Poster: Smart Eyewear Enabled Interactive Pet Toy for Users with Limited Mobility

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ABSTRACT

Smart eyewear that detects eye movements and head motions have been applied to studies on detecting oneâĂŹs mental state [5], engagement level in social interactions, and measuring concentration [4]. However, applications for these smart eyewear that offers intriguing and novel interactive experience has seldom been used as wearable device-control. As an application of this type of wearable, we used J!NS MEME that enables head motion data to control smart devices with hands-free operation in a pet toy system to facilitate human-animal interaction for people in cases of limited mobility either due to physical disability or the lack of enough space allowance. For our study, we primarily focused on exploring interaction possibilities between pet owners, who experience physical limitations due to the latter context, and their pets. The study result shows a promising start for opening up new interaction opportunities for our targeted audience in the context of physical limitation; however, the impact on those with physical disabilities is still arguable as it is yet to be evaluated.Nevertheless, since smart eyewear can act as an unobtrusive and useful body extension for people with limited mobility, we believe that it can be an alternative input option that can be applied not just to human-animal interaction but also to wider domains such smart devices and home systems for these users.

CCS CONCEPTS

• **Human-centered computing** → **Interaction design**; **User centered design**; • **Interaction**;

KEYWORDS

hands-free input; human-animal interaction; inclusive design; eye-wear computing; head movement interaction; assistive technology; computer interaction for disabled persons

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1 INTRODUCTION

Many people with disabilities have pets for physical and emotional support. Studies have shown that direct interaction with animals can aid in facilitating the human-animal relationship [1, 3]. Since most existing pet toys require some form of body coordination in order to interact with animals, this significantly limits the activities people with limited mobility can enjoy with their pets. Our research aims at overcoming this limitation.

In this paper, we propose an inclusive pet toy with smart eyewear control integration for people with limited mobility.

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Currently, smart devices and home systems being developed come in mainly two directions, input design by voice, like Google Home and Amazon Echo, and input by hand gestures [2]. Although these examples of smart home systems have been gaining popularity on the market, these inputs modules are not accessible to people with limited body mobility [9]. Moreover, response delays in voice-controlled assistants have encountered issues in past studies [2]. Research has been conducted to increase accessibility for people with disabilities in an attempt to replace traditional computer cursor interface that requires hands-input to systems using head and eye movement such as Malkewitz's study using eye-tracking and Lopresti's study using head-control [7, 8]. Application outside of the computer interface domain in this regard has had seldom exploration. We want to explore using head movement control to increase interaction options for people that have physical limitations which will help overcome their limitations when interacting with pets. We here define limited mobility to include people with physical disabilities neck down, people in situations with occupied-hands, people who have tasks at hand, people with limited spatial allowance and people in post-energy-intensive activities.

Approach

As an alternative to delay-prone voice commanded input, our approach is to use non-invasive wearable device J!NS MEME and its embedded sensors for head rotation as a medium for hands-free device control. Smart eyewear for sensing eye movements and head motions have been widely used in different types of user interactions. In particular, the smart eyewear we used to build our system, J!NS MEME, has been used on studies related to games, behavior training [6], and mental state detection [5]. According to previous studies conducted by Manresa-Yee, in a vision-based interface for computer accessibility, hands-free input options remains vital for people with limited mobility and physical disabilities [9]. For our study, we created a pet toy device for owners to play with their pets using only head movement, facilitating human-animal interaction in situations of limited mobility. By exploring possible applications of eye and head movement for achieving interaction between human and tangible forms in an encumbered situation, we hope to bring more interaction options for people with physical limitations, and with this system, help owners overcome physical limitations they may have when interacting with their pets.

2 SETUP

Our system setup includes J!NS MEME input that supplies owner-controlled directions to our output toy device, to interact with pets.

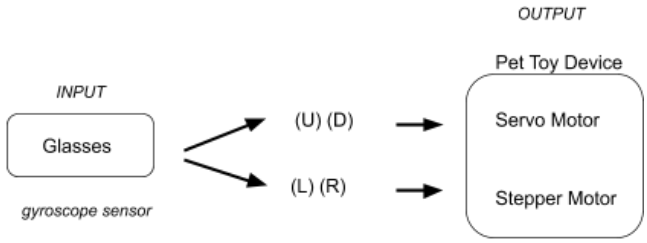

Figure 1: first prototype system

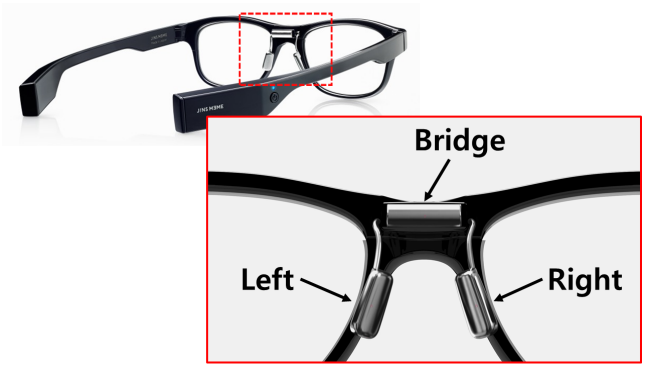

Figure 2: J!NS MEME sensors allow measuring head rotations on 6-axis. Via J!NS MEME (https://jins-meme.com/en/products/es/).

J!NS MEME

The J!NS MEME glasses has been studied on to detect head motions [4]. As shown in FIGURE 3, it has three electrodes (electrooculography) around the nose for detecting eye movements, and motion sensors (accelerometer and gyroscope) for detecting head movements. Our envisioned interaction includes the use of gaze interaction (short series of blinks, long blinks, combinations of directional movement and combinations) to activate interactions in the device.

FIRST PROTOTYPE

Our current prototype includes the following elements:

(1) J!NS MEME: smart eyewear we used as an input device for the pet toy. Readings from the gyroscope of the MEME are used to detect user's head motions. Head positions and motions are translated into directional and angular values for the toy device actuation.
(2) Pet toy device: a teaser-inspired device with a pom-pom attached that can rotate 180 degrees left and right, and tilt up and down. Actuation of the device is enabled by the combination of a servo motor and a stepper motor. The former operates on the vertical movement while the latter is linked to the left and right rotation.

Figure 3: Female participant and her dogs in experimental setup

3 USER STUDY

For this user study, we conducted qualitative tests on whether our device can assist pet owners who are in scenarios of limited mobility in interacting with their pets. To conduct this, we instructed our human participants to limit body movements they can exercise. In total, two participants (one male and one female both in the mid-20s) and their dogs took part. At the beginning of the test process, we asked our participants to sit on a chair and try to interact with their dogs without hand gestures and the device. In both cases, the participants used their voice to attract attention from their dogs, from which they expressed some level of frustration as they could not engage their pets without their usual combination of voice command, arms mobility, hand gestures and physical presence. The second phase of the study involved our system, J!NS MEME, and the pet toy device. When we introduced our device, the pets expressed immediate interest in the pet toy and did not display any problem with the device. As the human participants started to move their heads around with J!NS MEME on, their pets actively followed the direction of the pom-pom and tried to catch it. One of the dogs even lowered its body patiently waiting for the best timing to catch the pom-pom. The overall interaction between the user-head-controlled pet toy and the dogs were positive; however, the human participants' reactions were somewhat mixed. Some participants found it difficult to control the pet toy as the device reacted to every head movement they made. From this assessment, we concluded that interactions using the eyewear such as quick blinking patterns might be necessary as a triggering mechanism for the toy device activation. Nevertheless, from our unstructured interview, the participants recognized the benefits of using head-movements for human-to-pet interactions if they are in physically restricted situations as the system requires much less body exertion and is also natural.

4 CONCLUSION

The result of our two user tests showed positive response to a head movement approach for pet toy control as an alternative to voice-only device control and this could be a novel interaction opportunity for people with limited body mobility and people in hands-occupied situations. It also explores an area for smart eyewear application in linking eye and head movement with home devices. Since eye and head movements are intuitive, easy to control, and quick to respond, it might be a better way to control smart devices for people with impaired ability to move their hands and body and for smart home device control for people with occupied hands, however further work is required to test whether there will be obstacles preventing its effectiveness. The study adds on to the options to be explored in which people with limited mobility can take to overcome their physical limitations, it can also be extended to other areas like home appliances and other human-computer interaction asa method to bypass physical limitations

5 FUTURE WORK

- Improving on precision of device movement and differentiation between user-intended non-intended head movements in MEME-toy device interaction
- Adding functions to prototype such as blinking interaction to select by using combination of J!NS MEME accelerator sensor data and gyroscope data to adjust precision of device movement.
- As we observed the dogs becoming accustomed to the toy after exposure, another device function that can be explored is a reward interaction that can be activated by eye blink patterns. The interaction can be a potential training regime.
- Conduct user test on a larger participant sample as well as with pet owners who have physical disabilities to see the effectiveness of the device for differently trained pets.

- Furthermore we can conduct the same study with cat-owners to refine the design of the device-human-pet interaction to be inclusive of other house pets with different play-patterns

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