Data Transfer Interaction Technique for Multi-source Visualization in Mixed Space

Songqian Wu, Tiemeng Li*, Yanning Jin, Haopai Shi, Shiran Liu

1) School of Digital Media & Design Arts, BUPT 2) Beijing Key Laboratory of Network System and Network Culture

Figure 1: Interactive Flow chart. (a) Select 2D visualization; (b) Data switching between different device spaces; (c) Interactive data monitoring in multi-source visualization of mixed space.

Abstract

This paper presents a data transfer interaction technique for multi-source visualization in mixed space. The technical solution consists of three parts: a Web client to parse existing 2D visualization data; HoloLens mixed reality client that handles gestures and immersive visualization data; and the server that receives and distributes messages. The user selects data elements on the existing 2D visualization through natural freehand interaction and drags them to the 3D visualization space. The Web client completes data extraction, the server completes data transmission, and the mixed reality terminal is responsible for gesture interaction recognition and rendering in the process of data transfer.

Keywords: Mixed space visualization, Multi-source visualization, data transfer.

1 Introduction

In multi-source visualization of mixed space, the data transfer of visualization data between multiple devices is the basic condition to improve data cognition and user experience. The multi-source visualization of mixed space consists of traditional Web 2D visualization and augmented reality immersive visualization, which constitute the interactive space of mixed space visualization. The current data transfer is usually completed directly in the background, lacking intuitive and explicit interactive driving methods. Therefore, it often leads to user interaction loss and is not conducive to collaborative interaction between multiple devices and multiple people.

An effective solution would be to transform the data transfer process from a background transmission to an interactive operation in a multi-source visualization of mixed space. Users are allowed to independently control the data transfer process to improve the naturalness of collaborative interaction in mixed space.

In this work, the data transfer interaction framework adopts the server-client architecture. The server distributes client information. The client includes the Web side for analyzing the visualization data of Web pages and the HoloLens side for processing the immersive visual data. We use freehand interaction to complete the data transfer interaction task. HoloLens client will recognize gesture data and complete data transfer interaction tasks in multi-source visualization of mixed space by directly utilizing its physical coordinates or converting it to Web screen coordinates.

* email address tiemeng2000@gmail.com

2 Design

This paper presents a mixed space interactive technique for data transfer between multi-source visualization devices.

Fig. 1 is the task flow of the data transfer interaction. In the multi-source visualization scene of mixed space, users can use gesture to select the visual elements of 2D visualization, for the sake of parsing and extracting the original data within this range. The obtained visualization data is then captured by the HoloLens terminal for the construction of immersive visualization. Finally, the visualization of both terminals enters the real-time monitoring state of user interaction operation.

The technical framework of data transfer interaction is divided into client side and server side, as shown in Figure 2. The server is responsible for receiving and forwarding data information from the client. The clients for multi-source visualization of mixed space include the Web side which presents 2D visualization and the HoloLens mixed reality side which presents immersive visualization. Because of the standardized structure of Web page, the Web side extracts visualization data by parsing the DOM subtree of Web page. The HoloLens client exists in the form of a HoloLens application through which users process gestures and immersive visualization data.

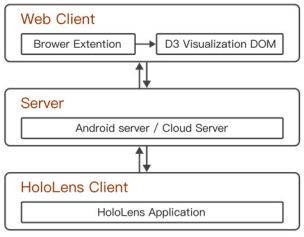

Figure 2: Technical architecture overview.

In terms of the specific functions of the data transfer interaction, the entire data transfer interaction technically can be divided into four modules: data extraction, data transmission, gesture interaction and visual feedback, as shown in Figure 3.

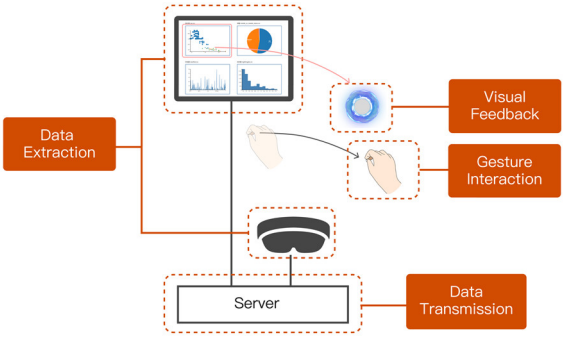

Figure 3: Functional framework: Data Extraction, Data Transmission, Gesture Interaction and Visual Feedback.

2.1 Data Extraction

Data transfer operations involve two types of communication objects: visual data and interactive data. Their extraction methods are also different.

Extract visual data. Existing visualizations on the network store a lot of reusable data information. For example, Interaction+[3] is a tool to enhances the interactive capability of existing web-based visualizations. It takes existing visualizations as input and analyses visual objects to facilitate visual exploration. In this paper, Harper and Agrawala[4] methods are used to extract visual data. This method realizes the deconstruction of visualization based on D3 tool library. It extracts the raw data bound by visualization, and analyses the mapping relationship between the original data dimensions and visual attributes.

Listen for interactive data. We obtain the system interaction by listening for visual element attribute changes. Interactions change one or more attributes of elements in the visualization. Our work adds a unique identifier ID to the raw data obtained in the 2D visualization and adds it to data attribute of the 2D visualization elements. In the multi-source visualization of mixed space, by detecting the changes of elements in the visualization, its identifier ID and the changed attributes are obtained and stored as interactive data.

2.2 Data Transmission

The server is responsible for forwarding data between different devices. In our work, WebSocket protocol is used to realize the server with Android mobile phone as the carrier, in order to complete the interactive task of data transmission.

2.3 Gesture Interaction

The data transfer interactive technique uses freehand interaction as the interactive input. HoloLens application is used to locate the physical location of the Web screen, and then the screen coordinates of the Web terminal and the spatial coordinates of the HoloLens terminal are coalesced, in order to construct a unified world coordinate system for the freehand interactive input space conversion.

The hand gesture should to be intuitive. In our work, the "Point" gesture with the metaphor of "drawing" is used to realize the scope selection and the "Pinch" gesture with the metaphor of "grabbing" is used to complete the device space switch.

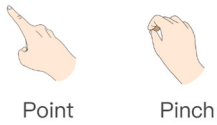

Figure 4: Basic gestures: point and pinch.

2.4 Visual Feedback

Visual feedback is used to present the state of the data interaction to the user. In this paper, data state is divided into two forms: ordinary form and interactive form. The ordinary form of data refers to the existing form of data when the user does not operate on the data and the data is relatively static in different devices of mixed space, which is presented in the form of data tables. The interactive form of data is the feedback state of data when visualization data is transferred between different devices, which is presented in the form of spherical virtual objects.

3 Conclusion and Future Work

This paper proposes a data transfer interaction technique scheme for multi-source visualization in mixed space, which transforms passivity into initiative and simplifies the process of building multi-source visualization for mixed space. The user selects the existing visualization on the Web side through freehand interaction and transfers the original data extracted from the visualization to the HoloLens side for creating immersive visualization. The visualization on the Web terminal and HoloLens terminal are also associated through the original data, and then enter the automatic monitoring state of visualization interactive data on both terminals, thereby realizing the linkage of multi-source visualization in mixed space. The future work of data transfer framework can also be improved from the following aspects.

Packet data forwarding. In the multi-source visualization scene of mixed space, the collaborative interaction is an effective mean for visual analysis. In the framework of data transfer interaction, users should be allowed to select the objects of data forwarding for efficient collaborative analysis.

Improve user interaction experience. In order to make the whole data transfer interaction process more smoothly and naturally, gesture elicitation study should be carried out in gesture design, and intuitive freehand movements are selected to reduce the memory burden of users. In terms of visual feedback, it is worth considering that the gradual change of data migration pattern between different devices to promote user understanding.

4 Acknowledgement

This work was supported by the National Natural Science Foundation of China (61702042).

References

[1] Hobson, Tanner, et al. "Alpaca: AR Graphics Extensions for Web Applications." 2020 IEEE Conference on Virtual Reality and 3D User Interfaces (VR). IEEE, 2020.

[2] de Araújo, Tiago Davi Oliveira, et al. "Real-time visualization reconstruction in a real-world environment using Augmented Reality." 2021 25th International Conference Information Visualisation (IV). IEEE, 2021.

[3] Lu, Min, et al. "Interaction+: Interaction enhancement for web-based visualizations." 2017 IEEE Pacific Visualization Symposium (PacificVis). IEEE, 2017.

[4] Harper, Jonathan, and Maneesh Agrawala. "Deconstructing and restyling D3 visualizations." Proceedings of the 27th annual ACM symposium on User interface software and technology. 2014.