Citation:

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VIRTUAL ENVIRONMENT LAB (V-LAB)

- [http://www.csloh.com/research/v-lab/](http://www.csloh.com/research/v-lab/)
- Established 2009
- Research in performance assessment with virtual training environment
- *Information Trail* © - *in situ* assessment framework
- Data visualization
- Serious Games Analytics
BACKGROUND OF THE STUDY

Types of Game Assessment

**Game Scoring**
- Target acquired (Baker, Niemi, & Chung, 2008)
- Obstacles overcome
- Time for completion (Reese & Tabachnick, 2011)

**External (ex situ) Assessment**
- Formative Summative Assessment
- (De-)briefing (Chin et al., 2009; Ifenthaler, 2009), After Action Review (AAR)
- MC-Test, Essay, Test Scores (Schrader & McCreey, 2008)

**Embedded (in situ) Assessment**
- Not interrupting the game
- Click-streams, log-files (Chung & Baker, 2003; Dummer & Ifenthaler, 2005)
- Information Trails© (Loh, 2007, 2012; Loh, Anantachai, Byun, Lenox, 2007; Loh & Li, 2010)

(Ifenthaler, Eseryel, & Ge, 2012)
BACKGROUND OF THE STUDY

- Eye Tracking
  - the process of recording gaze/eye movement, (micro saccade, fixation, scan path etc.) i.e., the way in which a person observes a scene, using a video-based device, eye-tracker

(Ristovski, Hunter, Olk, & Limsen, 2013).
BACKGROUND OF THE STUDY

- Eye Tracking
  - In Marketing

Eyes can guide your eyes
BACKGROUND OF THE STUDY

- Eye Tracking
  - In Human Computer Interaction (HCI)

The F-shape reading pattern of Website users
REFERENCES:

Jennet, et al. (2008)
- Investigated players’ immersion in First-person Shooting game
- Findings: Decrease of fixations per second in the immersive condition as compared to the increase seen in a non-immersive control condition

Kickmeier-Rust, Hillemann, and Albert (2011)
- Studied the usability of a game, learner satisfaction and learning efficacy by using eye-tracking
- Findings: High and low performers exhibit different visual patterns; Eye tracking could be successfully applied to measure critical aspects with regard to the quality of serious games
BACKGROUND OF THE STUDY

• Gap in the previous studies
  • Most existing studies focused on using eye tracking to understand *gameplay* (i.e., players’ behavior) in relation to game design
  • Little investigation has been focused on how eye-tracking data can help us understand play-learners’ behavior and (and possible assess) performance in Game-Based Learning environments
PURPOSE OF THE STUDY

• To investigate the use of eye-tracker for assessment in role-playing type serious games
Can we use eye-tracker for performance assessment in role-playing type serious games?

1. What kind of information can we obtain from eye-tracker?
2. Is there any difference on eye-tracking data between expert and novice players? If so, is it possible to differentiate players’ performance by analyzing the eye-tracking data?
3. What are the benefits/pitfalls on using eye-tracking for assessment with role-playing type serious games?
GAME ENVIRONMENT

• Backstory:
  • It’s time for you to join the rank of the village’s Guardians. All you need to do is to pass the qualifying test. But wait, since your old man held the record to the Guardian challenge, you are also given the chance of your life to break his record. It sure is tough to be the Champion’s kid… Do you have what it takes to be the new Champion?

• Goal of Game
  • Military-style Search and Rescue Mission:
  • Find 5 villagers and 1 blacksmith » Report to Mission Giver
GAME ENVIRONMENT

Found 1 villager.

Screenshot: “The Guardian” – by Christian S. Loh
EXPERIMENTAL SETTING

Diagram showing a participant and an observer set up for an experiment. The participant sits in front of a computer monitor connected to the Game PC, which is also connected to an external video source, e.g., a PlayStation. There is an SMI RED eye tracker set up to monitor the participant's gaze. The observer is seated next to the Game PC, monitoring the participant and the external video source.
DATA COLLECTION

- **Number of participants:**
  - 3 Expert players (2 male, 1 female)
  - 3 Novice players: 1 male, 2 female

- **Data collection process**

<table>
<thead>
<tr>
<th>Enter V-Lab</th>
<th>Consent</th>
<th>Instruction</th>
<th>Tutorial</th>
<th>Calibration</th>
<th>Play</th>
<th>Exit V-lab</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enter V-Lab</td>
<td>Complete consent form</td>
<td>How to navigate the game area, control the avatar, communicate with NPCs, equip and use items, etc.</td>
<td>Play training module until familiar with gaming environment and input control</td>
<td>Eye-Tracker calibration when ready to begin data collection</td>
<td>Play the game until the game over message appears</td>
<td>Exit V-lab</td>
</tr>
</tbody>
</table>
FINDINGS

• Research Question #1.
  • What kind of information can we obtain from eye-tracker?
    • Scan Path
    • Attention Map
    • Key Performance Indicators
    • Gridded Area Of Interest (AOI)
    • AOI Sequence Chart
    • Binning Chart
    • Event Statistics (ES)
    • Line Graph
INFORMATION #1

- **Scan path**
  - The visualized gaze data overlaid over the stimuli: image/video.
Game image is not static, there is no “scan path”, instead gaze is mostly fixated around the travel path of avatar.
<table>
<thead>
<tr>
<th>id</th>
<th>player_name</th>
<th>conv_recipient</th>
<th>conv_member</th>
<th>conv_text</th>
<th>action_description</th>
<th>time</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>Alene Swift</td>
<td>NPC</td>
<td>Elder Meyer</td>
<td>Talk to NPC</td>
<td>Start Conversation</td>
<td>14:35:00:358</td>
</tr>
<tr>
<td>9</td>
<td>Alene Swift</td>
<td>NULL</td>
<td>NULL</td>
<td>Acquire Item</td>
<td></td>
<td>14:35:47:3547</td>
</tr>
<tr>
<td>10</td>
<td>Alene Swift</td>
<td>NULL</td>
<td>NULL</td>
<td>Acquire Item</td>
<td></td>
<td>14:35:50:3500</td>
</tr>
<tr>
<td>11</td>
<td>Alene Swift</td>
<td>NULL</td>
<td>NULL</td>
<td>Acquire Item</td>
<td></td>
<td>14:35:50:3500</td>
</tr>
<tr>
<td>12</td>
<td>Alene Swift</td>
<td>NULL</td>
<td>NULL</td>
<td>End Conversation</td>
<td></td>
<td>14:35:56:3556</td>
</tr>
</tbody>
</table>

Scan path is very helpful, showing exactly how participant read the dialogs.

Scan path is very helpful, showing exactly how participant interact/read the dialogs.

Game log is not very helpful, no way to tell how participant interact/read the dialogs.
INFORMATION #2

- Attention Map
  - The information showing gaze patterns over the stimulus image visualized as Heat map or Focus map
Dynamic game scene changes too fast to create “heat map”. Only useful for “static screen” like dialogs.
INFORMATION #3

· **Key Performance Indicators (KPI)**
  · The data presenting relevant statistical data for each defined Area Of Interest (AOI) over the stimuli
  · Quantitative Data Type

  - Entry time
  - Dwell time
  - Hit ratio
  - Revisits
  - Revisitors
  - Average fixation
  - First fixation
  - Fixation count
INFORMATION #4

- Gridded AOI
  - Visualizing participants’ gaze patterns and statistics parameters by altering the color of a grid of AOIs over the stimuli based on the amount of attention received
More than 20 sec will be red color.
Cannot handle long gameplay (minutes to hours).
OTHER INFORMATIONS

AOI Sequence Chart
The data displaying the AOI hit order over time.

Binning Chart
A statistical overview of AOI hits per binning frame.

Event Statistics (ES)
ES compute diverse statistics based on events and AOI hits

Line Graph
Gaze data plotted as event (y-axis) over time (x-axis).
• Research Question #2:
  • Is there any difference on eye-tracking data between experienced and novice players? If so, is it possible to differentiate players’ performance by analyzing the eye-tracking information?

• We found differences between expert and novice players.
  • Scan path data analysis showed that
    • Experienced players tend to skip unimportant texts, but novices tend to read all the text very thoroughly (DUH!)
    • Experts look ahead systematically to ‘emerging’ events and paths (to anticipate what is coming), novices don’t know where to look (randomly looking around).
  • Gridded AOI information may have some use
    • Novice players (tend to spend too much time in the game). Experts have more focused red areas, novices have ‘diffused’ area.
FINDINGS

Gridded AOI data of an Expert
FINDINGS

Gridded AOI data of a Novice

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Fixation Count Average: [6, 13, 19, 26, 33, 39, 46, 53, 60, 67, 74, 81, 88, 95, 102, 109, 116, 123, 130, 137]
\section*{FINDINGS}

\textbf{Research Question #3:}
\begin{itemize}
  \item What are the benefits/pitfalls on using eye-tracking with role-playing type serious games?
\end{itemize}

\textbf{Benefits}
\begin{itemize}
  \item mixed data for qualitative and quantitative analyses
  \item \textit{ex situ} assessment to understand players’ behavior
\end{itemize}

\textbf{Issues}
\begin{itemize}
  \item continuously moving game scenes
  \item difficulty on keeping still the participants’ head position
\end{itemize}
FINDINGS

• Benefits of Eye Tracker in Game-based Assessment
  • Mixed data for qualitative and quantitative analyses
  • Qualitative data:
    • Scan path data containing video clip recorded players’ behavior in game environment
  • Quantitative data
    • KPI, Gridded AOI
  • More detail information to understand actual players’ behavior, which cannot be collected/analyzed by using game log data only
    • e.g., whether or not players actually read the conversation texts
FINDINGS

- Pitfalls to watch for:
  - The continuously moving game scenes made hard to
    - Capture consistent gaze point of the participants in the game environment
    - Set custom AOI for analyzing specific parts of the game environment
    - Get the attention map data (i.e., heat map and focus map)
  - The difficulty on keeping still the participants’ head position
    - Participant change posture based on dynamic emotional status
    - Eye-tracker may “loose” participants’ eye movement
  - Current eye tracking software cannot fully accommodate “gameplay”
    - Gameplay study can take a long time (hour-hours) -- compared with media/advertisement research (minutes, or seconds)
CONCLUSION

• **Eye-tracking method can**
  • Be used for role-playing type Serious Games in spite of several issues to be resolved
  • Complement players’ *in situ* behavioral gameplay data: to explain what players actually do in real world (triangulation of data)
  • Useful for performance analysis in game environments in the future (if issues are resolved)
  • Maybe used in conjunction with other analytics to create new *insights*

• More research is needed
SERIOUS GAMES ANALYTICS

**Purpose:**
- Analyzing play-learners’ behaviors during game-based learning/training environments, through:
  - *ex situ* method – e.g., Eye Tracking, psychophysiological devices (but NOT pretest/posttest, or self-reported data), and
  - *in situ* method – e.g., telemetry, or *Information Trail*

To create *actionable insights* to raise skills and improve performance.
NEW BOOK!

- “Serious Games Analytics: Methodologies for Performance Measurement, Assessment, and Improvement”

  - Edited by Loh, C.S., Sheng, Y. and Ifenthaler, D.
  - 2015, forthcoming – to be published by Springer
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