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# The Rubber Slider Metaphor: Visualisation of Temporal and Geolocated Data

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## ABSTRACT

In the context of the IEEE VR 2022 3DUI Contest entitled “Arts, Science, Information, and Knowledge - Visualized and Interacted”, this paper presents a VR application to highlight the usage of the rubber slider metaphor. The rubber slider is an augmentation of usual 2D slider controls where users can bend the slider axis in order to control an additional degree of freedom value in the application. This demonstration immerses users in a Virtual Environment where they will be able to explore a database of art pieces geolocated on a 3D earth model and their corresponding art movements displayed on a timeline interface.

**Index Terms:** Human-centered computing—Human computer interaction (HCI)—Interaction paradigms—Graphical user interfaces; Human-centered computing—Human computer interaction (HCI)—Interaction paradigms—Virtual reality; Human-centered computing—Visualization—Visualization application domains—Information visualization

## 1 INTRODUCTION

The visualization of temporal data is common for immersive analytics applications, in which data has a temporal dimension. In such applications, a main requirement is to enable the user to control the time dimension to filter and select data of interest. A number of solutions have been proposed in the literature in the 2D interaction domain, such as TimeZoom [1], which proposed an interactive zooming solution offering multiple levels of detail, or the work of Morawa [3], in which users can interact dynamically with the data visualization by using key points of a graph representing the timeline. In this paper, inspired by 2D slider interaction, we propose the Rubber Slider metaphor, a novel, enhanced, pseudo-haptic control interface. The Rubber Slider metaphor gives better control to users over the displayed time range thanks to the additional degree of freedom and the pseudo-haptic feedback [4].

The Rubber Slider metaphor is illustrated through a VR application, which allows for the exploration of geolocated art pieces through different artistic and cultural periods. Art pieces are displayed on a 3D earth model, similarly to Orboot Earth AR<sup>1</sup>. Additionally, a side panel is used to show details about any selected art piece and a timeline enables the user to select a year that controls what art pieces are shown on the earth. The rubber slider metaphor is used to efficiently interact with the timeline.

## 2 VR APPLICATION STRUCTURE

In the proposed application, users are immersed in a virtual environment in which they can move freely and observe an earth model

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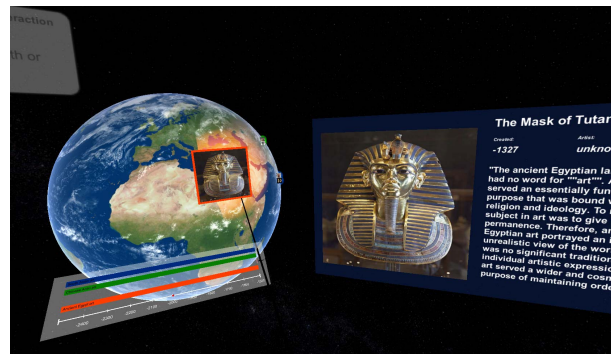


Figure 1: Overview of the application with the earth model showing art pieces being selected with the user ray (left), the timeline showing art movements (bottom left) and the selected art piece description panel (right).

on which various previews of art pieces are displayed (see Fig. 1). The Earth manipulation Below the earth, a timeline is displayed, as well as artistic movements that took place in the displayed time range. Users can switch between three different interaction modes: (1) Earth manipulation and art piece selection, (2) Timeline control and (3) continent selection for data filtering. All the interactions of the application are performed using one hand-held controller (e.g. HTC Vive controller) and a dedicated button is used for the mode switch.

### 2.1 Earth manipulation and art piece selection

On the virtual earth model, previews of art pieces are displayed at their creation location if they belong to one of the art movements occurring during the year selected on the timeline (see Sect. 2.2). In order to interact with the virtual earth and previews, users use a virtual ray originating from their controller. The ray can be used to hover, highlight and select a preview or rotate the earth model if no preview intersects with the ray. Selection of a preview is performed by pressing the trigger button which displays details regarding the corresponding art piece on the side panel (Fig. 1), including title, author, creation date and description. Rotation of the earth model is performed by holding the trigger button, and dragging it with the controller. This allows to observe previews of art pieces that were not directly visible in the previous position.

### 2.2 Timeline control

By adjusting the timeline, users can visualize on the earth art pieces from the art movements taking place from paleolithic to contemporary eras. The bottom of the timeline displays a ruler of years while the top displays the art movements as a stack of colored rectangles, symbolising the time range of each movement. The art previews displayed on the earth model are surrounded with a halo of the same

<sup>1</sup><https://www.playshifu.com/orboot/earth>

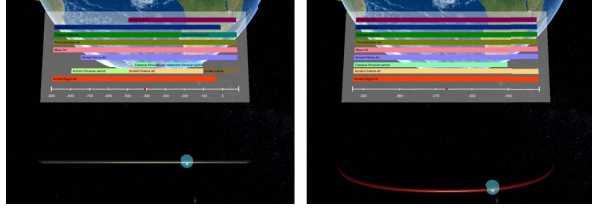


Figure 2: The rubber slider, located under the timeline, being manipulated (and also pulled on the right) by the user.

color as the movement they belong to. The central position of the ruler shows a cursor indicating the year currently selected. The timeline position and scale can be controlled using the rubber slider interaction, as explained in Sect. 3.

### 2.3 Continent selection for filtering

In this interaction mode, users can hover and highlight continents using a virtual ray. By pressing the trigger, the hovered continent gets selected which results in the filtering of the art movements on the timeline and art pieces on the earth model, so that only the art movement occurring on this continent are displayed.

## 3 SLIDER INTERACTION: THE RUBBER SLIDER

The rubber slider (Fig. 2) presented in this paper can be considered as a dual-value interaction interface. Similarly to a 2D slider, users can move the cursor along the main axis of the slider to select a bounded value  $V$ . The second bounded value,  $B$ , can be selected by pushing or pulling the cursor from the main axis, which will accordingly bend the slider main axis into a curve. When the rubber slider is bent, a color feedback is used. The more the slider is pushed or pulled, the more colored it gets, up to the maximum curvature.

### 3.1 Cursor and bending control

The rubber slider is used to control the selected year on the timeline and the time range to display. We propose two control modes to showcase different usages and control laws that can be used with the rubber slider.

#### 3.1.1 Direct Control

In this mode, the cursor value  $V$  of the slider is directly converted to a year on the timeline. Meaning the leftmost position represents the earliest year while the rightmost position represents the latest year. The bending value  $B$  changes the scaling of the time range. Users can display a narrower time range on the timeline by bending the slider or a wider time range by unbending the slider.

#### 3.1.2 Incremental Control

In this mode, the cursor value  $V$  of the slider is shifting the selected year on the timeline. When the cursor is on the left part of the slider, it decreases the selected year, when it is on the right part, it increases the selected year. The further from the center, the higher the increase/decrease value used, while around the center, a dead zone helps the user fix the selected year. Similarly to the direct control mode, the bending changes the scale of the time range displayed, but it also scales the increment number used to select value  $V$ . When users pull the slider, the time range displayed is scaled down, showing a narrower range of years, and the increment value used is decreased, allowing a more precise control when the users' arm are less extended.

While both values can be controlled continuously, a secondary optional mode is added to the rubber slider through a metaphor of hooks, enabling a discrete control of the bending value  $B$ .

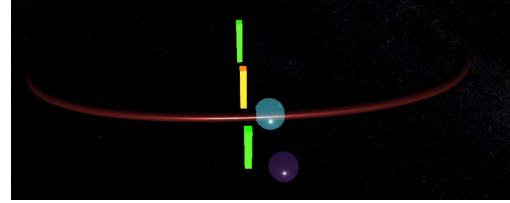


Figure 3: Hooks metaphor. The active hook is displayed in yellow. The purple cursor displays the position of the user controller (usually hidden) while the cyan one shows the pseudo-haptic position.

### 3.2 Hooks metaphor

Manipulating two values by the use of a single limb can sometimes prove difficult. The hooks metaphor shown on Fig. 3 aims at tackling this issue by proposing a limited number of discrete bending values  $B$  symbolized by visual elements. Users can select a bending value by pulling the slider. When the slider reaches a hook, the value  $B$  is updated to that bending value. If users need to change the bending value  $B$ , either to increase or decrease it, they need to pull the cursor up. When the cursor exceeds the hook height, the rubber slider can be pushed or pulled to a new hook to select a new bending value  $B$ .

### 3.3 Pseudo-haptic feedback

A pseudo-haptic feedback was added to the bending interaction with the rubber slider. This not only improves the realism of the interaction, but allows users to manipulate it more precisely. To create this effect, we incrementally shift back the cursor position and slider curve when the user pulls it (see Fig. 3).

## 4 CONCLUSION

This paper presents a VR application to explore a database of art pieces. In this application, a rubber slider control interface can be used for a precise and adaptive control of time display and selection on a timeline. The slider can be pushed or pulled to up- or down-scale the timeline display range. During this manipulation, a pseudo-haptic feedback improves the feeling of effort on the slider. Furthermore, different control modes of the rubber slider are presented, including a hook metaphor, that showcase various possible usages of this control interface. Users can also interact with a 3D earth model to select specific geographical areas, rotate the earth model, or select art pieces, to get additional details.

The database of art pieces and movements is handmade from various data sources. While the size of the database is limited in this use case, more data and different data types (music, architecture, ...) could be added in the future. The rubber slider could be enhanced with other control laws, orientations and behaviors for different use cases, and tested with a user study. Other manipulation techniques, like PRISM [2] could be combined to the rubber slider manipulation to improve precision.

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