Future of Work Checkpoint One

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1 Introduction

With augmented reality (AR) devices becoming cheaper and more common in the home and workplace, the range of potential uses for it in everyday life has expanded. One of the areas which AR can now assist in is aiding in physical construction or assembly tasks. Previously users have had to read instructions or watch videos to learn how to put together a new piece of furniture or appliance. This can be challenging especially when working with small or fragile components, and can prove expensive if pieces are broken. Along with the mental cost of context switching between the video or tutorial and the task at hand. With the ever increasing availability of AR, the potential for virtual tutorials in which a user could go step by step through the building process virtually are now available. This experiment seeks to examine ways in which instructions in AR could improve upon the current instruction types.

This can now potentially include helping with daily tasks such as tutorials to help with building physical object such as furniture or new appliances. Instead of the user watching a video on their smartphone and building the object at the same time, they could now have the opportunity to be guided through the process with a digital overlay of the task in AR. This style of tutorial could minimize context switching, helping to minimize errors and maximize speed in completing simple at home construction projects.

The purpose of this experiment is to explore the benefits of different instruction types within an AR environment.

2 Related Work

Research into the field of AR tutorials and building instructions has been an ongoing field of research for a considerable amount of time. Beginning in 1992 with Caudell and Miezell [2] presented a head mounted display which could show positions and textual queues for a drilling task. This research spurred a significant number of new possibilities for research into how building tasks could be improved with this new augmented reality model.

The work done in these papers has sparked significant interest in using AR as a tool to teach new skills, especially in assembly tasks. These techniques have so far been used and tested in industrial and military applications in which the environment is specifically tailored for this particular construction task.

Columbia University published a paper on this subject called ”Evaluating the Benefits of Augmented Reality for Task Localization in Maintenance of an Armored Personnel Carrier Turret” which focused on the application of AR in supporting armored vehicle mechanics [4]. This experiment was ”designed to facilitate task comprehension,location, and execution” [4] of the expert tank mechanics who would usually be performing these repairs. This study found that the AR system improved on the time and head movement between tasks in the sequence.

Another recently published paper called ”Comparing Conventional and Augmented Reality Instructions for Manual Assembly Tasks” explored the benefits of using AR over other instruction types [1]. This experiment compared different instruction types namely AR on phone and headset as well as standard paper instructions and analyzed their results. This study found that participants completed the basic building tasks faster with the standard paper instructions but made the fewest errors when using the Hololens AR headset.

More general studies have been completed having to do with different instruction types and their benefits. In 2019 IEEE had a paper called ”Annotation vs. Virtual Tutor: Comparative Analysis on the Effectiveness of Visual Instructions in Immersive Virtual Reality” [5]. This paper compared the differences between a written instruction and an instruction acted out by a virtual tutor in a VR environment. This study found that the group with written instructions had both better recall of the task and where able to complete the task faster than the group with a virtual tutor [5]. These results could potentially be used in this experiment to determine one of the instruction types as being a written set of instructions.

Another important paper was written by the university of Stuttgart in Germany which explored the usage of AR instructions in an industrial environment over an extended period of time [3]. This experiment was conducted over 11 days and compared expert and untrained users in the environment. This study found that there was a decrease in performance for participants who were already experts at the task, but a significant improvement in untrained worker performance. [3]

These studies highlight some of the interesting and important questions that can be asked about the usage of AR for various building tasks. The also highlight some of the ways in which this method of instruction has been found not to work. Given that our participants are not experts in the task which they will be performing at least one of our instruction methods should see some improvement in task completion time or accuracy over the different building tasks.

3 Methodology

This experiment will follow a between subjects design. The independent variable will be the type of instruction the participant is randomly assigned, and the dependent variables will be the speed and the accuracy with which they complete each task.

3.1 Apparatus

The environment for this experiment will be a combination of virtual and physical interfaces for the user. The virtual environment will be provided by the Hololens 2 augmented reality headset by Microsoft, combined with the Oak-D machine learning camera form open-CV. The bars will be identified with a tensorflow machine learning model as pictured in Fig. 1 The virtual environment will be provided by an application built with the mixed reality toolkit.

The physical interface of the experiment consists of a series of 3D printed bars and bolts which will constitute the construction materials for the building task. These will each have a unique color to help with the machine learning model which can be seen in Fig. 2 Each building task will be defined by a different shape that will need to be built by the participant, using the provided bars and bolts. Proper Completion of this task will be determined by the Oak-D cameras machine learning model.

3.2 Procedure

Each participant will be asked to sit at the desk and walked through how to put on and adjust the Hololens. The participant will then

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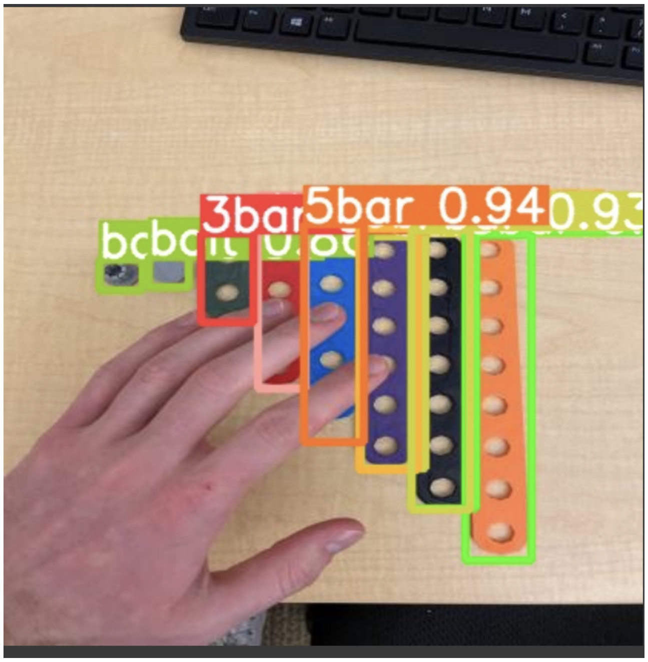

Figure 1: 3D Printed bars and bolt identified with tensorflow machine learning model.

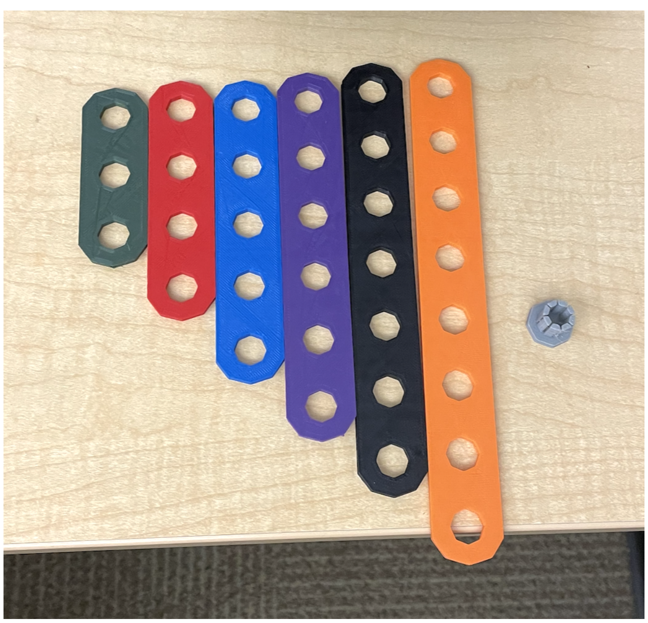

Figure 2: 3D Printed bars and bolt from size three to size eight.

be guided through a basic tutorial detailing the proper use of the augmented reality environment along with a basic building tutorial. Before the tutorial the participant will be randomly assigned to one of the instruction groups. The participant will then be guided through each of the building tasks with their specific assigned instruction set. After the completion of the experiment the participant will be asked for any feedback they might have in a small questionnaire and then dismissed.

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