CPSC 533C 2009F – Project Proposal
PerspectiveEye: Seeing the World from Different Perspectives

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Objective

This proposal describes an interactive geographic visualization system, PerspectiveEye, which utilizes both head motion and a conventional mouse for bimanual interaction with geospatial data.

Domain, Task and Dataset

PerspectiveEye focuses on visualizing and understanding correlations between two sets of geospatial data of different countries over time. In particular, I am interested in looking at poverty, crime rate, mortality rate and other similar data related to humanity, which can be obtained through GapMinder [4]. For example, how are poverty and population density related in different regions of the world over the past decade? The visualization system is intended to be easily extensible to work with other geographical datasets as well.

Personal Expertise

My Masters thesis is tied in to evaluating head-coupled perspective rendering, so I know enough background on head-coupled interaction and running related user studies. I am somewhat familiar with designing and developing web applications using Flash but have little experience in geographic visualization systems.

Proposed Solution

Most visualization tools allow for one dimension of interaction at any single point in time, i.e. using the mouse to select/rotate, using the keyboard to switch between categories/states, or using a combination of keyboard and mouse to zoom/pan. Would an additional dimension of interaction be beneficial to visualizing data, given that the added interaction does not burden the cognitive load of the user? Head motion is one possibility, as it is a natural motion we use in our daily lives to see things from different perspectives.

The system proposed in this document leverages on existing vision-based, real-time face detection technique to create a visualization that offers the user a smooth two-way interaction to explore geospatial data. While face detection results are usually unstable and unsuitable for high precision interaction tasks; it is possible to utilize the natural head motion to control higher level, coarse-grained interaction such as categorical selection or mode switching. This frees up the user's dominant hand to perform interactions that require high precision.

PerspectiveEye uses the analogy of “seeing the world from different perspectives”, in which the user sees different datasets on a world map based on the angle/position they are viewing the screen from. The visualization maps three sets of data to three corresponding regions in the camera’s field of view, and by detecting which region the user’s head is in, the visualization displays the corresponding datasets (the user first chooses two sets of data to visualize, the third set of data is automatically generated as the correlation between the two selected datasets). The mouse will be used to control the time dimension of the data simultaneously to visualize the changes of the two datasets and their correlation throughout the years.

Since only one set of data will be displayed on the world map at any given point in time, it is acceptable to use simple, fixed steps color encodings separated by country boundaries for the visualization. It is, however, important to carefully choose color encodings that distinguish between the two datasets and also their set of correlation data. More research will be done in this area to address the issue.

Scenario of Use

I am trying to visualize two datasets: poverty and crime rate of all the major countries in the past decade. I opened up PerspectiveEye, selected Poverty as my first set of data and Crime Rate as my second set of data. As I move my head to the left, I see the poverty data in one set of color encoding displayed on the map. Moving my head to the middle allows me to see the correlation values, and as I move to the right, the crime rate data are displayed. I move my head back and forth quickly to switch between the datasets and better understand the correlation between them in different regions in the map. As I drag on the visualization map with the mouse, I see the dataset transition through time, and I am able to intuitively select which dataset I want to see and which year I want to view them in. Figure 1 illustrates the interactions proposed for the visualization:

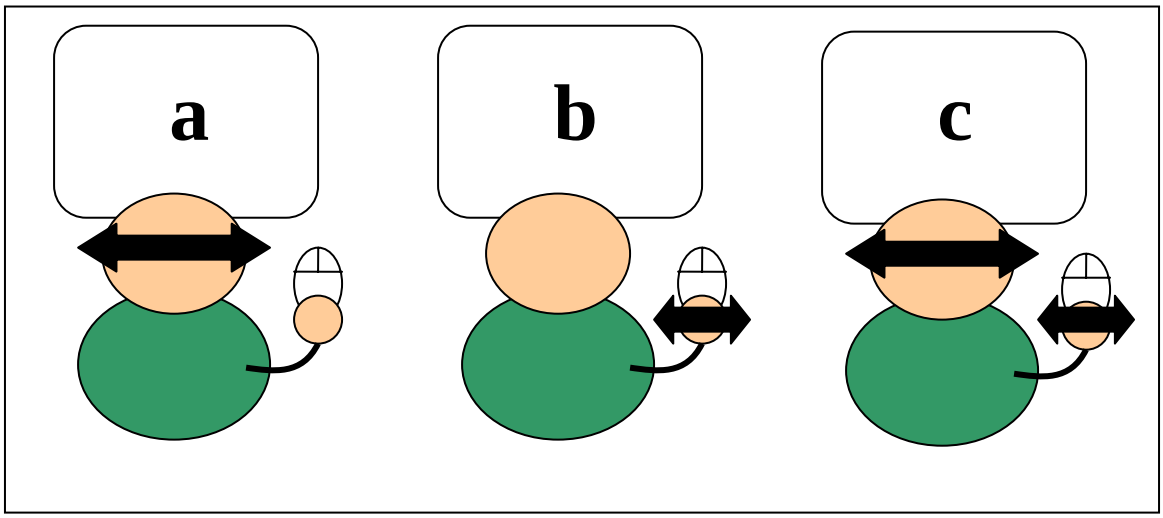

Figure 1. a) Using head motion to switch between viewing dataset 1, dataset 2 and their correlation; b) Dragging with the mouse animates the currently viewed dataset through time; c) Dragging with the mouse coupled with head motion switches between datasets while animating them through time.

Implementation Approach

I propose to implement the system as a web application using Flash. Potential ActionScript libraries that I will use include Marilena [6], which is capable of performing face detection, and Flare [3], which is a flash version of the Prefuse visualization toolkit.

Milestones

1. **November 2nd – 9th**
   Background research, setting up face detection and other libraries in Flash

2. **November 10th – 23rd**
   Design and Implementation I: controlling dataset using head motion

3. **November 24th – December 7th**
   Design and Implementation II: controlling animation using mouse

4. **December 7th onwards**
   System testing, paper write-up and final presentation preparation.

Previous Work

Little work has been done on coupling gestural inputs in visualization systems. Related to head-coupled interaction, Ware and Franck [7] evaluated the effectiveness of stereo and head-coupled perspective rendering for tree structure visualization and concluded that a combination of both techniques led to a significant increase in performance than 2D rendering. However, the study was done with primitive tasks that involved abstract 3D tree structures; transferring its findings to abstract datasets that have no particular spatial relationship is questionable.

In more recent work, Ball and North [1,2] explored the effects of physical navigation in large-scale, high-resolution display. It is interesting to note that their results showed physical navigation provides a better performance improvement than peripheral vision in map exploration, but performing physical navigation on a small-scale display is a much different interaction. Besides, the interaction we proposed is an abstract mapping instead of a spatial one. Guiard [5] extensively studied on bimanual interaction related to two-handed inputs; it would be interesting to see if bimanual control using a combination of head motion and the dominant hand is a preferable and efficient interaction scheme.

References

[1] Ball, R., North, C., & Bowman, DA. Move to Improve: promoting physical navigation to increase user performance with large displays. CHI Human Factors in Computing Systems 2007, 191-200.

[2] Ball, R., & North, C. The effects of peripheral vision and physical navigation on large scale visualization. Proceedings of GI 2008, 9-16.

[3] Flare Visualization Toolkit. http://flare.prefuse.org/

[4] GapMinder. http://www.gapminder.org/

[5] MacKenzie, I.S., & Guiard, Y. The two-handed desktop interface: are we there yet? CHI Human Factors in Computing Systems 2001, 351-352.

[6] Marilena ActionScript Library. http://www.squidder.com/2009/02/26/realtime-face-detection-in-flash/

[7] Ware, C., & Franck G. Evaluating stereo and motion cues for visualizing information nets in three dimensions. ACM Transaction on Graphics 1996, 15(2), 121-140.