A Comparison of Desktop and Augmented Reality Scenario Based Training Authoring Tools

Andrés N. Vargas González[*]
University of Central Florida

Katelynn Kapalo[†]
University of Central Florida

Senglee Koh[‡]
University of Central Florida

Robert Sottilare[§]
Army Research Laboratory

Pat Garrity[¶]
Army Research Laboratory

Joseph J. LaViola Jr.[‖]
University of Central Florida

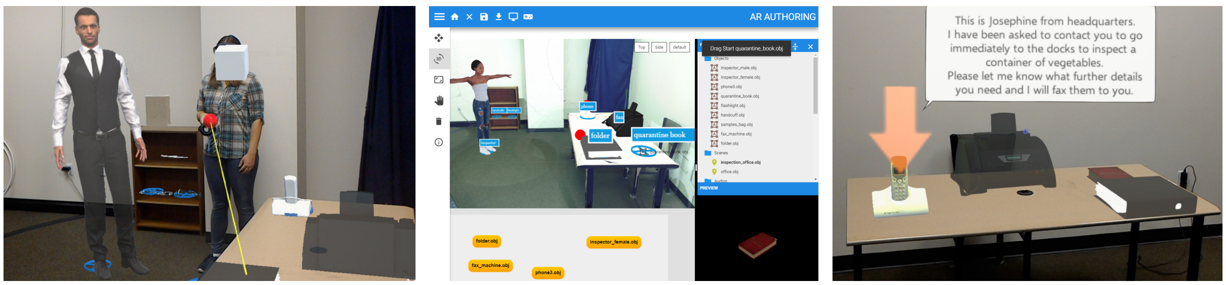

Figure 1: On the left, the AR authoring environment showing a participant placing objects and an avatar in the scene. The center figure presents the GUI of our desktop authoring tool and an object being placed on the table. On the right, the playback application to visualize an authored scenario.

Abstract

This work presents a comparison of two applications (Augmented Reality (AR) and desktop) to author Scenario-Based Training (SBT) simulations. Through an iterative design process two interface conditions are developed and then evaluated qualitatively and quantitatively. A graph based authoring visualization help designers understand the scenario learning artifacts and relationships. No significant difference was found on time taken to complete tasks nor on the perceived usability of the systems. However, Desktop was perceived as more efficient, corroborated by the significantly higher number of mistakes made in AR. Findings are presented towards building better AR immersive authoring tools.

Index Terms: Human-centered computing—Human computer interaction (HCI)—Interaction paradigms—Mixed / augmented reality; Computing methodologies—Modeling and simulation—Simulation support systems—Simulation environments

1 Introduction

Scenario content generation for AR/VR often requires extensive knowledge of programming and is not intuitive for novice users. Thus, situated authoring, the creation of instructional scenarios in situ, requires that subject matter experts create training scenarios with complicated technical languages or tools [1]. For example, commercial creative tools such as Unity 3D, Unreal, and Amazon Sumerian Engine require reasonable time with skilled instruction before a user can become familiar using the tool for content authoring. In addition, the instructor or content creator cannot readily visualize how the student will interact with the tool. To address these concerns, Situated Authoring has been proposed in VR/AR [2, 3, 7] and desktop contexts [4, 5, 8]. However, a comparison of such systems against traditional creative tools under the context of room-scale SBT is an under-explored topic, given that a user would need to ambulate around the scene while authoring and reviewing the content in real-time.

Nebeling et al. [6] identify three primary issues while categorizing AR-based authoring tools on the requisites of fidelity, skills, and resources required. In spite of these concerns, a study by Ng et al. studied a tool for building AR games using the situated authoring metaphor [7], including features such as virtual content positioning, scripted behaviors, and interactivity between scene artifacts. However, they report limitations on their selected interaction techniques; the study does not evaluate if such an interface can be as good as a traditional interface. Situated authoring through graph-based visual programming is explored in Ivy under VR for authoring intelligent environments [2]. While it follows a similar conceptual model with our work based on connecting nodes and link activations, their scope is focused upon information exchanges between IoT devices.

Under desktop-based authoring, prior work has mainly focused on user interactions needed when defining fiducials [4, 5, 8] that include attaching actions and behaviors. MacIntyre et al. [5] proposed many novel features for exploring AR content inside a MacroMedia environment [1], but only while off-line in a desktop setting. Lee et al. [3] compared between AR content modeling with tangible fiducials against a traditional approach using a mouse and keyboard. However, authoring is confined on a table-top that does not scale well [3]. Our work explores these ideas further as it scales to dynamic real-world environments, such as an office or art gallery. Two (AR and desktop) authoring interfaces are presented and compared in a formative user study (see Figure 1). A scenario is authored using 3D objects and multimedia assets represented as nodes. The resource must be activated by actions defined between nodes during authoring. A user can visualize the behaviors of objects or entities in the environment

[*]e-mail: andres.vargas@knights.ucf.edu
[†]e-mail: kate.kapalo@knights.ucf.edu
[‡]e-mail: ksenglee@knights.ucf.edu
[§]e-mail: robert.a.sottilare.civ@mail.mil
[¶]e-mail: patrick.j.garrity4.civ@mail.mil
[‖]e-mail: jjl@cs.ucf.edu

[1]https://en.wikipedia.org/wiki/Macromedia

through a graph based visualization.

2 User Study

Our experiment followed a between-subjects design user study to find user preferences on usability and perception on the two interfaces presented. Quantitative data was collected in the form of missed tasks, misplaced objects, and completion time. Qualitative data included responses to post-participation surveys. Half of participants used AR authoring on a PC and the rest interfaced with a Microsoft HoloLens AR authoring application coupled with a HTC Vive controller in a manually aligned space. Both groups were trained on the same tasks and were assigned the same problem. Twenty eight people (16 male, 12 female) aged 18 to 39 ($\overline{\chi} = 20.64, \sigma = 4.72$) were randomly distributed into two groups.

Tasks: In order to complete the tasks given in the application case, participants were required to place objects in the scene, add attributes (text, audio, questions, etc) to the items placed and create actions (events that trigger attributes) between these objects.

2.1 Application Case

Participants were asked to create a training experience for dealing with a quarantine problem. In the role of a creator, participants were given a set of tools that allow them to generate the training scenario experience following the tasks below (see Table 1). The scene replicated a real-life situation.

Table 1: Experiment Tasks

No.	Task
1	An inspector who is the user of your generated experience should be placed on a starting position in the scene marked with a label.
2	A quarantine manual book is to be placed in the scene with important information about the documentation (**quarantine_manual.txt**) required to carry out the task.
3	A phone is setup to ring (**phone_ring.wav**) at user interaction.
4	The person calling is your assistant Josephine who requests an inspection (**josephine_voice_message.txt**).
5	Josephine asks a question to the inspector about which documents (**documents_josephine_fax.txt** contains the question with the right answer) are needed to be faxed.
6	The inspector makes a call to Josephine through the fax machine (**phone_josephine.txt**).
7	The documents (**documents_faxed.txt**) are received by fax and placed on a folder on the desk.
8	An additional interaction with the folder will display a question (**do_inspection.txt**).
9	Two more items are placed on the bookshelf (flashlight and handcuffs) for the inspector to pick and assign descriptions (**flashlight.txt** and **handcuffs.txt**)

2.2 Study Procedure

The study was designed to be completed in approximately 60 minutes for both conditions. Each group followed the same protocol. Initially participants were asked to complete two questionnaires about demographics and previous experience. Next, the study task was briefly introduced followed by a training session of 15 minutes on the authoring tool randomly assigned to the participant. Training included an example of a singular action task, built on the interface by the proctor followed by a similar task performed by the participant. Next, participants were asked to solve the problem with the application provided, with their completion time being logged. Once the authoring was completed they were shown the result on the Hololens using the playback application. The participant then filled a NASA-TLX post-questionnaire and a SUS questionnaire about user experience and perception from the use of the tool. Participants also had an option to write any feedback regarding the system or experience.

3 Results

For the time data, an independent Welch Two-sample t-test ($t_{23} = -0.504, p = 0.618$) showed no significant difference between AR ($\overline{\chi} = 20.33, \sigma = 4.89$) and Desktop ($\overline{\chi} = 19.18, \sigma = 7.00$). The total number of misses per participant was counted and an independent Welch Two-sample t-test ($t_{26} = 3.618, p < .001$) shows that participants from the AR condition ($\overline{\chi} = 4.71, \sigma = 2.26$) missed significantly more attributes and actions than the Desktop counterpart ($\overline{\chi} = 1.79, \sigma = 2.00$) from a total of 18 possible misses. No object placement was missed from the scenario among either group. No significant difference was found on the number of objects incorrectly placed in the scenario ($t_{18} = -1.146, p = 0.267$). In terms of usability and perception, no significant difference was found on effort, cognitive load, challenge and frustration. However, Desktop was perceived as more efficient. Finally, a Mann Whitney U test revealed no significant differences on the SUS scores between the AR ($Md = 50.00, n = 14$) and Desktop condition ($Md = 55.0, n = 14$), $U = 68.5, z = -1.36, p = 0.18, r = 0.04$.

4 Conclusion

Despite the potential of AR to facilitate authoring content for scenario-based learning, at this state we find no compelling reason or motivation for practitioners to move away from their desktop tools. One big disadvantage of AR was the lack of general awareness of the authoring progress. Better visualization techniques need to be explored to show participants their current authoring state. A future study needs to explore contexts in which AR may have a real definitive advantage over Desktop. Our work aims to show differences on performance & usability and provide findings that can help the creation of tools that can support domain experts in authoring AR applications without extensive technical knowledge.

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