Socially Assistive Robot for People with Dementia in Home-Based Care

Rajiv Khosla, Khanh Nguyen, Mei-Tai Chu

***Abstract*—The paper reports on service design, service personalization and deployment of a socially assistive robot (named Lucy) to support older people with dementia in home-based care. The results analyzed from multi-modal data collection of the first ever longitudinal field trials in Australian home-based environments demonstrate that socially assistive robots like Lucy have the ability of breaking technology barriers, positively engaging with its human partner for remarkable frequency and time duration which has a potential to reduce caring time demand and give respire to the carers. This research also provide an evidence base to enable the selection of the robot services that are perceived most positively by people with dementia in home-based care.**

I. Introduction

The primary driving force behind this research is the predicted severe shortage of the human element and engagement in aged care in the coming decades. Like most of the developed countries, Australia's population is ageing. Over the next several decades, population ageing is projected to have the need for aged care services is growing at the rate of 68 percent but supply of health care workers is only growing at the rate of 14.8 percent labor [1].

Recently, health care researchers have shown the need for promoting person-centered care, self-identity and personhood for older persons and people with dementia [2-4]. Tobin [5]. Given the importance of pursuing this path, our research involves marrying personhood [3, 4] in health care with socially assistive robotics embodiment of care concepts [6] and context sensitive cloud computing techniques involving artificial intelligence, soft computing and computer vision techniques to realize a symbiotic robotic system. Research in this area has indicated that negative consequences of ageing and dementia can be mitigated by designing an approach towards care that respects and supports each individual's personhood [3, 4]. Personhood has been defined as 'the standing or status that is bestowed upon one human being, by others, in the context of relationship and social being' [7]. It includes three fundamental components, namely, interactional environment, subjective experience and social context. Figure 1 shows mapping of concepts related to these three components in Lucy.

The embodiment of interactional environment in Lucy involves modeling of human characteristics like gesture, emotional expressions, voice, motion, dancing, and dialog adaptation in Lucy. The subjective experience in an older person care context involves design of services personalized around the lifestyle of person with dementia. These lifestyle based services which reflect their personhood should enable a reciprocal relationship between Lucy and the older person and consequently make them more productive and useful [8].

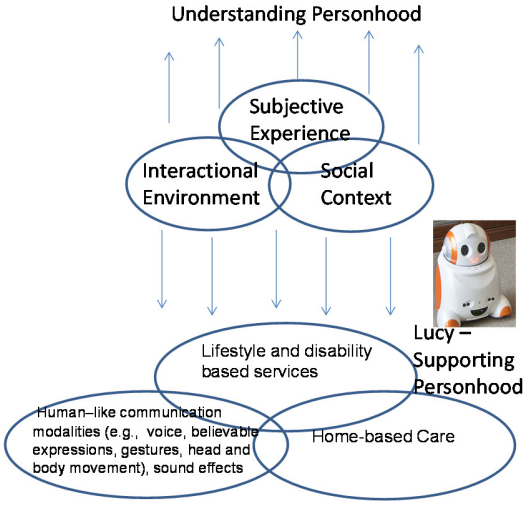

Figure 1. Mapping personhood in Lucy

The subjective experience would also imply use of flexible interaction modes (e.g., voice based, touch based, face based) between Lucy and the human partner based on their need and comfort. The interactional environment needs to employ human-like communication modalities like voice, emotive expressions, head and body movement, and gestures in an emotionally engaging manner to facilitate a reciprocal relationship [8].

The results analyzed from multi-modal data collection have shown by marrying emotional measuring techniques and adaptive service personalization in the design and applications, social robots like Lucy have the ability of breaking technology barriers, enhancing the interaction with human partner, and personalizing its services to individual's preferences which finally improves positive engagement and emotional well being of older people.

II. Field Trials and Results

A. *Field Trials*

The longitudinal study was conducted between 2 and 5 months in five Australian households. All participants are older people (ages 65-89) having dementia living in Victoria, Australia. Each participant has had a robot deployed at their home (figure 2). The robot has human attributes include baby face like appearance, voice vocalization, face recognition, face registration and face tracking, facial expressions, gestures,

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body motion sensors, dance movements, touch sensors, emotion recognition and speech acoustics recognition. The robot can deliver several lifestyle services in personalized way to the individual participant.

Figure 2. Snapshots of home-based trials.

B. Results

1) Engagement

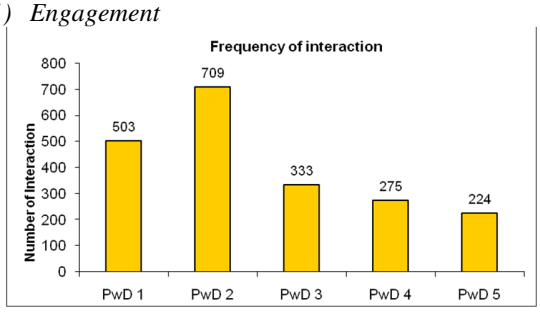

Figure 3. Interaction per participant

The total number of interaction between each participant to the robot is illustrated in Figure 3. The figure shows that the participants have approached and interacted with their robot significant of times, in which the participants 1 & 2 have the highest interactional level with 709 and 503 times of interactions respectively.

2) Respire to care

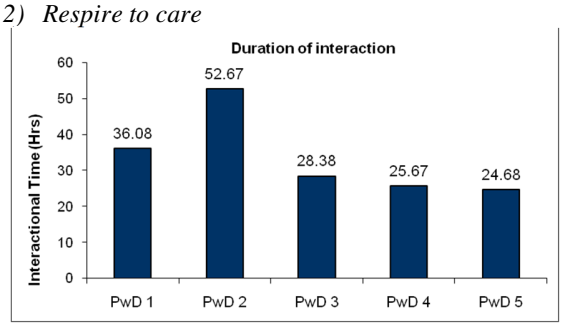

Figure 4. Interactional duration per participant

We analysed the interactional activity data to obtain the total duration time of interaction (Figure 4). The figure shows that five participants have spent 24 to 52 hours to interact with the robots. This not only gives family carers some respire but also potentially reduces caring time demand to persons with dementia.

3) Service preference

The statistics (Fig. 5 & 6) from activity logs indicate that all of participants prefer singing and dancing service most, with about 1000 times of interactions. The quiz, weather forecast, news reader, book reader and reminder are the next desired services. This implies that sensory enrichment service (singing & dancing) and cognitive support service (quiz) are most engaging the people with dementia at their home environment, thus should be installed in socially assistive robots to positively engage persons with dementia in the home environment.

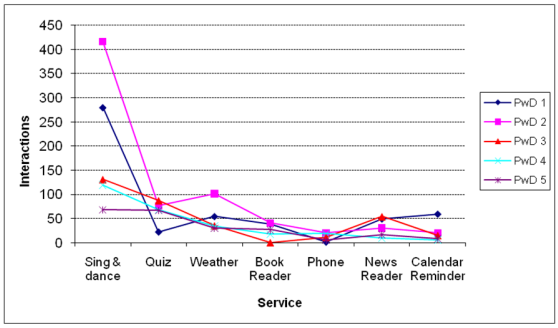

Figure 5. Pariticipants' interaction per service

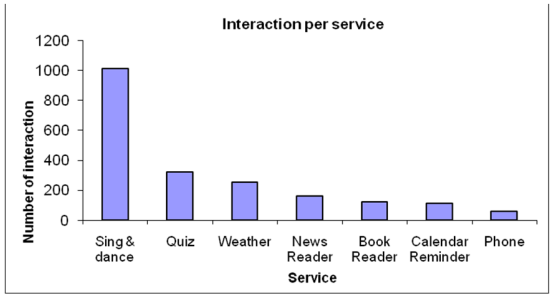

Figure 6. Service preference

4) Robot experience

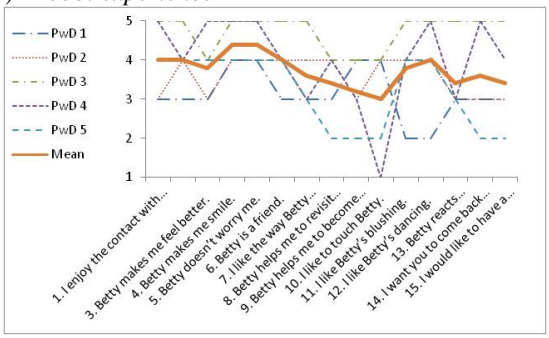

Figure 7. Quality of robot experience

The quality of robot experience survey has been conducted at the end of the trials using a standard five-point Likert scale (Strongly Disagree=1, Disagree=2, Neutral=3, Agree=4, Strongly Agree=5). Figure 7 shows the robot experience comparison amongst the participants and the mean. The figure shows that on average the responses are positive (above 3.0). This result validates that the socially assistive robots like Betty has break the technology barrier with the older people and provide positive engagement to their home living.

III. CONCLUSION

The personhood-oriented services in couple with service adaptation has been designed and implemented to give the socially assistive robot the ability of personalising it services to each individual in dynamic manner. The results consolidated from data analysis indicate that Lucy has successfully eliminated the barriers of use of technology by older people, positively engaged with the older people and shown potential to reduce caring burden to aged care in home-based environment.

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