

The 5th International Workshop on Pervasive Eye Tracking and Mobile Eye-Based Interaction

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ABSTRACT

Previous work on eye tracking and eye-based human-computer interfaces mainly concentrated on making use of the eyes in traditional desktop settings. With the recent growth of interest in smart eyewear and low-cost mobile eye trackers, gaze-based techniques for mobile computing is becoming increasingly important. PETMEI 2015 focuses on the pervasive eye tracking paradigm as a trailblazer for mobile eye-based interaction and eye-based context-awareness. We want to stimulate and explore the creativity of these communities with respect to the implications, key research challenges, and new applications for pervasive eye tracking in ubiquitous computing. The long-term goal is to create a strong interdisciplinary research community linking these fields together and to establish the workshop as the premier forum for research on pervasive eye tracking.

Author Keywords

Eye tracking; gaze-based interaction; wearable and mobile

ACM Classification Keywords

H.5.2 Information interfaces and presentation: User Interfaces: Input devices and strategies.

INTRODUCTION AND RATIONALE

Eye tracking technology has considerably matured in recent years and eye-based interaction is gaining attention in various application areas. While early work focused on gaze as an input modality to interact with desktop computers, it is becoming increasingly important to take eye tracking out into pervasive and mobile settings in various areas such as human-human and human-robot interaction and wearable computing. In everyday life, how and where we look provides rich information for understanding human interactions with real-world environments. Our gaze behaviours are closely related with human attention and are good indicators of objects of interests. Recently, the use of eye tracking has expanded from lab research into new applications in the context of real world

environments. For example, eye tracking has been applied to assist life logging [8], mobile geospatial applications [10], pervasive display interactions [19, 20] and game design [17].

The advent of mobile video-based eye-tracking technologies has paved the way for such new research in everyday environments and mobile settings [7]. A growing number of researchers study eye-based interaction in pervasive daily-life settings [6, 19, 20], thereby opening up new application areas and promising eye-based interaction to become mainstream. Mobile eye trackers can provide an indicator of user attention in daily environments [8, 10, 16, 5, 13], and eye movements can be used as a new modality for activity and context recognition [3, 9]. Eye tracking is beginning to be implemented on mobile devices such as smart phones and tablets, which are increasingly equipped with cameras facing towards the user [18, 12]. Wearable cameras or *smart eyewear*, such as Sony Smarteyeglass¹, are also gaining more attention in recent years, and eye tracking has the potential to become a key component in all interactions that users perform with computing systems in the real world.

We call this new paradigm *pervasive eye tracking* - continuous eye monitoring and eye-based interaction 24/7 [2, 1, 14]. The potential applications for the capability to track and analyse eye movements anywhere and any time call for new research to further develop and understand visual behaviour and eye-based interaction in mobile daily-life settings. Pervasive eye tracking opens up new research across a number of disciplines including ubiquitous computing, human-robot and human-computer interaction, eye-tracking research, ego-centric vision, cognitive psychology, and design. Identifying the implications and addressing the challenges of pervasive eye tracking and mobile eye-based interaction will require an interdisciplinary approach at the crossroads of these fields.

THE PETMEI WORKSHOP SERIES

The first workshop on pervasive eye tracking and mobile eye-based interaction was held in conjunction with UbiComp 2011 in Beijing, China [2]. PETMEI 2011 attracted about 30 participants who enjoyed 11 high-quality oral presentations and demos of the latest mobile eye trackers. Following the success of PETMEI 2011, the second workshop PETMEI 2012 was held in conjunction with UbiComp 2012 with 9 oral presentations and also approximately 30 participants [1]. In

¹<https://developer.sony.com/devices/mobile-accessories/smarteyeglass/>

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2013, PETMEI was held as a conference track at the 17th European Conference on Eye Movements (ECEM 2013), a conference of basic research in cognitive psychology, human vision, linguistics, and computer science. In this interdisciplinary setting, twelve oral presentations successfully attracted about 60 participants. The fourth PETMEI in 2014 was again part of UbiComp with the special theme egocentric vision [14]. Approx. 30 participants were attracted by 9 oral presentations.

OBJECTIVES

The main objective of the workshop is to bring together researchers and practitioners working in human-computer interaction, context-aware computing, computer vision, and eye tracking. The workshop will create a forum for these researchers to gather, present their ideas, and to discuss techniques and applications that go beyond classical eye tracking and stationary eye-based interaction.

Specifically, we want to encourage these communities to think about the implications of pervasive eye tracking for context-aware computing, i.e. the ability to track eye movements not only for a couple of hours inside the laboratory but continuously for days, weeks, or even months in people's everyday life. The workshop aims to identify the key research challenges in pervasive eye tracking and mobile eye-based interaction and to discuss the technological and algorithmic methods required to address them. The workshop shall provide intellectual stimuli and build bridges for future collaborations between these communities. The long-term goal is to create a strong interdisciplinary research community linking the different research fields and to establish the workshop as the premier forum for research on pervasive eye tracking in context-aware computing.

TOPICS OF INTEREST

Topics of interest cover computational methods, new applications and use cases, as well as eye tracking technology for pervasive eye tracking and mobile eye-based interaction.

Methods

Previous research in HCI and eye tracking has resulted in a large variety of methods, e.g. for eye detection and tracking [7], automated eye movement analysis [15], or evaluation of eye movement classification algorithms [11]. We invite participants to reflect on the specific characteristics of pervasive eye tracking systems and to contrast them with classical methods for eye tracking, eye movement analysis, eye-based interaction, and evaluation. Identifying the key differences will then allow to formulate key requirements for the implementation of mobile eye-based interfaces.

We solicit contributions reporting on methodological advances on all components of mobile eye tracking systems. This may, for example, include computer vision techniques to face and eye detection and tracking, pupil localization, calibration, and gaze estimation, pattern recognition and machine learning techniques for automated eye movement analysis, as well as methods and user studies to evaluate specific interaction techniques.

The workshop also covers latest technological advances in mobile eye tracking equipment. This includes creative use of existing measurement techniques and systems as well as potentially new types of eye tracking hardware.

- Tools for face, eye, and pupil detection as well as tracking
- Devices for wearable and ambient eye tracking
- Eye tracking technologies on mobile devices
- Head-mounted or remote gaze estimation
- Gaze and eye movement analysis methods
- Fusion of gaze with other modalities
- Integration of pervasive eye tracking and context-aware computing
- User studies on pervasive eye tracking

Applications

Classical eye tracking has found a large number of applications in both research and industry [4]. In addition to contributions reporting on methodological advances we also attract submissions that explore innovative applications of pervasive eye tracking and mobile eye-based interaction. We aim to identify and discuss which applications are possible and which are only imaginable. By inviting researchers from different disciplines, we aim to identify particularly promising applications (the “killer applications”) for pervasive eye tracking and mobile eye-based interaction.

This year we invite presentations on research on eye tracking and gaze interaction applied in the context of real world environments. This includes but not limited to eye tracking in office and home environments, public spaces, healthcare, and etc. We welcome applications on using eye tracking in mobile interactions and pervasive displays. To create new knowledge and extend current understanding, we also encourage multidisciplinary researches between eye tracking, computer vision, machine learning, human-computer interaction and ubiquitous computing.

- Pervasive eye-based interaction
- Mobile attentive user interfaces
- Eye-based activity and context recognition
- Security and privacy for pervasive eye-tracking systems
- Eye tracking for specialized application areas
- Cognition-aware systems and user interfaces
- Human factors in mobile eye-based interaction
- Eye tracking for pervasive displays
- Gaze-based interaction with outdoor spaces

FORMAT

PETMEI 2015 is a one-day workshop as part of the UbiComp 2015 workshop program. We expect approximate 30 participants with a background in context-aware computing, human-computer interaction, computer vision, and eye tracking. As the workshop covers a new area of research at the crossroads of these fields, we not only aim to attract domain experts but also newcomers with an interest in potential applications of pervasive eye tracking in their respective fields.

Before the Workshop

The Call for Papers has been distributed in multiple research communities, including those of ubiquitous and pervasive computing, eye tracking, computer vision, and HCI. We have set up a webpage², and used online media to disseminate the call. We have solicited submissions of up to 10 pages that describe original research related to pervasive eye tracking research. All submissions have been peer-reviewed via an international program committee. Demos of latest development of pervasive eye tracking have been encouraged from all participants.

At the Workshop

The timeline for the workshop is shown in Table 1: we have invited Ali Borji (University of Wisconsin, U.S.) as a keynote speaker. Also, participants will briefly introduce themselves and their main research interests (30 seconds). Each paper accepted for presentation will be given 20 minutes incl. questions. In the afternoon, participants will split up in groups and discuss PETMEI-related topics that were raised during the workshop. Each group can work on envisioning potential future applications, and brainstorm and discuss about selected emerging topics for future research. The results of the group sessions will be shared and discussed among all participants in a plenary session.

09.30 – 09.35	Opening
09.35 – 10.30	Keynote: Ali Borji, University of Wisconsin (U.S.)
10.30 – 11.00	Coffee break
11.00 – 11.15	Participant introductions and statements
11.15 – 12.30	Participant presentations I
12.30 – 13.30	Lunch
13.30 – 14.45	Participant presentations II
14.45 – 15.30	Demos
15.30 – 16.00	Coffee break
16.00 – 17.30	Envisioning and design (group work)
17.30 – 18.20	Discussion in plenum
18.20 – 18.30	Wrap-up

Table 1. Preliminary workshop schedule of PETMEI 2015

After the Workshop & Publication

Papers accepted for oral presentations will be included in the ACM Digital Library and in the supplemental UbiComp 2015 proceedings. Submissions accepted as a poster, presentation slides, and demo-related material will be made available on the workshop website.

²URL: <http://2015.petmei.org/>

ORGANIZERS

The workshop will be organized by three researchers who are actively involved in the research fields of eye tracking, human computer interaction, and context-aware computing.

Peter Kiefer is a senior researcher at ETH Zürich, Switzerland, leading the GeoGazeLab³. His eye tracking research is focused on gaze-based interaction with geo information and with real urban environments. He is specifically interested in new gaze-based assistive technologies that can help to improve the interaction with mobile geo-spatial services. He has organized two previous workshops on eye tracking (Eye Tracking for Spatial Research)

Yanxia Zhang is a Marie Curie Research Fellow and PhD student in the School of Computing and Communications at Lancaster University. Her research interests include assisted living, health monitoring, vision-based eye tracking and gaze enhanced interface design.

Andreas Bulling is head of the Perceptual User Interfaces Group at the Max Planck Institute for Informatics and the Cluster of Excellence on Multimodal Computing and Interaction, Saarbrücken, Germany. Andreas coined the term “pervasive eye tracking” and pioneered the use of eye movement analysis for context-aware computing. Andreas initiated the PETMEI workshop series in 2011, organised four PETMEI workshops (2011-2014) and two gaze interaction workshops at CHI 2012 and 2013 so far, and is member of the PETMEI steering committee.

**PETMEI PROGRAM AND STEERING COMMITTEE**

PETMEI 2015 is supported by the following program committee members:

Florian Alt, University of Munich (LMU), Germany

Roman Bednarik, University of Eastern Finland, Finland

Florian Daiber, German Research Center for Artificial Intelligence, Germany

Ming Ki Chong, Lancaster University, U.K.

Andrew T. Duchowski, Clemson University, SC, U.S.A.

Ioannis Giannopoulos, ETH Zurich, Switzerland

Carlos Hitoshi Morimoto, University of São Paulo, Brasil

Kris Kitani, Carnegie Mellon University, PA, USA

Antonio Krüger, German Research Center for Artificial Intelligence, Germany

Dan Liebling, Microsoft Research, USA

Diako Mardanbegi, IT University of Copenhagen, Denmark

Lucas Paletta, Joanneum Research, Austria

Thies Pfeiffer, Excellence Center Cognitive Interaction Technology, Bielefeld University, Germany

³<http://www.geogaze.org/>

Pernilla Qvarfordt, FX Palo Alto Laboratory, CA, USA
Martin Raubal, ETH Zurich, Switzerland
Oleg Špakov, University of Tampere, Finland
Yusuke Sugano, Max Planck Institute for Informatics, Germany
Veronica Sundstedt, Blekinge Institute of Technology, Sweden
Takumi Toyama, German Research Center for Artificial Intelligence, Germany

The PETMEI workshop series is also supported by a steering committee of international eye tracking experts. To ensure continuity in the workshop organisation, one steering committee member is appointed as third organiser each year.

Andreas Bulling, MPI Informatics, Germany
Dan Witzner Hansen, IT University of Copenhagen, Denmark
Päivi Majaranta, University of Tampere, Finland
Carlos Hitoshi Morimoto, University of São Paulo, Brasil
Pernilla Qvarfordt, FX Palo Alto Laboratory, U.S.

REFERENCES

1. Andreas Bulling, Shiwei Cheng, Geert Brône, and Päivi Majaranta. 2012. 2nd International Workshop on Pervasive Eye Tracking and Mobile Eye-Based Interaction (PETMEI 2012): Proposal for a Workshop (Mini-track) at UbiComp 2012. In *Proc. UbiComp '12*. 673–676.
2. Andreas Bulling, Andrew T. Duchowski, and Päivi Majaranta. 2011a. 1st International Workshop on Pervasive Eye Tracking and Mobile Eye-based Interaction (PETMEI). In *Proc. UbiComp*. 627–628.
3. Andreas Bulling, Jamie A. Ward, Hans Gellersen, and Gerhard Tröster. 2011b. Eye Movement Analysis for Activity Recognition Using Electrooculography. *IEEE Trans. on Pattern Analysis and Machine Intelligence* 33, 4 (2011), 741–753.
4. Andrew T. Duchowski. 2007. *Eye Tracking Methodology: Theory and Practice*. Springer.
5. Tom Foulsham and Alan Kingstone. 2012. Goal-driven and Bottom-up Gaze in an Active Real-world Search Task. In *Proc. ETRA*. 189–192.
6. Ioannis Giannopoulos, Peter Kiefer, and Martin Raubal. 2015. GazeNav: Gaze-Based Pedestrian Navigation. In *17th International Conference on Human-Computer Interaction with Mobile Devices and Services (MobileHCI)*. ACM. accepted.
7. Dan Witzner Hansen and Qiang Ji. 2010. In the Eye of the Beholder: A Survey of Models for Eyes and Gaze. *IEEE Trans. on Pattern Analysis and Machine Intelligence* 32, 3 (2010), 478–500.
8. Yoshio Ishiguro, Adiyana Mujibiyana, Takashi Miyaki, and Jun Rekimoto. 2010. Aided Eyes: Eye Activity Sensing for Daily Life. In *Proc. AH*. ACM, Article 25, 7 pages.
9. Peter Kiefer, Ioannis Giannopoulos, and Martin Raubal. 2013. Using Eye Movements to Recognize Activities on Cartographic Maps. In *Proc. SIGSPATIAL*. ACM, 498–501.
10. Peter Kiefer, Ioannis Giannopoulos, and Martin Raubal. 2014. Where am I? Investigating map matching during self-localization with mobile eye tracking in an urban environment. *Transactions in GIS* 18, 5 (2014), 660–686.
11. Oleg V. Komogortsev, Sampath Jayarathna, Do Hyong Koh, and Sandeep Munikrishne Gowda. 2010. Qualitative and quantitative scoring and evaluation of the eye movement classification algorithms. In *Proc. ETRA*. ACM Press, 65–68.
12. Kai Kunze, Shoya Ishimaru, Yuzuko Utsumi, and Koichi Kise. 2013. My Reading Life: Towards Utilizing Eyetracking on Unmodified Tablets and Phones. In *Proc. UbiComp '13 Adjunct*. 283–286.
13. Thies Pfeiffer and Patrick Renner. 2014. EyeSee3D: A Low-cost Approach for Analyzing Mobile 3D Eye Tracking Data Using Computer Vision and Augmented Reality Technology. In *Proc. ETRA*. 195–202.
14. Thies Pfeiffer, Sophie Stellmach, and Yusuke Sugano. 2014. 4th International Workshop on Pervasive Eye Tracking and Mobile Eye-based Interaction. In *Proceedings of the 2014 ACM International Joint Conference on Pervasive and Ubiquitous Computing: Adjunct Publication (UbiComp '14 Adjunct)*. ACM, New York, NY, USA, 1085–1091.
15. Dario D. Salvucci and John R. Anderson. 2001. Automated eye-movement protocol analysis. *Human-Computer Interaction* 16, 1 (2001), 39–86.
16. Takumi Toyama, Thomas Kieninger, Faisal Shafait, and Andreas Dengel. 2012. Gaze Guided Object Recognition Using a Head-mounted Eye Tracker. In *Proc. ETRA*. 91–98.
17. Jayson Turner, Eduardo Velloso, Hans Gellersen, and Veronica Sundstedt. 2014. EyePlay: Applications for Gaze in Games. In *Proceedings of the First ACM SIGCHI Annual Symposium on Computer-human Interaction in Play (CHI PLAY '14)*. ACM, New York, NY, USA, 465–468.
18. Erroll Wood and Andreas Bulling. 2014. EyeTab: Model-based Gaze Estimation on Unmodified Tablet Computers. In *Proc. ETRA*. 207–210.
19. Yanxia Zhang, Andreas Bulling, and Hans Gellersen. 2013. SideWays: A Gaze Interface for Spontaneous Interaction with Situated Displays. In *Proc. CHI*. 851–860.
20. Yanxia Zhang, Jörg Müller, Ming Ki Chong, Andreas Bulling, and Hans Gellersen. 2014. GazeHorizon: Enabling Passers-by to Interact with Public Displays by Gaze. In *Proc. UbiComp*. 559–563.