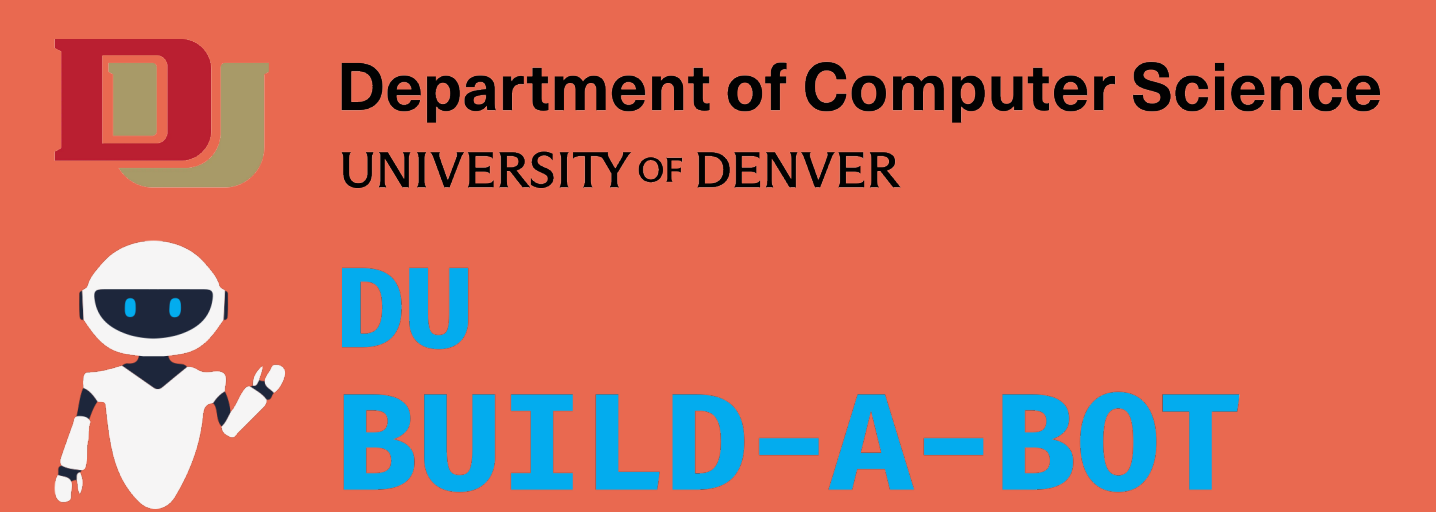


Exploring Augmented Reality Robot Design

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Goals

- Transfer the features of our existing web-based platform to an augmented reality (AR) application, allowing for intuitive and engaging robot design for novice users
- Evaluate and implement state-of-the-art AR interaction paradigms in the context of character creation
- Enable active participatory robot design and broaden participation in the robot design process
- Investigate differences in mental models formed between robots designed online and in AR
- Expand the capabilities of the web app by providing users with an immersive and interactive experience of building and designing their robot in a real-world environment
- To date, no widely-available AR character creation or customization platforms exist

Background

- We have developed the Build-A-Bot platform, an online 3D robot design tool [1, 2]
- Users can design robots using an interface similar to that of a character creation interface (CCI) in a video game
- The platform is designed with the following goals:
 - Investigate how humans form mental models of robots
 - Enable participatory robot design for a more inclusive user base [2]
- The Build-A-Bot platform, in its current form, enables users to visualize and create a robot design only in the context of a computer screen

Related Work

- Augmented reality character customization has been previously studied [3], however, it is still an underrepresented research area
- Seidinger (2016) found that participants in a human subject study preferred an AR-based character customization interface to a traditional non-AR interface [3], indicating that this area could benefit from further research
- A variety of input methods for handheld augmented reality (HAR) have been researched, which we believe can be intuitively utilized for character creation
- Two general styles of input in HAR seem to be prevalent: gesture/hand/finger tracking based input, and touchscreen/device based input
- Unuma and Komuro (2017) evaluated different implementations of the first style of input, finding that while participants were able to use the system, there were limitations to the interaction style that required further work and evaluation [4]
- Mossel et al. (2013) investigated two different techniques implementing the second style of input, finding that each technique had strengths in different tasks of 3D manipulation (translation, rotation, scaling) [5]
- These 3D manipulation tasks will be essential parts of our robot design platform, thus, further evaluation of these input styles will be a key next step

Intuitive Robot Design

- By applying the techniques discussed in the related work, we believe that we can create an intuitive robot design experience for novice users
- We postulate that, depending on experience with AR and computer games, users may find AR to be a more intuitive interface than the existing Build-A-Bot platform due to the similarities to real-world actions
- A comparison of our robot design interfaces will be conducted to evaluate intuitiveness and universal usability

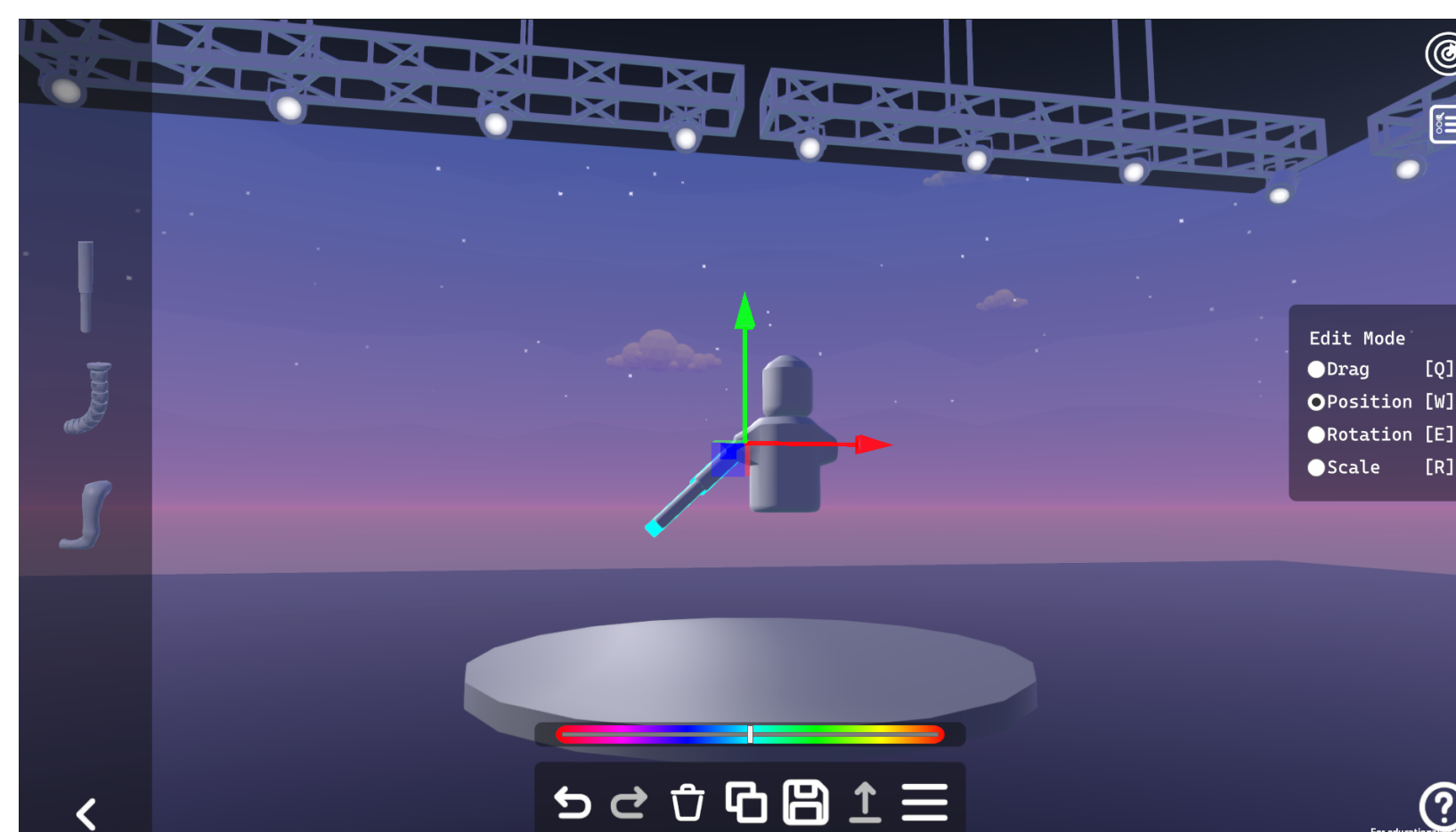


Figure 1. The existing web-based Build-A-Bot platform.

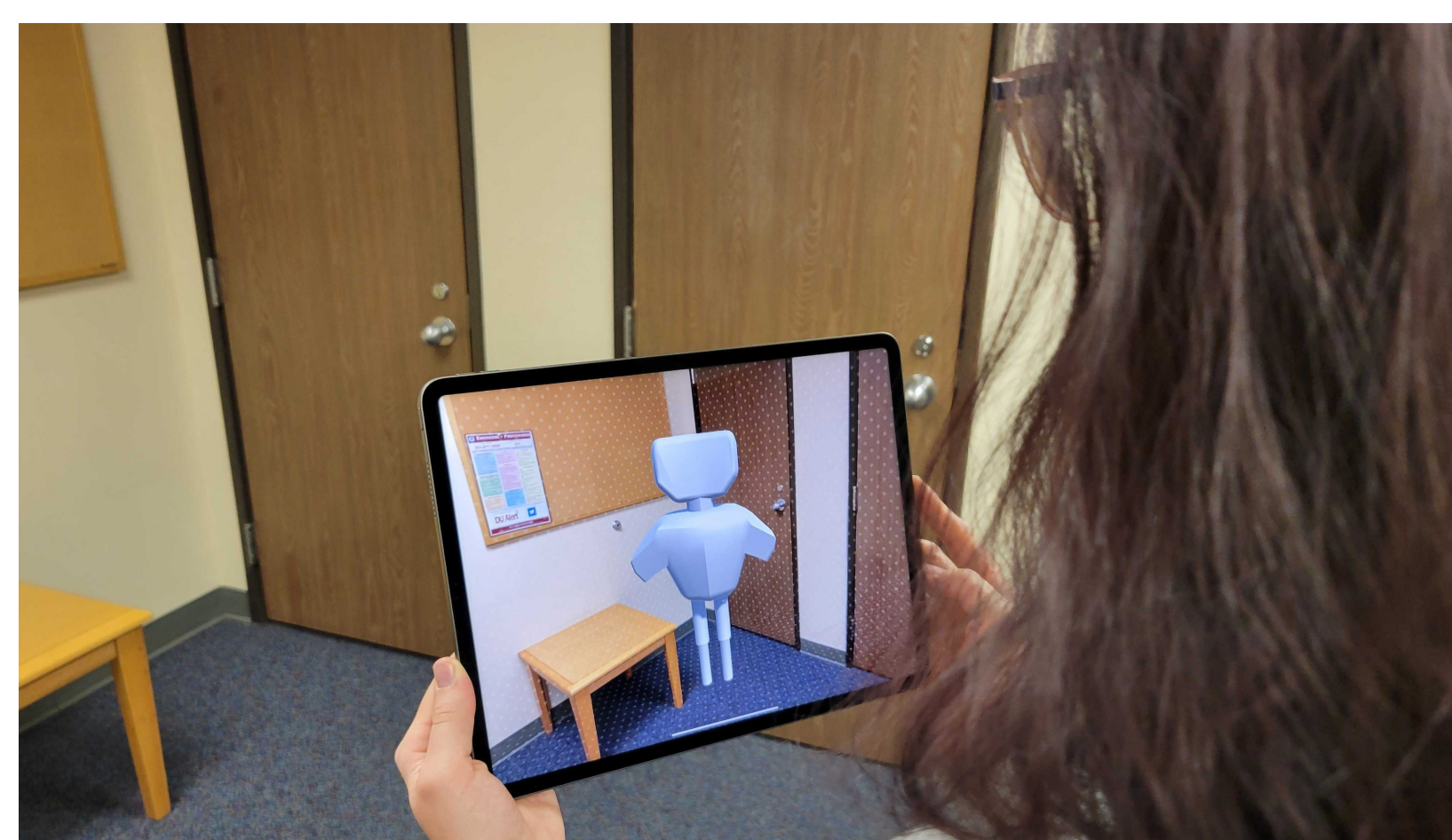


Figure 2. A user views a simple robot design through handheld augmented reality (HAR)

Enabling Participatory Design

- Although the Build-A-Bot platform in its existing form enables participatory robot design [2], the robots that can be designed are only at the scale of a computer screen
- We believe that through the use of AR, we can enable participatory robot design for robots that are at a scale that is more realistic to what a user would encounter in the real-world



Evaluating Robot Mental Models

- A mental model is an “internal [representation] of real, hypothetical, or imaginary world phenomena” [6]
- Research has shown that humans form mental models of robots [7]
- Understanding how humans form these mental models is a key goal of our existing platform and research
- Based on our initial testing, many robots designed on our platform have been humanoid
- We postulate designing robots with the real world as a reference may cause humans to form different or stronger mental models of those robots, and that these mental models may be closer to those formed of a real-world robot

Next Steps

- Implement initial prototypes of the proposed AR robot design interface using several different HAR input paradigms on Apple iOS devices using the Unity game engine
- Conduct an evaluation of these prototypes for intuitiveness and universal usability
- Further develop a prototype using evaluated input methods
- Conduct comparative evaluation of mental models formed of robots designed in our existing platform and in the AR platform

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