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VR Tour: *Guided Participatory Meta-Narrative for Virtual Reality Exploration*

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VR Tour:
Guided Participatory Meta-Narrative for Virtual Reality Exploration

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VR Tour is a platform for guided participatory virtual reality exploration based on a meta-narrative paradigm.

CCS Concepts: • **Computing methodologies** → *Graphics systems and interfaces*; • **Applied computing** → *Media arts*;

Additional Key Words and Phrases: virtual reality, meta-narrative, storytelling

1 INTRODUCTION

Virtual reality has been developing at a very fast pace recently. The hardware is improving in terms of both quality and usability. The software is incorporating many techniques that take advantage of current research results.

The above scenario motivates the development of novel applications that expand the possiblities in various areas, such as entertaiment, education, industry, and science.

In this document we present *VR Tour*, a technological platform for virtual reality exploration, and a methodology for the develpment of applications using it.

1.1 Guided Participatory Meta-Narrative Tour

VR Tour promotes a guided participatory meta-narrative exploration of content in virtual reality. The platform has a foundation in the following concepts:

- Meta-Narrative – It is assumed that the content is associated with a story. The exploration of this content uses meta-narrative techniques to present the story.
- Navigation – It is also assumend that the story takes place in a space. The environment is explored through navigation in this space.
- Guided Tour – The exploration is guided by a "host" that directs the participants ("guests") though their journey.
- Participatory VR – The guests experience the tour in a shared virtual reality environment. They can interact among themselves a also with the host .

1.2 Applications

The VR Tour platform has potential applications in many areas. Most specifically those that deal with story-based content.

In entertainment, virtual reality experiences engage participants to exploit the muti-faceted dimensions of a story.

In museums, exhibits can be enhanced by virtual reality exploration of content, including contextualization.

More generally, different forms of education and training are good scenarios for meta-narrative tours.

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2 META-NARRATIVE VR

Meta-narrative virtual reality exploits story-based content and provides mechanisms for immersive interaction of participants in a controlled environment.

2.1 Narrative-Based Content

The content is associated with a story that can be fictional, such as a theater play, or factual, such as a documentary.

2.2 Entities

The main entites involved into the story-based content are:

- Characters – the agents of a story;
- Sets – the ambients where the action takes place;
- Objects – the relevant artifacts for the plot.

These entities will represented in virtual reality integrating the virtual environment for interactive exploration.

3 VR KINO+THEATER

VR Kino+Theater [1] is a new platform for storytelling that shares various aspects of Coppola's vision of Live Cinema. The main difference is that it is based on 3D Computer Graphics and Digital Network Communications.

The platform we propose integrates traditional forms of entertainment, such as Theater and Cinema, with advanced technology, more specifically Virtual Reality and Gaming.

The main components of VR Kino+Theater exploits the conceps of *Situated Participatory Virtual Reality* and also *Live 3D Digital Cinema*.

The VR Kino+Theater is the technological infrastructure used in VR Tour.

3.1 Situated Particpatory VR

Situated Particpatory Virtual Reality [2] is a modality of VR that allows the creation of *Shared Multi-User Virtual Environments*. For this purpose, it combines real and virtual objects in tangible spaces, where the participants, represented by digital avatars, are completely immersed in a simulated world. They use VR headsets and markers for full body motion capture.

The above setting implements the *Theater* component of the platform. As such, the actors perform in a VR stage that is mapped into a virtual set.

Fig. 1 shows the real actors performing in the VR stage and the corresponding action of their avatars in the CG virtual set.
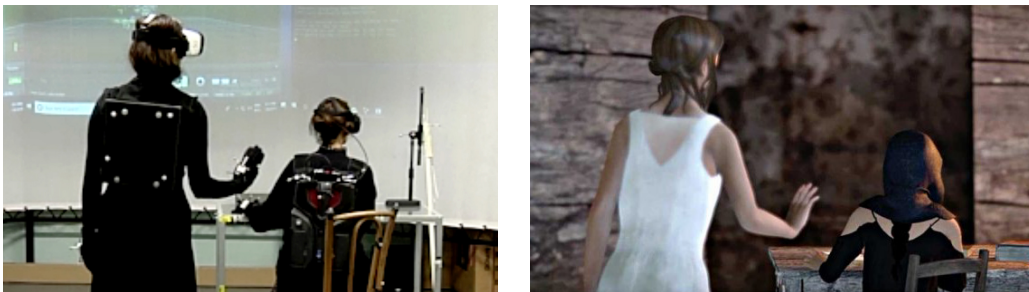

Fig. 1. VR Theater - VR Stage and CG Virtual Set.

3.2   Live 3D Cinema

Live 3D Digital Cinema is the technology behind the non-immersive Audio-Visual presentation format of VR Kino+Theater. It consists of the Computer Graphics infra-structure for Animation, Real-Time Simulation and Rendering of the experience.

The virtual cinematography framework includes *Pre-Programmed Cameras* and *Interactive Editing* for generating the cinematic content.

The above setting implements the *Kino* component of the platform. In this context, the director selects in real-time the views that are shown on the live movie projection screen.

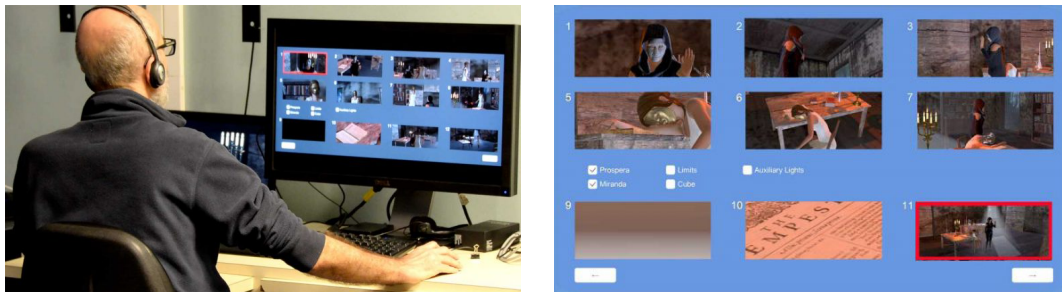Fig. 2 shows the director operating a multi-camera switcher during a live presentation.

Fig. 2. Director operating the camera switcher and detail of the interface.

4   VR TOUR

The VR Tour is a guided participatory experience of a narrative-based content in virtual reality.

In that context, the key elements are the people participating in the experience and the spaces where the experience takes place.

The VR Tour follows a program with a sequence of steps that accounts for the different parts of the experience.

4.1   People

The classes of people that make up the experience are:

- Host – acts as a *guide* that conveys the story to the participants. Typically, a real actor/actress that is represented in VR by an avatar.
- VR Guests – participants of the experience that are immersed in the virtual reality environment and interact directly with the Host. They are also represented in VR by avatars.
- Guests – participants sharing the experience in a " movie theater". They interact indirectly with the Host.
- Staff – technical crew members that operate the stages and help participants.
- Director – responsible for selecting the images of the virtual reality environment that are projected on the cinema screen for the guests.

4.2 Spaces

The physical and logical spaces where the experience takes place are:

- VR Stages – virtual reality studios for the host and guests with all support for situated participatory interaction.
- Theater – movie theater with a cinema screen and a live microphone, respectively for the guests to view the experience and interact with both the host and guests through an audio link.
- Web – support for pre and post experience engagement of the participants.

Fig. 3 shows one of the VR Stages at the VISGRAF Laboratory, IMPA.

Fig. 3. VR Stage.

4.3 Program

The VR Tour consists of a program that is composed by three main parts: *Preparation*; *Fruition* and *Follow-Up*.

The preparation takes place in the real world and accounts for the initial involvement of the participants with the VR Tour. It has the following steps:

- Registration / Data Collection – the potential participants first approach the VR Tour through the Web. They register for the experience and enter their personal data using the Internet Portal of the Tour.
- Reception – at the VR Tour site, the participants are welcomed by the techincal staff in order to give them instructions, take them to the VR Stages and hook up the VR equipment. Other participants may be directed to the movie theater.

The fruition of the experience happens in the virtual environment. The Host and VR Guests use the VR Stages and the regular Guests use the Movie Theater.

The experience can be structurally divided into three phases, that happen in different shared spaces in virtual reality, as described below:

- Introduction – the participants are introduced to the story in a neutral space, such as the *Atrium* of a architectural complex.
- Scenes – the story develops though a sequence situations that happen in different virtual *Sets* .
- Conclusion – the end of the experience is a closing that returns to the *Atrium*, before the participants leave the virtual environment.

After the fruition of the experience, the participants can continue to explore the story remotely through the Web.

- Follow-Up – the Portal of the Tour allows further interaction at home or using mobile and also connected to social media platforms.

5 VR AVATARS

The players in the VR Tour experience are individuals that can be divided into three classes: *Story Characters*; *Tour Host*; and *VR Guests*.

These players are represented in the virtual reality environment by digital avatars with different characteristics according to their classes.

5.1 Story Characters

The story characters are part of the base narrative content, such as a theater play. They have the following characteristics:

- Full Body Avatar – the characters are played by real actors and they are depicted by a digital humanoid in a style (i.e., realistic or cartoon) that is conducive to the nature of the story.
- Complete Motion Tracking – the movements of the actors are tracked by sensors of a motion capture system and transfered to the characters.

Fig. 4 shows an example of a digital avatar for the character Ariel of the Shakespeare's play The Tempest, interpreted by the actor Rick Yates. The avatar is modeled with the actor's physical proportions.

Fig. 4. Digital Character Avatar and Actor.

Fig. 5 shows the motion capture set-up for the digital avatar of the character Prospera. The system tracks the actress movements using sensors at her feet, hands, torso and head.
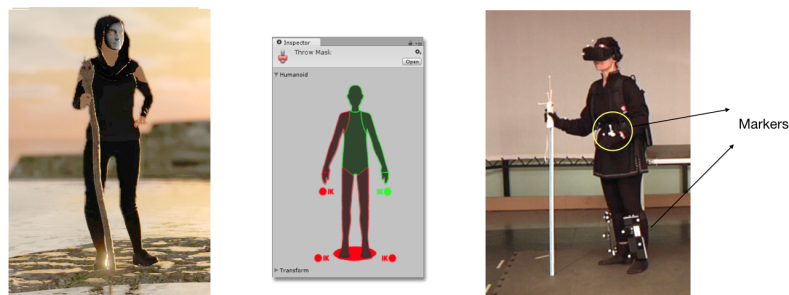

Fig. 5. Full Body Motion Capture.

The actor's performance for the narrative content are typically capture and recorded in pre-production and than played during the VR Tour. In this setting, the content can be segmented and played as separate clips during the VR Tour.

5.2 Tour Host

The Tour Host is responsible for guiding the participants through the VT Tour experience and is represented by a simple digital avatar that has only the following components:

- Head – to indicate the Host position and gaze to the participants.
- Hands – to allow a basic motion expression, such as pointing, for communication with the particpants

The Tour Host has also virtual interface elements, such as a HUD, at his disposal in order to control the Tour presentation, as will be discussed in Section 9.

The Host can be played live by a real actor or based on a pre-recorded performance previously captured. Another option is to employ an synthetic digital assistant generated using AI (artificial inteligence).

In any case, the visual appearance of the host should be distinctive for easy identification by all participants of the experience. Also it should reflect his nature, for example, an artifical hosts could be depicted as a robot, as shown in Fig. 6.

Fig. 6. Artificial Tour Host represented by a robot..

5.3 VR Guests

The VR Guests are immersed in a shared virtual reality environment. They participate of the experience live and interact with the VR Host. Their digital avatars are somewhat impersonal and minimalist, with the following components:

- Head – neutral appearance, possibly suggesting gender (male/female);
- Controller – for pointing to objects and making simple signs.
- Name Tags – for identification of their identities (ID).

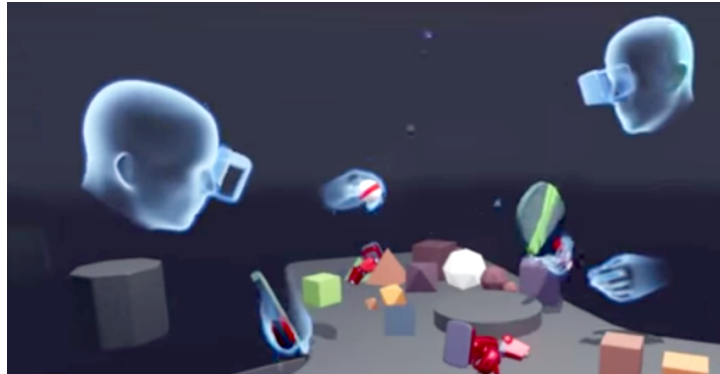Fig. 7 shows an example of the visual representation of the VR Guests avatars.

Fig. 7. VR Guests Avatars.

6 VR ENVIRONMENT

The VR Enviroment is constituted by the static components of the virtual world. They include the Virtual Spaces and the Virtual Elements;

6.1 Virtual Spaces

The Virtual Spaces are basically the "Sets" where the story takes place. Usually the narrative calls for various ambients that correspond to different sets.

These ambients can be indoors or outdoors, and include all elements that compose the sets, such as furniture and etc.

Fig. 8 shows an example of a Virtual Space, the Cell Set of the play The Tempest.

Fig. 8. Virtual Set - Top and Side View.

Furthermore, the virtual space is structured logically in order to facilitate the Tour to follow the narrative. In that respect, the following is defined:

- Spots – location where some action hapens in a segment of the story.
- Areas – parts of the virtual space that correspond to the VR motion capture physical area for tracking the VR Host and VR Guests.
- Paths – trajectories that are used to follow some action of the narrative.

During the Tour, for each segment of the story, the Areas are mapped to the corresponding Spot. Note also that, the VR Host and VR Guests do not need, necessarily to be co-located. In this case, their areas are different and usually mapped to disjoint relative locations in the Set.

Fig. 9 shows a top view of the Cell Set with the Areas for the VR Host (in outline) and the VR Guests (in red).
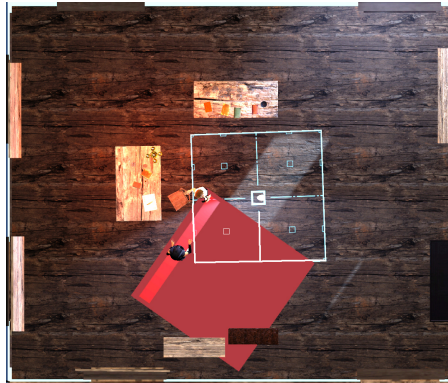

Fig. 9. VR Areas for the VR Host and VR Guests.

6.2   Virtual Elements

The Virtual Elements of the VR Enviroment are composed by the objects that are part of the Set and also other elements that are used for interaction during the tour.

The interactive Virtual Elements can be of the following types:

- Cards – descriptive graphical signs attached to parts of the Set.
- Captions – used to show the textual representation of dialogues.
- Markers – indicate specific locations of the Set.
- Active Images – used for videos and interactive animations.
- Lights – illumination controlled to highlight parts of the Set.
- Mechanisms – objects that animate and ca be interacted with.

7   TOUR SCRIPT

The VR Tour is described bt the Tour Script. It contains all the content data and structure of the experience. It has also a computational representation with the matematical models used by the procedural infrastructure.

7.1   Content

The Content of the Tour is composed by both the narrative and meta-narrative parts that fit together within a partial order. So, these components are as follows:

- Text – the basic text to guide the meta-narrative. It lists the main points that refer the storyline. It is intended to serve as a basis for improvisation by the host.
- Story Clips – parts of the story that integrate each segment and are played during the Tour.
- Partial Order – non-linear dependencies between the different parts of the meta-narrative.

7.2 Structure

The Structure of the experience consists of Sequences, Scenes and Segments. A Sequence is divided into Scenes and a Scene is broken into Segments.

- Sequences – main logical parts of the Tour.
- Scenes – parts of the story with spatial and temporal continuity.
- Segments – sub-parts of a scene with a meta-narrative text and a narrative clip.

7.3 Representation

The Computational Representation of the Script is a Graph that encodes a State Machine used in the Exploration.

- Graph – the nodes represent states that correspond to segments and edges that correspond to valid transitions from a current node to other nodes.
- State Machine – controls the traversal of the graph through time during the experience.
- Exploration – the active instance of an experience. It has a context that registers the current state as:
  - unvisited nodes (active)
  - visited nodes (inactive)

8 TOUR EXPERIENCE

The experience of the VR Tour is accomplished by the fruition of the meta-narrative of the story through the exploration in time-space of the faceted aspects of the content.

In that respect, the VR Host guides in this journey the VR Guests along the various paths inside the virtual reality environment, with the remote participation of the other Guests (i.e., non-vr). The relevant issues in the Tour experience are: Navigation; Guided Participation; Interaction; and Cinema Presentation.

8.1 Navigation

The navigation in the VR environment is controlled by the VR Host that uses teletransport to move between the Spots of different story Segments, as detailed below:

- Teletransport – the VR Host activates a teletransport mechanisms to take the VR Guests from one Spot to another. This transforms the relative locations of the Areas of both the Host and Guest to the Spot.
- Active Spot – the current part of the VR environment being explored during the Navigation. It is associated with a particular story Segment.

Fig. 10 shows an example of Teletransport feedback. The VR Host indicates the location of the next Spot anticipating the move to VR Guests.

Fig. 10. Teletransport Feedback.

8.2 Guided Participation

In each Spot, the VR Host uses meta-narrative techiniques (i.e., improvisation, etc.) to describe to the Guests a part of the story that corresponds to the Segment being explored in the visited Spot.

Typically, this description is divided in three parts: first, the Host comments on the main points of that part of the story; next, the story Clip is played; and finally, the Host makes concluding remarks. During this process, the Host may possibly ask for input and participation of the Guests.

The mechanisms for this guided participation are as follows:

- VR Host – uses the controller for the operations: Go (teletransport); Play (clip); Emphasis (indication/highlighting)
- VR Guests – can interact using the microphone and the controller for audio communication and pointing to objects, respectively.
- Guests – can interact remotely using group microphone.

As a result of this structure, the experience is similar of a visit to a Wax Museum, in the sense that the participants got to different locations of the environment where a scene is depicted. The characters are static as wax statues in the museum. But differently from the real museum, in the VR experience magic happens and the characters come to life to enact a part of the story.

8.3 Interaction

As mentioned in the previous subsection, both the VR Host and Guests can interact with the Set using the VR Controller as follwos:

- Highlighting – the Host has the option to highlight / activate by pointing with the controller to objects.
- Pointing – the Guests can only indicate with the controller to locations in the Set for visual communication.

Fig. 11 shows an example of the laser pointing effect using the controller.
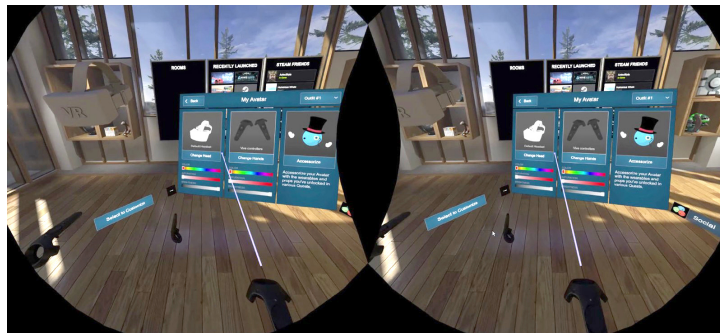

Fig. 11. Laser Pointing.

8.4 Cinema

The Guests that are not immersed in the VR environment participate of the experience throught a Cinema presentation, in the spirit of VR Kino+Theater. In that context, the following mechanisms are used.

- Cameras – programmed to show the views of the Virtual Set to the Guests. The can be controled by the Director or automatically.
- Microphone – the theater is equipped with a microphone in front of the movie screen for use by the Guests to communicate with the VR participants.

9 SYSTEM ARCHITECTURE

VR Tour is implemented in Unity on top of the VR Kino+Theater platform (See Sec. 3).

The system architecture of VR Tour is composed of a procedural layer that implements the VR Tour State Machine and the associated data structures for the VR Tour Representation, as described below:

9.1 Tour Script

The Tour Script, presented conceptually in Sec. 7, is the main representation of the system that is used by the VR State Machine. It is essentially as follows:

- Directed Graph – where nodes represent Segments and edges represent valid transitions.

9.2 Segments

The Segments represent the Data and Actions of the Script for Tour exploration.

- Data – spatial, temporal and symbolic information associated with the meta-narrative segment.
  - spot (position / orientation)
  - time interval (begin / end)
  - objects (effects)
- Actions – allowed operations for navigation and interaction.
  - go (spot)
  - play (interval)
  - trigger (effect)

9.3 Transitions

The Transitions from one Segment to another is implemented in the following way:

- off characters (current segment)
- teletransport (to next spot – indication)
- on characters (next segment)

9.4 Exploration Interface

The operation of the system by the VR Host entails the navigation and interaction using an interface composed of a HUD and a Controller.

- HUD – contains a grid of buttons corresponding to each segment in a scene. It is only visible by the VR Host and enabled / disabled using the Controller.
- Controller – has buttons to execute all the operations for navigation and interaction.

Fig. 12 shows an example of the HUD used for exploration. The elements of the grid indicate the ID of the Segment / Clip. Visited segments are distinguished by a different color. The current Segment is highlighted by an outline.
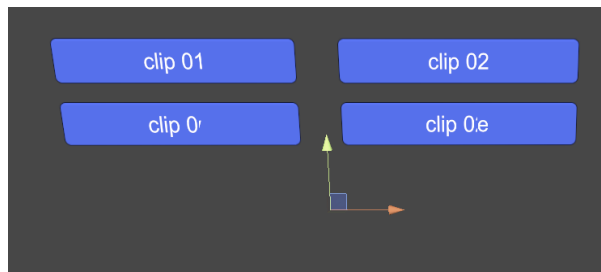
Fig. 12. HUD with the grid of segments.

Fig. 13 shows a diagram of the Controller with the indication of the buttons and respective operations. Nameliy: HUD On/Off; Play/Pause Clips; Teletransport to selected Spot; Context Reset (i.e., clears the VR Tour State).

1: HUD On / Off (Segments)
2: Play / Pause (Clips)
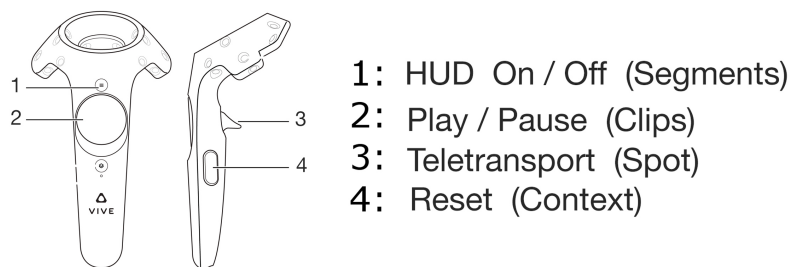**3:** Teletransport (Spot)
4: Reset (Context)

Fig. 13. VR Controller and buttons for operations.

10 CASE STUDY : THE TEMPEST

In order to demonstrate the concept of VR Tour and test the system we are going to use the experiment "The Tempest" based on the Shakespeare's play and developed by the VISGRAF Laboratory [3].

We selected from the Tempest experiment two scenes to compose our narrative as a cut of the story. The scenes are taken from Act I of the play.

The program for the experience follows the canonical structure discussed in Subsect. 4.3 with the Scenes of the narrative, plus an Introduction and Conclusion

The Introduction and Conclusion Segments take place in an Atrium. This Set is an virtual room with hexagonal form, where each wall has a poster related to the Tempest play. Fig. 14 shows the Atrium virtual set.
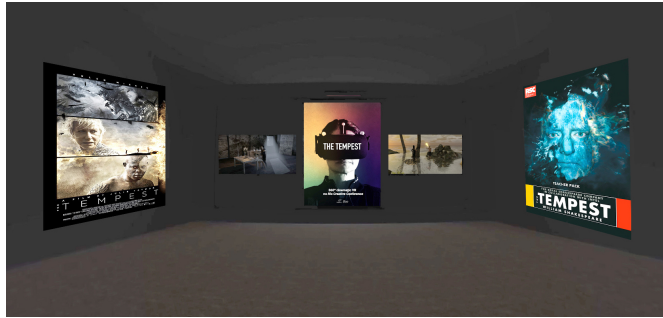
Fig. 14. Atrium Set.

The first scene is a dialogue between the characters Prospero and Miranda that is situated on Prospero's Cell. Fig. 15 shows the Cell Set.

Fig. 15. Cell Set.

The second scene is a dialogue between the characters Prospero and Ariel that happens in a Clearing in the Island where the story unfolds. Fig. 16 shows the Island Set.

Fig. 16. Island Set.

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