Towards Interactive Virtual Dogs as a Pervasive Social Companion in Augmented Reality

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Abstract

Pets and animal-assisted intervention sessions have shown to be beneficial for humans' mental, social, and physical health. However, for specific populations, factors such as hygiene restrictions, allergies, and care and resource limitations reduce interaction opportunities. In parallel, understanding the capabilities of animals' technological representations, such as robotic and digital forms, have received considerable attention and has fueled the utilization of many of these technological representations. Additionally, recent advances in augmented reality technology have allowed for the realization of virtual animals with flexible appearances and behaviors to exist in the real world. In this demo, we present a companion virtual dog in augmented reality that aims to facilitate a range of interactions with populations, such as children and older adults. We discuss the potential benefits and limitations of such a companion and propose future use cases and research directions.

CCS Concepts
• Human-centered computing → Mixed / augmented reality;

1. Introduction

Positive influence of interactions with animals on humans' health have been extensively researched taking into account various factors, such as the nature of human-animal relationship (e.g., pets and animal-assisted intervention) and human population profiles (e.g., older adults and children) [BUMJK12, Wel09]. For instance, Wells identified that both physical interaction with companion animals and their mere presence can have positive physical health benefits [Wel09]. However, such benefits are not widely available to all for various factors, which reduce interaction opportunities, such as hygiene restrictions, allergies, and resource and care limitations.

Technological virtual animals can address the aforementioned limitations while providing the benefits of real animal interactions. While immersive virtual reality (VR) provides the opportunity that users can interact with virtual animals in computer-generated synthetic environments, recent advances in augmented/mixed reality (AR/MR) have further allowed for the realization of virtual animals with flexible appearances and behaviors to exist in the real world. Looking at virtual animals as a social companion that exerts positive influence over the users (e.g., pet owners), Johnsen et al. [JAM*14] explored the efficacy of a virtual dog in a MR environment for promotion of children's physical activity, and found positive influence of an interactive virtual dog responsive to children's exercise and interaction levels, compared to an interface without the virtual dog.

In light of these positive findings and advances in AR/MR technology, we present an interactive virtual dog prototype using human-in-the-loop simulation model (*Wizard of Oz*), while envisioning development of a fully autonomous virtual dog agent in the future. The demonstrated prototype has been employed for several human-subjects experiments, which investigate the effects of virtual dog appearance and behavior on human perception [NKL*19]. We also propose a couple of use cases for the companion virtual dog with the needs of children and older adult populations in mind, and discuss some of the benefits and limitations identifying future research directions.

2. Demonstration: Interactive Virtual Dog in AR

We developed a human-in-the-loop interactive virtual dog in AR, which is highly useful for any human-subjects experiments that investigate effects of human-animal interactions on human perception and behavior, for example, stress reduction, task performance, and well-being together with support animals. We employed a pre-rigged and animated 3D model of a virtual beagle from Unity Asset Store for the implementation of the companion virtual dog using Unity version 2018.2.7f [Nit]. Our prototype adopted a server-client format for Wizard of Oz human-subjects studies allowing the experimenter to control the behaviors of the dog on the client side through a server user interface, and collect behavioral data by recording users' head position and orientation [NKL*19]. The Mi-
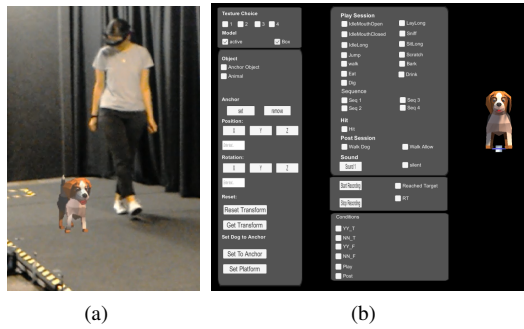
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Figure 1: *An example of interaction between the user and the virtual dog in AR (left), and a sample graphical user interface to control the dog on the server side (right).*

crosoft HoloLens head-mounted display (HMD) was utilized to realize the virtual dog on the client side. A range of behaviors were implemented to represent interactions that indicated a dog's general behavior (e.g., resting, sniffing), its responsiveness to and accompaniment of the user (e.g., walking with the user), and actions on the user's side aimed at caring for the virtual dog (e.g., feeding).

3. Use Cases

Considering the potential of virtual animals to promote healthy behavior for different populations, here, we present two use cases for children and older adults aimed at exploring motivations previously identified during interactions with real animals. These aspects are (a) fostering a sense of care and responsibility in children and (b) promoting healthy behaviors through dog walking for older adults. Such interactions can occur using different platforms (e.g., desktop-based), but we speculate that the virtual dog's presence augmented in the real world might increase its effectiveness.

Children Having a companion and fostering a sense of care and responsibility has been identified as one of the reasons for families acquiring pets for children; however, the results on the effectiveness of this approach is not conclusive due to factors, such as a child's fear of blame and feeling of incompetency [MWL15]. We propose the examination of the companion virtual dog prototype to cultivate children's confidence in their ability to care for the virtual dog by interactions like providing it with virtual nourishment and involvements in play sessions. Additionally, similar to work by Johnsen et al. [JAM*14], the health of the virtual dog can be linked to the amount of care and attention it receives.

Older Adults Dog-walking has been linked to physical health benefits for older adults [RMR*11] with promising results when compared to walking alone [MKKY06]. We propose the examination of virtual dogs as an interactive companion that can be programmed to adjust its speed based on the needs of the user and encourage the user through its behavior. With increasing ubiquity of fitness tracking devices informing users on factors, such as number of steps and heart rate, we envision the potential of the companion virtual dog to utilize such information to adjust its behavior intelligently. For instance, if the user's heart rate is exceeding a set amount, the virtual dog can rest and act relaxed and invite the users to take breaks.

4. Future Directions

While virtual dogs can provide flexibility in embodying different appearances and behaviors, the influences of their lack of physicality on users is not well-researched. In the future, improvements in tracking algorithms and technology can support experiences where the virtual dog behaves as if it is placed in and aware of the physical world. Such realistic behaviors could compensate for the lack of physicality in a companionship context, which needs further research. Additionally, the employment of artificial intelligence (e.g., computer vision and natural language processing algorithms) allows for more natural user interactions (e.g., voice or gestures based) and increases the chance of adopting such companions for common needs such as stress reduction.

Acknowledgments

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