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Poster

Creating adaptive and interactive stories in Mixed Reality

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Abstract

The following paper proposes the study, the design and the preliminary development of a solution for supporting users without programming experience in creating stories in a Mixed Reality environment. We focus on a Mixed Reality interface split into two parts: the creation and observation phases. During the creation phase, the end user can build his/her own story in the immersive mode of the Mixed Reality experience. The user can also enjoy the stories that other users have designed by seeing the characters appear in their surrounding environment.

CCS Concepts

• ***Human-centered computing*** → *Mixed / augmented reality; User interface toolkits;* • ***Computing methodologies*** → ***Scene understanding;*** • ***Software and its engineering*** → *Integrated and visual development environments;*

1. Introduction

The interest in AR, VR and MR technologies and applications is constantly growing, involving more and more people. According to the Seeing is believing report by PwC [†], it is forecast that over 23 million jobs will be enhanced by Virtual Reality (VR) and Augmented Reality (AR) technologies globally by 2030. The fields of application are many, including medicine, engineering and entertainment. Each application is designed to carry out an activity in a simplified way or to create new interactive environments set in their own reality. Indeed, in the last few years, many tools for immersive authoring have emerged (Oculus Quill, Google Tilt Brush, Microsoft Maquette). However, the majority of those tools employ Virtual Reality, and therefore, they don't consider aspects such as the correspondence between virtual and real objects. The goal of our work is to create a Mixed Reality application that enables users without programming experience (end users) to build a story invented or taken from books, directly in their own physical space. Moreover, they can also enjoy stories created by other users directly by seeing the characters appear in their surrounding environment.

2. State of the Art

End-User Development (EUD) [LPKW06] approaches focus on supporting users without programming skills in developing or adapting software applications. Many prior works support end-user storytelling in both research literature and commercial fields. An open-source visual storytelling tool called Fungus [Gam20] was created as a Unity 3D extension and functions for both 2D and 3D games. Additionally, there are relevant techniques in the literature that focuses on interactive 360° video editing. Blečić et al. [BCF*21, FST*19] offered an authoring tool for creating 360° video-only point-and-click games, describing the behaviour through rules. VR GREP [ZDAM16] proposed the solution closest to the one we present in this paper: a tool dedicated to end users for the design and development of VR applications. The support for behaviour definition is restricted to navigation and reaction to button presses, even though it offers a typical interface and manipulation capabilities for statically specifying the environment configuration.

3. Adaptive Interactive stories in Mixed Reality

The main goal of the project is to provide an editor for the immersive creation of stories with the addition of a special feature: adaptability. Adaptability is meant the capability of a scene to be adjusted according to the physical space it is projected. To reach this goal, the project is split into two phases: **creation** and **observation**, described in Figure1. In the first phase the application helps the user in placing the character, in the second the system finds the best location for the characters by adapting the story to the surrounding environment.

3.1. The creation phase

The creation phase refers to the modality that allows the user to create stories directly into the surrounding environment. Since we work on Mixed Reality, we designed the interface to be controller-independent, adopting the interactions allowed by Hololens, i.e. gestures and voice commands. In this modality, the user can import characters and objects through an interface equipped with a set of 3D models. The prototype provides a dedicated interface to

† https://www.pwc.com/seeingisbelieving

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change the attributes of each character: gravity, interaction, manipulation (rotation, scale and movement) and colour. Moreover, the Speech feature allows to include a dialogue box with a recorded message implemented with the Microphone Stream provided by HoloToolkit. Lastly, the user can animate the character by choosing one animation among the ones available in our system. Those parameters will generate the various settings to give to the story. The focus of this phase, however, is on positioning constraints to be able to perform the story in the user environment. The user can choose whether to place the 3D model in a valid position manually or automatically. A valid position is an area free from any physical or digital object, where the character's bounding box does not collide with physical or digital objects. We exploited Spatial Mapping and Spatial Understanding information through the set of ObjectPlacementDefinition, Topology, Shape query and Raycast mechanisms provided by the Holotoolkit. Spatial Mapping provides a detailed representation of the surfaces of the real world in the physical environment, while through Spatial Understanding it is possible to obtain a higher level of information and therefore go beyond the meshes and surface planes. These algorithms allow during the observation phase to understand which are the valid surfaces for the repositioning of all the characters so that the story can be adapted to a completely different environment. In manual positioning, the user receives feedback on the position thanks to a circle placed under the character's feet: if green the area is valid, and in red it is not. For automatic positioning, the user chooses the typology of the surface (floor, wall, sit) and the application finds the best positioning area (using the character's bounding box). The user needs to specify for each character one of the following constraints:

- **Group Constraint**: Characters who are part of a group are physically close to each other. It ensures that during the observation phase the characters are placed in the same way, at the same distance and without any physical obstacle between them.
- **Positioning constraint for single character**: the characters can be placed in the room as long as the position is valid.

The user might want to insert the character at an not-valid area, in this case s/he can relax this constraint.

3.2. The observation phase

During the observation phase, the user is able to enjoy a story even if s/he is not the creator, regardless of the room. Firstly, the system scans the room, to collect all the data necessary to reproduce the story. Once the room has been mapped, the observation phase is divided into 3 phases:

- Calculate the bounding box of the character(s)
- Initialize the query made available by the ObjectPlacement
- Enrich the query with further constraint and rules query based on appropriate specifications

Constraints are constraints that the ObjectPlacementSolver (a class inside the Holotoolkit package) will try to observe, while rules are constraints that the solver must necessarily observe. For the project, most of the rules constraints' were used, so as to fully satisfy the constraints imposed by the story builder during the creation phase in the fruition phase. If there is a group constraint, the bounding box

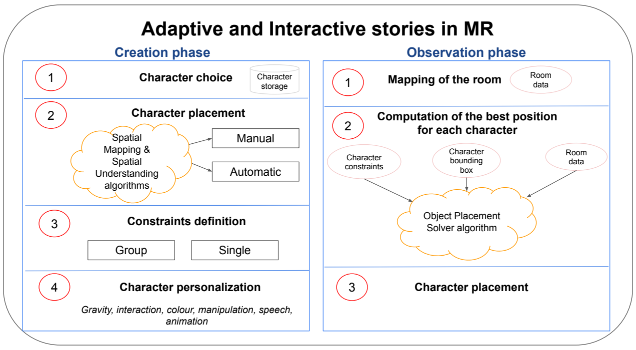

Figure 1: *The system's phases and components. In the left column, the steps of the creation phase are: 1) character choice (they are picked from dedicated storage), 2) placement (manual or automatic, in both cases we use Spatial Mapping and Understanding algorithms), 3) the definition of constraints (group or single), and 4) character personalization. The right column shows the observation phase which starts with 1) the mapping of the room (it produces the room data), 2) the computation of the best position for each character (the object placement solver algorithm takes as input the room data, the character bounding box and constraints), and 3) the character placement (based on the previous output).*

of the group's characters will be calculated so that the ObjectPlacement of the Spatial Understanding considers the overall bounding box of all the characters together with the bounding box of the area between each of them. By doing so, the solver in combination with some rules and placement queries will look for the best free area that can include all the characters in the group, maintaining their arrangement and respecting the constraints imposed by the story builder. In the case of a positioning constraint for a single character, the solver will compute the best positioning area respecting the rules defined during the creation phase. The analysis we made considering the bounding box is not enough, because it can happen that a mesh includes both a part of the wall and part of the floor. To solve this problem, we proceeded with a more refined analysis to identify the typology of the surface. Sometimes, it may happen that the room is not suitable for the story developed. For instance, the room is too small, the furniture is arranged in such a way that it is not possible to replicate the character placement or a combination of them. The system will ask the user to choose another room in this case.

4. Conclusions and Future Works

The objective of the project was to develop a Mixed Reality prototype that would allow users without programming experience to build a story directly around the physical space and to be able to enjoy the stories that other users have designed. Future work will focus on the introduction of a set of features to make the experience more immersive, replicating the lips movements of the characters, expanding the set of animations and surfaces and offering more visual effects. We will also introduce some storytelling components in a future version. In the near future, we are going to collect some user feedback by organizing an evaluation session where we would let them experience the interface and produce some results.

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