VR Safari Park: A Concept-based World Building Interface using Blocks and World Tree

Shotaro Ichikawa
Tohoku University, Japan
sho8219@riec.tohoku.ac.jp

Kazuki Takashima
Tohoku University, Japan
takashima@riec.tohoku.ac.jp

Anthony Tang
University of Calgary, Canada
tonyt@ucalgary.ca

Yoshifumi Kitamura
Tohoku University, Japan
kitamura@riec.tohoku.ac.jp

ABSTRACT

We present a concept-based world building approach, realized in a system called VR Safari Park, which allows users to rapidly create and manipulate a world simulation. Conventional world building tools focus on the manipulation and arrangement of entities to set up the simulation, which is time consuming as it requires frequent view and entity manipulations. Our approach focuses on a far simpler mechanic, where users add virtual blocks which represent world entities (e.g. animals, terrain, weather, etc.) to a World Tree, which represents the simulation. In so doing, the World Tree provides a quick overview of the simulation, and users can easily set up scenarios in the simulation without having to manually perform fine-grain manipulations on world entities. A preliminary user study found that the proposed interface is effective and usable for novice users without prior immersive VR experience.

CCS CONCEPTS

• **Human-centered computing** → **Virtual Reality**;

KEYWORDS

Concept-based Modeling, Interaction Design, Entertainment

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1 INTRODUCTION

Recent advances in virtual reality technologies enable us to create an imaginary world in immersive virtual environments (IVEs). In VEs, we can construct buildings, terrains, ecosystems, weather patterns, and complex simulation as a "god" of the worlds. Immersive virtual reality tools allow us to create worlds by directly manipulating world artefacts and features. However, world building in full IVEs is still difficult and cumbersome because they require meticulous object manipulation. As such, it is difficult to rapidly prototype new worlds, or to explore different alternatives without considerable work.

Figure 1: Abstract image of our proposal interface

We are interested in a different approach with a more conceptual and enjoyable world building experience, rather than relying on direct and delicate object manipulations. This would help non-technical designers and illustrators to exploratory create multiple alternative imaginary worlds.

In this paper, we propose a novel concept-based world building interface using the metaphors of blocks and a world tree. Blocks represent world elements that are easily graspable with VR handheld controllers in IVEs. The world tree is an abstract representation of the world simulation where the height of world tree's branches corresponds to the world's layers. For example, the highest and lowest branches correspond to the world's sky and ground conditions respectively. The user's playful experience is based on the idea of playing with children's toy blocks: a user grasps and manipulates blocks representing elements (e.g. animals, weather patterns, etc.), attaching them to the branches of the world tree adds the element to the simulation, and varies the combination of connected blocks on it for exploratory describing abstract concepts of imaginary worlds and interactions between elements. Once blocks are attached to the world tree, a

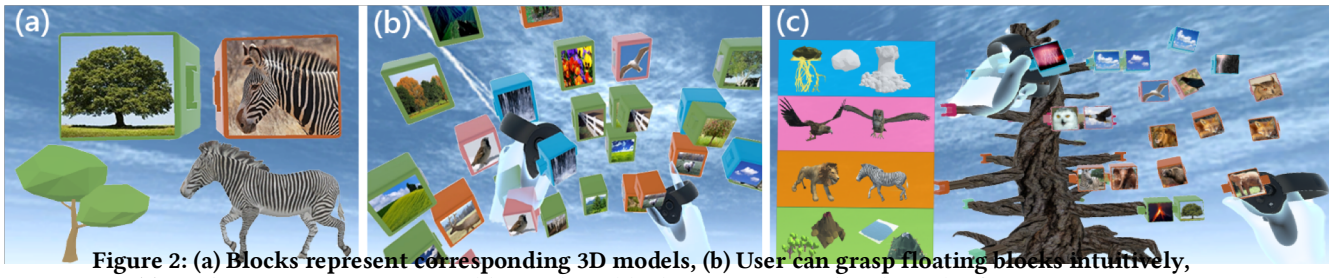

Figure 2: (a) Blocks represent corresponding 3D models, (b) User can grasp floating blocks intuitively, (c) To design an imaginary world, attaching blocks to corresponding branch of tree connector

corresponding animated 3D objects appear and they are automatically arranged into the world using our simulator. This approach allows users to rapidly and enjoyably create new worlds, and to explore variations of the world through simple block manipulations. Further, the world tree acts as a simple overview of the world structure.

We conducted a preliminary evaluation of this approach with 8 participants, and they found this approach allowed them to create an imaginary world more smoothly. It indicates that our proposal interface has adequate usability for novice users.

We make three contributions in this paper: first, we introduce a concept-based world building approach; second, we illustrate this approach through VR Safari Park, which provides a block-based interface for the concept world building approach, and combines this with direct manipulation for finer-grained manipulations; finally, through a preliminary user study, we demonstrate that this approach is easy to learn and allows novices to rapidly and enjoyably create new worlds in a world simulation.

2 RELATED WORKS

While numerous efforts have been explored world design tools, we briefly review related work from manual and procedural modeling approaches.

2.1 Manual modeling

The most common approach to design virtual worlds is where a user manually selects game assets from a database and (re)arrange them into the world using a graphical menu and a pointing interface [e.g. 3, 4, 5]. This approach is still used for modeling through immersive virtual environments using HMDs and controllers [e.g. 6, 7, 8, 21]. While this allows for detailed and delicate element arrangement, most of these approaches require considerable meticulous manipulations.

2.2 Procedural modeling

Another approach is procedural modeling, which has been an active research topic for decades. The basic idea is to use world simulators with preset 3D models, textures and their parameters, which automatically generates various terrains such as buildings [9], cities [10] and plant ecosystems [11]. This approach does not require meticulous user manipulations; however, it is difficult for users to edit and modify details of automatically generated 3D models and worlds.

Some approaches combine procedural and manual operations, where the system interactively simulates worlds based on user's live sketch [e.g. 12, 19, 20]. This is most similar to our approach, but still hard for non-technical users or non-illustrators to sketch an overall landscape from scratch.

2.3 Block UI for modeling

Toy blocks are a well-known tool to develop children's various skills through play, such as stacking and connecting. This metaphor has been well explored to allow users to construct virtual objects and worlds in an intuitive and playful manner [1,2]. This approach benefits from the use of the block metaphors for exploratory and abstract worlds creations. We follow this basic idea and aim to enable users to describe their high-level abstract ideas using block connections.

3 PROPOSAL: Concept-based World Building with Blocks and a World Tree

We propose a new concept-based world building interface where users focus on describing concepts of imaginary worlds to easily and rapidly to sketch out a world. For example, "There is a clear sky, some elephants walking by a waterside and a few lions wandering around a hill for hunt..." This kind of rough imaginary information is an example of the concept of world creation in this work. As we describe, our approach relies on using the metaphors of blocks and a world tree which enables to create worlds rapidly without fine-grained manipulation/orientation of objects in the scene. The basic workflow involves selecting elements represented by blocks from the pool, and then arranging them around the virtual world tree. This cycle is repeated to progressively create worlds. We describe these two main components:

3.1 Blocks

We use colorful blocks to represent elements of the world. Figure 2a shows two types of blocks, trees and animals. One of the faces of the block has an iconic figure corresponding to the 3D object it represents. The reason we use the block representation instead of miniature of 3D models is to evoke childhood block play experiences. Also, blocks can be easily graspable and connectable each other by VR handheld controller (Figure 2b), which we hoped would encourage users to manipulate in order to test various worlds. This block-shaped interface is based on ViBlock [13],

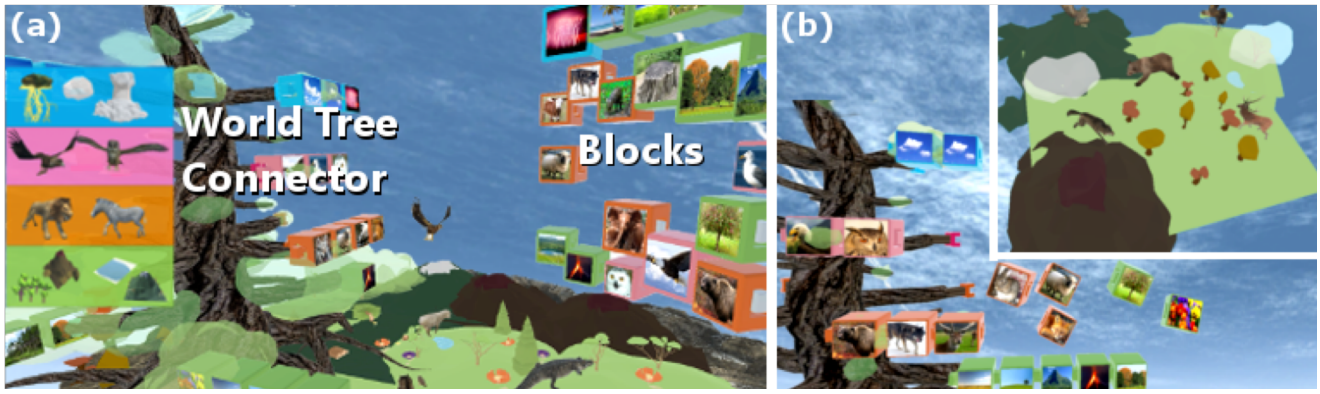

Figure 3: VR Safari Park. (a) World Tree Connector and Blocks, (b) Tree shape represents the world's structure

which also uses blocks and a connector interface to interact with virtual animal picture book.

As the Figure 2b and 2c show, there are several different block types in different colors. Each block should be connected to the same color branches of the world tree interface (Details are found in the next subsection).

3.2 World Tree Connector

The world tree connector is a tree-shaped interface that forms the basis of the connection between the elements and the simulation. The tree is a metaphor of world's structure in mythology like Tree of Life, but also a famous visualization method of hierarchal information[14]. We merge these two concepts and use it in our concept-based world building interface. Several works have proved the benefits of combining a tree diagram and tangible elements (e.g., [15]). As an example, in our VR safari park prototype (see Figure 3a), the world tree has four layers of branches, each representing different types of world elements: weather, flying animals, terrestrial animals, and terrain (see Figure 2c). Thus, user can attach desired blocks to or detach unnecessary blocks (elements) from the branches of the world tree connector to describe the concept of the imaginary worlds.

Once a block is connected to the world tree's branch connector, a corresponding 3D model appears and is arranged on the ground automatically using our park simulator. If the block is removed, the models disappeared from the world. With this new concept-based world building interface, a user is able to focus on describing the imagined scenario using different types of world elements using blocks and world tree connector.

4 VR SAFARI PARK APPLICATION

We implemented VR Safari Park, an interactive park building tool as our proof of concept prototype. The following introduces the work process of Ken, a typical user who uses the system to build a safari simulation.

At the initial stage, there is an empty miniature scene, a world tree connector and blocks floating in front of Ken's view. He selects and grasps building blocks that he would like to see in the park, then describes the concepts of the worlds by attaching them to the corresponding branches of the world tree (Figure 3a). After

Figure 4: Example of created park

corresponding 3D objects appear on the ground, Ken is able to refine their positions and orientations with finger-based direct interactions. If he wants to explore different concepts, he can detach, attach or exchange blocks on the world tree. The shape of the world tree is an abstract representation of the worlds structures (Figure 3b). If a ranch is created, he can connect several cows blocks on the second lowest branch, and perhaps includes a few terrain blocks on the lowest branch. Figure 4 shows a created park when a variety of animals and terrain blocks are constantly arranged on the tree.

After building, he switches his viewpoint from god view to the ground level first person view (Figure 5b). In front of him, rabbits are wandering inside the forest, birds are flying over the mountains and, hippopotamuses and crocodiles are resting near the water's edge. In our simulator, the system recognizes geometrical information like natural elevation and inclination of the terrain, and these affect the behaviors of the animals. For example, animals cannot go up a steep slope. Instead, they look for a gentle path. Moreover, simple interaction among elements are also simulated to approximate natural behaviors. For instance, putting a hungry lion near a zebra means the lion attacks to the zebra. Animal activities change according to weather condition. For example, when thunderstorm occurs, birds fly away, and terrestrial animals go under the trees. After a user gets to the ground, he can walk through the world by manipulating the joystick of the VR controller or directly walking in real space within the headset capture area. Thus, he can enjoy watching

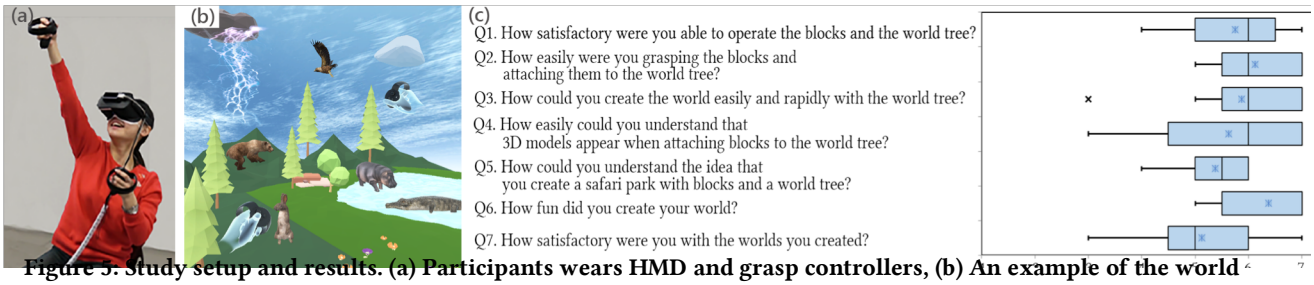

Figure 5: Study setup and results. (a) Participants wears HMD and grasp controllers, (b) An example of the world created in the study from ground level first person view, (c) Results of questionnaires

animals' interactions and interacting with them. Here, animals are designed to respond to the user's touch interaction with short animations and sounds. When he wants to make minor changes to the safari park, he can return to the god viewpoint and customize the world by rearranging the blocks on the tree.

More detailed system behaviors can be found in our video figures. VR Safari Park is a sophisticated working system that will provide new exploratory and playful user experiences for world builders.

5 PRELIMINARY EVALUATION

We conducted a preliminary user study to evaluate usability and possibilities of the proposed interface. For this study, we recruited 8 participants (4 female, 4 male) with an average age of 21.3 (SD=0.99). They reported almost no VR experience with HMD, but four participants had experience with 3D CAD tools.

Participants played VR Safari Park about 10 minutes after a brief introduction. We took enough time to instruct them how to manipulate virtual blocks and use the tree connector. They also practiced several times before the actual session. They wore the Oculus Rift CV1 to get immersive virtual environment, and used Oculus Touch as controllers (Figure 5a). The study took place in the university lab's experiment room. The tracking area provided by Oculus Sensor for Rift and Touch is $2\text{m} \times 2\text{m}$. Participants were asked to create their original safari park using four type of blocks and they had to switch to ground level view at least once. After the experience, participants answered SUS (System Usability Score) test [15] and questionnaire on the system and the experience. This questionnaire used a 7-point Likert scale.

While each participant had different design strategies, they all clearly understood that the tree connector shows the status of the worlds in construction and branch's height shows the hierarchy.

Result of SUS usability sore was 77.2 (M=77.5, SD =7.50) on average, which means "GOOD" in adjective ratings and "ACCEPTABLE" in acceptability ranges, according to Bangor's report [16]. We could see that our interface had enough usability.

Figure 5c shows the results of questionnaire. Q1 and 2 indicate that user could satisfactorily manipulate virtual blocks and connect them to the world tree. We observed that at the beginning of the experience, some participants could not correctly perceive the distance between their hands and the virtual blocks. However, as time passed, they got used to it and enjoyed the world building. The rest of our questions were about the main features of the interface. High scores (more than 5.4) in Q3 and 4 show that they quickly understood our approach that combining blocks on the world tree. From Q5, we know that they could construct the world quickly and easily. And, Q6 and Q7 show that they were satisfied with and enjoyed creating their own worlds. All question items had high scores and the interface was generally preferred by all participants.

6 DISCUSSION

We examined our proof of concept prototype in the study. As a next step, we will compare our interface with other tools such as Editor VR [8] (since the proposed system is implemented using Unity [17]). We expect our approach to be more effective in constructing imaginary worlds from abstract concept than conventional methods because users only need to consider what and how many elements they want to use. On the other hand, it may be challenging to build complex building structures by combining and stacking parts precisely. Thus, this concept-based approach is mainly suited for world building situations where elements do not have a strict spatial relationship with one another. Potential target users of our interface would be VR game designers who want to create various types of game world terrains with certain ecological simulations. Other possible users include illustrators or paint creators as our system can easily provide 2D image from different viewpoints by screen capture. Furthermore, when the simulation includes more realistic ecological knowledge, we believe that the system can be extended into an interactive educational application through playful and rapid world building experiences. Regarding the interface design, our block connection has various visual and sound feedback that was preferred by participants while the viewport switching part can be improved in the next version.

7 CONCLUSION

We proposed a novel concept-based world building approach where users can rapidly create and manipulate worlds simulation using blocks and a world tree. We built VR Safari Park as our first prototype and discussed its usability and potential through a preliminary user study. We found that the proposed interface is effective and usable for novice users without prior immersive VR experience. Future work includes a novel visualization with more features of tree shape, but a more solid comparative study with other tools should also be necessary.

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