

Related Work

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Outline of the Working Session

1. Introduction
2. Related Work
3. Eye-trackers
4. Examples
 - 4 different research questions
5. Demo
6. Q&A
7. Conclusion



Outline

1. Layouts and aesthetics
2. Usability, mental workload
3. Eye-tracking *per se*
4. Eye-tracking and source code
5. Eye-tracking and UML

Layouts and Aesthetics

- Effective layouts [Sun'05, Andriyevska'05, Eiglsperger'03]
- Influence of stereotypes [Kurniaz'05, Staron'05]
- UML aesthetics [Eichelberger'02, '03, Purchase'01, '02]



Effective Layouts – Sun'05

- Proposed key criteria and guidelines for the effective lay out of UML class diagrams
 - Orthogonality, inheritance direction, and color
- Concluded that these (perceptual) factors are important for devising diagram design and guidelines



Effective Layouts – Andriyevska'05

- Assessed three different layout techniques (including one using stereotype information)
- Found that architectural information assists more comprehension of UML class diagram than the general graph drawing aesthetics



Influence of Stereotypes – Kurniaz'05, Staron'05

- Evaluated the influential role of stereotypes in understanding UML class and collaboration diagrams
- Showed that the use of stereotypes plays a significant role in comprehension of the diagrams



UML Aesthetics – Eiglsperger'03

- Proposed a set of aesthetic criteria and semantic clustering of nodes to increase the readability of UML class diagrams
- Uses design criteria, HCI criteria, and principles of aesthetics
 - Number of children, class size metrics
 - Spatial distribution, enlargement
 - Edges direction, semantic clustering of nodes

UML Aesthetics – Purchase'02

- Conducted user studies to evaluate the effect of aesthetics criteria on the UML diagrams
 - Minimize bends, edge crossing, orthogonal
- A large number of subjects preferred diagrams with fewer crosses, bends, and a more orthogonal layout



Conclusion

- Previous works tend to show the impact of the provided information and of the layouts on program comprehension
- In Section 4 – Examples, we show a study of the impact of various adornments and layouts on program comprehension

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Usability

- Usability studies [Arisholm et al.'06, Briand'05]
- Mental workload [Iqbal'05]
- Web page viewing [Beymer'05, Nakamichi'06, Pan'04, Whalen'05]



Usability Studies – Briand'05

- Controlled experiments to understand the use of OCL (Object Constraint Language)
- Showed that the combined use of OCL and UML offers significant benefits in defect detection, comprehension, and maintenance of diagrams



Usability Studies – Arisholm'06

- Controlled experiments that investigate the impact of UML diagrams on software maintenance
- Found that UML diagrams provide significant improvements in the functional correctness of changes and overall quality of design for complex tasks



Mental Workload – Iqbal'05

- Investigated the mental workload of users using an eye tracker
 - Subjects' subjective rating, task completion time, and eye movements were collected
- Results show that a more difficult task demands a longer processing time, induces higher subjective ratings, and reliably evokes a greater papillary response than a less difficult task

Web Page Viewing – Beymer'05

- Developed the tool *WebGazeAnalyzer* to record and analyze eye movements during Web browsing sessions
- A key contribution is overcoming inherent drift error in remote eye trackers by robustly matching horizontal groups of gaze fixations to lines of text on the web page



Web Page Viewing – Nakamichi'06

- Advocated the use of gaze-point velocity to detect low usability Web pages
 - Used operation time, mouse movements, and eye movements (i.e., moving distance, and moving speed)
- Results showed the effectiveness of using the speed of gaze-points in detecting low usability Web pages



Web Page Viewing – Pan'04

- Used eye tracking measures to study factors such as gender information, Web page viewing order, and different types of web sites (e.g., news)
- The results of the scanpath analysis revealed a possible relationship between scanpath variability among individuals and the structural/visual complexity of the web page



Web Page Viewing – Whalen'05

- Conducted a study to determine the elements in Web browsers that are viewed (and ignored) and how easily they can be noticed
- Results demonstrated that the lock icon in the browser security cue is most often looked at while the certificate information is rarely used



Conclusion

- Certain visual information is clearly more important (i.e., seeked) than other information during comprehension tasks

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Eye-tracking *Per Se*

- Eye tracking research [Jacob '90, Duchowski '03, Hyona '03]
- Vision Science [Palmer'99]



Eye Tracking Research – Jacob'90

- Discussed the human factors and technical considerations in using eye tracking in Human Computer Interaction (HCI)



Eye Tracking Research – Duchowski'03

- Provided a comprehensive overview on eye tracking, including an introduction to the human visual system and key issues in visual perception and eye movement
- Surveyed eye-tracking devices and provided a detailed introduction to their technical requirements



Eye Tracking Research – Hyona'03

- Provided an overview on research on cognitive and applied aspects of eye movements
- Included chapters on
 - Visual information processing
 - Empirical studies,
 - Computational models of eye movements in reading, and eye-tracking as a tool to study human-computer interaction

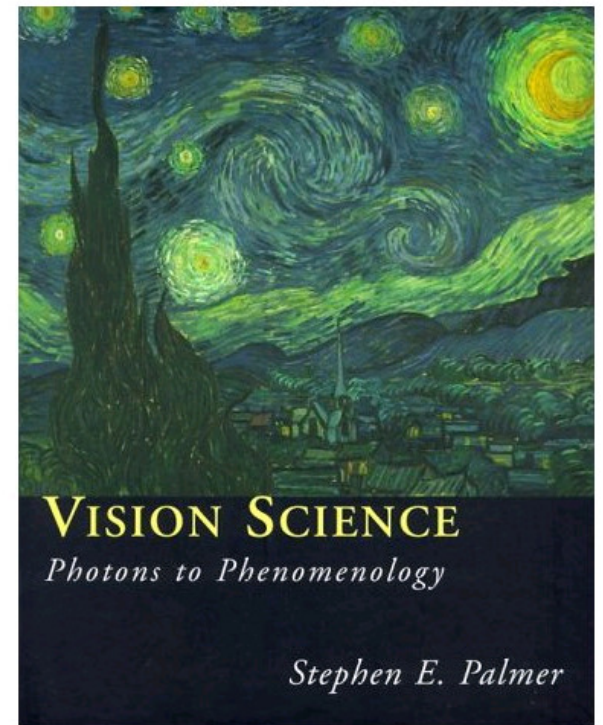


Vision Science – Palmer'99

- Summarised in a complete, consistent, and comprehensive book knowledge of the human perception systems, focusing on the visual system

Vision Science – Palmer'99

- Included chapters on the visual system and the various steps of acquiring and comprehending visual data





Conclusion

- Provided invaluable background information on the human visual system, including eye tracking

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Eye-tracking and Source Code

- Eye tracking on Source code
[Bednarik'06, Uwano'06]



Eye tracking on Source code – Bednarik'06

- Used eye tracking to study comprehension of Java programs
- Found that more experienced subjects read the code first, and then run the program in a single execution
- Less experienced subjects did not read the code first, instead animated the program several times



Eye tracking on Source code – Bednarik'06

- Provided subjects with additional visual information to confirm and fine-tune their previously established mental model and hypotheses
- Concluded that visualisation is more important in the early phases of comprehension than at the later stages



Eye tracking on Source code – Uwano'06

- Used fixation data to characterize the subjects' performance in reviewing source code (scan patterns)
- Showed that subjects who did not spend enough time for the scan tend to take more time for finding defects



Conclusion

- Showed the difference of eye movements characterising expert with novice subjects
- In Section 4 – Examples, we report the preliminary results of a similar study

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Eye-tracking and UML

- Eye tracking and UML [Guéhéneuc'06, Yusuf, Kagdi, and Maletic'07]



More to Come...

- In Section 4 – Examples, we will detail Yusufu, Kagdi and Maletic's study