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Considering Health and Family Dynamics: How is Home Temperature Decided?

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The primary position of this research is to delineate design considerations for building a home energy management system that understands the dynamic nature of household structures; a system that can interact with situational variants and assist in temperature decision making, relieving user of added stressors during times of familial changes. This research discusses implications for building a home energy management system that considers household structures: changing needs when faced with a new heath situation or simply when life changes established routines. Home energy systems should be built to assist in decision making including how to set home temperature in order to maximize personal comfort and alleviate stress.

Guides; instructions; design kit; Energy; HCI; Context; Design; Consumption; decision support

1. INTRODUCTION

Navigating relationships between household members is convoluted at best. A health event like a diagnosis of cancer or the onset of menopause increases the desire to improve individual comfort levels, which compounds the situation. The result is a never-ending attempt at compromise: compromise between people in the home as well as their pets, their plants, their desire to save money or even save the planet. All of these factors impact the decision making process in setting home temperature.

The primary goal for this work is to discover design aspects of a novel, perceptive interface for interaction with home energy, in particular the home's HVAC (heating, ventilation, and air conditioning) system. In turn, this will inform their choices in consideration of the varying nature of household dynamics, particularly when one occupant is faced with a significant health event.

2. RELATED WORK

This work builds upon previous research on collecting contextual data for home energy management and usability studies related to home energy consumption.

Home energy consumption and decision making spans a large breath of research areas both within and without the HCI arena, including information systems, sustainability, security, pervasive computing, behavior studies, design, psychology, and healthcare. This work will focus on a subset of these topics, including consideration and design for all home occupants, health and well being, individual comfort, and security.

There is a large body of research in the sensor community that focuses on augmenting energy consumption or smart meter data with contextual data (Froehlich, 2009; Kulkarni, Welch and Harnett, 2011). This data can help in building better predictive models of energy usage and better demand response systems. Collecting this data requires deploying sensors such as temperature, motion, light, and humidity (Pierce and Paulos, 2011; 2012), and inferring user activities such as cooking or work (Costanza, Ramchurn and Jennings, 2012).

Unfortunately, the approach taken in the sensor community is to first collect data from varied sensor modalities, and post-priori analyze the data to find ties between energy usage and the underlying context. However, this information doesn't augment the decision making process without a proper understanding of the factors that affect home energy consumption. This is because there are several factors such as social structure, family hierarchy, income, and health status (Fréjus and Guibourdenche, 2012; Lu, et al., 2010; Pierce, Schiano and Paulos, 2010; Sloo, et al., 2014) in

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addition to known factors like household activity and occupancy that affect home energy consumption.

Our approach to the problem is to use interviews to first understand the underlying causes of energy consumption in the home and then use these insights to build a prototype perceptive user-driven home energy management system.

2.1 Understanding household context

An initial interview-based study was conducted with 22 households in Baltimore City, Maryland, across a wide range of income groups, occupant types (age, number of home occupants, and occupation), and house types (rentals and user-owned). Using a semi-structured interviewing process, several novel insights emerged regarding home energy consumption (Irwin, et al., 2015). In addition to household dynamics, familial hierarchy, routine behaviors and individual habits, we found that non-human occupants, such as pets, significantly influence home energy consumption and decision-making.

2.2 Understanding energy use perceptions

Our initial interview participants stated that pets play a big part in their energy decisions. Currently, no system takes into account that the family pet is still at home when others are out or how many times the dog door is being used.

Additionally, existing or changing health plays a factor in climate comfort levels. Chemotherapy, for instance, has varying side effects (Kulkarni, Welch and Harnett, 2011) that include changing perception of hot and cold temperatures. Similarly, menopausal side effects such as chills and hot flashes change an individual's desire to control the home's temperature settings. Thus, the impact on household dynamics regarding home energy could be significant. Studying households during these events can assist in building a system that not only knows when the occupants are home, but when they are experiencing a fluctuation in temperature perception. Such a system could inform and assist in everyday decision making, thus removing the stress of constant compromise which compounds dealing with the stress of the individual health event (Li, et al., 2015).

To understand how health events impact home energy decision making, we conducted interviews and surveyed households across the United States. Participants included four households who have family members receiving chemotherapy and 22 with family members experiencing menopausal side effects.

To date, it has been difficult recruiting chemotherapy patients. However, of the four interviewed, 100 per cent indicated that receiving chemo affected how they sense hot and cold temperatures. One caretaker stated:

> He tells me it is too cold in the house even when it seems ok or even warm so I sometimes have to turn up the heat on the thermostat when I otherwise would not (Participant C4).

Correspondingly, 100 per cent of the participants going through menopause indicated their symptoms affect how they sense both hot and cold temperatures.

> I get hot more often. I rarely turn the heat on. I use the air conditioning in the winter. I stick my head in the freezer sometimes (Participant M5).

> Some days I have hot flashes, and some days I have chills, I try to adjust the temperatures in my house so I can avoid these symptoms (Participant M9).

Participants discussed the difficulty in setting a home temperature that is comfortable for everyone in the house. When one person is having to deal with a health event, concern for those surrounding them is significant (Pierce and Paulos, 2012), adding to the stress of the situation. Study participants indicated that changing the home's temperature is a constant discussion.

> I noticed that it wasn't normally as cold as he would have put it. Like last night I was cold and he was hot. Instead of putting it down to 65, he put it down to 68. (Participant C1).

3. DECISION MAKING

People do not want a complicated interface for their HEMS. Often they want to 'set it and forget it' and be able to rely on their system to make the best choices based on the current household dynamic.

A system that has started to address these issues is the Nest thermostat. However, it doesn't as yet do an effective job at learning within a multi-occupant home (Yang and Newman, 2013). Even working with a programmed schedule, the dynamic nature of households warrants an interface that can perceptively assist with decision making. Leveraging naturalistic decision making (NDM) and visual feedback would benefit system design.

Visual feedback helps users understand their energy consumption (Jorge, et al., 2015) which is a good start to developing a system that users are willing to engage with, but the needed component is the system's understanding of the complexity of the family. Incorporating NDM in the design takes into consideration the work being done in health information technology (Cristancho, et al., 2013; Patel, Kaufman and Kannampallil, 2013). and could be used to design a system that would be informed when a family member has received chemo, for example. Weighing the needs of this person in relation to other personal preferences and schedules, the system would decide on an optimal home temperature for all household members.

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