Developing Novel Cyborg Interactions From Atomic Tasks

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ABSTRACT

We propose exploring new possibilities of complex cyborg interactions by first deriving simple cyborg tasks from existing atomic tasks humans accomplish in day-to-day life. We define cyborg as a human-machine hybrid with organic and mechatronic body parts which can be worn. The cyborg experience of equipping additional arms is not fully understood. As such, there is much to be explored and discovered about the capabilities of the healthy human body with four arms instead of

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KEYWORDS

Cyborg; atomic gestures; taxonomy;

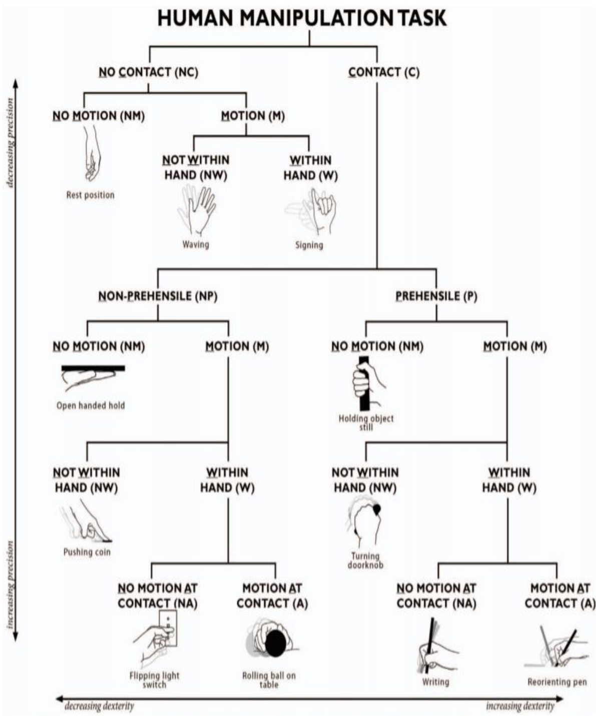

Fig. 1. Human manipulation taxonomy. Manipulation tasks are classified based on several criteria defined in section III.A. Representative examples are provided for each leaf of the tree.

Figure 1: The taxonomy proposed by Bullock et. al

two. By first developing simple applications revolving around simple tasks, more complex tasks and interactions can be built from simpler building blocks, thus paving the way for exploring cyborg applications that have yet to be discovered.

INTRODUCTION

Given the novelty of the wearable arm experience, deep and innovative cyborg applications still have great room to be explored and designed. The wearable arm experience is still being understood, but as these wearable experiences are poised to fully enter our lives, and as people begin to transform themselves into four arm entities for long periods, it is important to learn what capabilities we have and what is in the realm of possibility for a multi-arm, cyborg experience.

Biologically speaking, humans have developed tasks and gestures to perform activities in daily life such as moving, sleeping and eating. And in terms of human history, wearables and augmentation are extremely young and thus, we have not had the time evolution affords to naturally develop tasks and applications for four-arm entities. Moreover, how the introduction of long-term wearable experiences effect existing experiences like sleeping and eating is not fully understood. Hence, with the rapid introduction of cyborg technologies, an introduction that has not been subtly integrated through evolution, the human body's capabilities are suddenly greater in ways not possible with our existing limb set.

RELATD WORK

Cyborgs, have been discussed and prototyped in HCI [1, 2, 3, 4, 5]. For example, projects such as the MetaArms prototype [3] and those by Panetti et al. [2] and Tran et al. [4, 5] examine the use of wearable arms. These projects discuss potential uses cases for cyborgs such as lifting load, communication, and navigation.

Note that the assumption in this proposal is that the humans, or users, in question are fully healthy humans with no physical disabilities. Moreover, the definition of cyborg here is focused on wearable limbs [2, 4,5], meaning extending the number of limbs a healthy human has rather than augmenting existing ones.

HAND MANIUPLATION TASK TAXONOMY

Bullock et. al proposed a classification of human-hand manipulation tasks [6]. As shown in Figure 1, these hand-centric tasks are classified based on the contact, motion and prehension involved within the task. Example tasks within this taxonomy include hand resting, which is a no motion, no contact task, and holding an object with an open palm, which is a contact, non-prehensile and no motion task.

Figure 2: In this image, the five designers are sketching during the design session

Figure 3: In this image, two designers are demonstrating their design for the signing atomic task four letter words using wearable arms

Bullock et. al's proposed task classification breaks down hand-based manipulation tasks into atomic tasks. Tasks such as these cannot be meaningfully broken down or classified any further. As such, Bullock et. al speculate that this taxonomy, and the tasks within it, can be used to build more complex tasks and actions. Consider an individual who is writing a book; this interaction, or rather, series of tasks, can be broken down using the following taxonomical gestures: 1. Lifting the pen from the table 2. Rotating the pen into a writing position and 3. Writing with the pen and then repeating the process.

Bullock et. al's theory suggests that simple, biological atomic tasks within the taxonomy can be used as building blocks to construct complex interactions. We build on this theory by suggesting that cyborg interactions can be conceived and built using simpler, atomic cyborg tasks. In other words, by first designing and creating the simplest possible, or atomic, cyborg tasks, complex multi-arm cyborg actions can then be created from these foundational atomic tasks. Bullock et al's taxonomy breaks down complex hand-based gestures into simpler ones, a top-down approach, and we propose a bottom-up approach based on their theory.

DERIVING ATOMIC CYBORG TASKS

While constructing cyborg interactions from atomic tasks is a novel method for designing cyborg interactions, the original obstacles resulting from the novelty of the cyborg experience still remain; how do we construct atomic tasks for the cyborg experience so that we can create more complex ones? The original problem of creating novel cyborg interactions is now focused on much simpler tasks that need to be designed, but these tasks still need to be conceived. What are these atomic tasks? How do we design them?

In order to facilitate this necessary creation of atomic cyborg tasks, it is advantageous to consider the existing hand manipulation task taxonomy again (Figure 1). The atomic gestures shown as leaves on the taxonomy were created based on the human being's inherent biological capabilities. More specifically, the hand manipulation tasks shown, such as waving and holding a pen, revolve around our biological hands. However, by nature, becoming a four-armed cyborg entity means that the human capabilities have changed; no longer are we limited to the capabilities of our two hands, as we now have two more. With these new capabilities, a series of new questions can now be asked; how will the atomic hand gestures on the taxonomy behave when the healthy human's capabilities have now been extended to four arms? Are there new and better ways to accomplish these simple tasks we've grown used to accomplishing on a day-to day basis? Are there new limitations introduced by having four arms that require modifications to the atomic tasks?

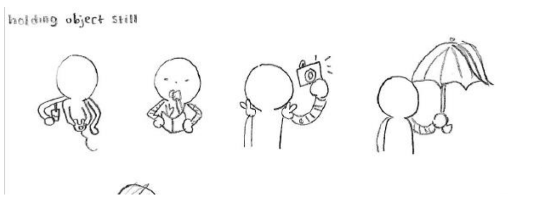

Figure 4: A series of sketches by one of the designers demonstrating novel and simple cyborg tasks

Figure 5: Another set of sketches that demonstrate cyborg tasks derived from the taxonomy including using the wearable to help with holding a nail and hot coffee

THE DESIGN SESSION

By establishing these questions, there is now a mechanism by which cyborg atomic tasks can be designed, thus paving the way for creating composite cyborg interactions. This mechanism provides the structure needed for brainstorming simple cyborg tasks, a structure that was severely lacking when trying to conceive these simple tasks. Moreover, the series of questions posed when attempting to translate the original taxonomical tasks to cyborg tasks still provides immense room for creativity for designers to formulate new ideas. As a first step towards exploring this new path, an informal gathering of designers was organized (Figure 2). These designers were asked to prototype simple cyborg tasks by first examining Bullock et. al's taxonomy and attempted to translate the atomic tasks into atomic cyborg tasks. The designers sketched their ideas and demonstrated their designs by using human-human prototyping.

Despite the constraints placed upon the designers, their creativity still shone through, and their ideas were thought provoking (Figures 3,4,5). For example, when asked to translate the hand waving task to the cyborg context, one designer suggested that having multiple arms means the user will no longer have to wave themselves in certain situations, such as being too tired or too busy to acknowledge someone. Despite the simplicity of the waving task, the social implications of waving with four arms, or rather, having the cyborg arms wave for the user, are different than those of waving with two arms in a non-cyborg context. Another example using the waving task was proposed where the cyborg arms wave while the user reaches out to shake the greeted person's hand, which streamlines the greeting experience more than what is experienced in a non-cyborg context.

The focus of the session was translating atomic tasks to the multi-arm cyborg context, but the designers still speculated complex cyborg interactions based on the atomic tasks they brainstormed. For example, after brainstorming how to translate the signing atomic task (Figure 3), the designers proposed a complex cyborg application where the cyborg arms can act as a sign language interpreter when speaking to an individual with hearing impairments. This complex task is composed of the atomic signing task, and highlights the potential of cyborg applications, and the human's extended capabilities, in ways not possible with our evolutionary limb set.

CONCLUSION

With the advent of new wearable technology, the tasks humans accomplish are no longer constrained due to inherent biological capabilities. In order to examine and design how these four-arm experiences can change our lives, we suggest constructing novel and complex cyborg experiences by first speculating on simpler, or atomic, cyborg tasks. These atomic cyborg tasks are themselves derived from the biological atomic tasks humans take part in, but can now be modified or enhanced in a multi-arm context. Thus, cyborg applications can be designed, and humans can accomplish more than what our evolutionary capabilities have given us.

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