DogPulse: Augmenting the Coordination of Dog Walking through an Ambient Awareness System at Home

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ABSTRACT

This paper presents DogPulse, an ambient awareness system to support the coordination of dog walking among family members at home. DogPulse augments a dog collar and leash set to activate an ambient shape-changing lamp and visualize the last time the dog was taken for a walk. The lamp gradually changes its form and pulsates its lights in order to keep the family members aware of the dog walking activity. We report the iterative prototyping of DogPulse, its implementation and its preliminary evaluation. Based on our initial findings, we present the limitations and lessons learned as well as high-light recommendations for future work.

Author Keywords

Dog Walking; Coordination; Augmented Artifacts; Ambient Awareness; Peripheral Awareness; Shape-changing interface

ACM Classification Keywords

H.5.m. Information Interfaces and Presentation (e.g. HCI): Miscellaneous

INTRODUCTION

Supporting the coordination and negotiation of household activities is challenging, since much of this work is invisible [15] and requires extensive planning [12] and communication [8] among family members. However, household task coordination centered around pets has received little attention in previous work [12, 8, 15]. Unlike the members of a family, the family pet is not able to express itself verbally and may therefore be forgotten, neglected or its needs put on hold.

To investigate the household tasks and cooperative work centered around family pets, we initially interviewed a household consisting of a mother, two children (17 and 21 years) and their dog (Fido). Even though the family members had a high degree of awareness of each other's whereabouts and activities during the day, we found that the family often do not perform an explicit coordination of who takes Fido for a walk or when. This lack of coordination occasionally lead to

mishaps, e.g., forgetting to take Fido for a walk, because a family member assumed that someone else already did it.

Inspired by this initial investigation and considering our personal experience with caretaking of dogs, we decided to further investigate how to improve the coordination of dog walking, so family members could avoid mishaps that could result in negligence or detrimental effect to the health of the family dog(s). To address this problem, we have iteratively designed and implemented DogPulse as a proof of concept to explore how technology could support family members to become aware of their pet's needs without having to explicitly coordinate caretaking tasks with each other. DogPulse enables family members to continue with their primary tasks while also making them aware of their dog's needs, relieving the family members of some coordination work and reducing their cognitive load.

In the following, we present the related work, our design iterations with DogPulse as well as its preliminary evaluation followed by a discussion on lessons learned and future work.

RELATED WORK

More than fifteen years ago, Weiser proposed the idea of transparent and seamlessly integrated technologies that could “*empower our periphery*” of attention with the notion of *Calm technology* [16]. Taking this notion into account, Pousman and Stasko define peripheral technologies as “ambient information systems” (AIS) that: a) display information that is important but not critical, b) can move back and forth from the periphery to the focus of attention, c) focus on tangible representations in the environment, d) provide subtle changes to reflect updates in information, and e) are aesthetically pleasing and environmentally appropriate [14, p.68].

Furthermore, Bakker et al. provide an understanding of human attention abilities based on fundamental attention theories to investigate how information technology can fit into people's everyday life — in particular, how to design for the periphery [1]. In this regard, Park et al. suggest that peripheral interaction can be represented through “*dynamic changes in light, sound, form, or color in physical space*” [13, p. 3718], which users can be aware of without being attentive to them. In addition, Hervás et al. propose several “awareness marks” [6] to link contextual information with augmented objects in order to explore how technology can support everyday activities in an implicit way. Similarly, several awareness systems have been implemented to enable individuals to become aware of each other's daily activities with a special

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Figure 1. (a) The augmented dog leash attached to the collar; (b) the ceiling lamp in both relaxed and tensioned state; (c and d) preliminary evaluation

focus on supporting family coordination and communication [15, 2, 8]. For example, Khan et al. state that awareness systems can provide support for availability, reassurance and affection among the family members through the use of implicit inputs that enable information exchange without much effort [9, p. 542]. Although these technologies have focused on supporting family coordination and planning of household tasks, the caretaking of pets have received little attention.

Based on the notions of AIS and awareness systems, we explore how ambient awareness systems [14] can support the caretaking of household pets, making family members *peripherally aware* of each other's activities in a more transparent way, to ease the integration into people's everyday life.

DOGPULSE: CONCEPT AND ITERATIVE DESIGN

DogPulse is proposed as a non-invasive (in both family life and the home) system that could support the coordination of caretaking of household pets. Based on our initial interview (see above) and our own personal experiences (serving as initial personal observations), DogPulse initially focuses on supporting a specific household caretaking task – walking the family dog. A proof of concept was designed to peripherally inform the family members about the family dog's needs by creating and augmenting everyday objects, i.e., a dog collar, leash and a lamp. In particular, the lamp was purposefully selected due to its inherent utility and decorative features to explore how it could enable the introduction of AIS and awareness systems in a complex setting such as the home.

Based on the related work [14, 13] and our early insights, we define the following list of initial requirements:

- **Peripheral feedback:** Inform the current status of the walking activity,
- **Visual and tangible representation:** Provide dynamic changes in light and form,
- **Move back and forth from the Periphery to the centre of attention,** and
- **Aesthetically pleasing:** Easily integration into the family home and routines.

After purposefully selecting the lamp and having in mind the aforementioned requirements, we iteratively started our physical prototyping process making use of early low fidelity prototypes (paper-based mockups) and high fidelity physical prototypes, to explore how a lamp could inform about the last time the dog was taken for a walk, without explicitly notifying or alerting the family members. As a result, the current DogPulse lamp is designed to gradually change its form from

relaxed to a tensioned state. This shape changing feature is intended to keep the family members peripherally aware of the dog walking activity when passing by (hence, the name DogPulse). Furthermore, DogPulse supports three awareness levels. The first level (and lowest awareness level) is right after taking the dog for a walk. At this point the lamp is in expanded form and displays a continuous light to represent a relaxed state. In contrast, at the second level, when the dog is increasingly in need of a walk, the lamp is gradually tensioned, to illustrate the progressive tension of the dog situation. At the third level, the lamp is fully tensioned and the lights pulsate to communicate the distress of the dog.

We envisioned a set of use cases during our design explorations. The following scenario illustrates the use of DogPulse: “*Maria arrives home at 3pm. Fido eagerly greets her while wagging its tail. Maria knows that her brother usually walks Fido at 1pm, so she plans the next walk at 5pm. Shortly after entering the living room, Maria notices the lamp, because it is fully tensioned and pulsating its lights. Suddenly, she remembers that her brother is at the dentist, thus he could not have walked Fido. She takes Fido for a walk as it has not been out for several hours*”.

System Description

DogPulse consists of three physical computing modules: the dog collar, the leash, and the lamp. Here, we describe the implementation of DogPulse and our technical decisions.

The Dog collar

The dog collar module (see Figure 1a) is based on a common dog collar, easily found at a pet store. We decided to augment the dog collar to take advantage of its intrinsic features (e.g., durability, appearance, etc.), and thereby avoid security hazards (e.g., harmful sewing patterns). Neodymium magnets were chosen to augment the collar to produce a strong magnetic field, needed to activate the reed switch located in the leash (see next Section). To avoid burdening the dog with a heavy collar, magnets is the only added part, the rest of electronic components are attached to the leash.

The Dog leash

Similarly to the dog collar, the leash module (see Figure 1a) is based on a common dog leash, augmented with different sensors inside a container (an outdoor cord protector) that can be easily attached or detached. The container has a custom PCB inside with a reed switch, an ATmega8 microcontroller, an EasyRadio transmitter and a 5V voltage regulator for adjusting the internal power supply provided by a 9V battery. The reed switch (a magnetic field sensor) is used to detect

the close proximity between the leash and the collar. This switch was also chosen due to its low-cost and power efficient properties in comparison to other alternatives (e.g., RFID). Furthermore, the circuit inside the container is only consuming power when the reed switch is placed within the range of the magnets, located on the collar. This strategy not only increases the battery life but also reduces the complexity of the software and electronics. For wireless communication, we selected EasyRadio because it provides sufficient signal range (up to 250 metres line of sight) within the household.

The Ceiling Lamp

Rather than augmenting a table lamp, and use a linear actuator, a ceiling lamp with a servo were chosen to extend the actuation range, thus taking advantage of gravity. We embed a custom PCB within the top part of the lamp that contains: an ATmega8 microcontroller, an EasyRadio receiver, a continuous bi-directional servo, and a 5V voltage regulator. Furthermore, 16 wide-angle white LEDs are attached (following a circular pattern) underneath the PCB. Regarding the shape of the lamp, several basic forms were tried out (e.g., a cylinder) but ultimately fell out of favor, because the form language it conveyed was less nuanced when actuated. The relaxed state of the lamp is inspired by the shape of a water droplet and materialized in a variety of different cardboard materials and plastic sheets (see Figure 1b), but is envisioned as being built entirely in plastic and steel.

When powered, the lamp lights up starting from the last walking time and gradually hoists itself to a tensioned shape by rolling a fish line (attached to the bottom of the lamp) onto the servo wheel, until the desired time for next walk. When reaching the outmost tensioned form, i.e., the desired timeframe is surpassed, the lights start pulsating slowly. Upon receiving a signal from the EasyRadio transmitter on the leash, the lamp drops back into an relaxed position and the LEDs illuminate continuously once again (hereby resetting the lamp). In particular, these different shapes and transitions of the lamp use traits from organic design [4] styles in order to underlie a metaphor of a symbiosis between the dog and the lamp. The current actuation time of the lamp is set to about 30 seconds for each direction. Such fast actuation time is not intended for real usage, but only for communicating ideas and get early feedback. In a real use case scenario the actuation time between walks is adjustable (e.g., hours scale).

PRELIMINARY EVALUATION

We performed a concept validation through a focus group [3] in a home setting to get early feedback, not only regarding the DogPulse-designed features, (e.g., changes in shape, movement and light) but also to uncover user's needs, challenges and opportunities in the real setting (see Figure 1c and d). More specific, we visited a couple living with their two teenage sons and their family dog Babushka. The mother happened to be a veterinarian who worked with dogs for more than 25 years. The participants were initially briefed on the main objectives of DogPulse and its features to aid pet care among family members. Next, we explained how to use DogPulse with her dog and she tried it out (e.g., putting the collar on the dog – see Figure 1c). DogPulse was used as a “trigger”

[11] to facilitate the communication of ideas, raise questions and support discussion among the participants. After the participants tried out the system, a small follow-up interview was conducted. The most relevant themes were identified through an affinity diagram and are presented in next section.

FINDINGS

The Aesthetics Properties of the Lamp

Overall the participants expressed that they could see the value of DogPulse and they understood all levels of awareness provided by the lamp. In particular, the participants stated that they found the lamp suitable for their home, as *“it looks like a modern cool lamp”*. Participants emphasized that the lamp had the *“looks of a Scandinavian design lamp”*, mainly due to its shape, material and neutral color. In addition, the dimensions of the lamp were positively received as the participants recognized that the lamp had to be large enough to be noticed, but not too large, making it less obtrusive in the home decoration. Regarding the placement, participants agreed that the lamp should be placed somewhere central in the house, where all family members spend time during the day. In particular, the mother suggested that it could ideally be placed over the dog basket in the living room (see Figure 1 d).

Ambient Awareness of the Dog Walking Activity

Regarding the designed features, participants stated that they liked the pulsating lights from the lamp and they perceived them as distinctive but not obtrusive. When participants were asked if the lamp should pulsate in another color (e.g., red) they objected and stated that *“it would look like a heating lamp”*. Similarly, the shape-changing property of the lamp was perceived as non-obtrusive, but still noticeable enough for creating awareness. In particular, the mother suggested that the shape-changing lamp would be particularly useful for a family with young children, as it could serve as *“a quick way to reveal if somebody had forgotten or neglected to walk the dog”* as she would often text her son to ask whether or not he had walked the dog. Furthermore, participants commented that other alternatives such as sound or blinking lights for notification could eventually lead to irritation and frustration.

Beyond the Dog Walking Activity

Participants commented that DogPulse could be seen as a way to mediate the communication between the dog and the family members beyond the walking activity. For instance, the mother pointed out to another relevant coordination task that concerns the family dog: *“the lamp could also be used for the medication of the dog. For example, old dogs with diabetes or arthritis”*.

Technical Challenges

The main problems we identified with the prototype were concerned with hardware. Participants commented negatively on the noise from the servo during the actuation of the lamp. They also pointed out that the electronic container on the leash should be smaller, as the mother was worried that it could hit the dog. The reed switch was found to be quite limiting, as it only worked within a 2 cm range. Furthermore, a more rugged implementation of the reed switch should be considered as it was damaged during the evaluation.

DISCUSSION AND CONCLUSION

The main contributions of this paper are the DogPulse proof of concept, the participants' insights and the lessons learned from our iterative process. Overall, participants found DogPulse intuitive in supporting the coordination of dog walking. In particular, the aesthetics of the lamp played an important role as the use of organic design styles [4] proved to be useful for designing objects that could easily fit in people's homes. The dynamic changes provided by DogPulse (in lights and shape) were well perceived as non-obtrusive, in comparison with sound. In particular, the peripheral feedback, provided by the shape-changing lamp, could work as a change blind interface [7] while making the transitions very slowly over time from the tensioned form to the fully relaxed form.

Moreover, participants discussed how DogPulse could offer opportunities not only to support household tasks by making visible [15] whether the dog was walked, but also promoting the redistribution of tasks facilitated by the embedded knowledge in the lamp (what Latour [10] has termed as delegation). For instance, delegating such notification to the lamp about the status of the dog walking activity could remove the overhead of texting family members to coordinate this task. In addition, DogPulse renders the dog's needs in a more visible and tangible way, making the family aware, while augmenting everyday objects. In fact, participants also stated that DogPulse could be used for supporting the coordination of other caretaking activities related to the dog (e.g., medication intake).

In addition, the preliminary evaluation provided insights regarding certain technical aspects of DogPulse that can be modified to improve the user experience with the prototype. For example, the placement of the electronic container on the dog leash and the choice of the magnetic field sensor have to be reconsidered. One possible solution could be moving the container to the handle instead, to register grip rather than proximity. We also plan to add a distance sensor (e.g., IR or ultrasonic) to the next iteration of the lamp to overcome calibration issues regarding the actuation of the lamp. In addition, we will look at different isolating materials to look for a solution to encapsulate the servo's noise.

Although our preliminary evaluation looked at the qualities of the design and the system modalities, future work should also explore different shapes of the lamp to account for the individual differences among family's homes. A long-term evaluation is planned to look at the broader context and everyday practices to investigate how the lamp could be integrated into the home and support the coordination of dog walking on daily basis (e.g., more than 4 weeks [5, p. 2976]).

Our initial findings provide early insights in this area but are far from complete. We encourage the AH community to continue exploring how augmenting everyday objects with ambient awareness features could support the coordination of pet's caretaking among family members at home and beyond.

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