EYE TRACKING BASED EXPERIMENTS WITH EXPLORVIZ

MASTERTHESIS PRESENTATION OF MARIA-ANNA KANDSORRA

15.06.2017
OVERVIEW

- Introduction
- Foundations & Technologies
- Approach
- Implementation
- Evaluation
  - Experiment Design
  - Experiment Results
- Conclusion
- Future Work
INTRODUCTION
INTRODUCTION
GOALS

- G1: Determine Experiment Management Systems Requirements
- G2: Concept and Implementation of Experiment Mode with Eye Tracking
- G3: Evaluation of the Experiment Mode with Eye Tracking
Productivity for developers, performance for users

GWT is used by many products at Google, including Google AdWords and Google Wallet. It's open source, completely free, and used by thousands of enthusiastic developers around the world.

FOUNDATIONS & TECHNOLOGIES
GOOGLE WEB TOOL KIT (GWT)
WebRTC Experiments & Demos

- It is a repository of uniquely experimented WebRTC demos; written by Muaz Khan.
- No special requirement! Just WebRTC compatible web-browser (e.g., chrome/firefox/opera on desktop/android).
- These demos/experiments are mostly client-side; i.e., no server installation needed.
- You can use all these demos in PHP/Python/Ruby/ASP.NET/etc., and they're only relying on JavaScript and 3rd party services.

How to use?

Each demo has a unique directory. Simply download that directory, upload in your webserver, and use it; and it'll work.

You don't need to modify any single line to use it. No single installation or modification is needed :)

DetectRTC | Is WebRTC Supported On Your Browser?

A tiny JavaScript library that can be used to detect WebRTC features e.g., system having speakers, microphone or webcam, screen capturing is supported, number of audio/video devices etc.

Live Demo: https://www.webrtc-experiment.com/DetectRTC/

 Foundations & Technologies
 EXPERIMENT WEBRTC
APPROACH

REQUIREMENTS FOR EXPERIMENT MANAGEMENT SYSTEMS [JAKOBOVITS ET AL. 2000]

- System Integration
- Data Integration
- Workflow Support
- Remote Collaboration Facilities
- Advanced Data Type Management
- Intelligent Navigation
- Adaptive User Interface
COMMUNICATION IN EXPLORVIZ

Client

Visualization

Experiment:
Questionnaire:
questions
prequestions
postquestions

Server

ExplorViz' server

Experiment:
Questionnaire:
questions
prequestions
postquestions

JSON

JSON files
IMPLEMENTATION
EYE TRACKING & SCREEN RECORDING

Client
- visualization/experiment
- tools
  - ExperimentToolsPage.xtend
  - ExperimentToolsPage.java

Server
- server/util
  - JSONServiceImpl.java
  - UploadFileServiceImpl.java

Model
- shared/experiment
  - async RPC

Files
- war/js/exp_eyeTracking
  - exp_eyeTracking.js
  - eyeApi.js
- Questionnaire.xtend
- ExperimentJS.java
- JSON files
IMPLEMENTATION
FIRST RESULT
MODAL
IMPLEMENTATION

MODALS DURING EXPERIMENT PARTICIPATION
IMPLEMENTATION
EXTERNAL COMMUNICATIONS SERVER WITH EYE TRACKER
EVALUATION

- Experiment Design
- Experiment Results
Research Questions:
- What is the ratio between participants gazing not at the display, gazing at the question modal, and the ExplorViz interactive interface?
- Is there a correlation between correctness of answers and amount of gaze time on the question modal versus on the interactive interface?
- What does a participant mostly do (gaze and interaction with interface) when answering a question incorrect?

Hypotheses:
- The ratio of gazing at the question modal, interface and not at the display differs between participants.
- The correctness of answers differs between participants that gaze more at the question modal than the interface and vice versa.
EVALUATION
EXPERIMENT DESIGN

- Empirical Methods
- Tasks
  - Dependent and Independent Variables
  - Treatment
  - Personal Information
  - Population
EVALUATION
EXPERIMENT OPERATION

- Experimental Set-Up
- Create Input
- Tutorial
- Questionnaire
- Pilot Study
- Procedure
- Data Collection:
  - Timing and Tracking Information
  - Correctness Information
Prequestions:
- Experience with JPetStore: 1,2667
- Experience with ExplorViz: 1,8667

Correctness Information:

<table>
<thead>
<tr>
<th>ID</th>
<th>Mean</th>
<th>SD</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1.1</td>
<td>0,8</td>
<td>0,4332</td>
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<td>T1.2</td>
<td>1,2667</td>
<td>0,9501</td>
<td>2</td>
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<td>T1.3</td>
<td>0,5333</td>
<td>0,5001</td>
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<td>1,8667</td>
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</tr>
<tr>
<td>T4</td>
<td>1,0667</td>
<td>0,9356</td>
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Eye Data Results (in %):

<table>
<thead>
<tr>
<th>Category</th>
<th>Mean</th>
<th>SD</th>
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<tbody>
<tr>
<td>Question Modal</td>
<td>17,0679</td>
<td>8,0997</td>
</tr>
<tr>
<td>Interface</td>
<td>78,0356</td>
<td>20,0754</td>
</tr>
<tr>
<td>Non-Display</td>
<td>4,8965</td>
<td>4,137</td>
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## Postquestions:

<table>
<thead>
<tr>
<th>Category</th>
<th>Mean</th>
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<tbody>
<tr>
<td>Pressure Time</td>
<td>1.733</td>
<td>0.7988</td>
</tr>
<tr>
<td>Pressure Eye Tracking</td>
<td>1.2</td>
<td>0.6399</td>
</tr>
<tr>
<td>Pressure Screen Recording</td>
<td>1.467</td>
<td>0.7988</td>
</tr>
<tr>
<td>Difficulty T1.1</td>
<td>1.933</td>
<td>0.4577</td>
</tr>
<tr>
<td>Difficulty T1.2</td>
<td>1.933</td>
<td>0.4577</td>
</tr>
<tr>
<td>Difficulty T1.3</td>
<td>2.333</td>
<td>0.8997</td>
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<tr>
<td>Difficulty T2</td>
<td>2.929</td>
<td>0.8287</td>
</tr>
<tr>
<td>Difficulty T3</td>
<td>2.429</td>
<td>0.9376</td>
</tr>
<tr>
<td>Difficulty T4</td>
<td>2.857</td>
<td>0.663</td>
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</tbody>
</table>
EVALUATION
EXPERIMENT RESULTS

CORRECTNESS OF TASKS:

<table>
<thead>
<tr>
<th>TASKS</th>
<th>PARTICIPANTS CORRECTNESS</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1.1</td>
<td>80.00%</td>
</tr>
<tr>
<td>T1.2</td>
<td>63.33%</td>
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<tr>
<td>T1.3</td>
<td>53.33%</td>
</tr>
<tr>
<td>T2</td>
<td>53.33%</td>
</tr>
<tr>
<td>T3</td>
<td>93.33%</td>
</tr>
<tr>
<td>T4</td>
<td>53.33%</td>
</tr>
</tbody>
</table>
EVALUATION
EXPERIMENT RESULTS

AVERAGE OPINION OF TASKS:

<table>
<thead>
<tr>
<th>TASKS</th>
<th>OPINION FROM EASY TO DIFFICULT</th>
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</thead>
<tbody>
<tr>
<td>T1.1</td>
<td>31.11%</td>
</tr>
<tr>
<td>T1.2</td>
<td>31.11%</td>
</tr>
<tr>
<td>T1.3</td>
<td>44.44%</td>
</tr>
<tr>
<td>T2</td>
<td>64.29%</td>
</tr>
<tr>
<td>T3</td>
<td>47.62%</td>
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<tr>
<td>T4</td>
<td>61.90%</td>
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</tbody>
</table>
PARTICIPANTS RESULTS:
EVALUATION

EXPERIMENT RESULTS

PARTICIPANTS GAZE-RATIOS:

Mean | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15

- Question Modal
- Interface
- Non-Display
EVALUATION
EXPERIMENT RESULTS

DURATION OF EXPERIMENT PARTICIPATION:

<table>
<thead>
<tr>
<th>Participants</th>
<th>questionModalMS</th>
<th>interfaceMS</th>
<th>nonDisplayMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
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<td>17.5</td>
<td>0.9</td>
</tr>
<tr>
<td>1</td>
<td>2.2</td>
<td>3.9</td>
<td>5.1</td>
</tr>
<tr>
<td>2</td>
<td>0.2</td>
<td>20.5</td>
<td>4.7</td>
</tr>
<tr>
<td>3</td>
<td>0.5</td>
<td>15.3</td>
<td>5.2</td>
</tr>
<tr>
<td>4</td>
<td>8.9</td>
<td>14.4</td>
<td>1.5</td>
</tr>
<tr>
<td>5</td>
<td>2.1</td>
<td>19.5</td>
<td>1.3</td>
</tr>
<tr>
<td>6</td>
<td>1.3</td>
<td>0.8</td>
<td>5.2</td>
</tr>
<tr>
<td>7</td>
<td>2.8</td>
<td>18.5</td>
<td>0.6</td>
</tr>
<tr>
<td>8</td>
<td>1.3</td>
<td>15.0</td>
<td>1.0</td>
</tr>
<tr>
<td>9</td>
<td>1.7</td>
<td>27.5</td>
<td>1.7</td>
</tr>
<tr>
<td>10</td>
<td>1.3</td>
<td>21.3</td>
<td>2.2</td>
</tr>
<tr>
<td>11</td>
<td>2.2</td>
<td>18.6</td>
<td>0.3</td>
</tr>
<tr>
<td>12</td>
<td>4.1</td>
<td>14.8</td>
<td>0.1</td>
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<tr>
<td>13</td>
<td>4.2</td>
<td>16.5</td>
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<td>14</td>
<td>4.1</td>
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<td>19.1</td>
</tr>
<tr>
<td>15</td>
<td>1.1</td>
<td>19.1</td>
<td>19.1</td>
</tr>
</tbody>
</table>

Experiment Duration in Minutes

0 5 10 15 20 25 30 35

Participants
SUMMARY & CONCLUSION

- Improvement of Usability of Experiment Mode
- Enhancement of Experiment Mode with Eye Tracking and Screen Recording
- Execution of an Experiment
- Experiment Results in Comparison to Research Questions
- Conclusion
FUTURE WORK

- Improve ExplorViz’ Interactive Tutorial Save Process
- Automated Merging of the Screen Recording Media Files
- Import of existing Experiment Data
- Automated Analysis of Eye Tracking Data
BIBLIOGRAPHY

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- http://samoa.informatik.uni-kiel.de:8181/
- http://www.gwtproject.org/
- https://github.com/muaz-khan/WebRTC-Experiment
- https://canjs.com/index.html
- https://eclipse.org/artwork/
- http://brand.qt.io/downloads/
