The Crime Scene Investigation

ZHU LI and WEIHAN JI, University of Washington

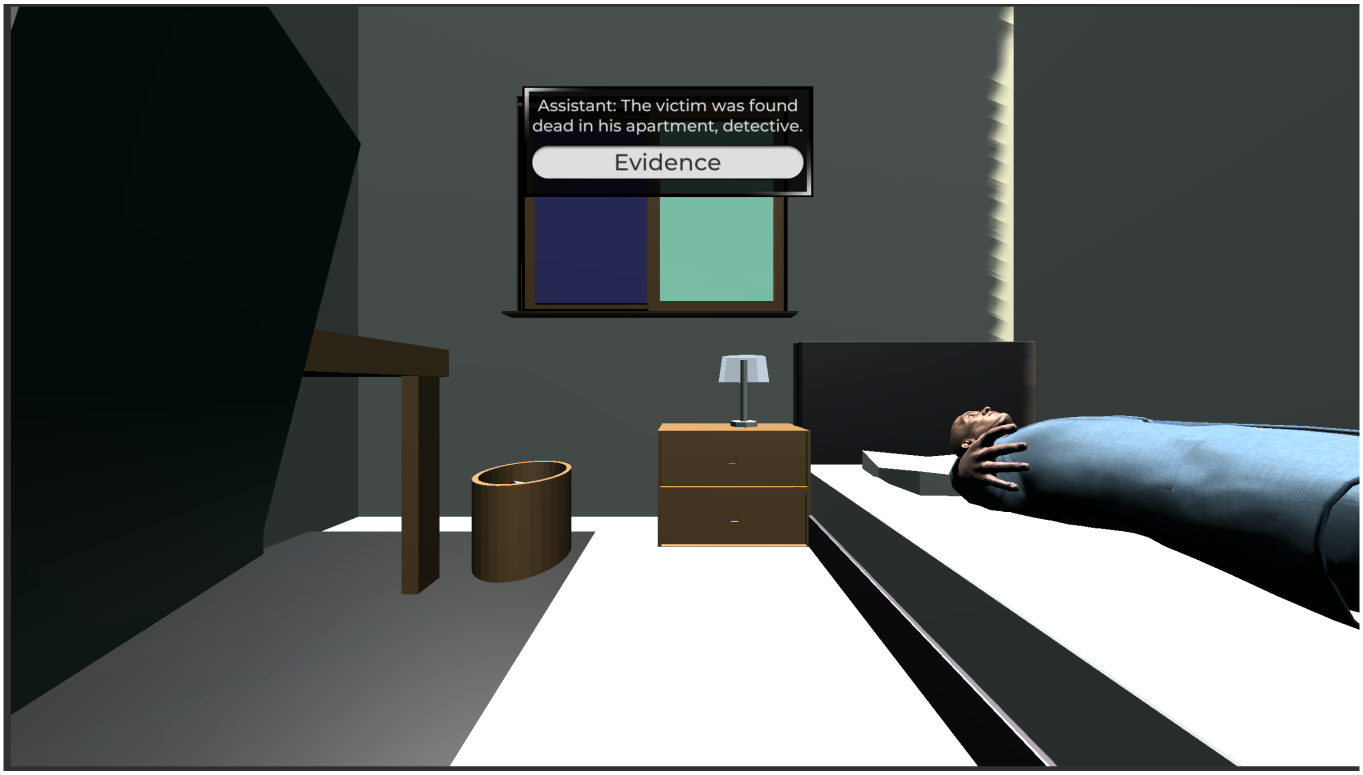

Assistant: The victim was found dead in his apartment, detective.

Fig. 1. Our final project is a virtual 3D simulation of crime scene investigation. The user is able to turn his or her head around to have a 360 degree view of the scene and click on certain objects in the room to receive more information about the evidences to solve the case. Unity and blender are used to to build up the scene. Teaser video can be found at: https://youtu.be/_1cHiOYaJwI

Our group project aims to design a virtual 3D simulation of a crime scene investigation. The user will need to have a VR headset and hand controllers. After they put on the head set, the users will be able to view a crime scene in 360 degrees by turning their heads around, and find evidences by clicking on different models they found to be suspicious in the scene using hand controllers.

1 INTRODUCTION

In our project, we designed a 3D-simulation of a crime scene. Wearing a Oculus Quest headset, the user will be able to view a crime scene in 360 degrees by turning their heads around, and look for evidences. They will also be able to click on certain spots inside the scene using hand controllers. There will be text displaying next to the evidence after the user made the selection. After acquiring sufficient information, the user should be able to identify what is the cause of death of the victim. The inspiration comes from many existing VR tour applications made using Unity. Some of the applications involve house tour and famous scenery tour. They aim to provide the users with a 360 degree view of the surroundings, and sometimes if the user click on certain spots, they should be able to receive more information about that particular spot.

Our group thinks that similar work can be done to reconstruct some realistic views of crime scenes to allow the users to solve the case by clicking on different spots to received more hints on the evidences. For future work, we expect that the user is able to get a closer look on the evidence by clicking it to receive a magnified view. Also, potential scene changes could be triggered when some evidence has been discovered. Moreover, evidence collection could be enabled to help players review what they know about the case.

1.1 Contributions

- Story design, scene design and creation of a crime scene in Unity using free unity assets and blender models.
- Add UI text display triggered by OVRInput from quest hand controllers in the Scene.

Authors' address: Zhu Li, liz67@cs.washington.edu; Weihan Ji, weihaj@cs.washington.edu, University of Washington.

- Enable interactions between controller input and game objects in the scene.
- Utilized OVRCameraRig plugin to replace the normal Unity camera

2 RELATED WORK

Previous works has been done on creating skyboxes to create 360 degree view for real world scenes [2018]. By using a cylindrical panorama, they have created a skybox material and add it to the scene from the lighting menu. When wearing a VR headset, the user will feel like they are sitting in the center of s sphere and the images got projected onto the inside of this sphere. They have also cube mapped images to create a 6-sided cube sky box material as well. Both types of skybox have generated a pretty realistic virtual experience.

We are also inspired by work done on adding ray selection to unity project [[n.d.]a]. This blog has a very detailed explanation on how to set up ray cast interactions between controllers' laser pointers and other game objects in the scene. It provides a very clear explanation on event systems and UI interactions with VR gears.

3 METHOD

3.1 Design

In the design phase, we outlined the story including the process of crime, chain of evidence, and the underlying worldview.

In the story, there are multiple suspects so that the user need to make their mind to figure out the correct criminal with a reasonable modus operandi. On the surface, the victim without any external or internal injuries or abnormal seems to die of cardiac failure due to overwork. During the exploration, we want to lead the players to uncover the suspects with the objects in the scene, and discover unusual things going on in the virtual world. For instance, when the players find the victim's phone, they will discover a contact list including different suspects. They will be able to contact different people after this step for testimony and oral confession.

In order to achieve realistic experience, we designed multiple story lines that leads to different endings according to the player's decision of the case. As a detective, the player may decide that the person died from cardiac failure, suicide, or one of the suspects. We have also designed a "true ending" that is intended to be the official truth and ending for the story which is, however, the most difficult to uncover. The "true ending" will describe the world view and ask ethical questions related to virtual reality for the player to think about even after playing.

To increase the complexity of the game, we have design a full chain of evidence. Figure 4 shows a flowchart for part of the evidence.

Next, we designed the scene according to the story and evidence. We set the initial scene to be at an apartment room with the essentials that a bedroom should have. For the body of the victim, our initial thought was to use white lines outlining a human figure as in a real crime scene after the body has been moved away. However, the drawback is losing visual evidence that only a body may show, such as the shoes on the victim (unusual because the victim was found on his bed). Therefore, we decided to use a free Unity asset for building a human model.

3.2 Implementation Details

The hardware we used is Oculus Quest, includinhg a headset and two controllers. We primarily worked on Windows 10 computing system, with a mixture of macOS Mojave.

The software we used to build graphical models is Blender. We also included free Unity assets including picture model from Maksim Bugrimov [[n.d.]] and the victim body's model Studio New Punch [[n.d.]]. Then, we primarily used Unity2019.3.5.f1 for game functionalities and user interactions, and integrate in Oculus for inputs and outputs. Our major software packages in use are Android SDK and Oculus integration including the OVR Utilities Plugin. It has the benefit of showing different eye anchors and containing a tracking space to track everything. We referred to the documentation provided by Oculus for implementations [[n.d.]b].

For the position and head tracking, we used OVRCameraRig which is a custom VR camera in the OVR Utilities Plugin.

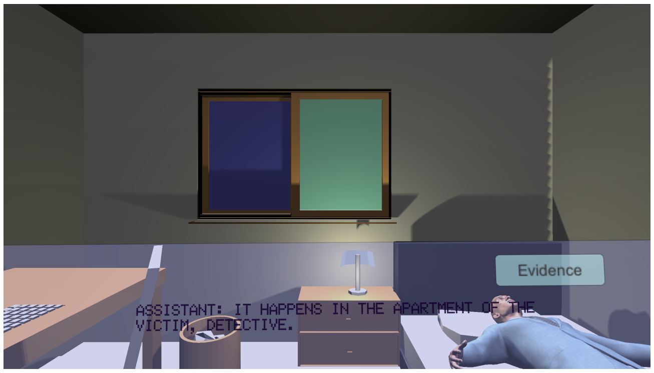
For hand tracking, we created custom hand objects and attached them under the left and right hand anchor within the tracking space of the OVRCameraRig. We also attached scripts including the OVR grabber to enable hand pose tracking.

For object and UI item selections, we added a ray caster to the right hand. Upon entering the game, there will be a magenta ray going from the right hand to the direction that the hand is pointing. During the game, players can press button "B" on the controller to enable or disable the ray. We added layer masks on the ray caster and arranged game objects into different layers. In this way, it is guaranteed that players can interact with objects corresponding to our designed evidence chain.

For the interactive UI panel that display hidden evidence associated with objects and guiding player's investigation, we wrote script for a canvas that inserts UI components dynamically into the scene. Upon interaction with different objects, the script accepts the object's unique name as a key to determine the specific display for that object. We have also considered different ways of text display. Figure 2 shows a previous approach we took that attach the panel into the tracking space of the camera. The benefit is that the players can always see the texts during the game regardless of their movement. The downside is that it hinders part of the vision and object selections. Since we would want to enable interactions with almost all the objects in the scene, we decided to fix the canvas at one position inside the scene that does not affect any of the objects (Figure 3).

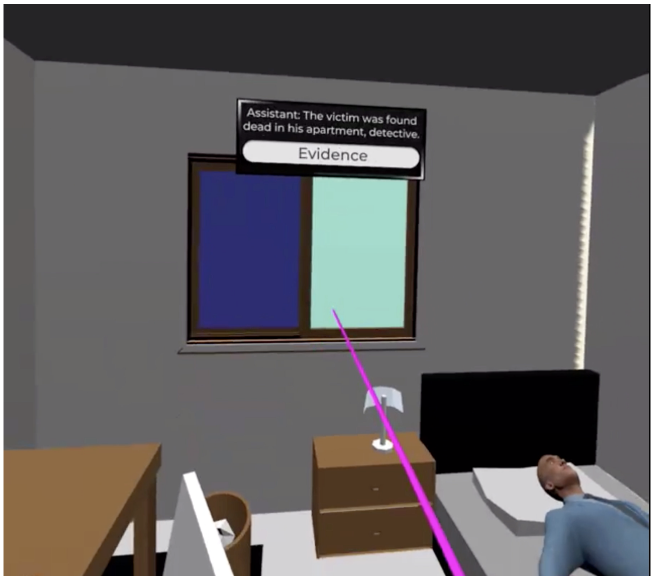
4 EVALUATION OF RESULTS

The final outcome of our project allows user to look around the room and look at the evidences. They are able to take a closer look at different evidences in the scene. They can interact with a part of the objects for a pop-up UI text window that may allow them to check deeper into. The text displayed in the UI text box is clear and easy to read. Also when the user is moving his/her head around or handler sound, there is not any noticeable time lagging in the view change.



ASSISTANT: IT HAPPENS IN THE APARTMENT OF THE VICTIM, DETECTIVE.

Fig. 2. Text display UI sticking to the camera, while hindering part of the vision.



Assistant: The victim was found dead in his apartment, detective.

Fig. 3. Text display UI at a fixed position that does not move with the camera.

However, there are still a lot of things to work on for this project. One major issue with the project is that when the users are using ray caster to shoot lasers from hand to select target evidences, it does not feel very realistic. There is some small deviations between the hand positions and the laser initialization positions. This might cause the user unable to choose their targeted objects in the scene if they do not move the hand controllers with close attention.
Another issue in the project is the entire scene feels like very unrealistic, especially when light falls on certain models on the scene and creates shadows. This is a problem caused by unrealistic ray tracing. We could see there are some "jaggies" on where the shadow is casted and this is caused by aliasing. The transition from the shadow to the light area does not look smooth. Potential fix for this problem is to apply some anti-aliasing techniques such as super-sampling to eliminate those "jaggies".

5 FUTURE WORK

One of the feature that could be added in the future is to have a magnified / detailed view of the selected items.We believe that this could be achieved by adding hot spots on the scene to make the user feel more interactive when reading about evidence details.

Another feature is to add scene switching in the is project. In order to achieve that, we would need to incorporate the use of scene manager in Unity. For criminal case investigation, it is not ideal to limit the investigation in only one room. One example is to create a separate living room scene and put some evidences there. This will give more potential for exploration for the players.

For a better case solving experience, another feature to add is to enable storage of found evidence at a given time during the game, such as a handbook or a bag. This can help players review what they have discovered and chain the evidence together. At the moment, we embedded a placeholder of this functionality as an "evidence" button in the UI text panel. Future work may explore different approaches that enhances the game experience.

We also expect to work on improving the pop-up evidence, potentially changing more text into graphics. This is because graphical items are more user friendly than pure texts. For instance, future work may change the contents in the computer into a realistic screen of a computer.

6 CONCLUSION

Our project inspired by virtual tourism applications aims to provide a virtual experience of the a crime scene such that the user is able to have a 360 degree view of the scene when wearing a VR headset. They are able to take closer investigation on different evidences by using hand controllers. Due to the time limitation, we believe that there are still a lot of modification could be done to improve this project. Potential future work include the use of Unity scene manager to switch between difference scenes; add magnified view of the evidences after the user clicked on the object and add a storage of discovered evidences as well.

ACKNOWLEDGMENTS

We would like to express our thanks to CSE490V staff for their help on the projects, especially a special thanks to Kirit for lending us Oculus quest.

REFERENCES

[n.d.]a. Easy Controller Selection. https://developer.oculus.com/blog/easy-controller-selection/
[n.d.]. Maksim Bugrimov. https://www.artstation.com/maxbugor
[n.d.]b. Oculus Unity Getting Started Guide. https://developer.oculus.com/documentation/unity/book-unity-gsg/
[n.d.]. Studio New Punch. https://assetstore.unity.com/publishers/11404
Tessa Chung. 2018. How to Design VR Skyboxes. https://medium.com/aol-alpha/how-to-design-vr-skyboxes-d460e9eb5a75

A FLOWCHART FOR PARTIAL EVIDENCE CHAIN

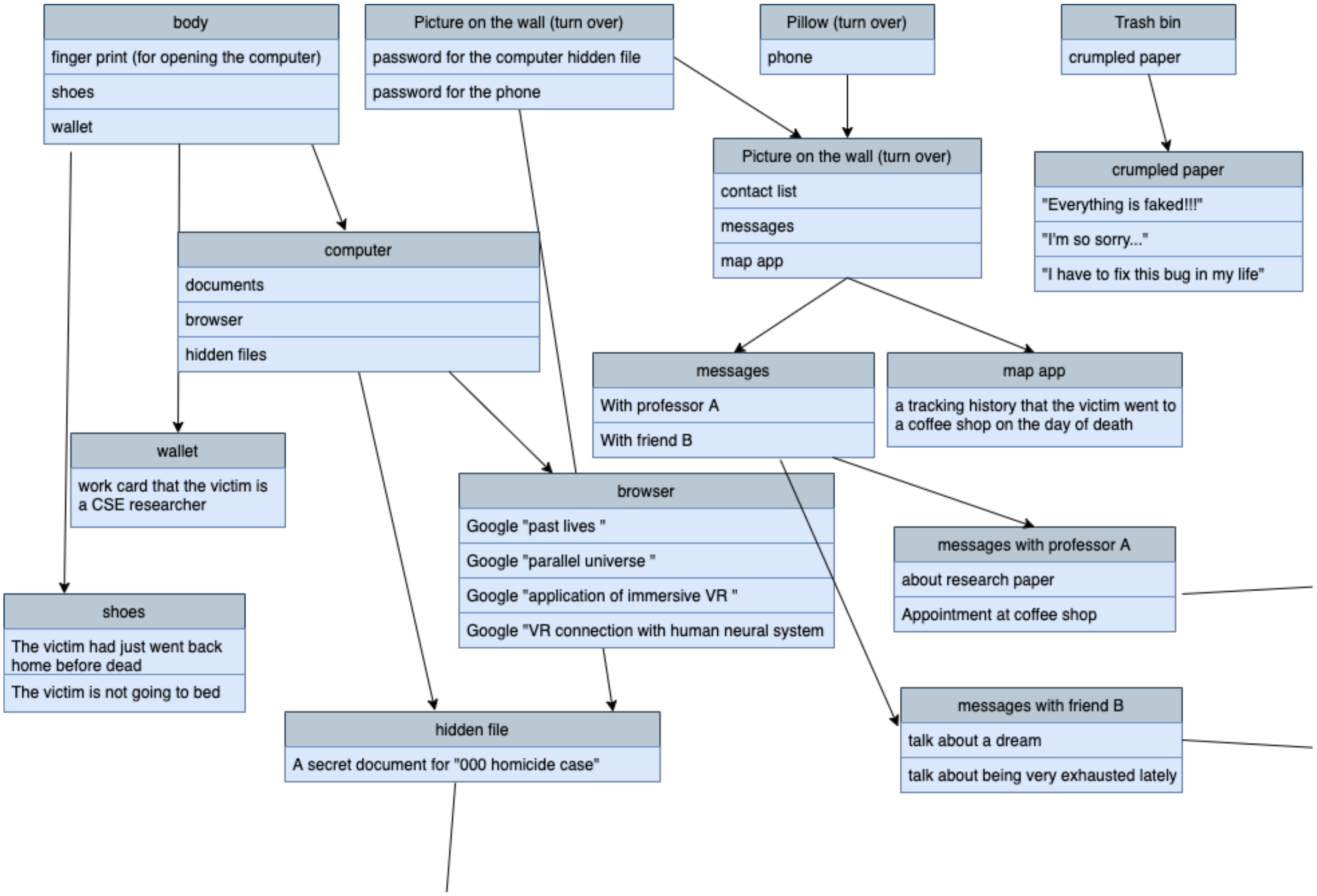

body
finger print (for opening the computer)
shoes
wallet
Picture on the wall (turn over)
password for the computer hidden file
password for the phone
Pillow (turn over)
phone
Trash bin
crumpled paper
Picture on the wall (turn over)
contact list
messages
map app
crumpled paper
"Everything is faked!!!"
"I'm so sorry..."
"I have to fix this bug in my life"
computer
documents
browser
hidden files
messages
With professor A
With friend B
map app
a tracking history that the victim went to a coffee shop on the day of death
wallet
work card that the victim is a CSE researcher
browser
Google "past lives "
Google "parallel universe "
Google "application of immersive VR "
Google "VR connection with human neural system
messages with professor A
about research paper
Appointment at coffee shop
shoes
The victim had just went back home before dead
The victim is not going to bed
hidden file
A secret document for "000 homicide case"
messages with friend B
talk about a dream
talk about being very exhausted lately

Fig. 4. Flowchart for part of our designed evidence chain