

Activity Recognition for the Mind

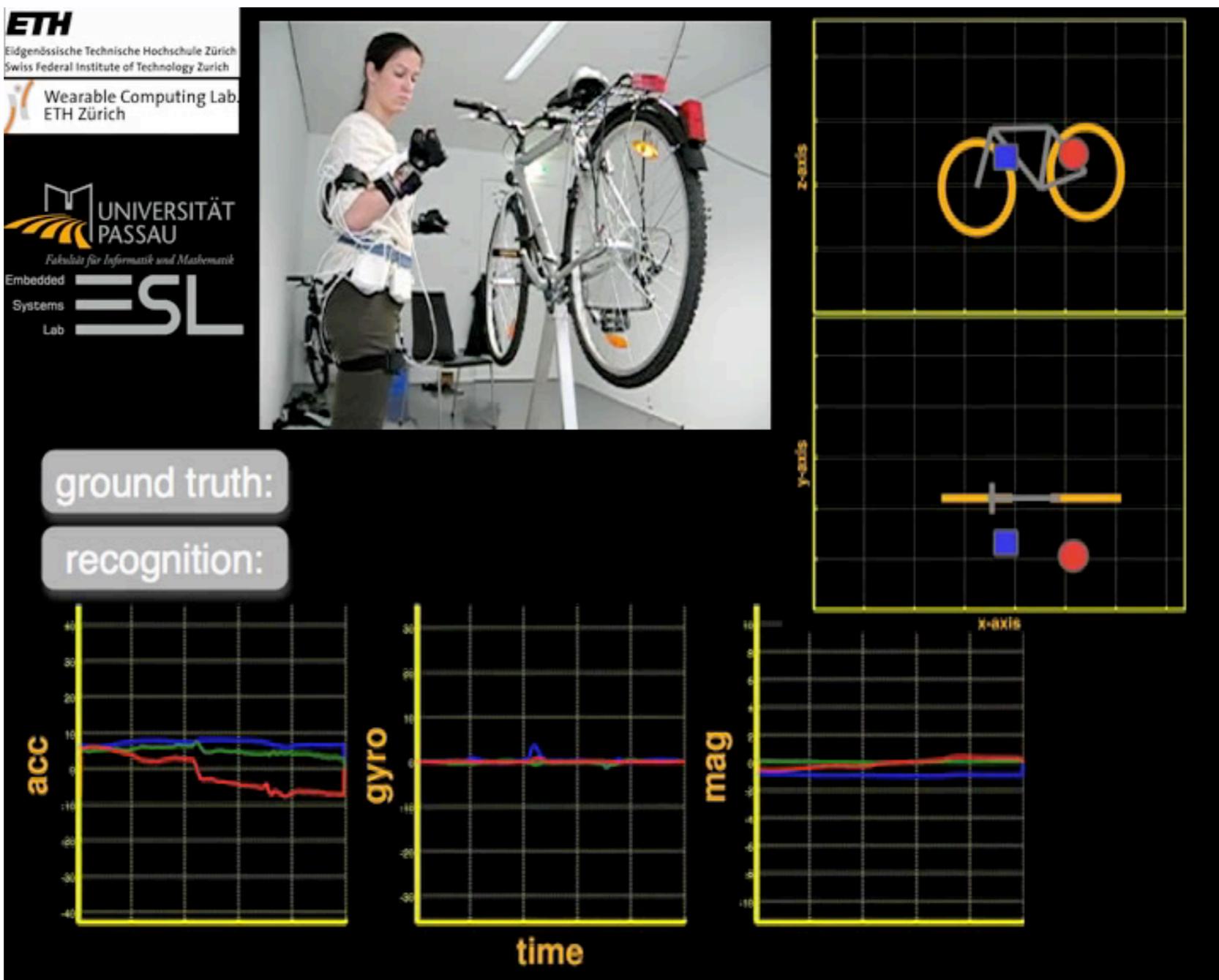
Tracking Reading Habits

Kai Kunze, Koichi Kise
Osaka Prefecture University

Outline

Motivation
Tracking Reading
how much?
what type?
comprehension?
Opening Tech
to Everybody
Demos (hopefully ..)

Wearable Computing



Research by: Georg Ogris, Thomas Stiefmaier

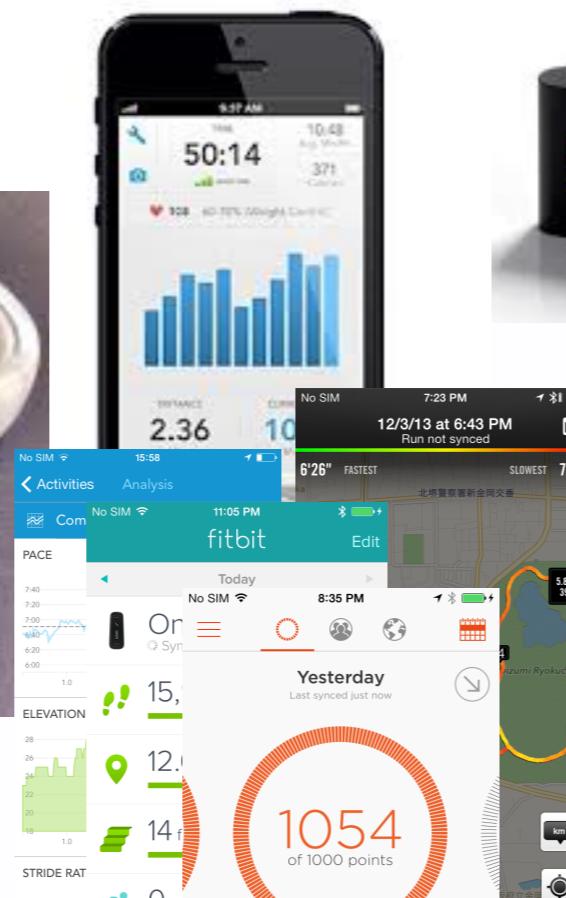
Physical Activity Recognition becoming mainstream

Sensors in everyday objects, clothes, accessories ...

We see the first commodity devices tracking physical activity

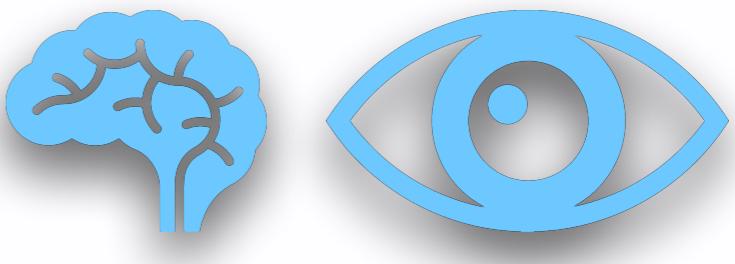
-> towards physiological sensing

May soon extend to cognitive tasks



Cognitive Activity Recognition

obvious approach: track brain activity directly



drawback: often obtrusive, expensive hardware,

most interesting (wearable etc.):

Electroencephalography (EEG) and Functional Near-Infrared Spectroscopy (fNIRS)

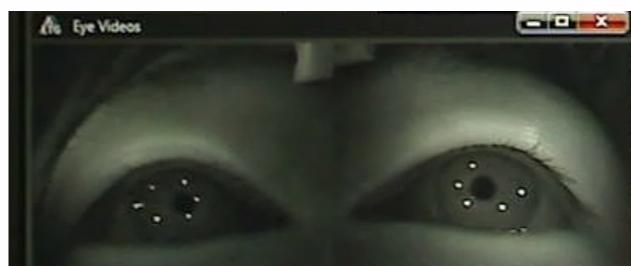
or using secondary sensing:

especially eye gaze

two prominent ways to do eye tracking:

Electrooculography (EOG)*

optical, usually using infrared light/cameras



*Eye Movement Analysis for Activity Recognition Using Electrooculography
Andreas Bulling, Jamie A. Ward, Hans Gellersen and Gerhard Tröster
(2011), in: *IEEE Transactions on Pattern Analysis and Machine Intelligence*,
33:4(741-753)

How can we track progress?

Key: Tracking Cognitive Activities in real life

Tracking Reading Habits (reading life log)

People who read more

higher vocabulary skill

“Can I copy the habits of my thesis advisor to become a better?”

If you give quantified feedback people can improve their habits

similar to apps/devices that track fitness and health

they have been shown to improve physical fitness

Very Few In-Situ Studies [2]

[1] A. Cunningham and K. Stanovich. What reading does for the mind. *Journal of Direct Instruction*, 1(2):137–149, 2001.

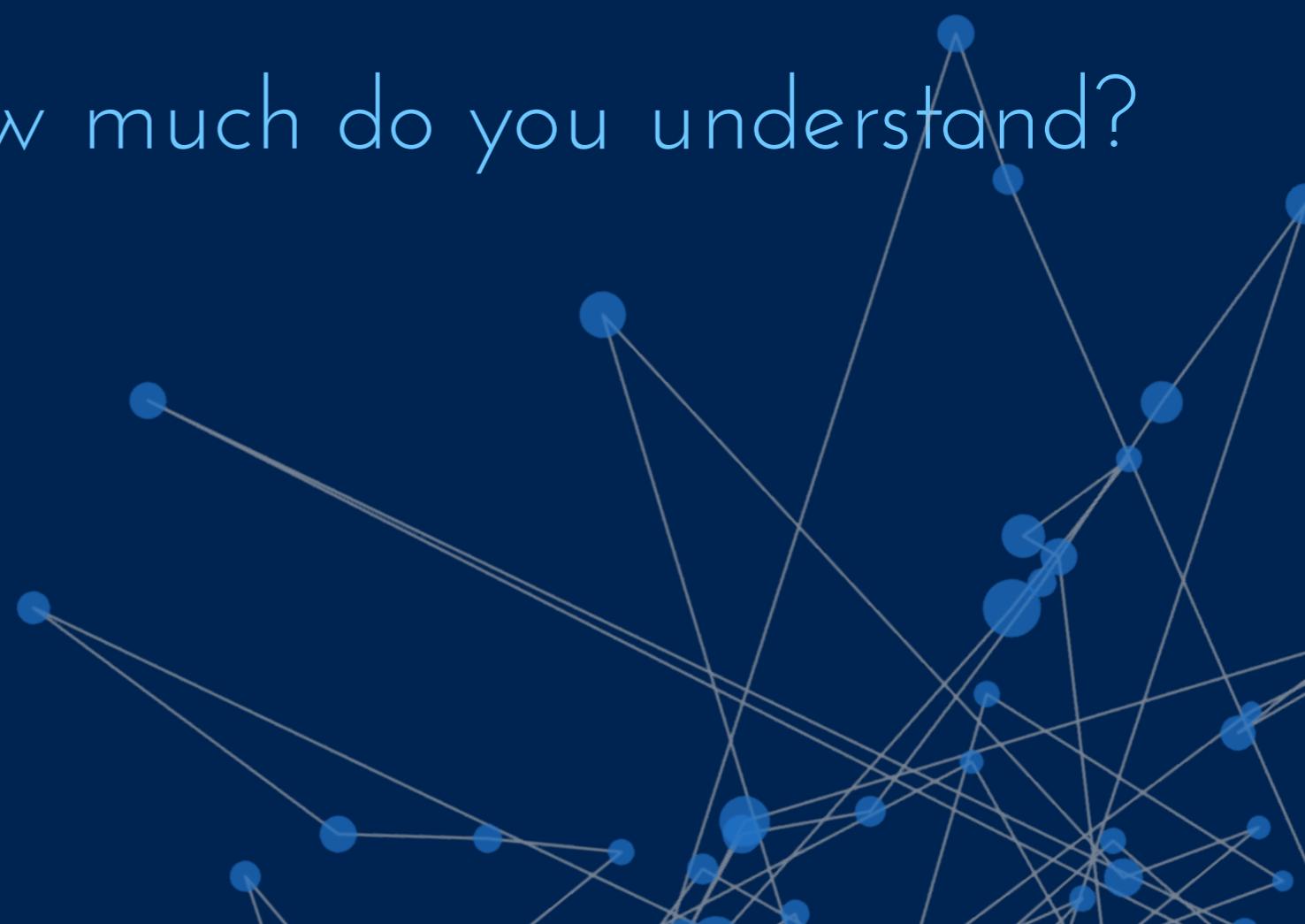
[2] A. Bulling, J. A. Ward, and H. Gellersen. Multimodal Recognition of Reading Activity in Transit Using Body-Worn Sensors. *ACM Trans. on Applied Perception for the Mind* 6



How much are you reading?

What are you reading?

How much do you understand?

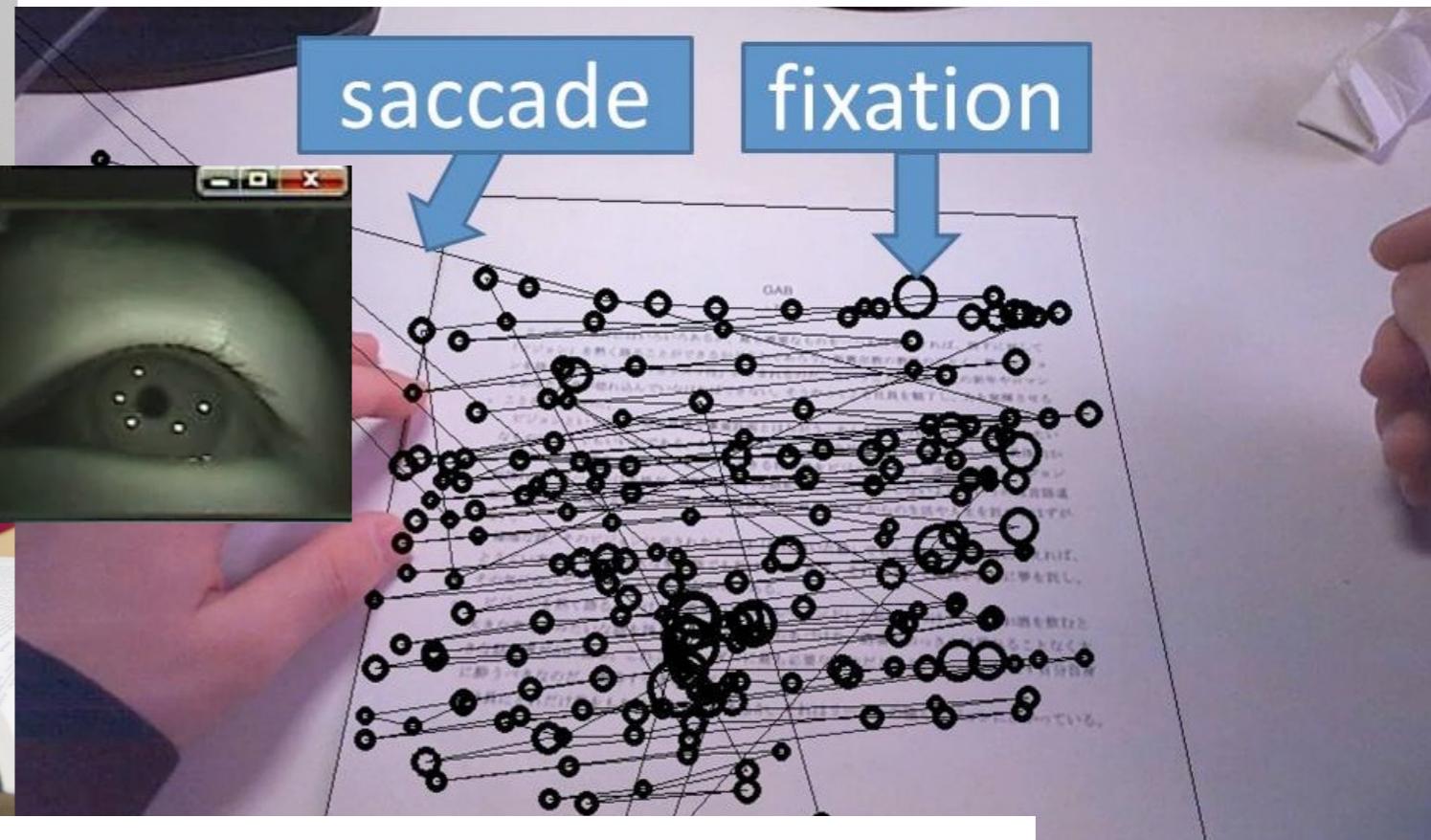




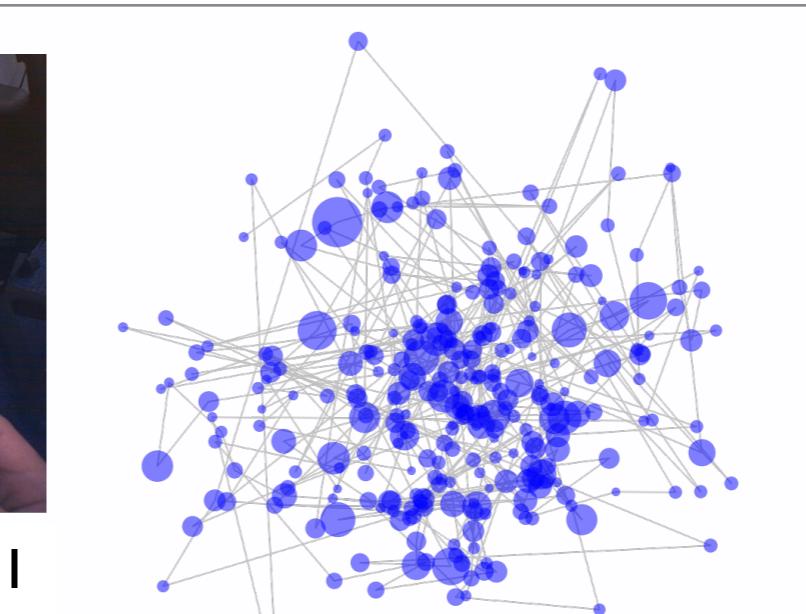
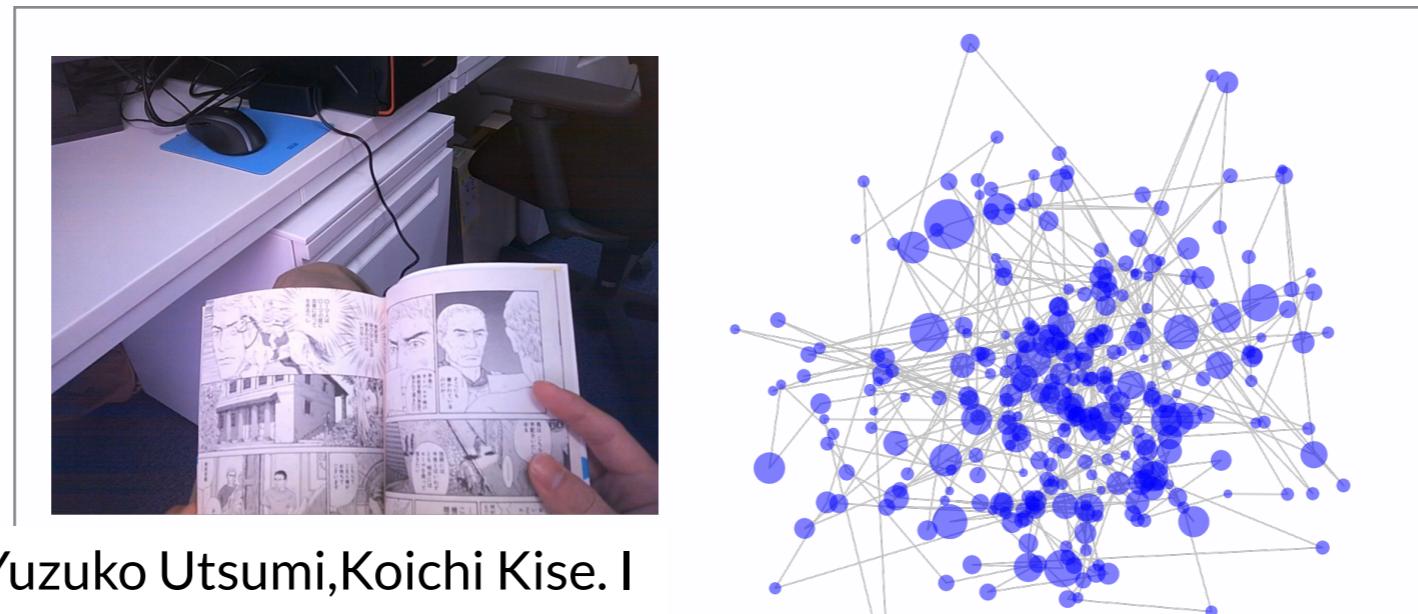
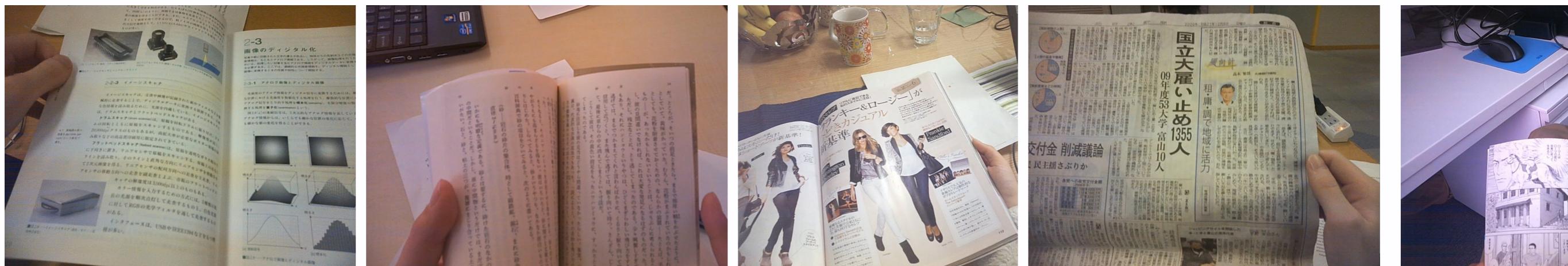
How much are you reading?

using eye tracker to count
number of lines read
-> estimate words read.

Wordometer

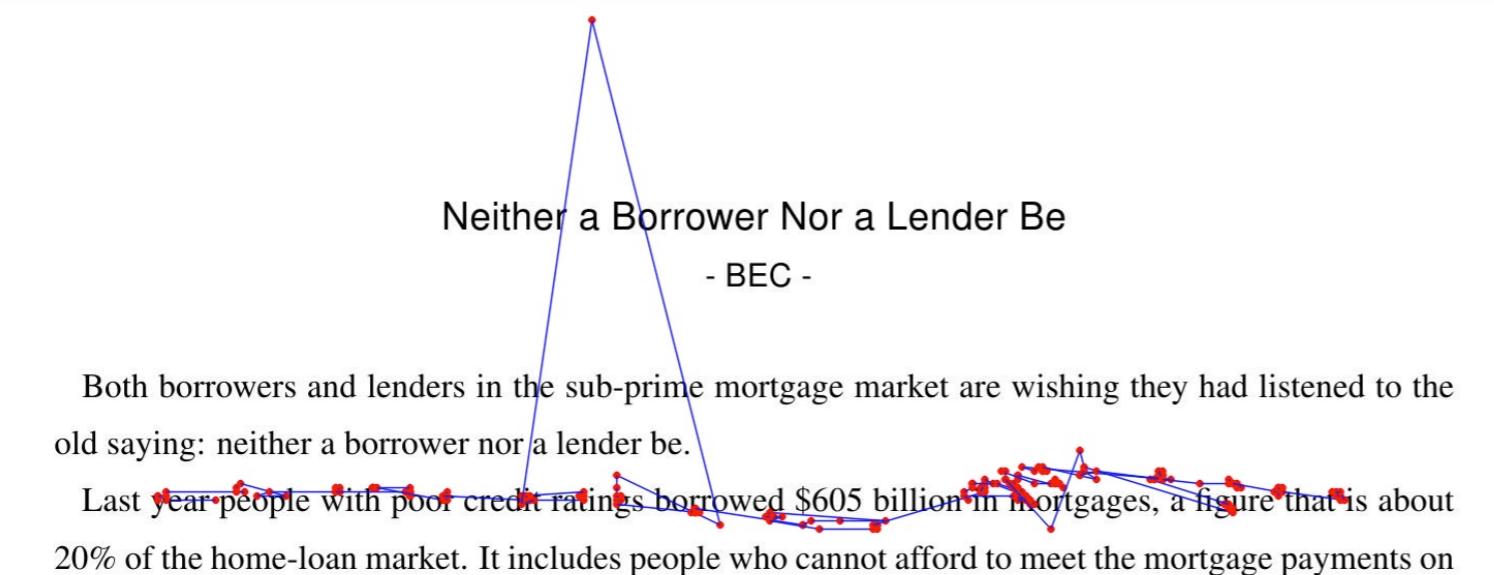


K. Kunze, H. Kawaichi, K. Yoshimura, K. Kise. The Wordometer – Estimating the Number of Words Read Using Document Image Retrieval and Mobile Eye Tracking ICDAR 2013. Best Paper Award



Kai Kunze, Andreas Bulling, Yuzuko Utsumi, Koichi Kise. I know what you are reading – Recognition of document types using mobile eye tracking, ISWC 2013, Zurich.

Trying to Infer TOEIC Scores - Detecting Difficult Words



Eye-gaze translated to Document coordinate System using LLAH

Horizontal projection To a line

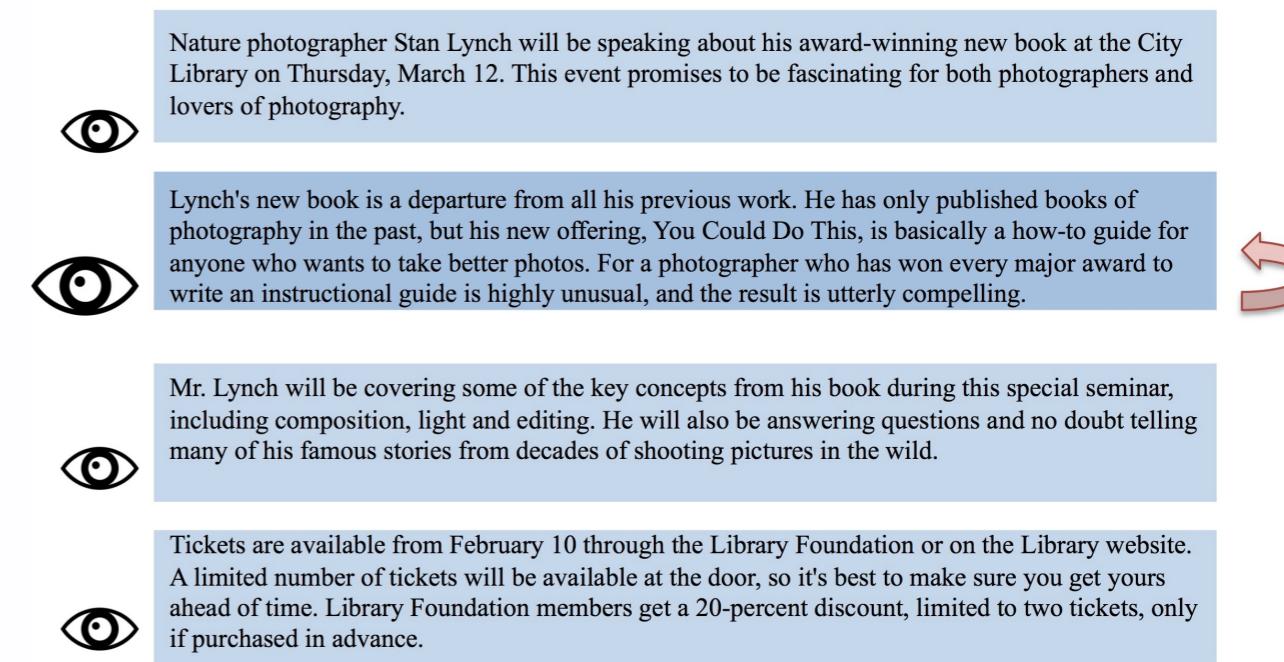
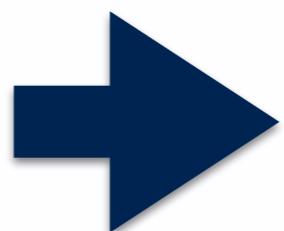
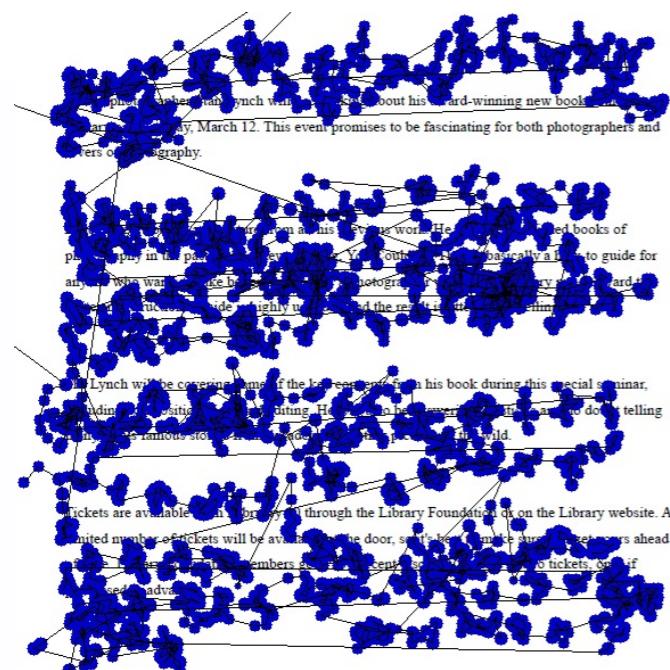
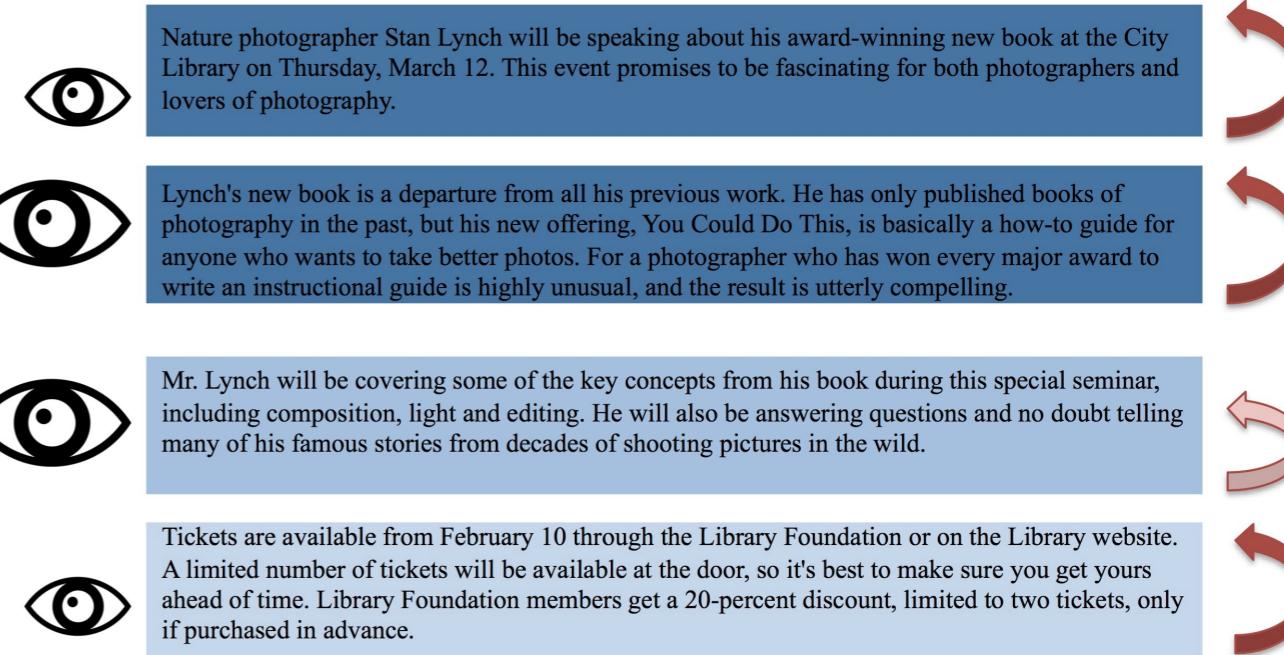
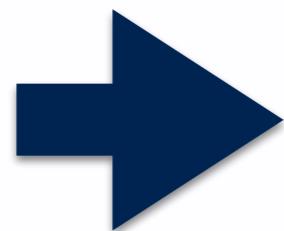
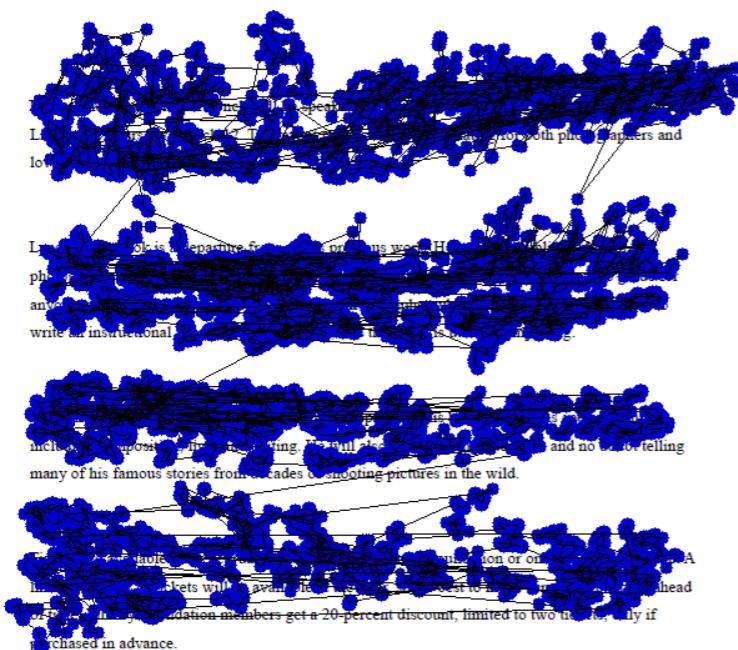
Last year people with poor credit ratings borrowed \$605 billion in mortgages, a figure that is about 20% of the home-loan market. It includes people who cannot afford to meet the mortgage payments on

Both borrowers and lenders in the sub-prime mortgage market are wishing they had listened to the old saying: neither a borrower nor a lender be.

Last year people with poor credit ratings borrowed \$605 billion in mortgages, a figure that is about 20% of the home-loan market. It includes people who cannot afford to meet the mortgage payments on

histogram

Implicit Gaze Annotations



Ayano Okoso, Kai Kunze, Koichi Kise, Implicit Gaze based Annotations to Support Second Language Learning to be published in Ubicomp Adjunct 2014.

Future Work -A Fitbit for the Mind?-

The screenshot shows the read.it dashboard interface. At the top, there's a navigation bar with icons for file operations, a search bar, and links for Dashboard, Log, Community, Premium, STORE, and Reader. A user profile icon is also present.

The main area displays activity data for Thursday, August 08:

- Activity:** A bar chart titled "words read" showing word counts at various times of the day. The y-axis ranges from 0 to 1,500. The chart shows several peaks, notably around 10:00, 12:00, 18:00, and 22:00.
- word count:** A circular gauge showing 8497 words read.
- Manga:** A circular gauge showing 15 pages read.
- Science Papers:** A circular gauge showing 20 pages read.
- Concentrated Reading:** A circular gauge showing 30 min of concentrated reading.
- Japanese:** A partial circular gauge.
- Overview:** A partial circular gauge.

To the right, there's a "Friends" section listing users with their word counts:

Rank	User	Word Count
1	You	67,071
2	codysumter	36,155
3	Sulistyo	24,538
4	Jessy	13,868
	Shoya I.	No recent activity
	ubiquitousdude	No recent activity
	James	No recent activity

A cartoon character in the bottom right corner is thinking about "Border".

How can we build cognitive tools to
augment our brain?



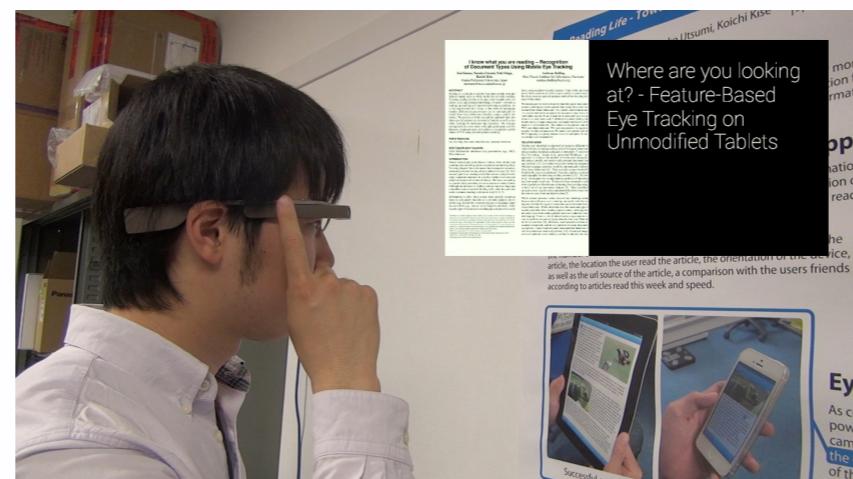
Cognitive Activity Recognition for Everybody

Eye trackers are expensive and for tracking learning habits we should apply the technology to a lot of people

Is there technology that can be used more broadly ..



Eyetracking on Tablets



Google Glass



JINS MEME
(Electrooculography)

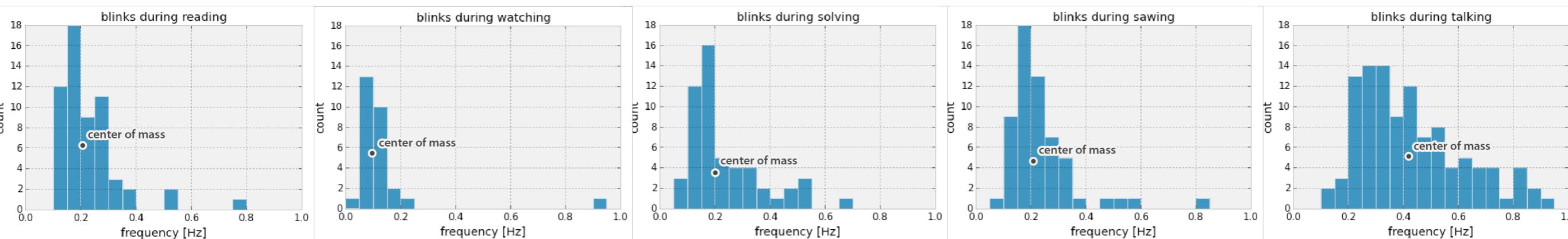
Demo: Toward Eye Tracking on Tablets



Demo: Google Glass Blink Detection



What can you do with it?



- **reading** a book on an eBook reader
- **watching** a video on laptop PC
- **solving** mathematical tasks
- **sawing** a cardboard
- **talking** with another person

Shoya Ishimaru, Jens Weppner, Kai Kunze, Andreas Bulling, Koichi Kise, Andreas Dengel, and Paul Lukowicz. In the blink of an eye - combining head motion and eye blink frequency for activity recognition with google glass. In 14th Augmented Human. ACM, 2014, to appear.

Smart Glasses

J!NS MEME

very different idea from Google Glass
... not a full fledged computer,
no display, NO camera ...
a sensing device connected to phone.



Electrooculography and motion sensors
(accelerometer and gyroscope)

We are working with Inami-Sensei
from Keio Media Design and J!NS
directly on the prototype



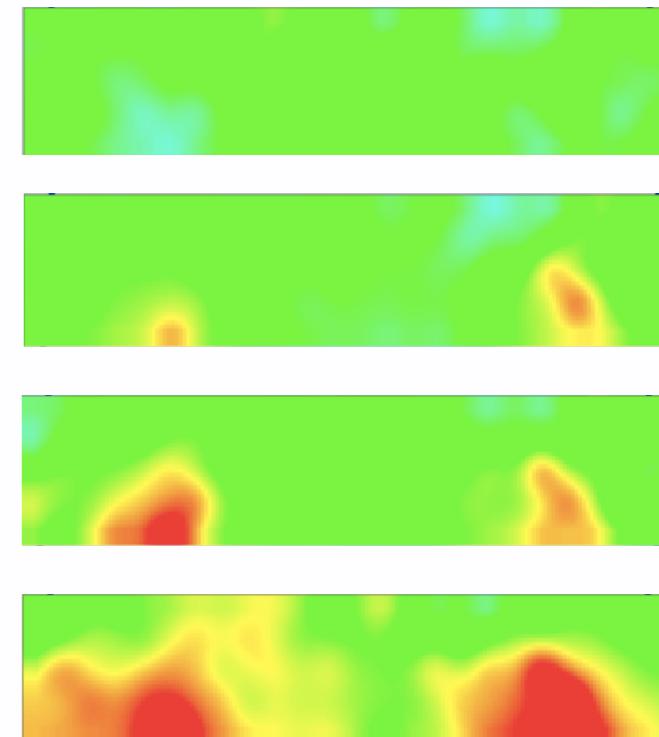
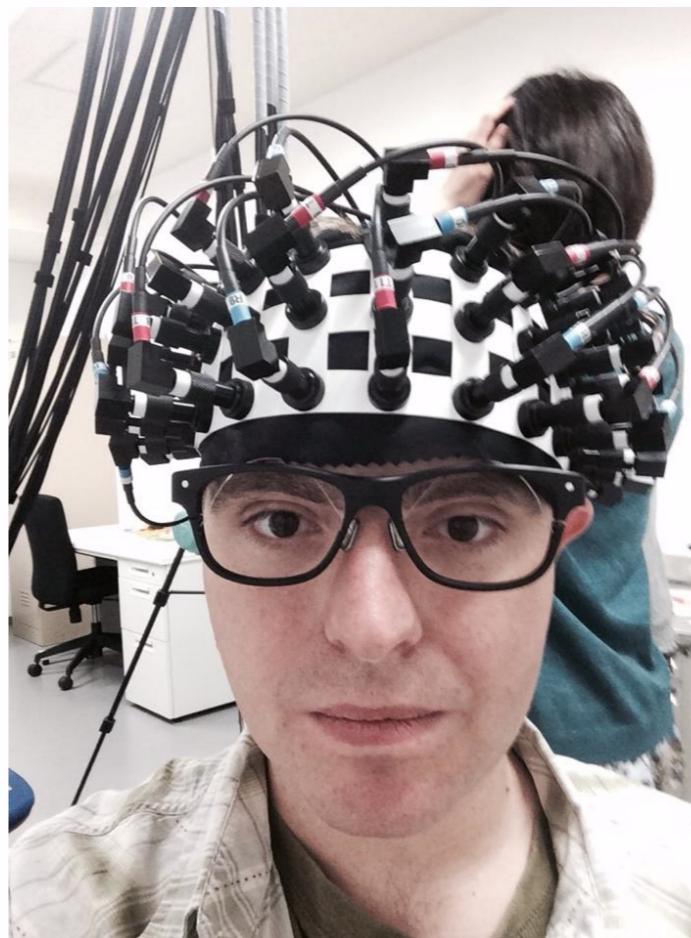
Demo: J!NS MEME Raw Data



Estimating other Cognitive States

Reading and other tasks with varying difficulty requiring different levels of concentration

LabNIRS by Shimadzu, Stationary Eye Tracker, J!NS MEME



interested in the data set? Send me an email ... Published sometime next year.

Questions, Remarks, Violent Dissent?

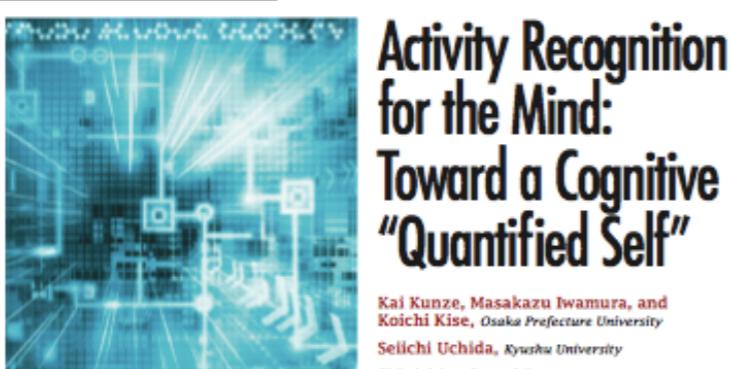


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Activity Recognition for the Mind IEEE Computer Article



Applying mobile sensing technology to cognitive tasks will enable novel forms of activity recognition.

Physical activity recognition technology has become mainstream—many dedicated mobile devices and smartphone apps count the steps we climb or the miles we run. What if devices and apps were also available that could count the words we read and how far we've progressed in our learning? The authors of this article demonstrate that mobile eye tracking can be used to do just that. Focusing on reading habits, they've prototyped cognitive activity recognition systems that monitor what and how much users read as well as how much they understand. Such systems could revolutionize teaching, learning and assessment both inside and outside the classroom. Further, as sensing technology improves, activity recognition could be extended to other cognitive tasks including concentrating, retaining information, and auditory or visual processing. While this research is extremely exciting, it also raises numerous ethical questions—for example, who should know what we read or how much we understand?

People increasingly use mobile computing technology to track their health and fitness progress, from simple step counting to monitoring food intake to measuring how long and well they sleep. Smartphone applications such as RunKeeper (<http://runkeeper.com>) and Lose It! (www.loseit.com) and wearable devices such as the Fitbit FLEX wristband (www.fitbit.com) foster better eating and exercise habits, decrease the risk of obesity-related diseases, and improve quality of life.

Activity-tracking abilities are still hampered by the limited battery power of today's mobile devices, but emerging technologies such as the M7 motion-sensing coprocessor in the new iPhone 6s make it easier to aggregate and interpret sensor data in a power-efficient manner. In addition, as mobile sensing technology

Workshop on Ubiquitous Technologies for Augmenting the Human Mind, Ubicomp Seattle,
<http://recall-fet.eu/wahm2014/>

Fitbit for the Mind, New Scientist <http://bit.ly/fitbitmind>

