B-Handy: An Augmented Reality System for Biomechanical Measurement

Poster · March 2022

DOI: 10.13140/RG.2.2.17004.23685

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B-Handy: An Augmented Reality System for Biomechanical Measurement

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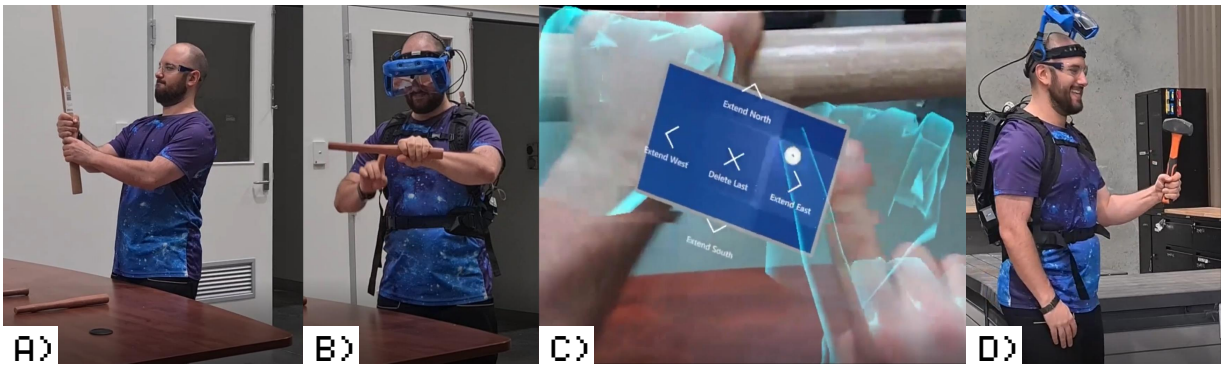

Figure 1: Figure 1: We introduce B-Handy, a system that supports the usage of bio-mechanics as a means of measuring every day objects. In our example: A) A user is confused, unable to determine the right handle length for a hammer. B-C) The user interacts with the B-Handy UI to create virtual copies of their hand to aid in bio-mechanical measurements. D) The result of our system enables the user to rapidly infer measurements of every day tools through this process.

Abstract

The study of bio-mechanics allows us to infer measurements for every day objects without needing measurement tools. A limitation of this comes from the complex mental transformations of space involved. The efficiency of this task degrades the larger these measurements become. We present B-Handy, a system that offloads this mental workload by providing visual transformations of space in the form of tracking and duplicating the user's hand in AR. It is our hope that this system will simplify the complexity of these mental transformations and increase the efficiency of bio-mechanical measurements.

Index Terms: Human-centered computing—Human computer interaction (HCI)—Interaction paradigms—Mixed / augmented reality; Human-centered computing—Human computer interaction (HCI)—Interaction techniques—Pointing

1 Introduction

The human hand is one of our oldest tools. As humanity has evolved, we have designed tools that improve the efficiency of what our hands used to do, such as digging, cutting, screwing, gripping, etc. Understanding how the relationships between these elements of bio-mechanics are involved in these tasks allows us to make better tools for that task. Lee et al. [5], has shown that it is possible to measure the user's limbs, inferring the size required to design and build furniture from the captured measurements. However, this does not directly overlay the visualization of the resulting measurement into the user's view of the environment, requiring additional mental transformations. Alternatively, Hoang et al. uses haptic gloves to perform these measurements [4], but provides no visual feedback to the user. Hegarty et al., has shown that there is a distinct and measurable delay when a user performs mental hand transformations [3]. B-Handy aims to minimise this overhead by offloading these tasks from the mental space to the visual space. We implement this by optically tracking the user's hands and fingers then displaying re-projected virtual hands in the AR scene. The replicated hands exhibit the same pose as the tracked hand. We hope that by demonstrating this novel approach, we can facilitate further exploration in the effectiveness and usefulness of in-situ AR-projected bio-mechanics.

2 B-Handy

B-Handy is a system that directly enables the use of Bio-Mechanics by virtually re-projecting the users hand, anchored around their real hand. B-Handy does so by having the user interact with the system with the following steps:

1. The first state is active when the user faces their palm towards their face. A button prompting the user to activate B-Handy appears next to the user's wrists.

2. The user then orientates their left hand away, palm facing away from their face, as if to place it alongside a real-world object as one normally does when inferring scale measurements. A second menu is virtually anchored to the back of the hand and is comprised of a 5-button 'D-Pad-Center' style navigation.

3. IF there are projected hands present in the scene then pressing a direction OTHER than the current projected direction will remove the furthest hand from the user's perspective, until either no 'other direction' hands are present, or a direction button is pressed that corresponds to the direction the AR

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hands currently extend to, in which case a duplicate is made and extended on that direction as normal.

4. The system continues to track the users' left hand pose, dynamically updating the virtual hand models. This is to allow a variety of hand positions such as gripping an object and flexing the hand to be accurately re-projected.

3 Implementation

We deploy the B-Handy software using Project Esky [2] for our demo. For hardware, we use a Project Northstar[1] Head-Mounted Display (HMD). We can alternatively also deploy on eith Project Ariel [1], or any other head worn display that features hand tracking.In our case, we use the UltraLeap hand tracking[2] equipment. For 6DOF head tracking, we employed the Intel RealSense T261[3] module. For software development, we use the Unity game engine, running on a MSI GT83VR 7RF Gaming Laptop with the following specifications: Intel Core i7-7920HQ, 64 GB RAM, and twin-SLI NVIDIA GeForce RTX 1080 graphics chipsets. For the video demonstration, we use an HP VR Z G2 backpack PC with the following specifications: Intel Core i7-8850H 32Gb RAM and an NVIDIA 2080RTX graphics chipset.

4 Demonstration

We demonstrate B-Handy by showing a basic AR scene with several real-world objects. As the live actor interacts with the Hand-Mounted-Menu, they can extend and place virtual replicas of their hand in any cardinal direction. The resulting visual feedback gives the user a bio-mechanically constrained scaling measurement tool in the Augmented Space.

Since the conference will be held virtually, we intend to present the system as a live online streamed demonstration under the guise of an 'Info-mercial', to match the entertaining aesthetic of the accompanying video. While we have a live actor demonstrating the system, we encourage viewers to interact with our actor. Users can collectively guess the scale of the various objects in our actor's environment as the live-actor plays the roles of a salesperson, explaining the system's function.

5 Conclusion and Future Work

B-Handy allows the complex mental transformations involved in bio-mechanical measurement to be off-loaded from into the visual space. We hope to analyse the effectiveness of such measurement systems in future user studies. One possibility of domain expansion can include using other body parts as well. Sensors such as the XBOX Kinect allow fitness-based games to utilise full-body tracking and pose estimation, akin to what we achieve with B-Handy. Therefore, it's possible to extrapolate not only the hand measurements for hand-held tools, but use bio-mechanics to measure and facilitate the design of other everyday objects by inferring limb length/girth (Such as chairs, tables etc.).

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