Stare-Based Hub Amendment in an Information Revelation Method

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***Abstract* - As the complication and amount of real world data continuously grows, modern revelation methods are changing. Traditional information revelation techniques are often not sufficient to allow an in-depth visual data exploration process. Various view systems shared with linking & brushing are only one building block of a successful Info Rev system. In this paper we propose the integration of cheap and simple stare-based communication. We employ the tracking Information not for selecting data (i.e. mouse interaction) but for an intelligent adaption of 2D and 3D revelations. Derived from the focus+context pattern, we call this stare-focus.**

***Keywords* - Information Revelation, Stare Tracking, Multiple Views, Hub Amendment.**

1. INTRODUCTION

Information Revelation (Info Rev) strives to visualize abstract data in an easily understandable way. Over the years, several paradigms such as linking & combing, focus+context and details on demand were recognized and are widely accepted as critical success factors for an InfoVis system. Focus+context and details on demand are usually implemented based on a assortment, triggered by a mouse or keyboard interaction. A user clicks some element, which is then put into focus, for example by zooming, while other elements are compressed and possibly abstracted. When analyzing this workflow, we noticed that in order to select an element one has to first identify it in the background symbol of the data. The human vision has a rather small angle of focused sight, compared to the wider peripheral vision. We therefore implemented a system where the currently focused part in the revelation correlates as closely as possible to the fixation of our eyes, the stare-focus. We do this by tracking the stare of a subject and putting the element a subject is looking at, in the focus of the revelation.

2. METHODS

In the following we differentiate between stare-based methods within a single view and interaction that aims for the organization and handling of multiple, linked revelations in a 3D setup.

2.1 Single view stare interaction

Parallel coordinates are well suited to visualize several thousands of data points simultaneously over a limited number of dimensions. As the number of dimensions increases, details are lost due to the reduced spacing of axes. While truly large amounts of dimensions need special approaches, which produce a reduced subset, e.g. (Yang, et al., 2003), manual distortion can increase the number of dimensions perceivable simultaneously. In this process a large umber of axes (around 40) are shown at a time. The spacing, and thereby the eadability of interesting regions can be increased (creating a fisheye distortion). These properties lend themselves perfectly to stare-based scene manipulation. Since only a small region is observed sharply in the fixation phases of the eye, this region is enlarged, once a user looks at it. The spacing of the other axes is reduced, thereby using less screen real estate while still providing the contextual information. Fig. 1 shows a screenshot of the implementation, where the stare was close to the green vertical line.

In a **heat map** the magnitude of a value is mapped to a color. Affiliation with a property is spatially encoded. As a consequence, the number of simultaneously visualized elements has a strict upper limit: the number of available pixels on the screen. In some tasks this is not sufficient. Therefore, we use a hierarchical approach with three levels. An overview of all 30.000 elements is rendered on the left, a data subset with up to 1000 elements in the center, and a detailed view on the right. We again employ a stare following automatic focusing feature, to maximize the clarity of the focused revelation. When a user looks at the second level, it is enlarged, facilitating easier browsing in the dataset. Once the user stares at the detail view, this view is focused, thereby putting an emphasis on the individual elements.

2. 2 Multiple view stare interaction

In order to examine different aspects of a dataset, the information is depicted in multiple revelations. In combination with linking & combing techniques, the user has a powerful tool to execute visual data exploration and analysis. State-of-the-art multiple view systems arrange views side by side on the screen. Fono, et al., (2005) showed how to zoom in on an application window - which can also be applied to multiple view applications. However, this method is naturally limited by the available screen space and can therefore only be used for a very low number of views. Planes containing the content of 2D revelations are arranged in a bucket-like layout. The bottom of the bucket contains the view in focus. Four contextual views are forming the bucket walls. The rim of the bucket contains a thumbnail list of views that are currently not of immediate interest, but can be swapped in later on. The user can arbitrarily rearrange views inside the bucket and its rim by using drag and drop.

Selected entities are synchronized between all views and highlighted accordingly. Recent research in the field of information revelation uses visual links (i.e. simple connection lines) among dependent views. The bucket employs visual linking to emphasize relations between elements. While the multi-level approach (bucket bottom, walls and rim) enables the organization of abundant views, it introduces a distortion problem. Especially text is difficult to read when rendered on the bucket walls. Therefore, we extended the static bucket setup to a "rubber" bucket by taking into account the user's stare information. The bucket is rotated according to the stare direction, reducing the distortion of the view looked at. When the user moves the head towards the screen, the focused revelation in the 3D scene is transformed to the user's direction (diving into the bucket). Additionally the stare navigation immerses the user into the scene.

3. IMPLEMENTATION

The stare-focus implementation is having very low cost hardware setup, sufficient for a proof-of-concept prototype. The stare direction was determined by a head-mounted Nintendo® Wii™ Controller and an infrared bar mounted on top of the screen.The presented revelations are created in the Caleydo Revelation Framework (Streit, et al., 2008). Caleydo is a multiple view system supporting modern Info Rev paradigms. Although it is a general purpose revelation framework, the predominant use case deals with biological data. All figures show real world data from our life science partners. For 3D rendering we use the Java OpenGL library (JOGL). JOGL is capable of rendering in an applet that can be run in a browser. Alternatively, the application can be delivered to the user via the JNLP webstart technology.The bucket is adopting according to the user's focus point (orange). In (a) the user stares at the left bucket plane while in (b) the user looks at the lower plane.

Modern tracing technology such as RFID has made it possible to reveal item-level information of almost any product in any industry. We investigate the incentives to reveal such information in a competing market dealing with a homogeneous product. We find that it pays for firms to completely reveal information if the common demand is volatile. If the demand is stable, however, it's worse off if competing firms reveal any of their product information. This result applies if the unsold product clearance discount rate is constant or decreasing. If the discount rate increases with the number of unsold products, neither complete nor zero information revelation is consistent with an equilibrium for both firms. We also find that the above findings apply even if the item-level information is not symmetrically distributed. One interesting problem in signaling is a firm's best information transmission strategy if it can selectively reveal information to maximize its own utility.

4. CONCLUSION

In this paper we present methods to integrate stare-based manipulation of 2D and 3D views in an information revelation system. While our current setup is sufficient for expansion, a real life system has to be less obtrusive and more precise. However, for the *stare-focus*, we do not need the accuracy of specialized eye tracking systems. Instead we aim to integrate a low cost webcam based eye tracking module in the revelation framework, thus bringing this type of user communication to a broad public.

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