Way Out: A Multi-Layer Panorama Mobile Game Using Around-Body Interactions

Shan-Yuan Teng
National Taiwan University
Taipei, Taiwan
tanyuan@cmlab.csie.ntu.edu.tw

Mu-Hsuan Chen
National Taiwan University
Taipei, Taiwan
wenny820622@gmail.com

Yung-Ta Lin
National Taiwan University
Taipei, Taiwan
lynda0214@cmlab.csie.ntu.edu.tw

CHI 2017, May 6–11, 2017, Denver, CO, USA.
ACM ISBN 978-1-4503-4656-6/17/05.
http://dx.doi.org/10.1145/3027063.3048410

Abstract
Thanks to motion sensors embedded in smartphones, we are able to navigate an omnidirectional panorama by moving the device around the body, as if the display is a peephole to another world. However, existing applications mainly focus on the spherical surface around the user with a constant radius, *i.e.*, *single-layer* navigation. We present *Way Out*, a game allowing players to navigate *multi-layer* panorama scenes by around-body interactions. *Way Out* explores the interaction possibilities of reaching out into panorama with depth. By utilizing the front-facing camera, the system tracks the player's face and infers the distance between the user and the device based on the size of the face, thus enabling depth interactions. In this game, the player can walk through a panoramic forest maze that consists of four layers in depth and drag items in physical 3D space.

Author Keywords
Mobile Games; Around-Body; Mobile Interactions

ACM Classification Keywords
H.5.m [Information interfaces and presentation (e.g., HCI)]: Miscellaneous

Figure 1: *Way Out* is a mobile phone game requires player to move the device around the body for navigation.

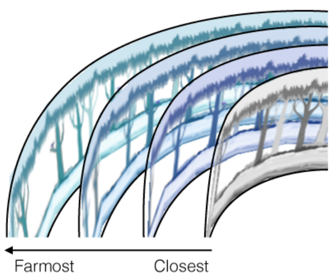

Figure 2: The game scene consists of four discrete concentric cylindrical layers.

Introduction

Motion sensors embedded in mobile devices enable panorama navigation through small screens by around-body motions. Users move the device around their body to unveil the surrounding scene, as if the screen is a peephole [4] into another world. However, during the navigation, the user can only see the panorama from a constant distance with a *static* viewing distance.

Inspired by a more recent work proposed using multiple panoramic sketches for story-telling in VR [3], we explore a new possibility of panorama interaction named *multi-layer panorama*. Different from *single-layer* panorama enabling zooming into a static image, a multi-layer panorama displays different levels of visual contexts according to different viewing distances. For example, users can browse a forest in the first layer and transit themselves to the second layer for observing additional details such as trees or bushes, as if they walk into the scene.

To control the viewing distance, we propose using around-body interactions – A user can transit himself or herself among the layers by moving a smartphone afar or close to his or her face. Such interaction leverages the user's spatial memory, enabling fast and precise transitions among layers. In order to compute the distance between the user and the device, the front-facing camera on smartphone is used to detect the user's face size. Larger face size represents closer distances, resulting closer layer of the panorama.

We finally propose *Way Out* (Figure 1), a mobile game demonstrating the potential of our design. In this game, the player can move intuitively in an omnidirectional forest maze. The player needs to pickup assigned items and cross different depths of the forest by using our method.

Related Work

This work was inspired by mobile panorama interactions and around-body interactions. Mobile peephole interface [4] is a way to experience immersive content on mobile devices. The user moves the smartphone around the body to view different directions of the scene. However current applications only provide one-layer spherical surface around the body. Recent work proposed multi-layer panoramic storyboards in VR [3]. Designers can quickly build up 3D scenes by rolling panoramic images into concentric cylinders. The work emphasized on the creation process, while we focus on the interaction between the viewer and multi-layer panorama.

Around-body interfaces [2] present ideas on moving the smartphone around various body parts at different distances to unveil digital information. The interface brings new dimensions to the existing system and leverages the user's spatial memory. However, the concepts have not yet been discussed in panorama. This inspires us to create a game exploring the possibilities of interacting with around-body multi-layer panorama.

Design

Way Out is a first person adventure game where the player's goal is to walk the way out of a multi-layer snowy forest maze for survival.

Limited by the narrow field of view (FOV) of the mobile device, players need to spend some time looking around the panorama to situate themselves into the scene. We let the player control the pace and focus on the environment.

Multi-layer panorama scene

To allow players to experience rapid transitions in a multi-layer panorama , we design a four-layer forest maze that the player can walk through, as shown in Figure 2. The

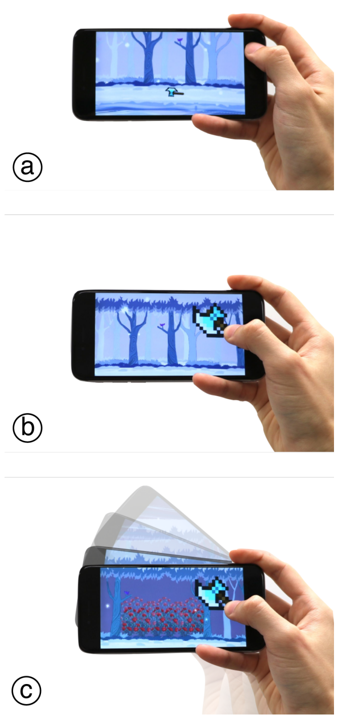

Figure 3: Manipulating game items: (a) Picking up the axe by touching the screen. (b) Touch and hold the screen to hold the axe. (c) Wave the axe to destroy the rose bush by shaking the smartphone.

player can see the deeper layers of the forest from between the trees. This attracts the player to move toward to explore. The trees are intentionally designed to be similar in each direction and layer. This forces the player making use of their spatial memory and the sense of body movement, making the experience more immersive.

To form a forest maze, we place light hazes (Figure 4(a)) to indicate where the player can go deeper into the forest; and trees and rose bushes (Figure 4(b)) to represent barricades that the player cannot pass through. Only by going through the correct light hazes in each layer can the player exit the forest.

Navigation in 3D space
To move farther into the scene, a common solution is to teleport by tapping the destination on the screen. Such transition breaks the immersion during the navigation because of the mismatch between the transition of virtual content and distance between the body and the scene.

To enhance immersivity, we let the user move the device afar to shuttle their region of interests into the distant destination (Figure 5), and move close to body to go back to the near scene. What is more, such around-body interactions enable quick transitions among different layers.

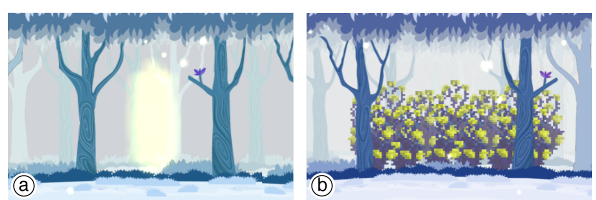

Figure 4: Maze signs: (a) The light haze. (b) The trees and rose bushes.

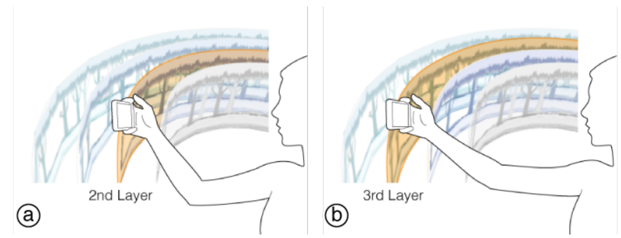

Figure 5: The player can move the smartphone away from body to go from current layer (a) to the farther layer (b).

Dragging and manipulating items for exit
The final exit is blocked by a rose bush. The player needs to pick up an axe in the specific third layer by touch and hold the screen using the thumb, as shown in Figure 3. The smartphone now acts like an axe, offering physical affordance to hold in hand.

The player grabs the axe across the layers to the exit, and waves the axe by shaking the smartphone, feeling like holding a tangible axe, to destroy the rose bush. The player survives the forest.

Implementation
The game was developed with Unity 5.3.4 on iPhone 6. For estimating the distance between the device and the user, we choose to track the player's face because when viewing panorama on mobile phone, the viewer is always facing toward the screen. Tracking the face size can infer the distance between the player and the device. We utilize the front-facing camera on the smartphone to track faces using LBP feature-based cascade classifier in OpenCV library. For each player, our game requires one-time calibration by asking the player to place the smartphone as near to face as possible while the player's can still focus their visual attentions on the screen.

To increase the stability of the size of the captured face, we use 1€filter [1] to wipe out noises. The game then infers the distance between the player's face and the device according to the stablized sizes of the face, resulting reliable transitions between layers.

The distance is mapped to the depth layers accordingly. However, we also found that the player's hand position would be unsteady when holding the device, resulting in unstable shifting between layers near the depth boundary of the layers. Therefore we design *dynamic* boundaries, *i.e.*, , once entering a new layer, the system dynamically sets a boundary for preventing unintentional movements. Within this manner, The player can only transit to another layer with significant inward or outward movements.

Future Work

Since players view the panorama through small screens, many regions of interest may be out of sight and not be discovered. Thus we plan to add spatial visual and auditory cues to guide players. Also, by wearing earphones with 3D sound, the gaming experience can be more immersive.

Besides face sizes, we can track the facial expression of players to enable new inputs on panorama games. For example, the player can smile to the animal in the scene to trigger conversations.

Conclusion

Based on the built-in motion sensor and front-facing camera on mobile phones, we implement a mobile game *Way Out* to explore the interaction possibilities of reaching out into a panorama with depth concept. In this game, the player can walk through a four-layer panoramic forest maze and drag items in physical 3D space. We present the interactions and limitation of the interfaces in gaming. The ambition of this game is to inspire future game design making use of physical 3D space.

Acknowledgements

We thank Dr. Da-Yuan Huang for his valuable suggestions.

References

[1] Géry Casiez, Nicolas Roussel, and Daniel Vogel. 2012. 1€Filter: A Simple Speed-based Low-pass Filter for Noisy Input in Interactive Systems. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '12)*. ACM, New York, NY, USA, 2527–2530. DOI: http://dx.doi.org/10.1145/2207676.2208639

[2] Xiang 'Anthony' Chen, Julia Schwarz, Chris Harrison, Jennifer Mankoff, and Scott Hudson. 2014. Around-body Interaction: Sensing & Interaction Techniques for Proprioception-enhanced Input with Mobile Devices. In *Proceedings of the 16th International Conference on Human-computer Interaction with Mobile Devices & Services (MobileHCI '14)*. ACM, New York, NY, USA, 287–290. DOI: http://dx.doi.org/10.1145/2628363.2628402

[3] Rorik Henrikson, Bruno Araujo, Fanny Chevalier, Karan Singh, and Ravin Balakrishnan. 2016. Multi-Device Storyboards for Cinematic Narratives in VR. In *Proceedings of the 29th Annual Symposium on User Interface Software and Technology (UIST '16)*. ACM, New York, NY, USA, 787–796. DOI: http://dx.doi.org/10.1145/2984511.2984539

[4] Ka-Ping Yee. 2003. Peephole Displays: Pen Interaction on Spatially Aware Handheld Computers. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '03)*. ACM, New York, NY, USA, 1–8. DOI: http://dx.doi.org/10.1145/642611.642613