



Dogs Need Friends Too: Unleashing the Potential of Dog Wearables in Enhancing Canine Social Well-Being

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ABSTRACT

Dog wearables have demonstrated promising potential in enriching human-pet interactions and facilitating healthier caregiving. However, one area that did not receive adequate attention is the tracking and support of dogs' social well-being through wearables. In this paper, we introduce PuppyFriends, an innovative platform designed to provide owners with insightful information on their dogs' social activities with other dogs. We report preliminary findings from interviews, featuring data collection and visualization, highlighting the potential effects of PuppyFriends on enhancing the social well-being of dogs. By shifting the focus from solely monitoring physical health to including social well-being, our work opens up new possibilities for improving the overall quality of life for dogs and nurturing more fulfilling human-pet relationships.

CCS CONCEPTS

• Human-centered computing; • Interaction design; Interaction design process and methods; User interface design;

KEYWORDS

Dogs, Social well-being, Wearables, Animal welfare

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1 INTRODUCTION

Existing scientific evidence has suggested that socialization has a direct and significant impact on dogs' health and well-being [22]. Regular dog-to-dog contact ensures that dogs could develop appropriate manners and become well-suited to modern society [8]. It also serves as opportunities to stimulate social interactions among owners and facilitate healthier lifestyles for both [4].

With the rapid development of pervasive computing and sensor technology, dog wearables have been extensively explored [18, 21]. Wearable computing enables owners to track and understand their

dogs' activities in a ubiquitous manner, thus providing suitable caregiving. However, prior work in this area puts particular emphasis on dogs' physical health [21], leaving social well-being broadly unexplored.

To navigate this research gap, we propose PuppyFriends, a platform capable of tracking and presenting information related to dogs' social activities, aimed at increasing owners' awareness, and facilitating healthier caregiving. In this paper, we describe the initial design of PuppyFriends and report the findings of a preliminary user study. Our work offers two contributions. Firstly, we unleash the power of dog wearables to enhance the social well-being of dogs. The data-driven visibility enables owners to reflect and tailor their caregiving approaches accordingly. Secondly, we provide qualitative insights into owner's perceptions regarding their dogs' social activities, and their preference for the visualizing their dogs' health conditions.

2 RELATED WORK

2.1 Socialization for dogs

Dogs are social beings [22]. A breadth of research has established close relationships between appropriate socialization, and dogs' cognitive and emotional development [12]. Social deprivation caused by the lack of dog-to-dog contact can cause severe behavior problems and emotional distress [20], which has been noticed within ACI [6, 19]. Many projects focused on developing remote computer-mediated systems which enabled owners to interact with home-alone dogs [5, 10]. For instance, Mankoff et al. deployed a remotely operated tennis-ball throwing device for pet owners and their dogs [14]. Recent efforts to improve the social welfare of pets have been focused on developing animal internet to prompt social interactions in remote settings [6, 7, 11]. For example, Douglas et al. created 6 scenarios of dog internet aiming at enhancing dog-to-dog interactions [6]. However, exploration in this area is still in its early stage, and few projects pay attention to utilizing the existing situation where owners walk their dogs to facilitate face-to-face social activities.

2.2 Dog monitoring with wearables

Due to the advancements of sensor technology, dog activity monitoring wearables have been studied extensively in ACI [9, 13]. Wearables can continuously track dogs' physiological data [2, 3] and identify specific activities (e.g., barking, running, chewing) [17], and represent these data to their owners in a meaningful way, thus improving their caregiving of dogs. For example, CompanionViz is a mediated platform designed to collect exercise and nutritional information of dogs and relay them to their owners in intuitive and

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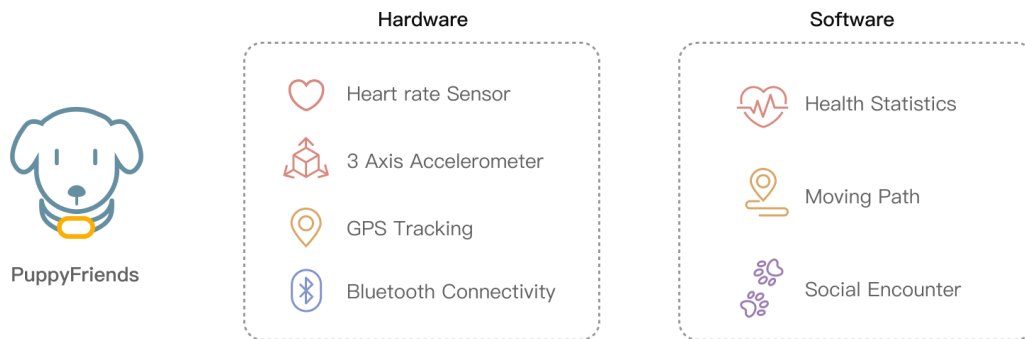


Figure 1: System design.

reflective ways, with the goal of promoting healthier lifestyles for both [16].

The majority of prior projects have revealed the potential of wearables in supporting dogs’ physical health [2, 9]. Yet, only a few projects have paid attention to how wearables could be leveraged to track dogs’ social activities and foster their social well-being. For instance, SNIF is a system that allows owners to interact through their dogs’ social networks, which supports tracking social networks and providing real-time feedback [4]. To the best of our knowledge, this leaves prominent research gaps in understanding how to collect and visualize information related to dogs’ social activities, and how this information influences human-pet relationships and encourages regular social practices.

To explore these questions, we propose PuppyFriends, a technological platform aimed at supporting dogs’ social well-being by increasing caregivers’ awareness and improving human caregiving. PuppyFriends enables owners to track their dogs’ social activities through wearables and presents information visualization through a mobile application.

3 PUPPYFRIENDS PROTOTYPE

In this section, we describe the components of PuppyFriends. First, we introduce the proposal of a hardware system capturing dogs’ social activities and other related information. We then present an interactive prototype that transforms and relays these data to caregivers in a meaningful way.

As shown in Figure 1, the hardware of PuppyFriends includes a mainboard, a heart rate sensor, a 3-axis accelerometer, a GPS tracking module, and a Bluetooth connectivity module. These modules are designed to integrate into a collar made of nylon and Velcro, which ensures convenience and comfort for dogs in different sizes. During the system initialization, we would proactively input the dogs’ information, including breed, age, and gender. Then, this information is transmitted to the Bluetooth connectivity module. When two dogs wearing the collar approach each other, the Bluetooth connections would automatically establish, initiating data exchange between the devices. The Received Signal Strength Indicator (RSSI) will be utilized to assess the distance between the dogs. A distance of less than 2 meters, persisting for a duration exceeding 2 minutes will be recognized as a social interaction event. Then the

dog’s information, position, heart rate, and physical activity level during social activities will be stored in the Bluetooth connectivity module and transmitted to owners’ smartphones for further visualization. Meanwhile, the GPS location and heart rate values will be sampled at intervals of 3 minutes, which ensures the accuracy of the information while minimizing battery consumption and data storage.

As shown in Figure 2, we present three representative interfaces. The first interface displays the monthly report, with the top section showing the current month’s calendar. The color of each day indicates the dog’s social condition, and the darker color represents longer social activities. In the middle, there is a “Friendship Leaderboard”, which presents the dog’s friends and related information within the month. The bottom section features a timeline displaying the social time. When the user clicks on a specific day on the calendar, the second interface will appear. The top section of this interface presents a map showing the dog’s outdoor path for the selected day. The colors of the path represent the active levels, calculated according to the heart rate and physical movement speed. Additionally, the avatars of other dogs with whom social interactions occurred are also displayed on the path. The bottom section presents a timeline of the dog’s social interactions and heart rates throughout the day. Clicking on any dog’s avatar, users can get the third interface, which presents relevant data about the selected social activities.

4 THE STUDY

To evaluate the platform and elicit initial feedback, we conducted a preliminary user study with 12 participants aged between 20 and 48. All participants currently own, or have owned in the past, at least one dog. Firstly, we introduced the background of our study and gave an explanation about the concept of PuppyFriends and the mechanism of the hardware and software system. Then, we let all participants use the interactive prototype to experience main user interfaces. Finally, all the participants were invited to participate in a semi-structured interview to talk about (i) what data related to dogs’ social activities are meaningful for owners, (ii) their preference for the visualization of dogs’ social data, (iii) how PuppyFriends would increase their awareness of dogs’ social well-being and affect their caregiving, and (iv) owners’ desires for

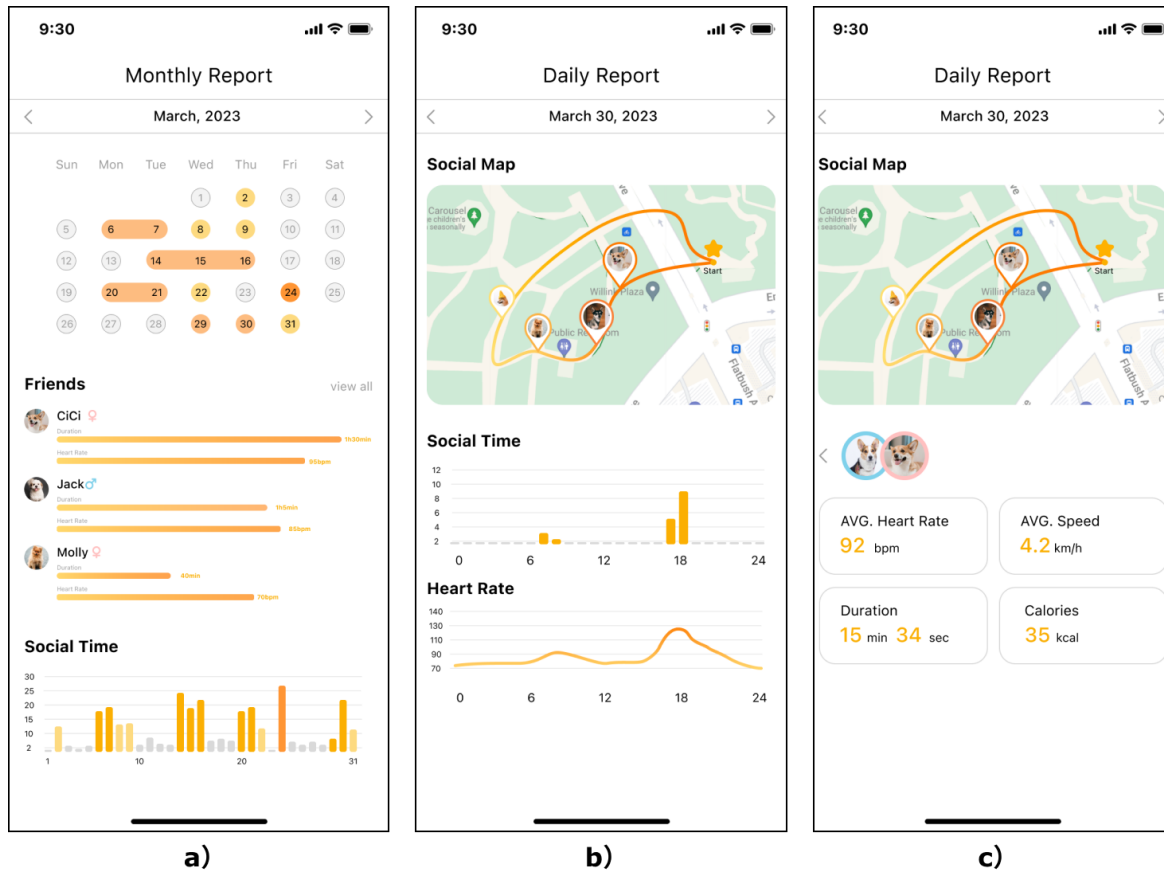


Figure 2: Main user interfaces of PuppyFriends APP: (a) the monthly report providing the overview of social interactions through a calendar, friendship leaderboard and timeline, (b) the daily report presenting the outdoor path, social time, and heart rate within the day (c) detailed information in one social activities.

dogs' social well-being. All the interviews were audio recorded and transcribed. Then, we analyzed the data using thematic analysis [1] to address the above questions.

5 FINDINGS

The results of the interview revealed a high acceptance of using wearables for tracking dogs' social activities and related information. A majority of participants thought regular dog-to-dog socialization was meaningful and essential according to their experience and habits. For example, *"My dog was always physically inactive. But with other dogs' company, it would be so exuberant in their play."*(P02) *"My dog is friendly, and it indeed has its own dog friends. And I would plan my schedule and walking routine to let it encounter its friends as much as possible."*(P04)

Regarding the information collected and inferred by PuppyFriends, most participants had positive attitudes. They indicated that these data could be effective in presenting a relatively thorough overview of dogs' social dynamics. On the flip side, they thought the information about dogs' identity should be further complemented. In addition to dogs' breed, age, and gender, they thought that the personality of dogs during social interaction showed the

largest effect on whether they were social matching. Participants showed great interest in knowing about the personality of their own dogs and their friends so as to find more "like-minded" friends for their dogs. Additionally, the current system could only collect information on the dogs that are social matching. Participants also suggested we add a function that can help them to record incompatible dogs and remind them in a secret way when encountering them again to prevent any potential risk. For example, *"My dog is diffident and reserved. So, some aggressive and extrovert dogs may be not compatible with his play style."*(P02) Participants indicated that the heart rate and physical movement speed could only provide owners with limited information and insights towards dogs' social activities. So they also proposed recognizing the barking and growl sounds and adding owners' subjective input to provide complementary descriptions of each social activity.

Participants indicated that the information related to dogs' social activities is easy to access through the on-screen visualization. However, human-dog bonding is subtle and emotional. The existing visualization in PuppyFriends, which presented quantitative numbers and graphs, could only offer a limited and rational view on the dogs' social well-being, and would hardly appeal to the owners.

Interestingly, inspired by the memes, some participants suggested using qualitative visualizations, e.g., avatars, to inform owners of their dogs' social conditions. For example, *"When I do not provide my dog with adequate social activities recently, a lonely and upset dog in the rainy weather will appear on my screen."* (P09) Compared with the on-screen visualization, participants also highlighted the importance and potential of tangible feedback. For instance, *"There could be a light or screen on the wearables, and the green light or the happy emoji would represent having reached standards."* (P05) Tangible interactions are always-on and enable users to interact with the data and reflect spontaneously.

Some participants indicated that PuppyFriends could engage them in critical thinking about their caregiving and daily routines. For example, *"I have never paid attention to dog-to-dog interactions before because I assumed that my company is just enough. But it was obviously wrong when I noticed that it was aggressive and nervous in the presence of other dogs."* (P11) Out of curiosity and responsibility, participants also anticipated gaining deeper insights into dogs' social dynamics, so as to set walking routes and schedules in tune with dogs' needs. For example, *"I would be able to understand when and where I could meet with more dogs and make my dog happy and physically active."* (P06) Furthermore, some participants also mentioned the potential of PuppyFriends to facilitate a solid social network and make a lasting effect. For instance, *"I could interact with other dog owners through my dog's networking. To ensure adequate social activities for our dogs, we could arrange to meet up and walk dogs together."* (P07)

6 DISCUSSION & CONCLUSION

In this paper, we introduce PuppyFriends, a wearable system designed to monitor dogs' social activities and provide owners with insightful information to increase their awareness and facilitate healthier caregiving. The user study revealed the high acceptance of leveraging wearables to assist in nurturing well-socialized dogs. Our results also enlighten a few directions that could be considered carefully in the future, which are summarized as follows.

Prior work have underscored the importance of pet wearables to give animals a 'digital voice' to speak about their needs and promote their physical health [18]. Such advancements have laid the groundwork for understanding the direct benefits of technology-mediated solutions in improving animal welfare. In our research, we build upon this foundation by integrating the concept of social well-being. By providing owners with information about their dogs' social activities, pet owners would possibly increase physical activity, adjust their schedule and enhance their social network. Compared with the tools, approaches, and applications developed directly to enrich the social activities of dogs, we focus on leveraging human-pet bonds to arouse reflection and facilitate positive changes among owners.

Our work also adds evidence to the research of assessing dogs' personality. Previous work focused on developing robust methods to predict dog personality through collecting dog's individual activities and proposed the possible practical applications for dog socializing [15]. According to owners' experiences and subjective feelings, our findings not only echo the results in previous studies

but also highlight the influence of dog personality in shaping inter-dog interactions. Building on this, future personality assessment systems can integrate behavioral metrics derived from dog-to-dog interactions. By examining dogs' responses in social settings, we can obtain a comprehensive understanding of their social temperaments. Such data-driven insights can be instrumental in creating a multi-dimensional profile of a dog's personality, encompassing not just its inherent traits but also its adaptability and responses in varied social environments. Furthermore, the potential applications of this enriched understanding are vast. For instance, leveraging this comprehensive profiling, platforms could be developed to match dogs with compatible "friends" based on their social personalities. This would not only foster positive interactions but also avoid potential conflicts arising from incompatible temperament pairings.

Previous work showed that providing pet owners with quantifiable awareness of their dogs' health could be effective in strengthening human-pet bonds and facilitating healthier lifestyles [16]. Our results also corroborate these findings in the literature. Furthermore, we suggested exploring more vivid and appealing visualizations to represent dogs' health conditions, thus engaging users to quickly gain insights in an intuitive and pleasurable way.

7 LIMITATION & FUTURE WORK

Our study is still in the early stages. Our preliminary user study was conducted within a limited scope and demographic. The findings may not be representative of all dog owners or different cultural contexts. For future work, we firstly plan to iterate our design concept according to the insights from the interview. Then, we plan to implement the functional prototype and conduct a field study in a community to identify the actual effects in real contexts.

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