Moyle, W., Jones, C., Sung, B., et al.: What effect does an animal robot called CuDDler have on the engagement and emotional response of older people with dementia? a pilot feasibility study. Int. J. Soc. Robot. **8**(1), 145–156 (2016)
8. Cohen-Mansfield, J., Marx, M.S., Freedman, L.S., et al.: The comprehensive process model of engagement. Am. J. Geria. Psychiatry. **19**(10), 859–870 (2011)

9. Perugia, G., Boladeras, M.D., Barakova, E.I., et al.: Social HRI for people with dementia: one size fits all? In: Proceedings of the Companion of the 2017 ACM/IEEE International Conference on Human-Robot Interaction, pp. 257-258. ACM, New York (2017)
10. Trahan, M.A., Kuo, J., Carlson, M.C., Gitlin, L.N.: A systematic review of strategies to foster activity engagement in persons with dementia. Health Educ. Behav. **41**(1), 70–83 (2014)
11. Jones, C., Sung, B., Moyle, W.: Assessing engagement in people with dementia: a new approach to assessment using video analysis. Arch. Psychiatr. Nurs. **29**(6), 377–382 (2015)
12. Lawton, M.P., van Haitsma, K., Klapper, J.: Observed affect in nursing home residents with alzheimer's disease. J. Gerontol. B Psychol. Sci. Soc. Sci. **51**(1), 3–14 (1996)
13. Feng, Y., Reijmersdal, R., Yu, S., et al.: Dynamorph: montessori inspired design for seniors with dementia living in long-term care facilities. In: 9th International Conference on Intelligent Technologies for Interactive Entertainment. Springer. (2017) (accepted)
14. Buettner, L.: Simple pleasures: a multilevel sensorimotor intervention for nursing home residents with dementia. Am. J. Alzheimer's Dis. **14**(1), 41–52 (1999)
15. Kolanowski, A., Buettner, L.: Prescribing activities that engage passive residents. Innovative Method. J. Gerontol. Nurs. **34**(1), 13–18 (2008)
16. Cohen-Mansfield, J., Marx, M.S., Dakheel-Ali, M., et al.: Can persons with dementia be engaged with stimuli? Am. J. Geria. Psychiatry. **18**(4), 351–362 (2010)
17. Kolanowski, A., Litaker, M., Buettner, L., et al.: A randomized clinical trial of theorybased activities for the behavioral symptoms of dementia in nursing home residents. J. Am. Geriatr. Soc. **59**(6), 1032–1041 (2011)
18. Cohen-Mansfield, J.: Conceptualization of agitation: results based on the cohen-mansfield agitation inventory and the agitation behavior mapping instrument. In. Psychogeriatr. **8**(3), 309–315 (1997)
19. Barakova, E.I., Gorbunov, R., Rauterberg, M.: Automatic interpretation of affective facial expressions in the context of interpersonal interaction. IEEE Trans. Hum. Mach. Syst. **45**(4), 409–418 (2015)
20. Hu, J., Frens, J., Funk, M., Wang, F., Zhang, Y.: Design for social interaction in public spaces. In: Rau, P.L.P. (ed.) CCD 2014. LNCS, vol. 8528, pp. 287–298. Springer, Cham (2014). doi:10.1007/978-3-319-07308-8_28

Hsinchun Chen · Daniel Dajun Zeng
Elena Karahanna · Indranil Bardhan (Eds.)

LNCS 10347

Smart Health

International Conference, ICSH 2017
Hong Kong, China, June 26–27, 2017
Proceedings

Lecture Notes in Computer Science **10347**

Commenced Publication in 1973
Founding and Former Series Editors:
Gerhard Goos, Juris Hartmanis, and Jan van Leeuwen

Editorial Board

David Hutchison
Lancaster University, Lancaster, UK
Takeo Kanade
Carnegie Mellon University, Pittsburgh, PA, USA
Josef Kittler
University of Surrey, Guildford, UK
Jon M. Kleinberg
Cornell University, Ithaca, NY, USA
Friedemann Mattern
ETH Zurich, Zurich, Switzerland
John C. Mitchell
Stanford University, Stanford, CA, USA
Moni Naor
Weizmann Institute of Science, Rehovot, Israel
C. Pandu Rangan
Indian Institute of Technology, Madras, India
Bernhard Steffen
TU Dortmund University, Dortmund, Germany
Demetri Terzopoulos
University of California, Los Angeles, CA, USA
Doug Tygar
University of California, Berkeley, CA, USA
Gerhard Weikum
Max Planck Institute for Informatics, Saarbrücken, Germany

More information about this series at http://www.springer.com/series/7409

Hsinchun Chen · Daniel Dajun Zeng
Elena Karahanna · Indranil Bardhan (Eds.)

Smart Health

International Conference, ICSH 2017
Hong Kong, China, June 26–27, 2017
Proceedings

Springer

Editors
Hsinchun Chen
University of Arizona
Tucson, AZ
USA

Daniel Dajun Zeng
University of Arizona
Tucson, AZ
USA

Elena Karahanna
Department of Management Information System
University of Georgia
Athens, GA
USA

Indranil Bardhan
University of Texas
Richardson, TX
USA

ISSN 0302-9743 ISSN 1611-3349 (electronic)
Lecture Notes in Computer Science
ISBN 978-3-319-67963-1 ISBN 978-3-319-67964-8 (eBook)
https://doi.org/10.1007/978-3-319-67964-8

Library of Congress Control Number: 2017957536

LNCS Sublibrary: SL3 – Information Systems and Applications, incl. Internet/Web, and HCI

© Springer International Publishing AG 2017
This work is subject to copyright. All rights are reserved by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed.
The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.
The publisher, the authors and the editors are safe to assume that the advice and information in this book are believed to be true and accurate at the date of publication. Neither the publisher nor the authors or the editors give a warranty, express or implied, with respect to the material contained herein or for any errors or omissions that may have been made. The publisher remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Printed on acid-free paper

This Springer imprint is published by Springer Nature
The registered company is Springer International Publishing AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Preface

Advancing informatics for health care and health-care applications has become an international research priority. There is increased effort to leverage information systems and data analytics to transform reactive care to proactive and preventive care, clinic-centric to patient-centered practice, training-based interventions to globally aggregated evidence, and episodic response to continuous well-being monitoring and maintenance. The annual International Conference for Smart Health (ICSH), which originated in 2013, intends to provide a forum for the growing international smart health research community to discuss the technical, practical, economic, behavioral, and social issues associated with smart health.

ICSH 2017 focused on studies on the principles, approaches, models, frameworks, new applications, and effects of using novel information technology to address health-care problems and improve social welfare. It successfully attracted scholars working on medical data/text mining and analytics, health community and social media, mobile health care, and economic impact and behaviors in health care. We are pleased that many high-quality papers were submitted, accompanied by evaluations with real-world data or application contexts. The work presented at the conference encompassed a healthy mix of different disciplines.

ICSH 2017 was held in Hong Kong SAR, China. The two-day event encompassed presentations of 31 papers. The organizers of ICSH 2017 would like to thank the conference sponsors for their support and sponsorship, including Hong Kong RGC Theme-based Research Project No. T32-102/14 N, City University of Hong Kong (the Information Systems Department as well as the Systems Engineering and Engineering Management Department) and the INFORMS College on Artificial Intelligence (CAI). We further wish to express our sincere gratitude to all Program Committee members of ICSH 2017, who provided valuable and constructive reviews. We further wish to express our sincere gratitude to all our sponsors.

December 2017

Hsinchun Chen
Elena Karahanna
Daniel Zeng

Organization

Conference Co-chairs

Hsinchun Chen	University of Arizona, USA
Elena Karahanna	University of Georgia, USA
Daniel Zeng	University of Arizona, and Chinese Academy of Sciences, China

Program Co-chairs

Indranil Bardhan	University of Texas at Dallas, USA
Jiexun Li	Western Washington University, USA
Xin Li	City University of Hong Kong SAR, China

Workshop Co-chairs

Hsin-Min Lu	National Taiwan University, Taiwan
Yu Tong	City University of Hong Kong SAR, China
Qingpeng Zhang	City University of Hong Kong SAR, China

Honorary Co-chairs

Youhua (Frank) Chen	City University of Hong Kong SAR, China
Choonling Sia	City University of Hong Kong SAR, China
Kwok Leung Tsui	City University of Hong Kong SAR, China
Weiguo (Patrick) Fan	Virginia Tech, USA
Ting-Peng Liang	National Sun Yat-Sen University, Taiwan

Publication Co-chairs

Hsin-Min Lu	National Taiwan University, Taiwan
Xiaolong Zheng	Chinese Academy of Sciences, China

Publicity Co-chair

Qingpeng Zhang	City University of Hong Kong SAR, China

Local Arrangements Chair

Yu Tong	City University of Hong Kong SAR, China

Program Committee

Muhammad Amith	Texas Medical Center, USA
Mohd Anwar	North Carolina A&T State University, USA
Ian Brooks	University of Illinois at Urbana-Champaign, USA
Zhidong Cao	Chinese Academy of Sciences, China
Xiaohui Chang	Oregon State University, USA
Michael Chau	University of Hong Kong SAR, China
Chien-Chin Chen	National Taiwan University, Taiwan
Guanling Chen	University of Massachusetts Lowell, USA
Xiaofeng Chen	Western Washington University, USA
Tingru Cui	University of Wollongong, Australia
Yimeng Deng	National University of Singapore, Singapore
Shaokun Fan	Oregon State University, USA
Qianjing Feng	Southern Medical University, China
Yuan Feng	Technische Universiteit, The Netherlands
Wai-Tat Fu	University of Illinois at Urbana-Champaign, USA
Xu Han	University of Connecticut, USA
Hung-Yu Kao	National Cheng Kung University, Taiwan
Kyoji Kawagoe	Ritsumeikan University, Japan
Dan Ke	Wuhan University, China
Erhun Kundakcioglu	Özyeğin University, Turkey
Juhee Kwon	City University of Hong Kong SAR, China
Jia Li	East China University of Science and Technology, China
Jiao Li	Chinese Academy of Medical Sciences, China
Mingyang Li	University of South Florida, USA
Yan Li	Harbin Institute of Technology, China
Yunji Liang	University of Arizona, USA
Yi-Ling Lin	National Chengchi University, Taiwan
Yu-Kai Lin	Florida State University, USA
Ben Liu	City University of Hong Kong SAR, China
Hongyan Liu	Tsinghua University, China
Na Liu	The University of Sydney, Australia
Xiao Liu	University of Utah, USA
Xuan Liu	East China University of Science and Technology, China
Yong Liu	Chinese Academy of Sciences, China
Zhong Lu	City University of Hong Kong SAR, China
James Ma	University of Colorado, Colorado Springs, USA
Deepti Mehrotra	Amity University, India
Mevludin Memedi	Dalarna University, Sweden
Riccardo Miotto	Icahn School of Medicine at Mount Sinai, USA
Jin-Cheon Na	Nanyang Technological University, Singapore
Radhakrishnan Nagarajan	University of Kentucky, USA
W. Nick Street	The University of Iowa, USA

M.V. Panduranga Rao	Indian Institute of Technology Hyderabad, India
Chih-Hung Peng	City University of Hong Kong SAR, China
Jerry Peng	East China University of Science and Technology, China
Xiaoming Sheng	University of Utah, USA
William Song	Dalarna University, Sweden
Xiaolong Song	Dongbei University of Finance and Economics, China
Barney Tan	The University of Sydney, Australia
Xiaoying Tang	Sun Yat-sen University, China
Alan Wang	Virginia Tech, USA
Haolin Wang	City University of Hong Kong SAR, China
Jiaojiao Wang	Chinese Academy of Sciences, China
Zoie Wong	St. Luke's International University, Japan
Yi Wu	Tianjin University, China
Dong Xu	University of Arizona, USA
Jennifer Xu	Bentley College, USA
Kaiquan Xu	Nanjing University, China
Ronghua Xu	City University of Hong Kong SAR, China
Yujing Xu	City University of Hong Kong SAR, China
Zhongzhi Xu	Central South University, China
Jonathan Ye	University of Auckland, New Zealand
Lin Yue	Trinity College Dublin, University of Dublin, Ireland
Anna Zaitsev	The University of Sydney, Australia
Xiaofei Zhang	Hong Kong Polytechnic University, SAR China
Zhu Zhang	Chinese Academy of Sciences, China
Kang Zhao	University of Iowa, USA
Yang Zhao	City University of Hong Kong SAR, China
Eric Zheng	University of Texas at Dallas, USA
Xiaolong Zheng	Chinese Academy of Sciences, China
Jiaqi Zhou	City University of Hong Kong SAR, China
Lina Zhou	University of Maryland, Baltimore County, USA
Bin Zhu	Oregon State University, USA

Contents