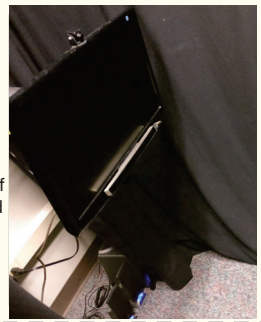
Developing a Data Analytics Tool Capable of Visualizing Temporal Data

Ethan Vogelsang, Dr. Chen Yu - Indiana University, Department of Psychological and Brain Sciences

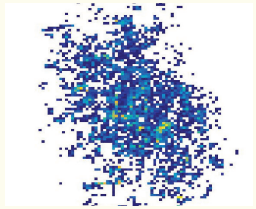
Introduction

- This year the lab launched a new study focused on researching behavioral patterns of infants when each subject is exposed to the same stimuli.
- Generally heat maps are good for visually quantifying large amounts of multidimensional data. In our case we use X & Y coordinates from eye trackers.
- The goal of this project is not only to make a programs that generates a heat map capable of this visualization, but to also add a temporal parameter to it.
- To the right is a picture of the setup being used for collecting the data of this project.

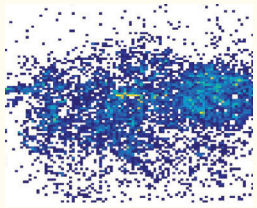


Examples of Typical Heat Maps

- Typical heat maps do not provide much insight on what's happening. Especially in the case of this experiment where there are multiple trials, each with different stimuli, a normal heat map is practically useless.



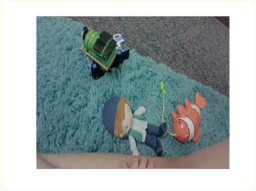
- These heat maps are generated using the eye tracking data. Positions of eye data are logged using X and Y coordinates. These coordinates are converted into colors which compiled together make up the heat map.



Design and Building Process

Building a Heat Map from Raw XY Data

- Subjects are positioned in a chair looking at a screen. An eye tracker is placed below the screen, and it records movement of the eyes and estimates the position they are looking at on the screen.
- Subjects go through a series of trials, each seven seconds long. Each trial contains a picture that the subjects freely look at during the trial time.
- As the eyes are tracked, the position that the subject is looking at is logged using a basic coordinate system. These coordinates represent a location on the screen.
- Coordinates are divided into a 100x100 grid. Each time a coordinate falls into a specific grid location, a value of one is added to a count. This count represents how many coordinates fall into each grid.
- A three dimensional histogram is created using the counts from each grid. The histogram can be converted into a heat map using a built in MATLAB function which overlays color based on the height of the object. In this case, a parula color scheme is used, meaning that high values will be given a color closer to yellow, and low values will be given a color closer to blue.
- The program currently takes two inputs:
- >> heat_map(subID, trialNum)
  - subID is the subject ID, each subject is assigned a unique id. trialNum is the trial number, each trial is identified by a number 1-40.
- The data is filtered to each trial based off trial number. The trial number is also used to load a background image of the trial's stimulus. The heat map is overlaid onto this background image and then displayed.



Future Developmental Plans

- The next stages for this program will be to add more functionality in a few different ways:
  - One of the goals of this tool is to implement a feature which allows the user to see temporal data across within each trial as well. For example a user will be able to divide the screen into parts that show data from the first half of the trial and the second half of the trial.
  - Another feature that needs to be added is the smoothing of the heat map. After the data is filtered down to each trial, there isn't a lot of data left. There are only 7 seconds of data being displayed for each trial which means there is not a lot of data points to generate a heat map from. Using an interpolation function on the data would add a smoothing effect allowing the data to have a more obvious trend.
  - Another solution to make the data trends more obvious, besides interpolating the data, could be to add a logarithmic scaling function. A log of each data value could be taken and then multiplied by a multiplier which would exaggerate the data a little and make it clearer.

Example Results

Trial 40. Regions of interest are mostly on the edges of toys.

Trial 7. ROI is mostly on the cake toy and ice cream cone

Summary

- Overall we hope this tool will provide researchers with insight on behavioral patterns when subjects are exposed to the same stimuli. This is a new step for our lab since in the past most of our data comes from fluid environments.
- This tool should provide a means of analysis for when researchers look at regions of interest. There are lots of ways to view ROIs, but a heat map of this manner can provide temporal data which could add a lot of depth to an analysis.
- There are lots of variables to view, such as behavior, saccades, fixations, etc, but this tool only focusses on ROIs with an aspect of temporal data.

Acknowledgements: MCCSC Science Research, IU Department of Psychological and Brain Sciences