Formative Work Analysis to Design Caregiver Robots

Keith S. Jones  
Department of Psychological Sciences  
Texas Tech University  
Lubbock, TX 79409-2051  
1-806-834-8745  
keith.s.jones@ttu.edu

Barbara Cherry  
School of Nursing  
TTU Health Sciences Center  
Lubbock, TX, 79430  
1-806-743-9209  
barbara.cherry@ttuhsc.edu

Mohan Sridharan  
Dept. of Electrical & Computer Eng.  
The University of Auckland  
Private Bag 92019, Auckland 1142 NZ  
+64-9-923-6514  
m.sridharan@auckland.ac.nz

ABSTRACT
This paper describes recent developments in a research project that seeks to explore and describe how caregiving robots should function by analyzing caregiving in elders’ homes, creating a detailed account of current elder care practices, and translating this account into design recommendations for caregiving robots.

Categories and Subject Descriptors
H.1.2 [Information Systems]: User/Machine Interfaces - Human Factors; I.2.9 [Artificial Intelligence]: Robotics – commercial robots and applications.

General Terms
Design, Human Factors.

Keywords
Elder, eldercare, caregiving, caregiver, caregiver robot, work analysis, formative analysis, context-conditioned variability

1. INTRODUCTION
Elders generally prefer to live independently [4], i.e., “age in place”, and report better health and quality of life when they do so [6]. However, to age in place, elders often depend on caregivers [10], and they are in short supply [8]. To address that shortfall, one option is to develop caregiver robots [2, 3, 10]. Elders are open to this possibility [1, 2, 14], especially if it allows them to regain their independence [1].

2. CAREGIVER ROBOTS AS PRODUCTS
To design caregiver robots, many have conceptualized them as consumer products and studied elders’ perceived needs for and preferences about such products. For reviews of that literature, please see [2, 5]. The following provides an illustrative example. Scopelliti, Giuliani, and Fornara [13] conducted a survey and reported that elders conceptualized robots as small and slow-moving task executors with serious demeanors; preferred to communicate with robots via short orders, and that robots do only what they are told. Furthermore, the authors argued, “... [their results] seem to be a good starting point to identify some basic acceptability requirements, which would provide robot designers and producers with useful guidelines for future innovation.” (p. 154). Thus, the authors argued that robots should be designed to align with consumers’ preferences. Such an approach, though, may overlook important aspects of caregiving. For example, robots that are small, move slowly, and do only what they are told would be inappropriate for elders who require mobility assistance (the robots would not be able to provide physical assistance) and live alone (the robots would not be able to initiate an emergency response if an elder lost consciousness). This example suggests that caregiver robots should not be designed to only reflect consumers’ generic preferences because those preferences can be at odds with elders’ caregiving needs.

3. CAREGIVER ROBOTS AS WORKERS
Alternatively, one can conceptualize caregiver robots as workers in complex socio-technical systems. Such systems are comprised of many people, technologies, and environments that interact to produce work (in this case, caregiving). Workers in such systems coordinate, have diverse backgrounds (e.g., helpful neighbors and elders’ physicians will likely have different backgrounds), may not be collocated (e.g., caregivers have to coordinate with medical personnel who are not present in the elder’s home), and interact with technologies that automate work (e.g., a device that measures blood pressure). Information in such systems is imperfect (e.g., unclear communication during shift changes), and frequently filters through technology (e.g., measuring temperature via an ear thermometer). Work in such systems changes over time (e.g., as elders’ needs change), involves unexpected events (e.g., a fall), and has serious consequences if not done correctly [15]. As a result of these qualities, workers must perform different sets of actions to accomplish the same goal depending on the current state of the system, which has been referred to as “context-conditioned variability” [15]. For example, when elders are recovering from an injury, caregivers may schedule elders’ doctor appointments on a single day in order to reduce the required amount of walking; however, once elders have recovered, caregivers might schedule elders’ doctor appointments on different days to increase social interaction.

Individual elements of a complex socio-technical system cannot be understood in isolation; rather they must be understood in relation to one another [15]. To conceptualize caregiver robots as workers in a complex socio-technical system, one would thus need a detailed account of the caregiving that takes place in elders’ homes. That is, one would need to thoroughly understand what caregivers do in elders’ homes, including how what they do is influenced by various elements of the complex caregiving system. Unfortunately, such an account does not exist. The literature indicates that caregivers assist elders with self-maintenance activities of daily life (ADLs), such as eating, toileting, and dressing [7], instrumental activities of daily life (IADLs), such as cooking, cleaning, and shopping [7], and enhanced activities of daily life (EADLs), such as participating in...
social activities and pursuing hobbies [12]. The literature also indicates that caregivers assist elders with tasks related to elders’ medical conditions, such as dressing wounds, operating medical equipment, administering medications, and attending medical appointments [10]. However, the existing literature does not provide detailed information about these tasks, which was noted in a National Research Council report [10], or about how these tasks are affected by other elements of the complex socio-technical caregiving system.

4. ANALYZING CAREGIVING

There are many ways to analyze work (for a discussion of general approaches, see [15]). They can be categorized into 3 general types: normative, descriptive, and formative approaches [15]. Normative approaches describe how work should be performed, e.g., this type of analysis would produce a single set of step-by-step procedures to accomplish a given caregiving task. Descriptive approaches explain how work is actually performed, e.g., this type of analysis would provide detailed information about how workers currently accomplish a given caregiving task. Formative approaches detail the requirements that must be met in order to accomplish work: they do so by identifying behavior-shaping constraints, e.g., this type of analysis would identify constraints, such as “must not lose track of time” or “must not do something for elders that they could do for themselves”, that must be met to accomplish a given caregiving task. Normative and descriptive approaches are not adequate for the analysis of complex socio-technical caregiving systems because they do not account for context-conditioned variability [15]. The former’s prescriptions specify a single “best” way to perform a task, so they ignore context-conditioned variability. The latter’s descriptions provide a snapshot about how workers accomplish their tasks while the system is in a given state, but cannot speak to how workers might accomplish their tasks when the system is in other states. In contrast, formative approaches are tailored to the analysis of complex socio-technical systems [15]. By identifying behavior-shaping constraints, formative approaches capture work requirements without specifying exactly how that work must be done or who must do it. For example, the constraint “must not lose track of time” captures a work requirement but allows for the associated work to be accomplished in a number of different ways (e.g., by checking a clock, setting an alarm) and by a number of different entities (e.g., family member, caregiver robot).

5. PRESENT RESEARCH

The present effort employs formative work analyses to capture how people care for elders in home settings. Researchers are observing actual caregiving in elders’ homes, and interviewing caregivers about their efforts. The results of that data collection will be leveraged to create detailed characterizations of elder care in home settings, including an Abstraction-Decomposition Space (from Work Domain Analysis [11], a Contextual Activity Diagram [9], Input-Output Diagrams [15], and Decision Ladders [15]. The ultimate goal is to translate those detailed characterizations of caregiving into design recommendations for caregiver robots. We will describe the project’s progress and preliminary findings at the conference, and solicit feedback from conference attendees.

6. ACKNOWLEDGMENTS

This research was supported in part by the U.S. National Science Foundation (Award #: 1452460). Opinions, findings, and conclusions are those of the authors and do not necessarily reflect the views of the NSF.

7. REFERENCES


