PaintBranch: Asynchronous Collaborative Art in Virtual Reality

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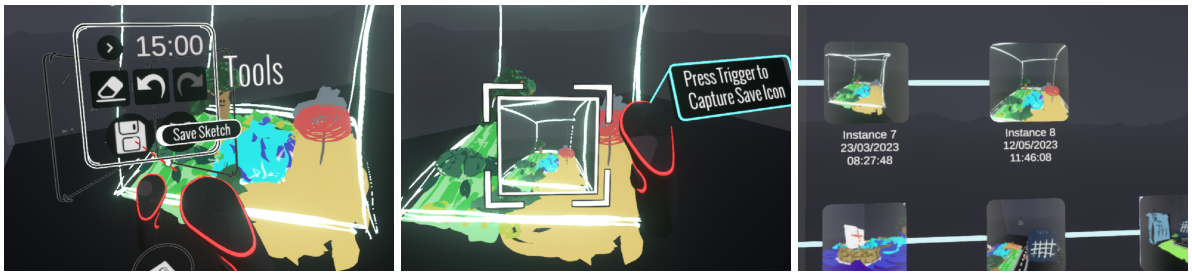

Figure 1: PaintBranch's version control and branching UI. A new node is created every time the user saves its progress (*left*). To do this, the user takes a snapshot of his painting (*middle*) to be later displayed in the version control timeline (*right*).

Abstract

We describe the development of PaintBranch, a virtual reality prototype designed to support asynchronous collaborative art. By incorporating version control (VC), PaintBranch aims to promote creative idea generation and reduce conflicts during collaboration. In a user study, eight participants were organized into four pairs and worked asynchronously for a week, with each participant having four painting sessions. We analyzed the emerging collaboration patterns and uses. Results indicated that experienced artists used these features effectively to meet collaborative and personal goals.

Index Terms: art collaboration, asynchronous collaboration, version control, virtual reality

1 Introduction and Related Work

Collaboration in art has been undertaken in various ways depending on the artists involved and their goals [2]. Virtual reality (VR) has been shown to not only enhance creativity [9, 3] but to strengthen relationships and co-creation [6]. Motivated by the increasing growth of artist communities in social media and in digital art movements that actively engage in asynchronous art collaborations [7], our work explores the challenges above via PaintBranch, a novel VR painting application that aims to allow artists to collaborate and exchange ideas while preserving individual creative freedoms while fostering collective artistic expression, without being constrained by time or location. We achieved this by building a VC system that enables artists to experiment, test, and iterate over their artwork. The VC mechanism integration into a VR application is not a novel contribution in itself [12], but it has never been deployed and tested in the context of collaborative art. This work stems from the growing need for tools that facilitate collaborative creativity in the digital age. As the art world increasingly embraces digital platforms, artists face new challenges and opportunities in collaborative creation. Traditional methods using physical materials naturally require artists to interact in the same physical space, even if not simultaneously. PaintBranch aims to establish collaborative spaces that preserve the benefits of solo artistic work while fostering a collaborative environment for artistic expression.

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2 PaintBranch

PaintBranch (shown in Figure 1) builds on two existing Unity projects. The first, **Ubiq**, is an open-source networking library designed to simplify the deployment of social VR environments [4, 10]. It provides a server for room management and offers features such as avatars, voice chat, object synchronism between the users, and connection management. Although Ubiq was primarily designed for synchronous collaborations, we have adapted it to host rooms for asynchronous work. We extend the object persistency in a Ubiq room by pressing a 'save' button in the interface that stores the sketches, allowing any following user to pick up and continue the work asynchronously by simply selecting from a history tree UI. The branching function is automatically prompted after the user saves its work if on a non-leaf node. Otherwise, the save operation is treated as a normal commit from the selected leaf node. After loading a snapshot, the new session automatically creates a room and loads the saved artwork as a sequence of sketches. Then, the user can modify the scene further. The second, **Open Brush** [1] is a room-scale 3D painting VR application based on Google's open-source project Tilt Brush [11]. It provides common painting tools and features for 3D environments, such as various brushes and bimanual controls. We have carried out the integration work necessary to have each Ubiq room be an instance of such an environment. PaintBranch was built in Oculus QUest 2 using Open Brush version 0.3.0 and Ubiq 0.1.1,and our overall project was implemented using Unity 2019.4.25.To facilitate asynchronous collaboration, we implemented a VC tree interface in PaintBranch to track the progress of art projects. The primary aim is to allow collaborators to edit without overwriting each other's work, revisit earlier versions, and encourage creative freedom. The VC tree is a hierarchical structure with nodes and branches, where each save creates a new node. Users can branch out from any node.Our system logs changes as a tree graph and exports this data as JSON, documenting nodes, their relationships, and associated sketch files.

3 User Study: Asynchronous Painting in Pairs

We recruited eight participants (F=5, M=3), forming four pairs, from local institutions. Half of the participants had formal training in the arts, either enrolled in an arts program or working in the field. In contrast, the remaining participants were amateur artists

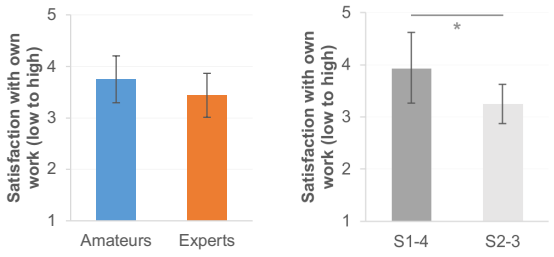

Figure 2: Left -participants' satisfaction with their work for participants with different painting expertise. Right - participants' satisfaction with their work across the edge (sessions one and four) and intermediate sessions (two and three). * denotes $p < .05$.

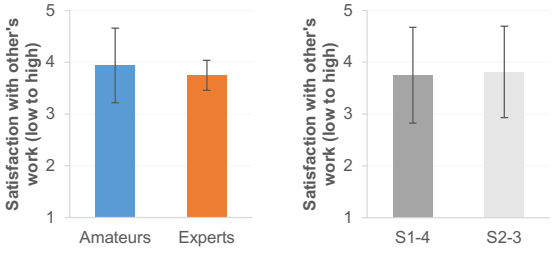

Figure 3: Left – participants' satisfaction with their collaborators' input for pairs of participants with different painting expertise. Right – participants' satisfaction with their collaborators' input across the edge and intermediate sessions.

with existing portfolios. The participants, aged between 18 and 62 years (M = 29.88, SD = 17.63), had minimal (N=5) or no experience (N=3) with VR. The study spanned four days, with each pair participating in two asynchronous painting sessions per day. On the fifth day, participants were interviewed together regarding their experience and the artwork produced. To avoid influencing dynamics, participants were not introduced to each other until the final day, minimizing prior relationships.We grouped participants by experience, forming two pairs of amateurs and two pairs of experienced artists. We recorded stroke distances, active painting time, and branches created during each session. After each session, participants completed a survey to evaluate their and their collaborator's contributions, using a 5-point Likert scale. Our analysis focused on two main factors: participants' expertise (amateurs versus experts) and session type (edge sessions: one and four versus intermediate sessions: two and three). Results indicated that amateur pairs painted for longer and participants reported greater satisfaction with their work (Figure 2) during edge sessions (M = 3.94) compared to intermediate sessions (M = 3.25, $t(7) = 2.76$, p = .028). Satisfaction with collaborators (Figure 3) showed no significant differences based on expertise or session type ($p > .704$). Three pairs used the branching feature, mainly during intermediate sessions, to explore new directions or modify work. The evaluation of PaintBranch was positive, with participants completing joint VR paintings and reporting an average satisfaction of 3.84 for their collaborator's work. Most participants enjoyed the unpredictability of their collaborators' input, finding it entertaining and a pleasant surprise, although some had difficulty following their partners' themes. Most, especially experienced artists, branched for exploration. Participants appreciated the asynchronous, anonymous format, which encouraged creative freedom. VC integration supported clear contributions management and visualization of artwork evolution, enhancing collaboration.

4 Future Work and Conclusion

This study used PaintBranch under specific conditions: asynchronous, anonymous collaboration across four short sessions involving participants of similar expertise. One limitation is that our findings cannot be generalized to all possible uses of PaintBranch, such as different participant numbers, session durations, or collaboration contexts. Future research should explore how factors like participant diversity, task nature, or different social settings impact collaboration. Further research should include AI-driven tools (based on Ubiq extensions [8, 5]) to enhance collaboration, synchronous features, and support for larger teams to study social dynamics. Additionally, the system's branching user interface could be optimized to manage more intricate projects involving multiple artists over extended timeframes. Another potential area for exploration is integrating augmented reality (AR) tools, which could allow real-world environments to serve as inspiration or even canvas spaces for VR-based collaborative art.

Acknowledgments

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