

From Activity Recognition to Eye Wear Computing

Towards Augmenting the Human Mind

Kai Kunze
Graduate School of Media Design
Keio University



OVERVIEW



Background

Physical Activity Recognition becomes mainstream

Cognitive Activity Recognition

Focus on Reading Activities

Cognitive Activity Recognition for Everybody

Demos (hopefully ...)

Outlook: Enabling Technologies



Bavaria from Passau, Bavaria.



BACKGROUND



Project Associate Professor

Graduate School of Media Design, Keio University

Research Assistant Professor

Osaka Prefecture University

Visiting Researcher at MIT Media Lab

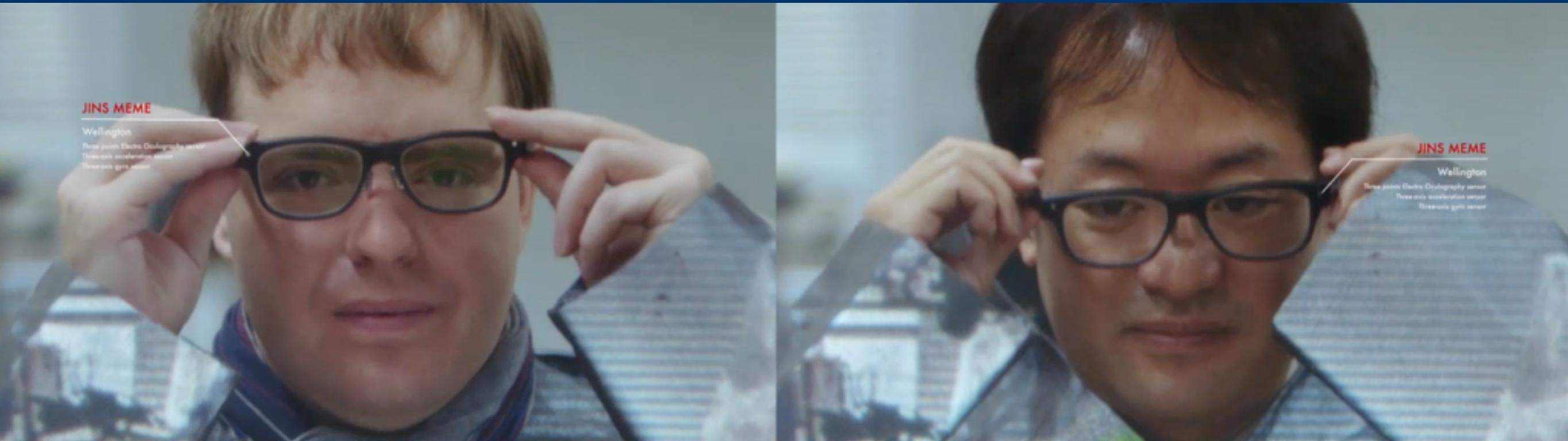
MIT, Cambridge, USA

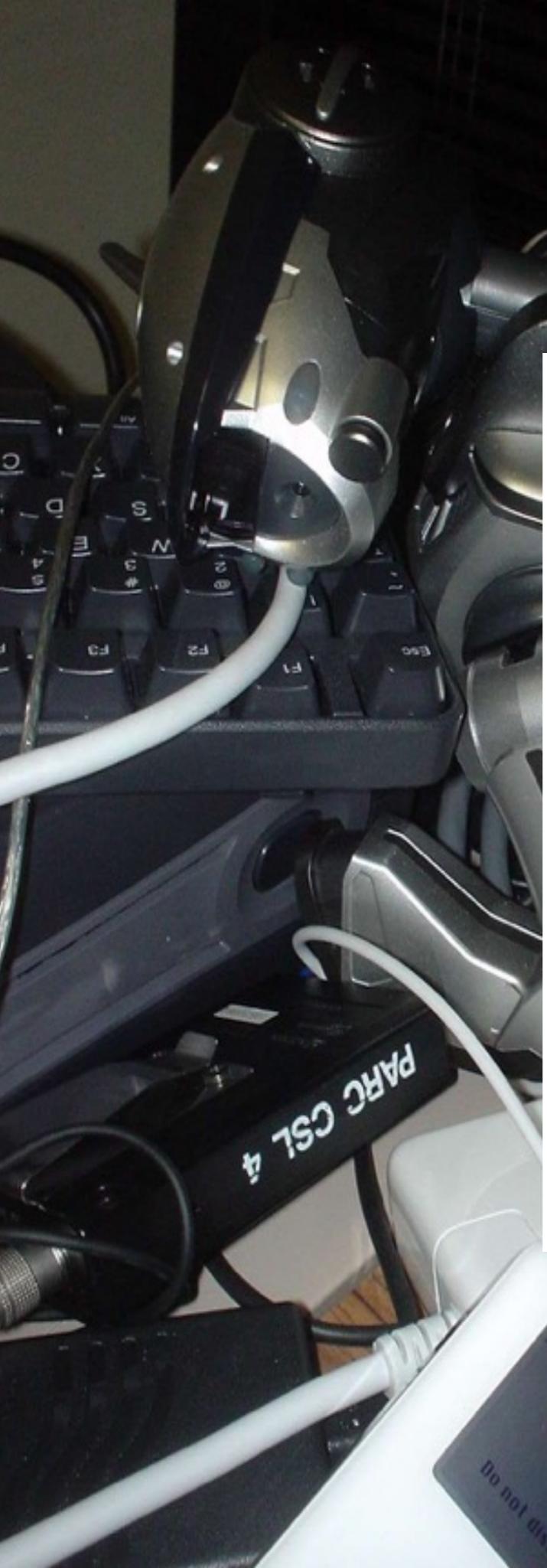
phD in Ubiquitous/Wearable Computing

University Passau, Germany

Collaborations with PARC, SUN, Deutsche Börse ...

Palo Alto, Grenoble , Frankfurt





With the computers surrounding us in everyday life,
the performance bottle neck is Human Attention.

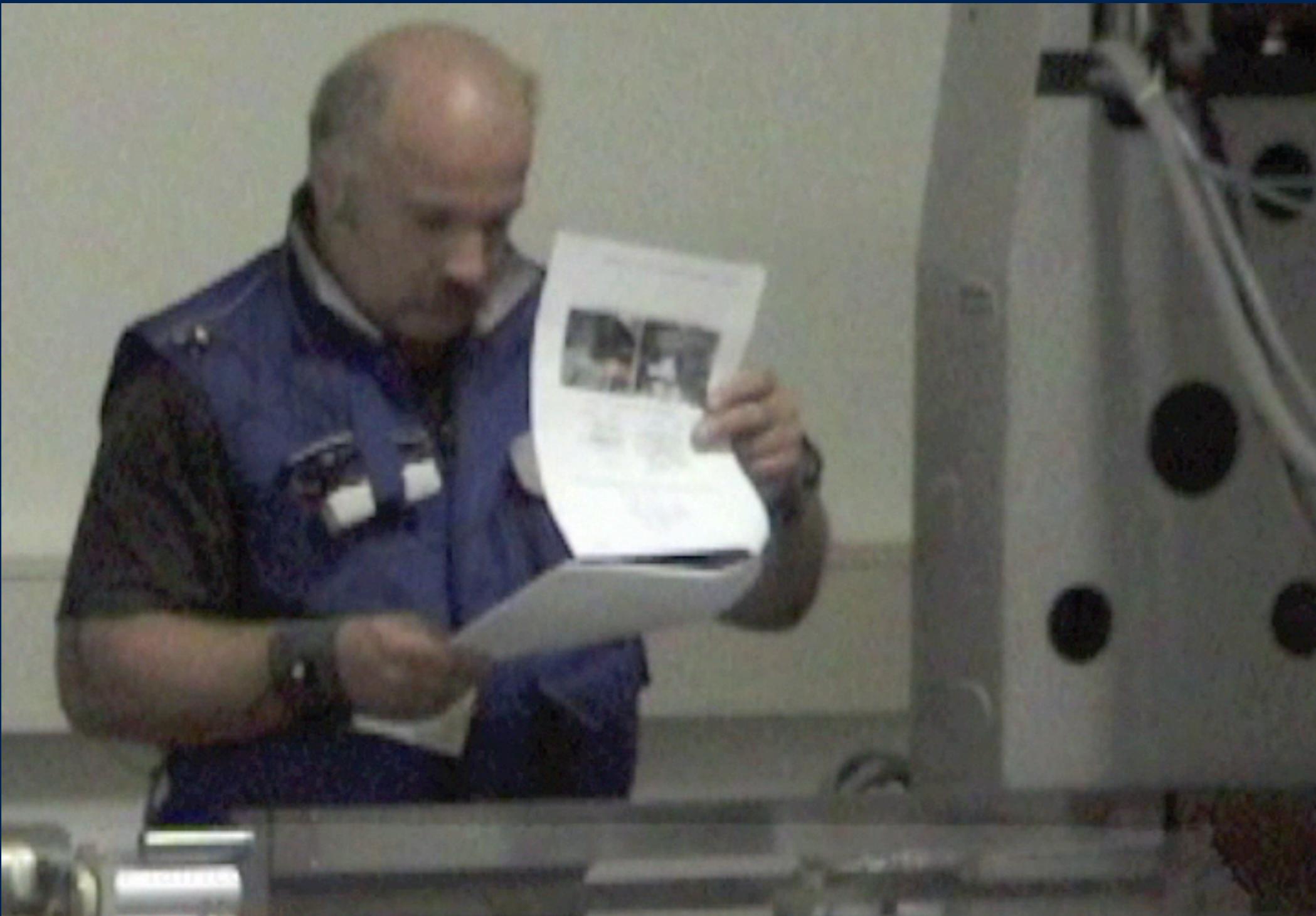
For Computing to become useful in everyday situations, the interface needs to vanish
as much as possible.

Computing needs to become pro-active
Activity Recognition → Context-Aware Systems



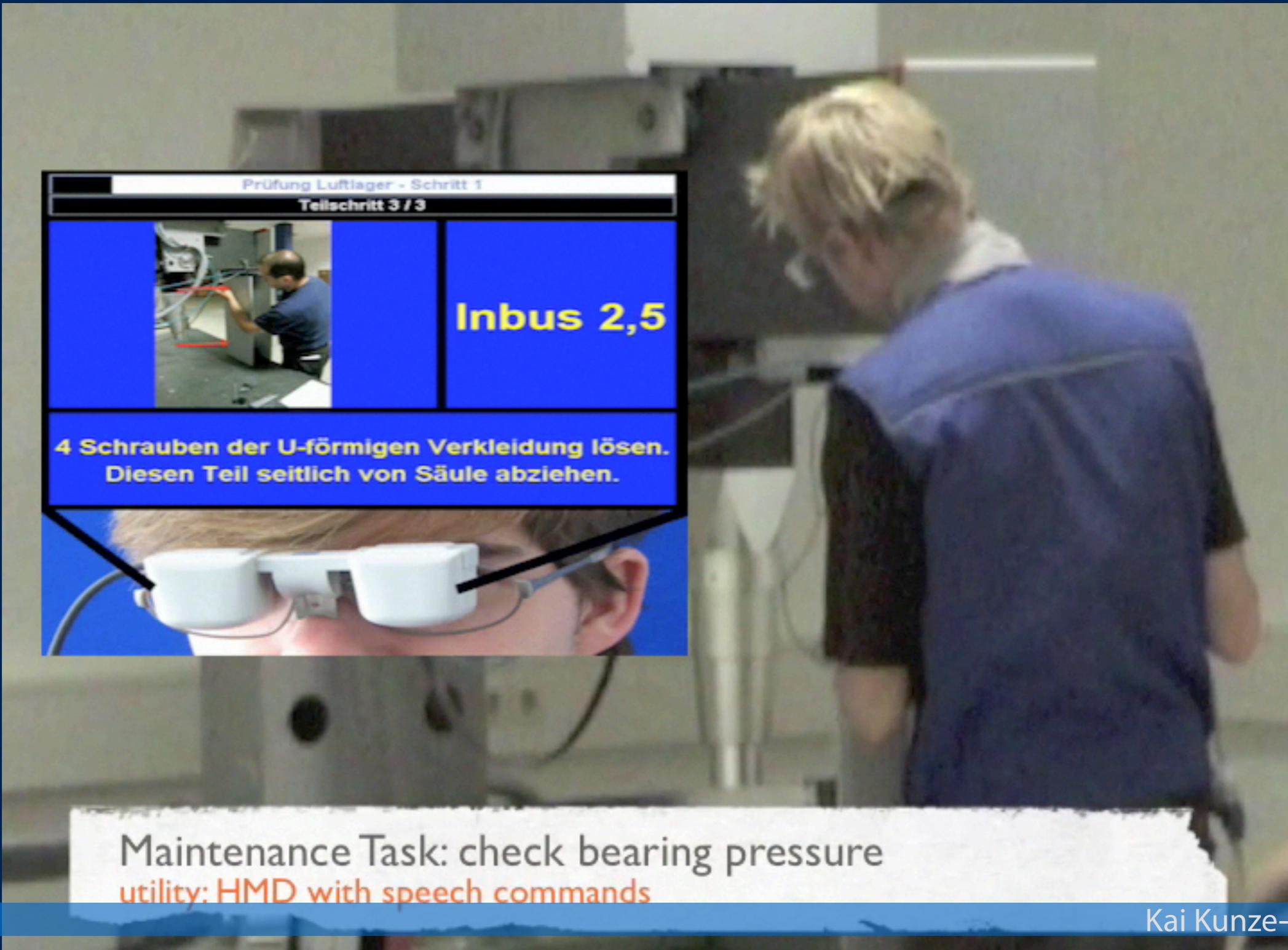
wearable computing in 2006

Maintenance Scenario Collaboration with Zeiss, Oberkochen.



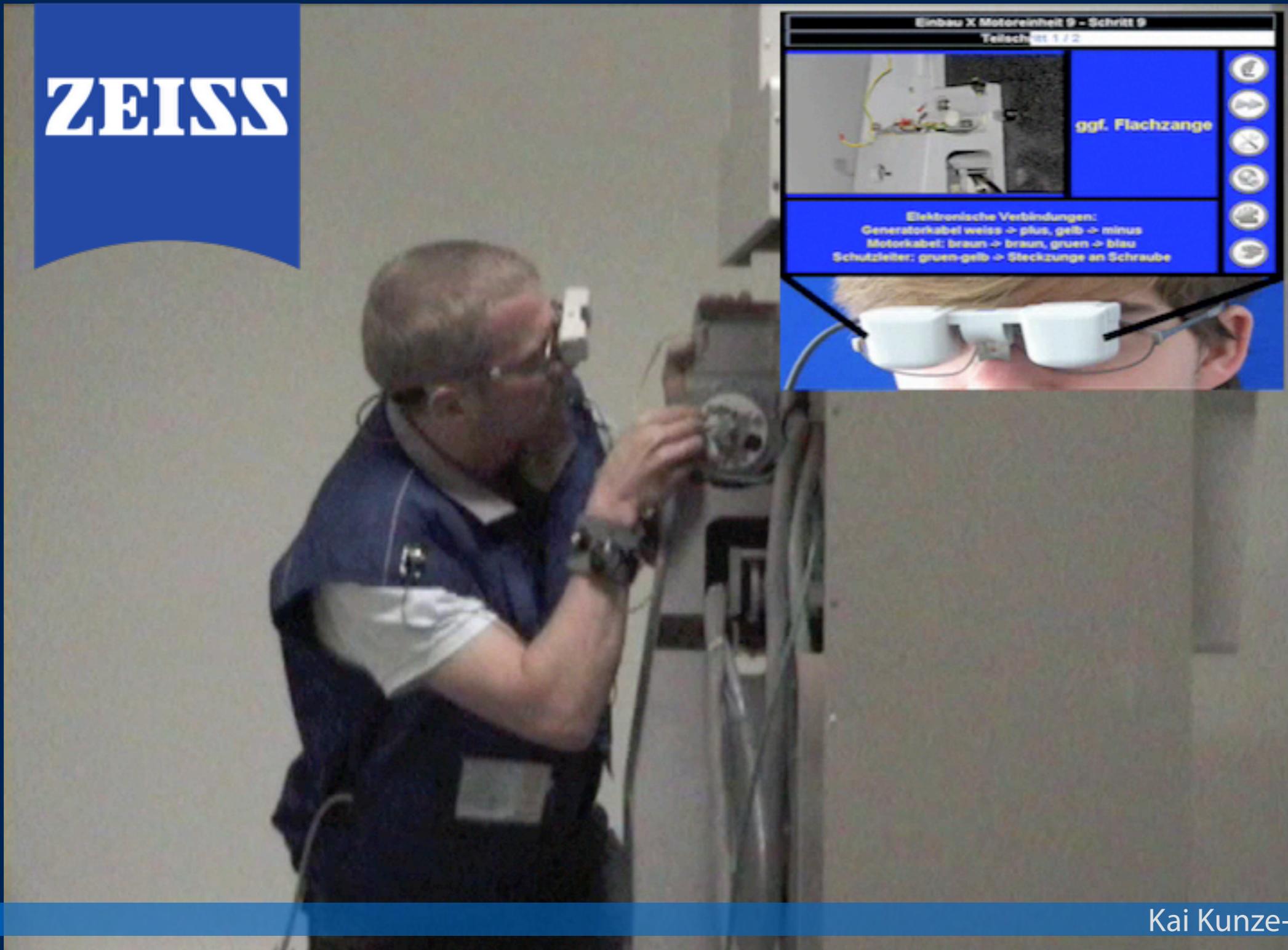
wearable computing in 2006

Maintenance Scenario Collaboration with Zeiss, Oberkochen.



wearable computing in 2006

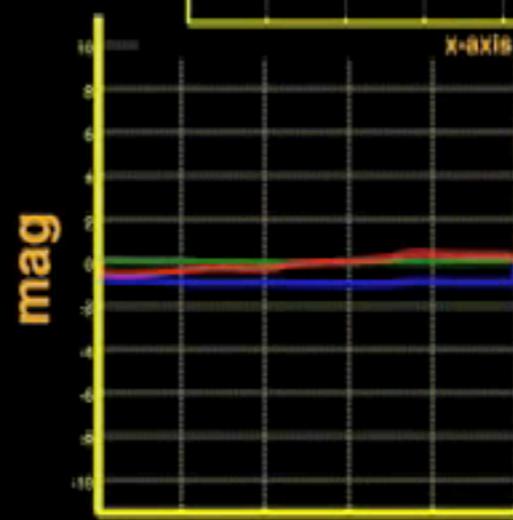
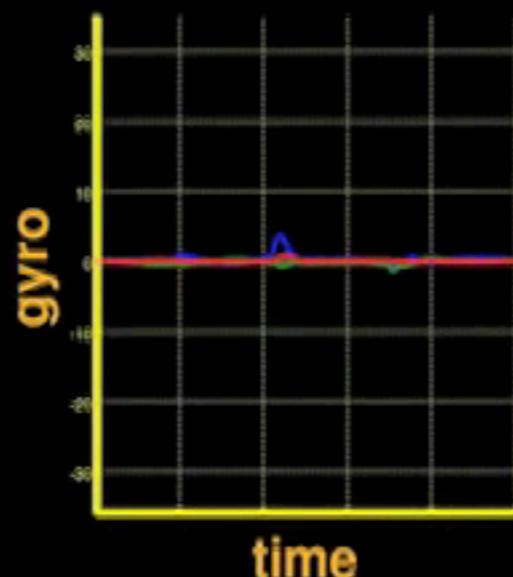
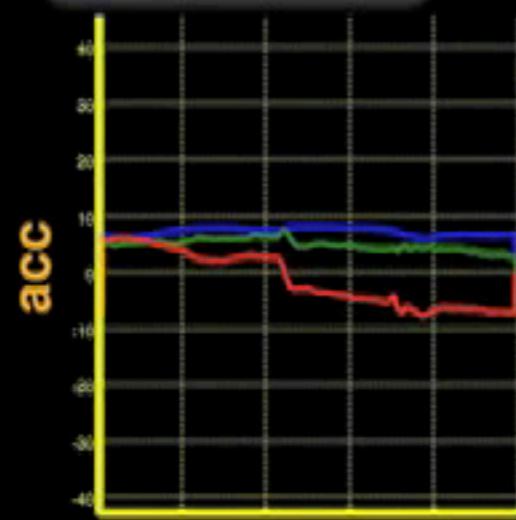
Maintenance Scenario Collaboration with Zeiss, Oberkochen.





ground truth:

recognition:



Applications



PHYSICAL ACTIVITY RECOGNITION BECOMES MAINSTREAM



Kunze Kai. Compensating for On-Body Placement Effects in Activity Recognition, 2011.

Cognitive Activity Recognition

Can we get some hints on what's going on in your mind using simple sensors during everyday life?

We started with tracking reading habits (reading life log)

People who read more

higher vocabulary skill

higher general knowledge [1]

If you give quantified feedback people can improve their habits
similar to apps/devices that track fitness and health
quantify progress education and life-long learning



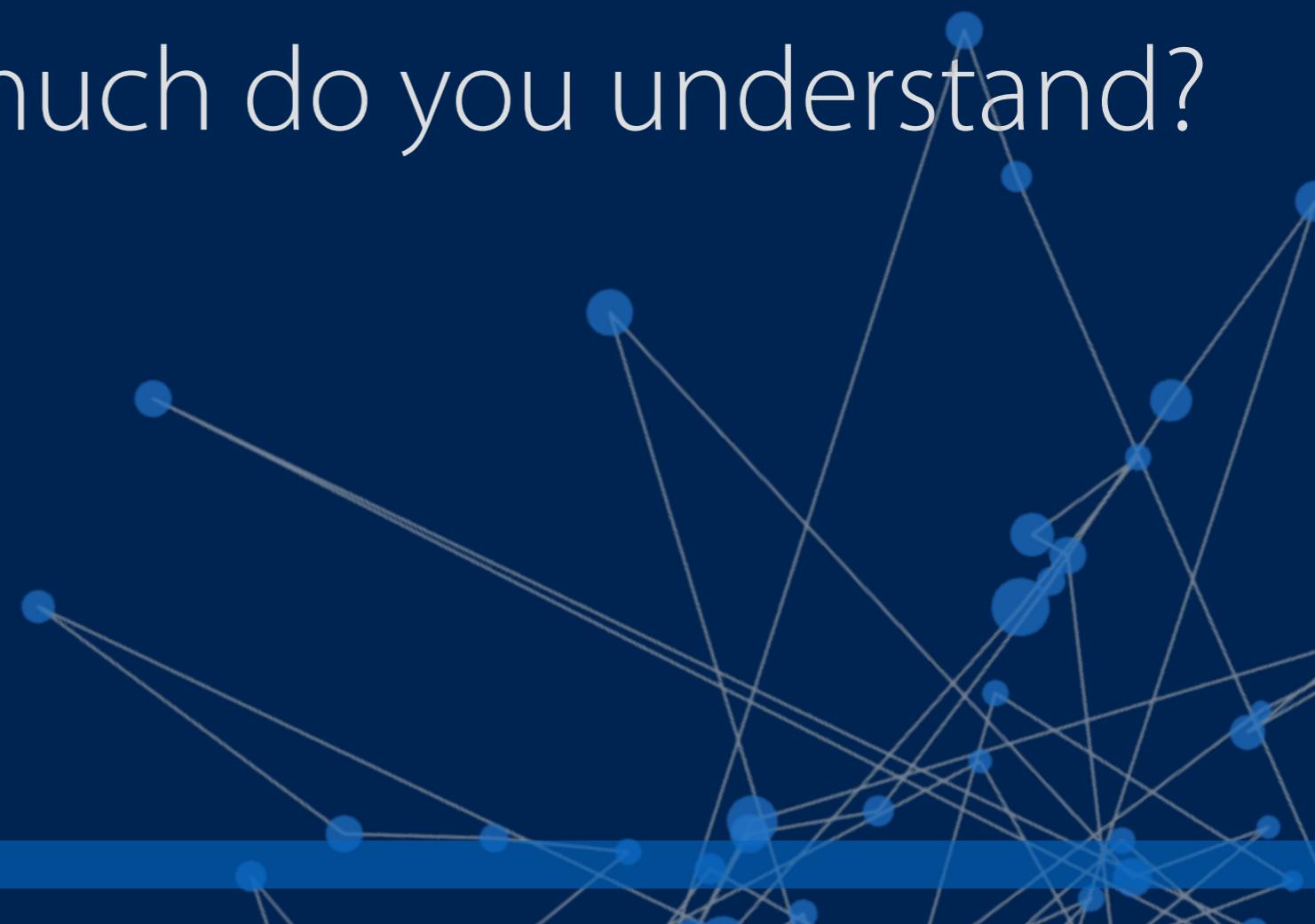
[1] A. Cunningham and K. Stanovich. What reading does for the mind. *Journal of Direct Instruction*, 1(2):137–149, 2001.

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

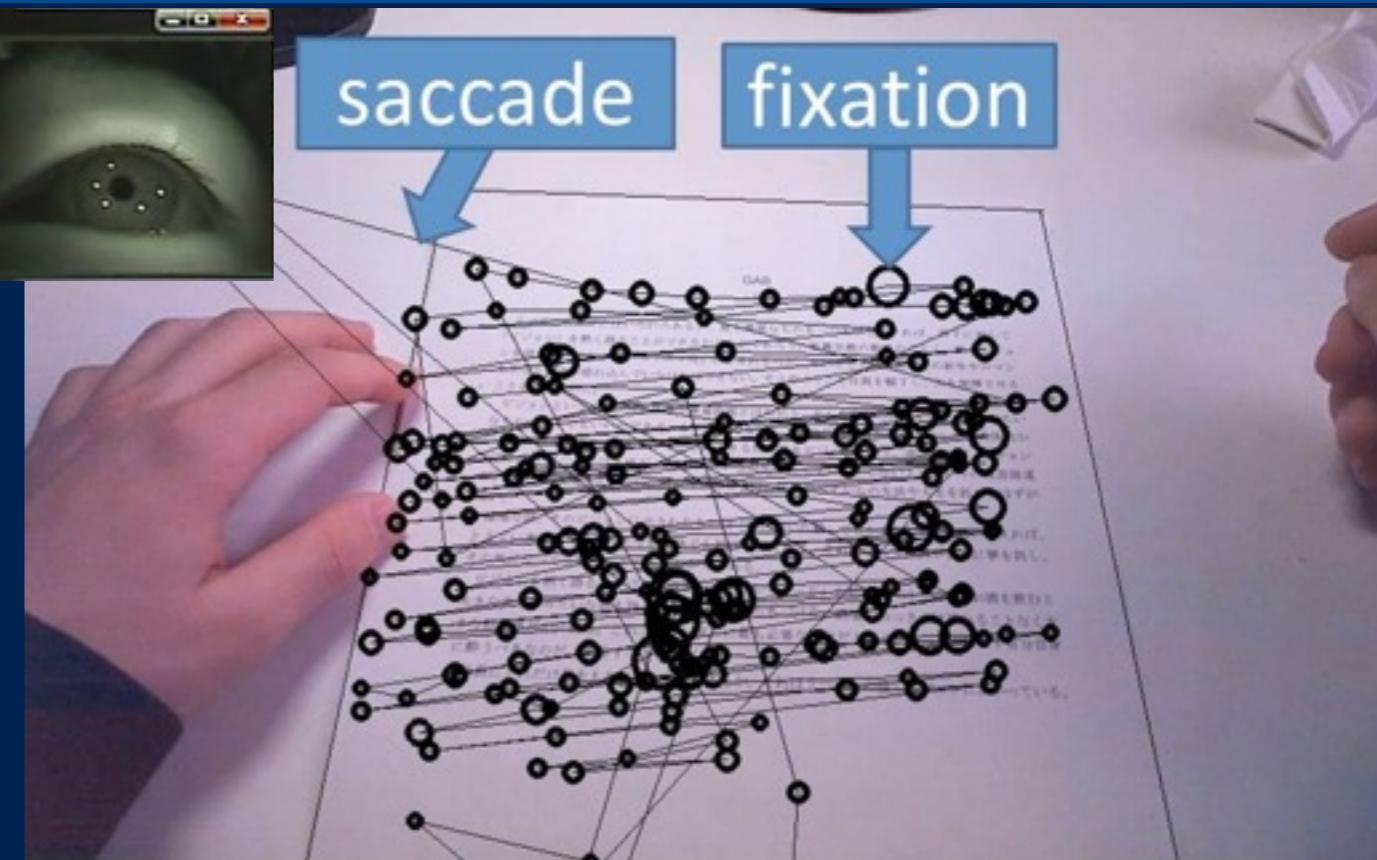
How much are you reading?

What are you reading?

How much do you understand?



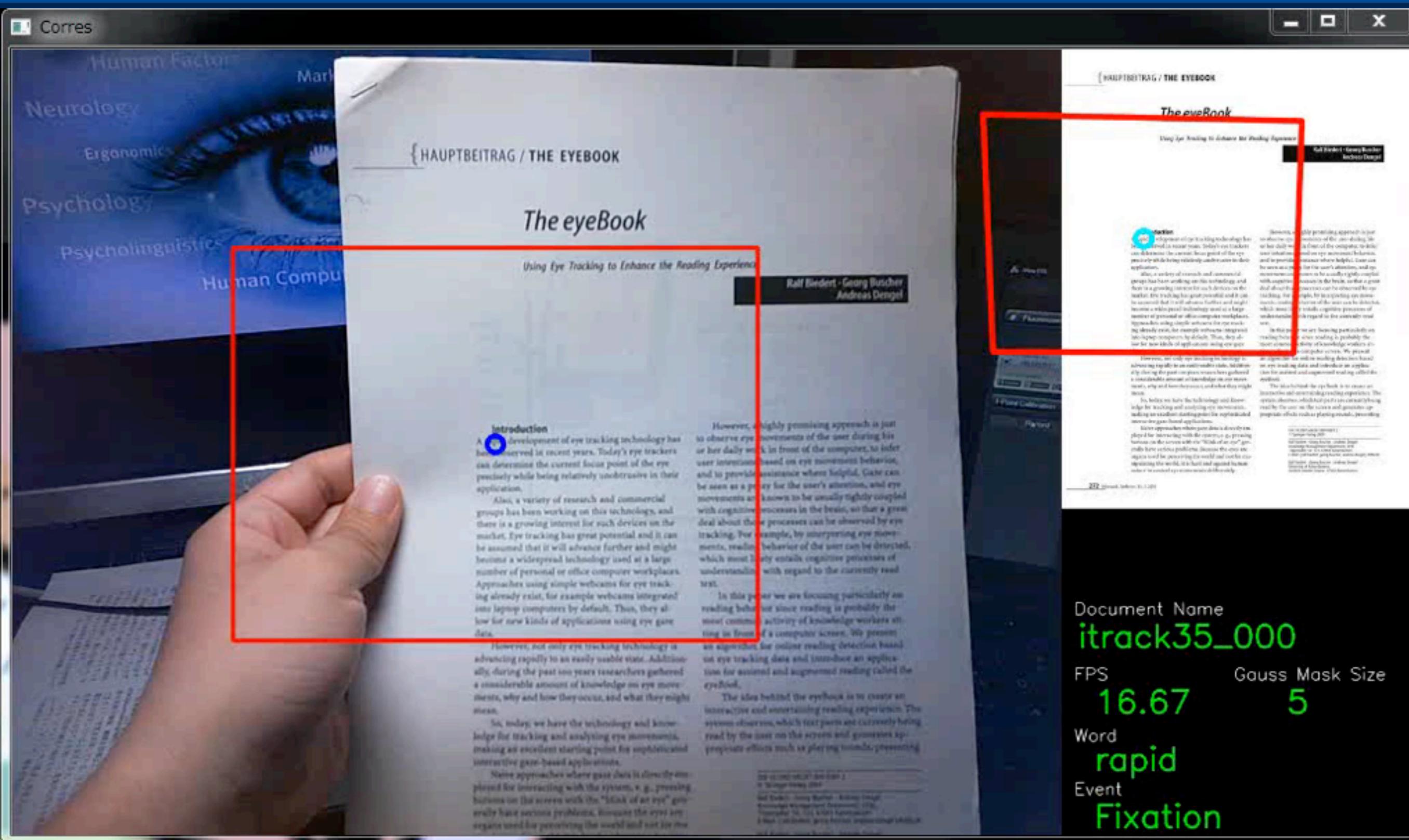
Wordometer - Count how much words you read



I always been a bit of an entertainer and played the funny man. I was a part-time media or , so I learned how to stand in front of audiences. It made me sure of myself. I like being liked and I love making everyone smile.

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

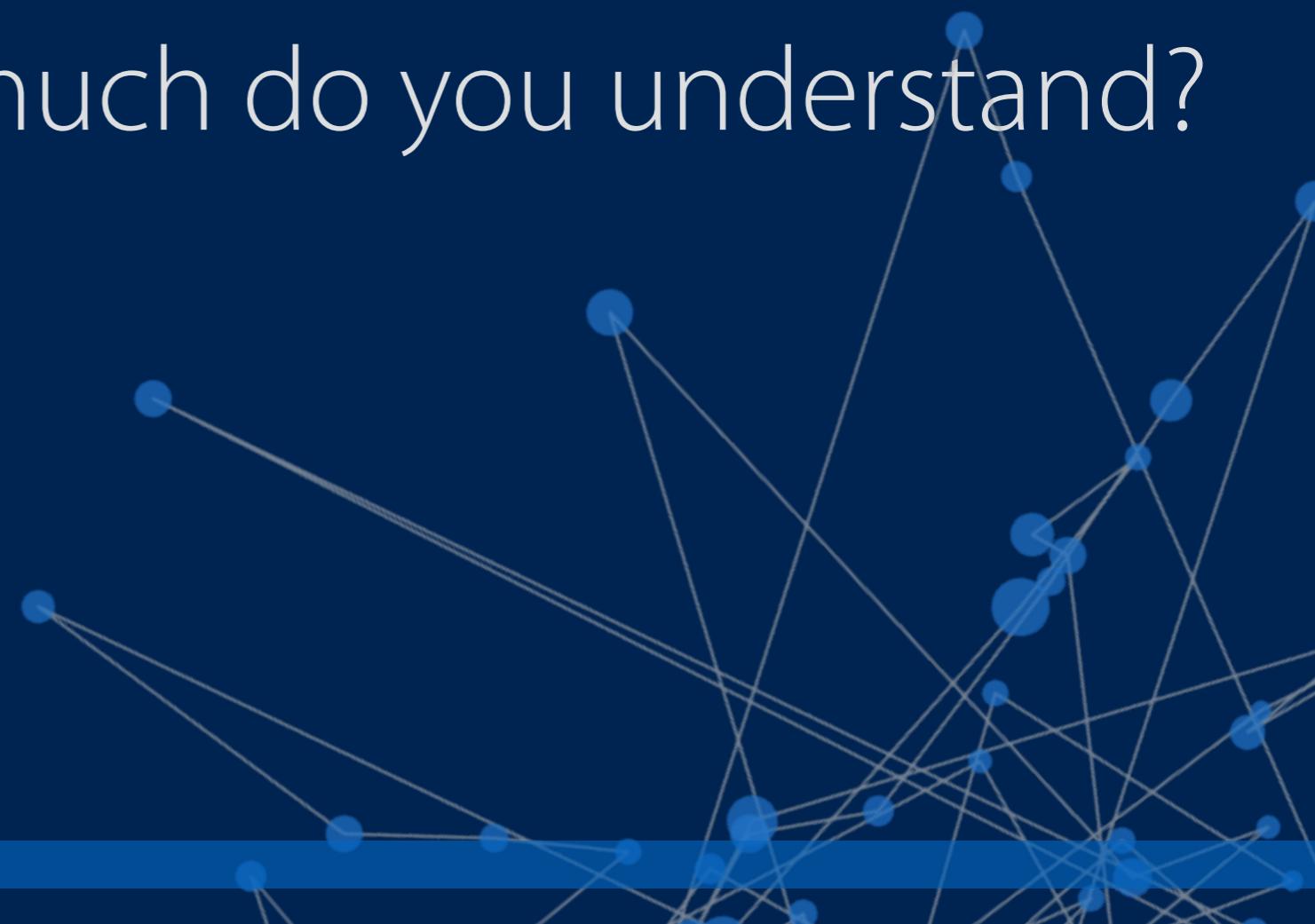
Reading Life Log - Document Image Retrieval and Eye Gaze



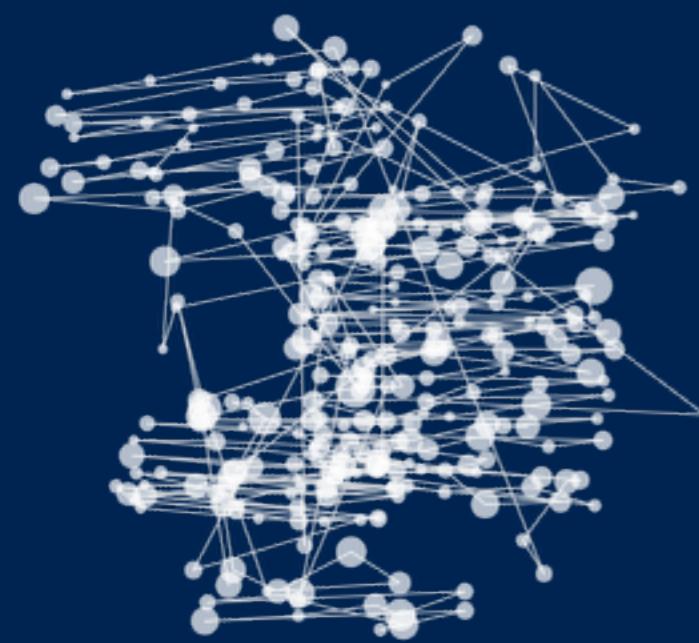
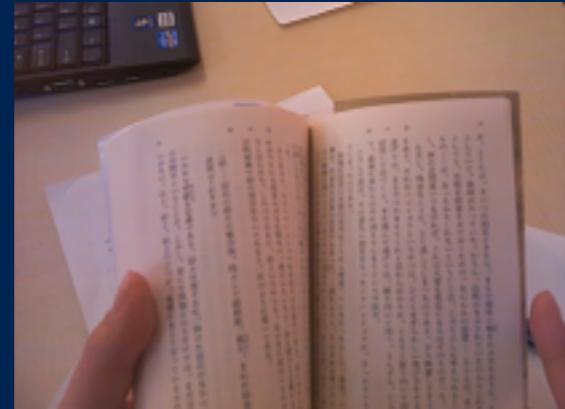
How much are you reading?

What are you reading?

How much do you understand?



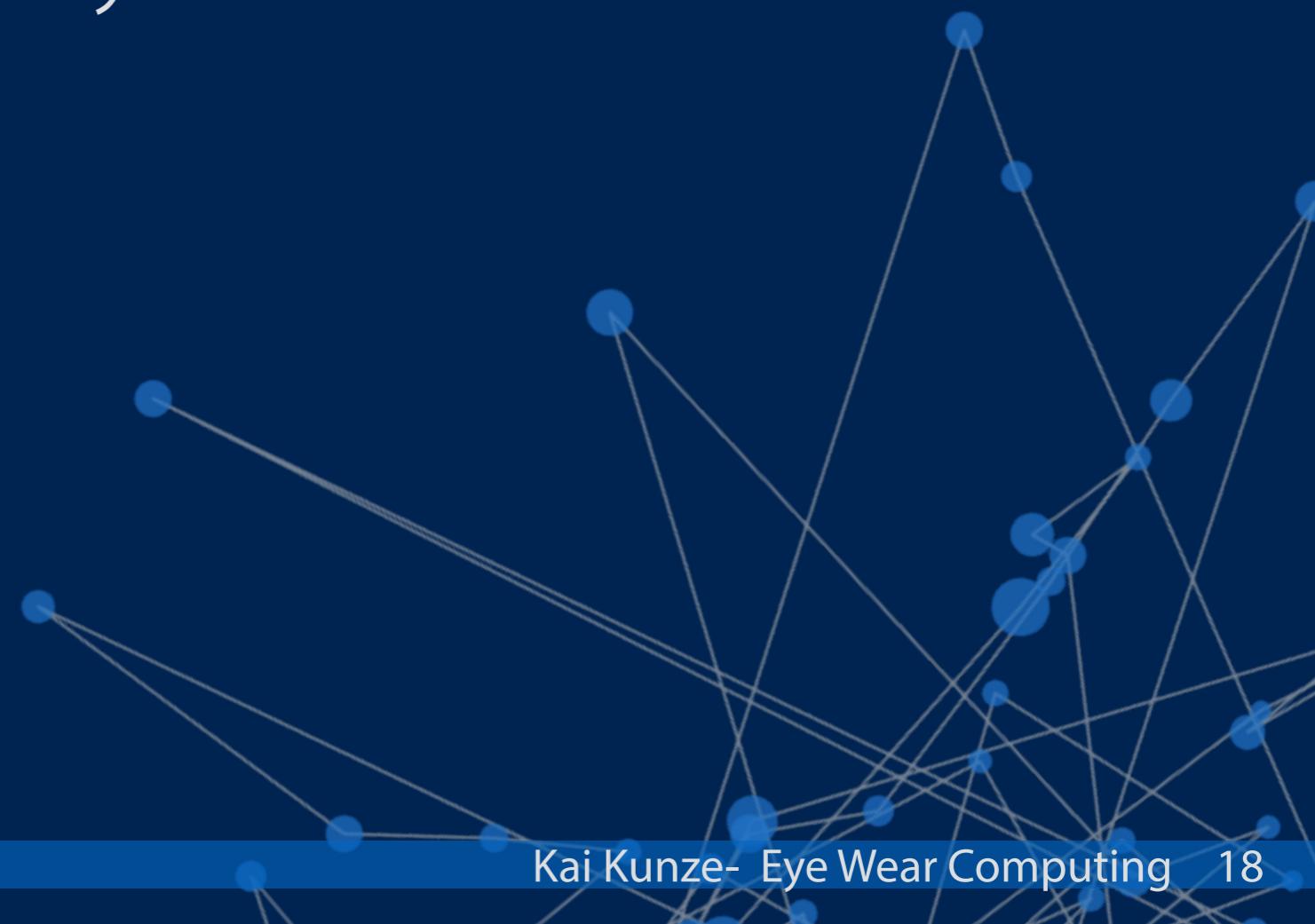
Document Type Classification



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.

Demo:

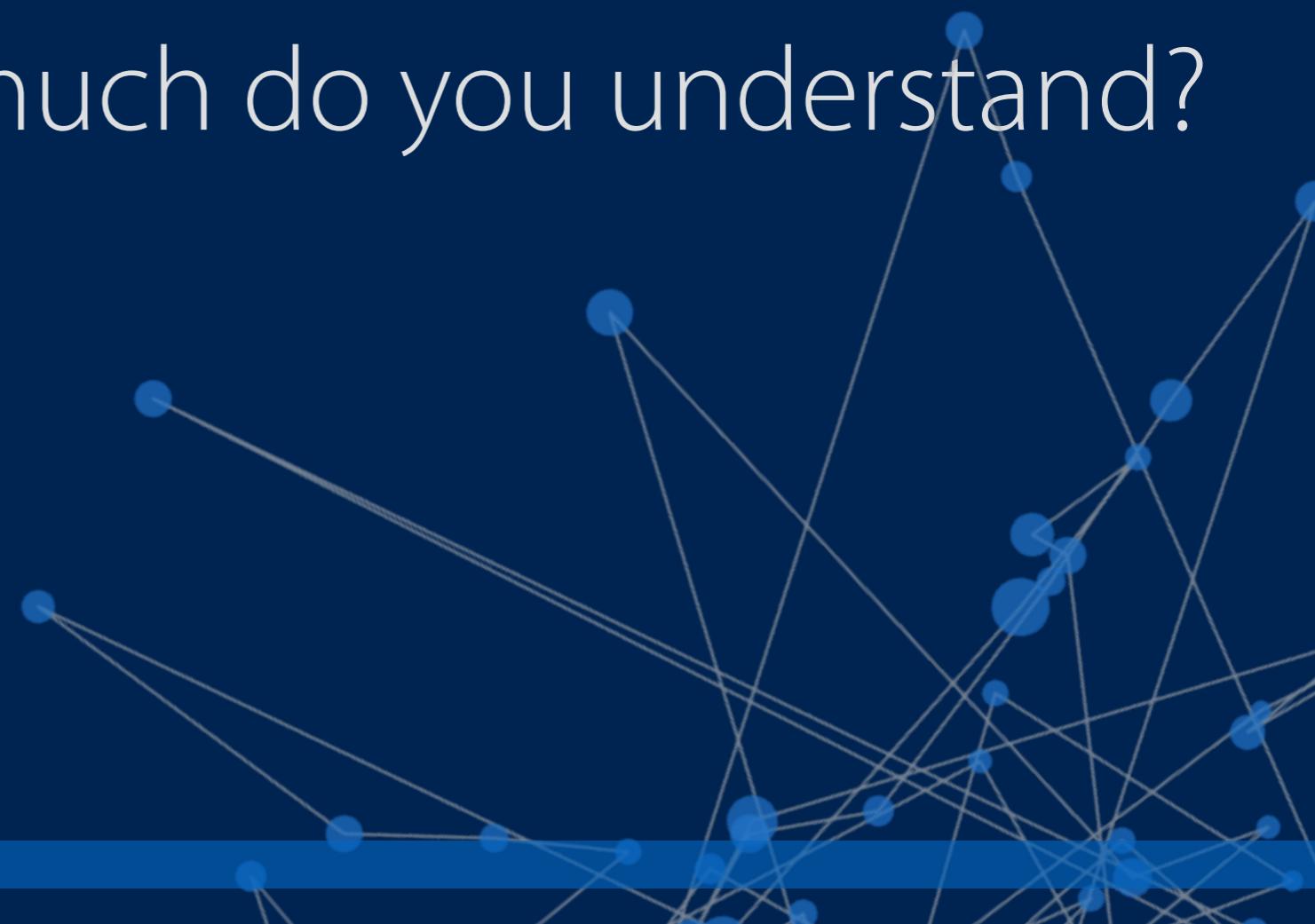
How to Analyze Eye Gaze Data



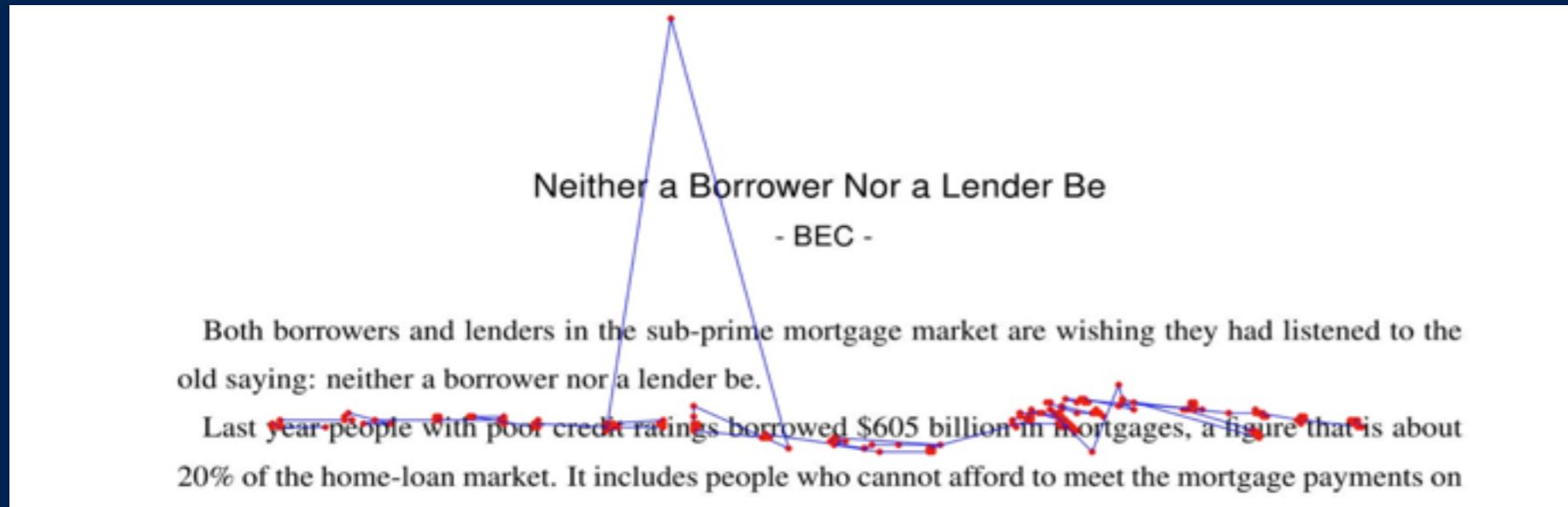
How much are you reading?

What are you reading?

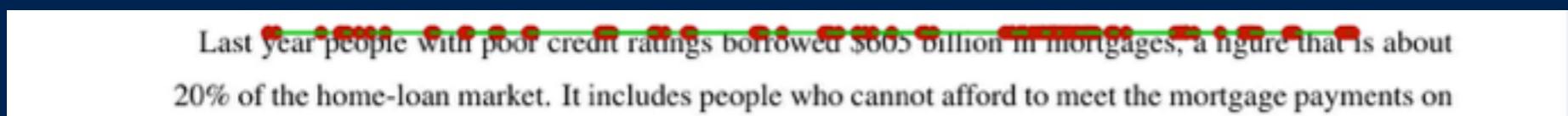
How much do you understand?



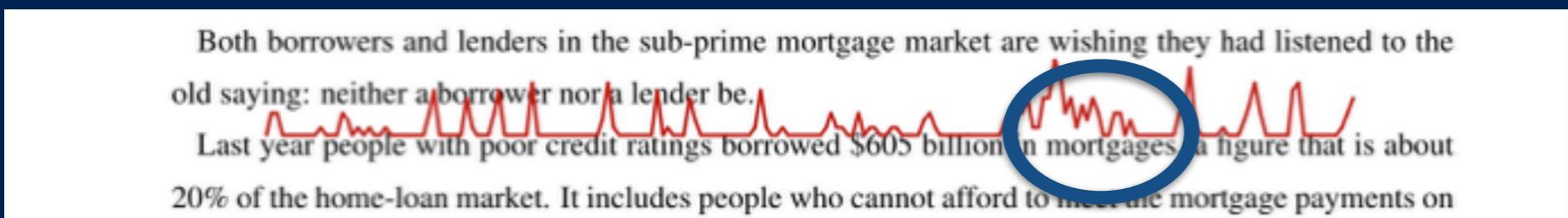
Detecting Difficult Words - Trying to Infer TOEIC Scores



Eye-gaze translated to document coordinates



Horizontal projection



Histogram

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 back, forward, search, and a user profile. The main header reads "read.it" and includes links for "Dashboard", "Log", "Community", "Premium", and a "STORE" button. To the right are icons for a user profile, message, and settings.

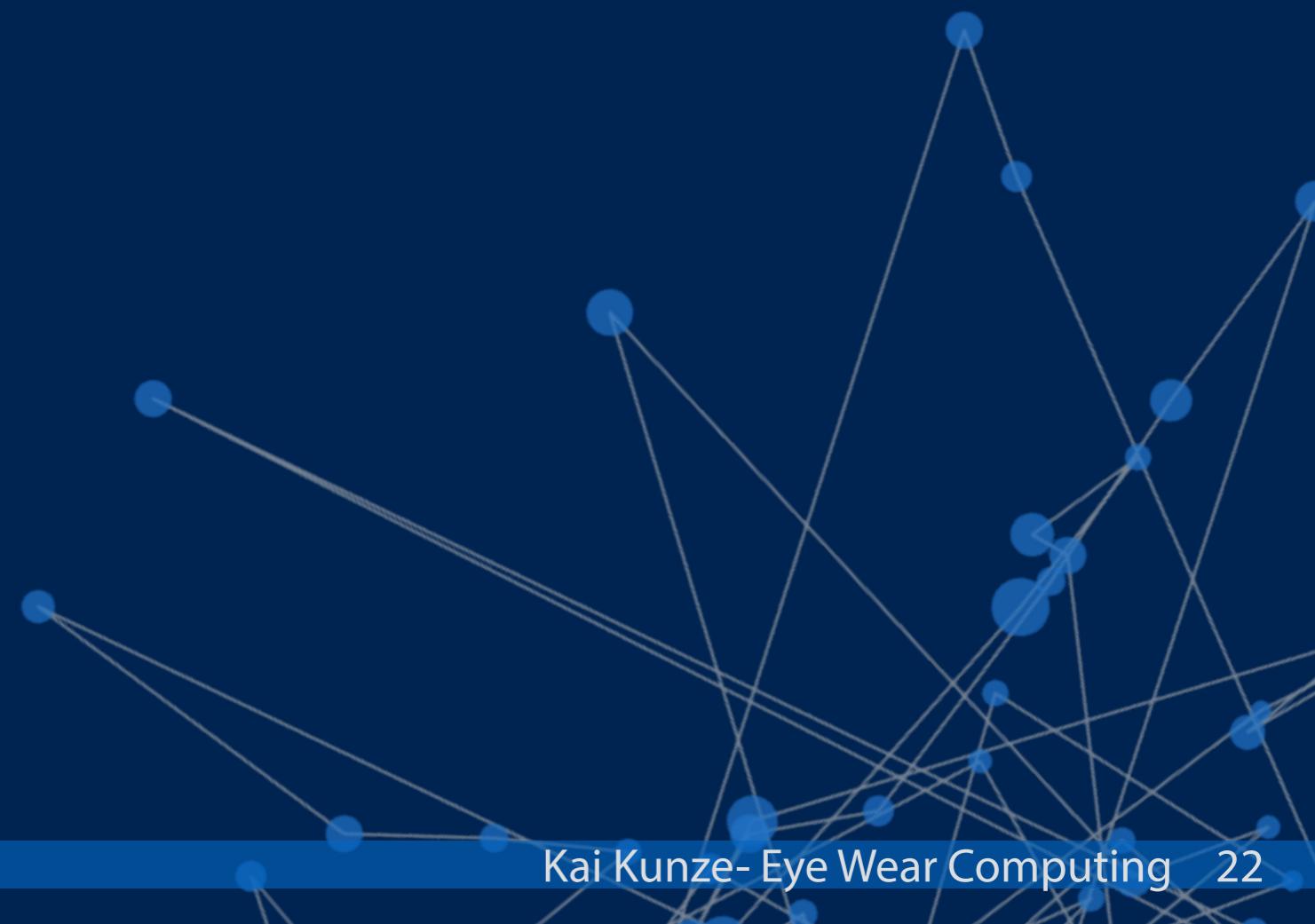
The central area displays a daily summary for "THURSDAY August 08". It includes a chart titled "Activity" showing word count over time, a circular gauge for "words read" (8497), and other metrics like "Manga" (15 pages) and "Science Papers" (20 pages). A "Concentrated Reading" section shows a head icon with gears and a duration of "30 min".

On the right side, there's a "Friends" list with a "You" entry (67,071 words) and a "Border" cartoon character. Below the friends list, there are sections for "Overview" and "Top Badges".

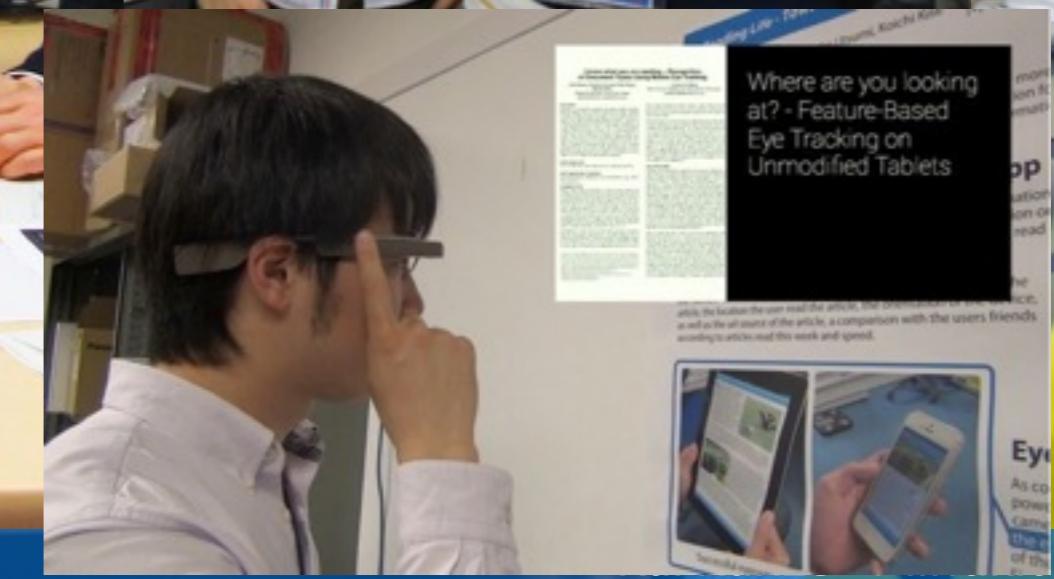
At the bottom right, the slide footer reads "Kai Kunze- Eye Wear Computing 21".

Cognitive Activity Tracking,
a First Step Towards a Goal:

Enhance our Critical Thinking Skills with Technology
Improve the Collective Intelligence of Society



Cognitive Activity Tracking for Everybody

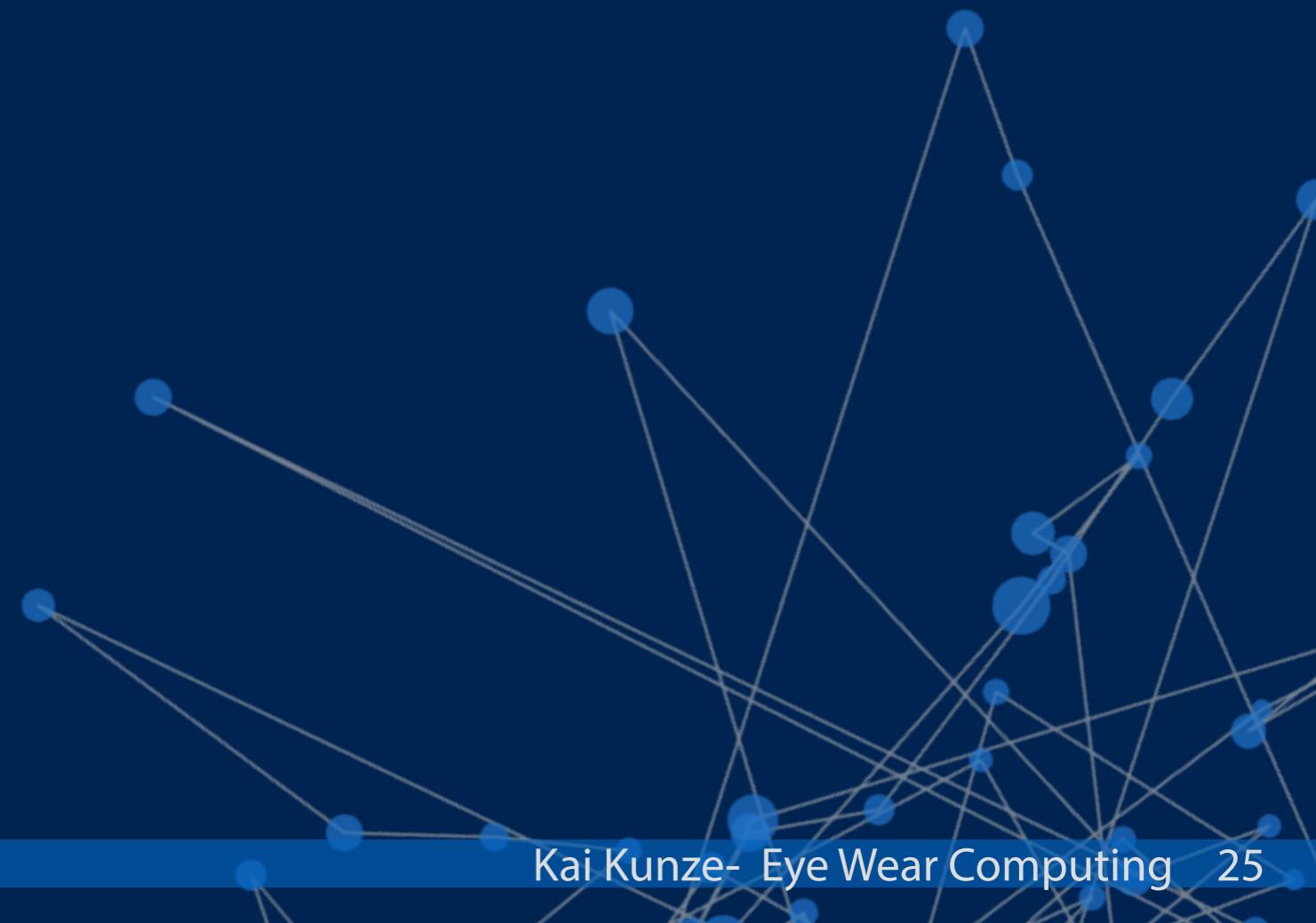


Cognitive Activity Tracking for Everybody



Demo

Blink Detection and Activity Recognition on Google Glass



Blinks and Head Motions

Distinguishing closely related activities



reading



watching



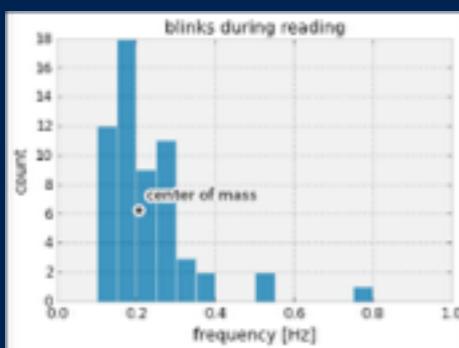
solving



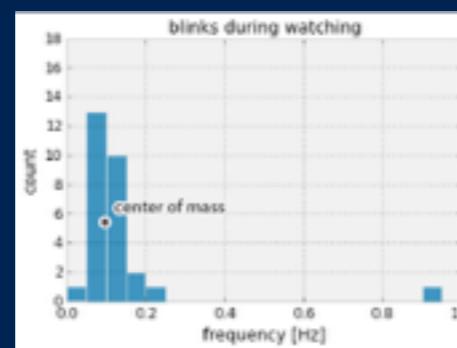
sawing



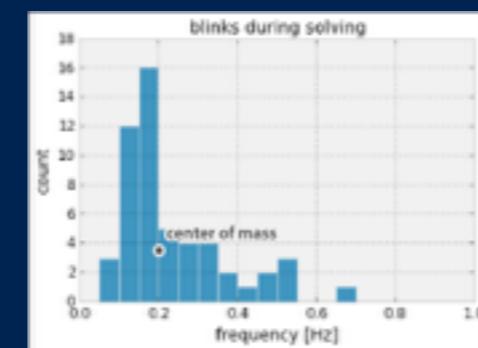
talking



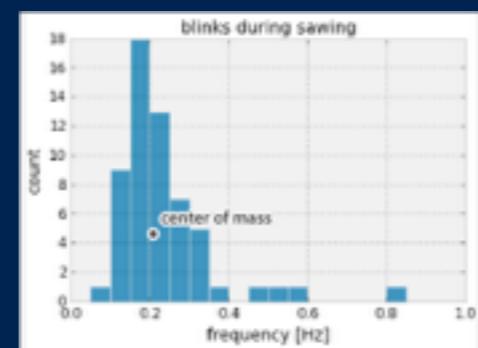
blinks during reading



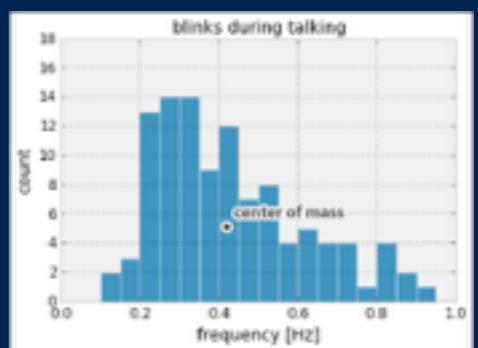
blinks during watching



blinks during solving



blinks during sawing



blinks during talking

67 % recognition accuracy for eye blink only, 82 % with head motion patterns

*In the Blink of an Eye - Combining Head Motion and Eye Blink Frequency for Activity Recognition with Google Glass.
Shoya Ishimaru, Jens Weppner, Kai Kunze, Andreas Bulling, Koichi Kise, Andreas Dengel and Paul Lukowicz.
Proceedings of the 5th Augmented Human International Conference. 2014.*

Cognitive Activity Tracking for Everybody



J!NS M3ME

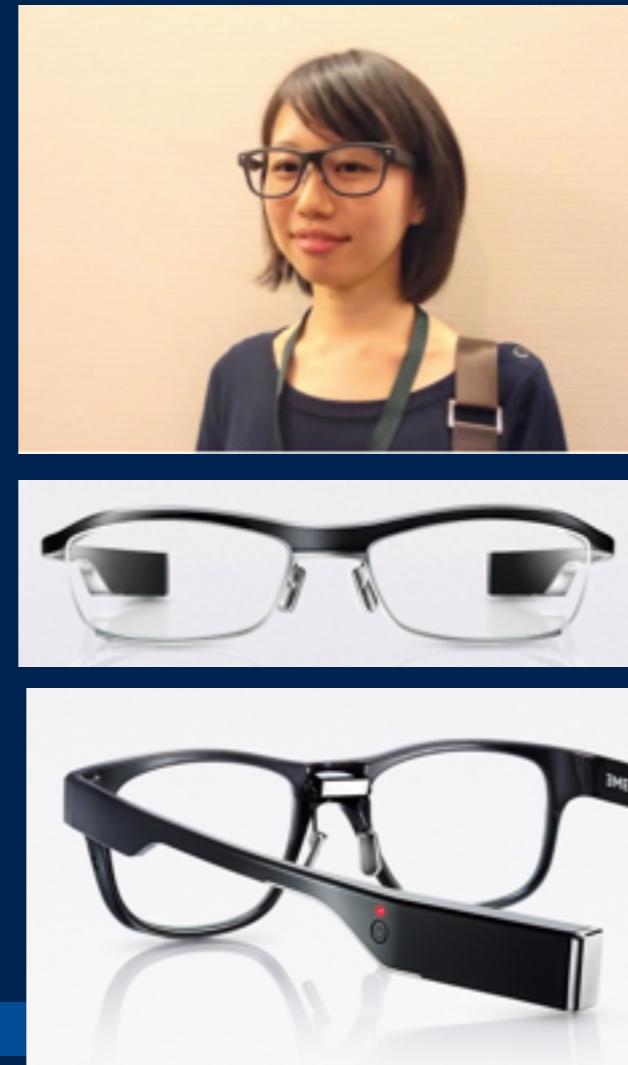
J!NS MEME

J!NS: a Japanese glasses company
very different idea from Google Glass
Not a full fledged computer!
no display, NO camera
a sensing device connected to phone.

Electrooculography
(detects eye movements)
and motion sensors
(accelerometer and gyro)

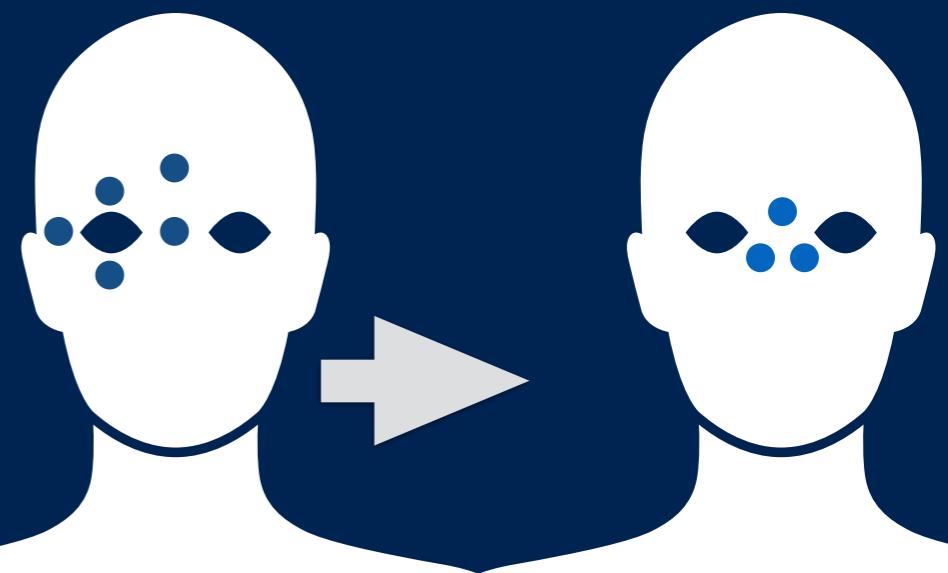
We are working with J!NS
on MEME research

[https://www.jins-jp.com/
jinsmeme/en/](https://www.jins-jp.com/jinsmeme/en/)



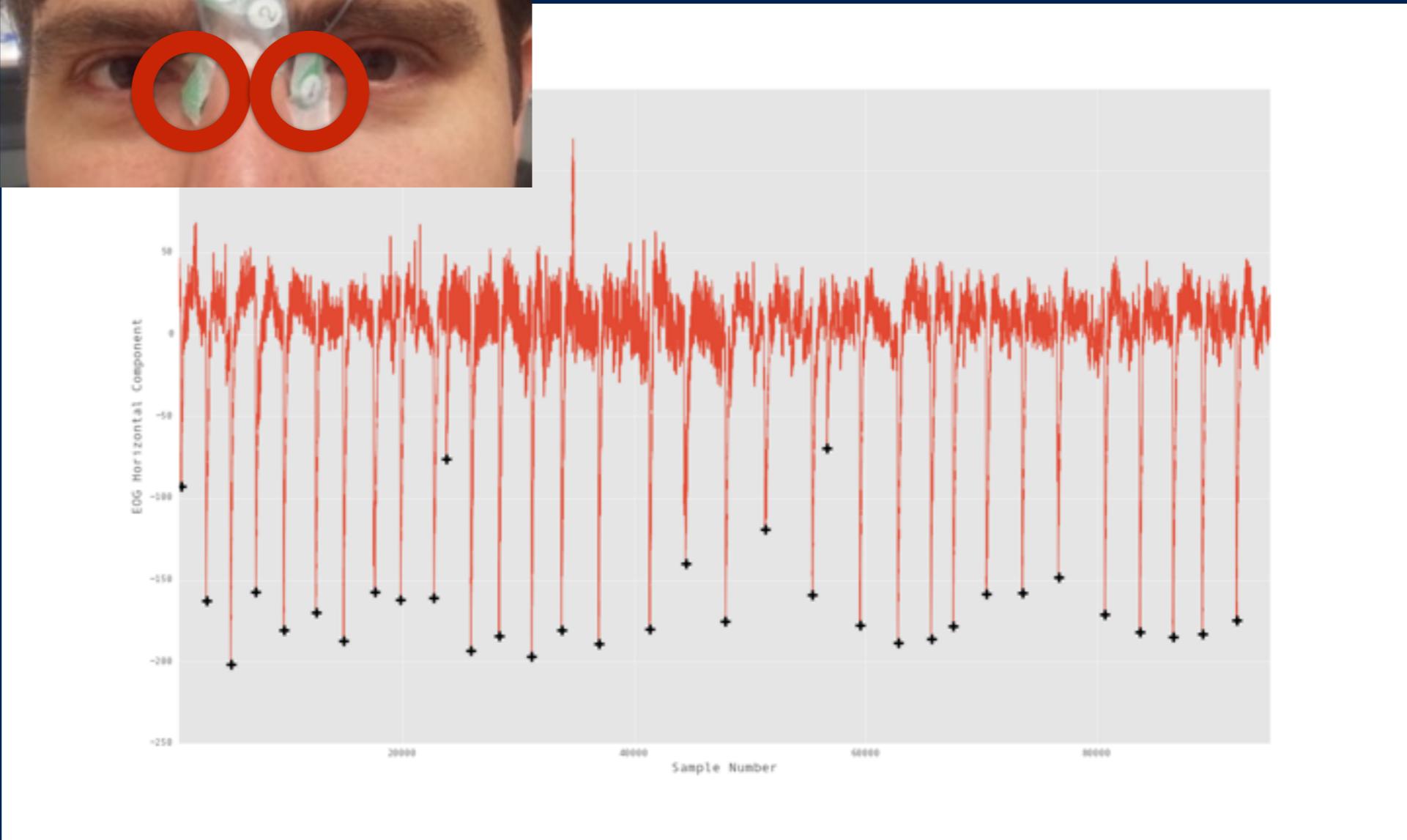
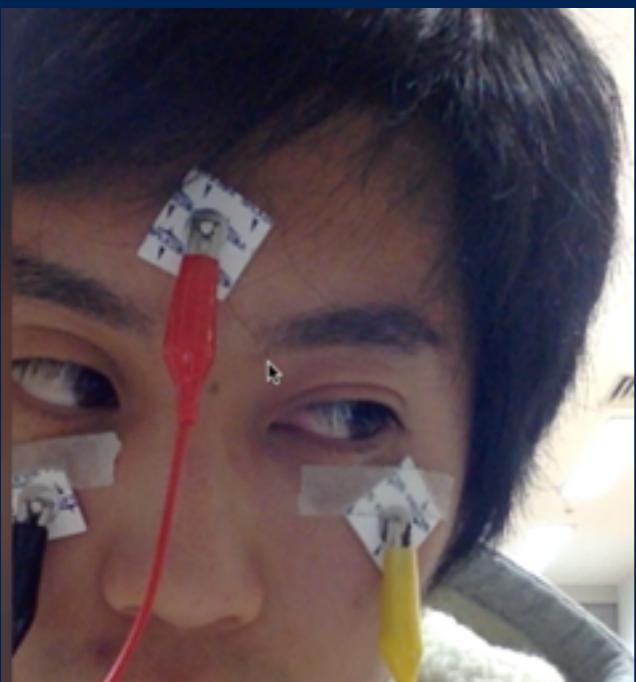
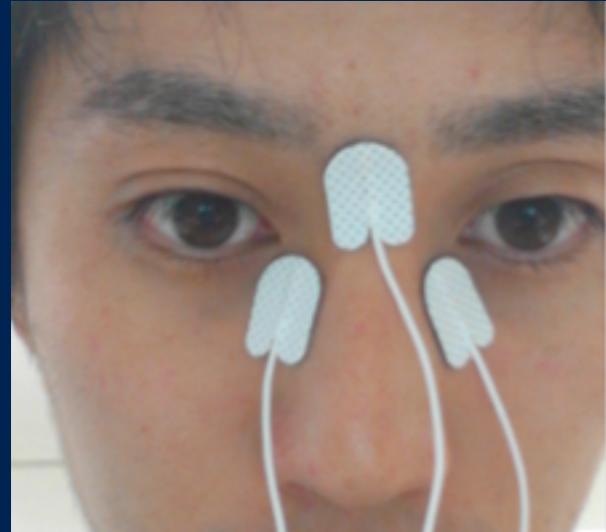
Innovative Tech Price
Digital Content Expo, Tokyo
<http://www.dceexpo.jp/?lang=en>

[http://www.digitaltrends.com/ces/
top-tech-of-ces-2015-award-
winners/](http://www.digitaltrends.com/ces-top-tech-of-ces-2015-award-winners/)



Activity Recognition on MEME

Can EOG be used for Reading Tracking?



to be published @ AH 2015

Brain Jogging: Fitbit for the Mind, How?

read.it

Dashboard

Log

Community

Premium

STORE



< | > Sunday JUNE 30

Activity

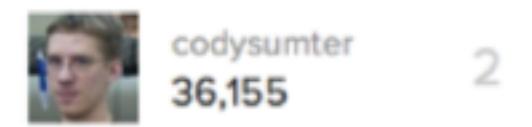


Word Count



6707 words

Friends



New Words



170 words

Reading Speed



210 words/min

Concentrated Reading



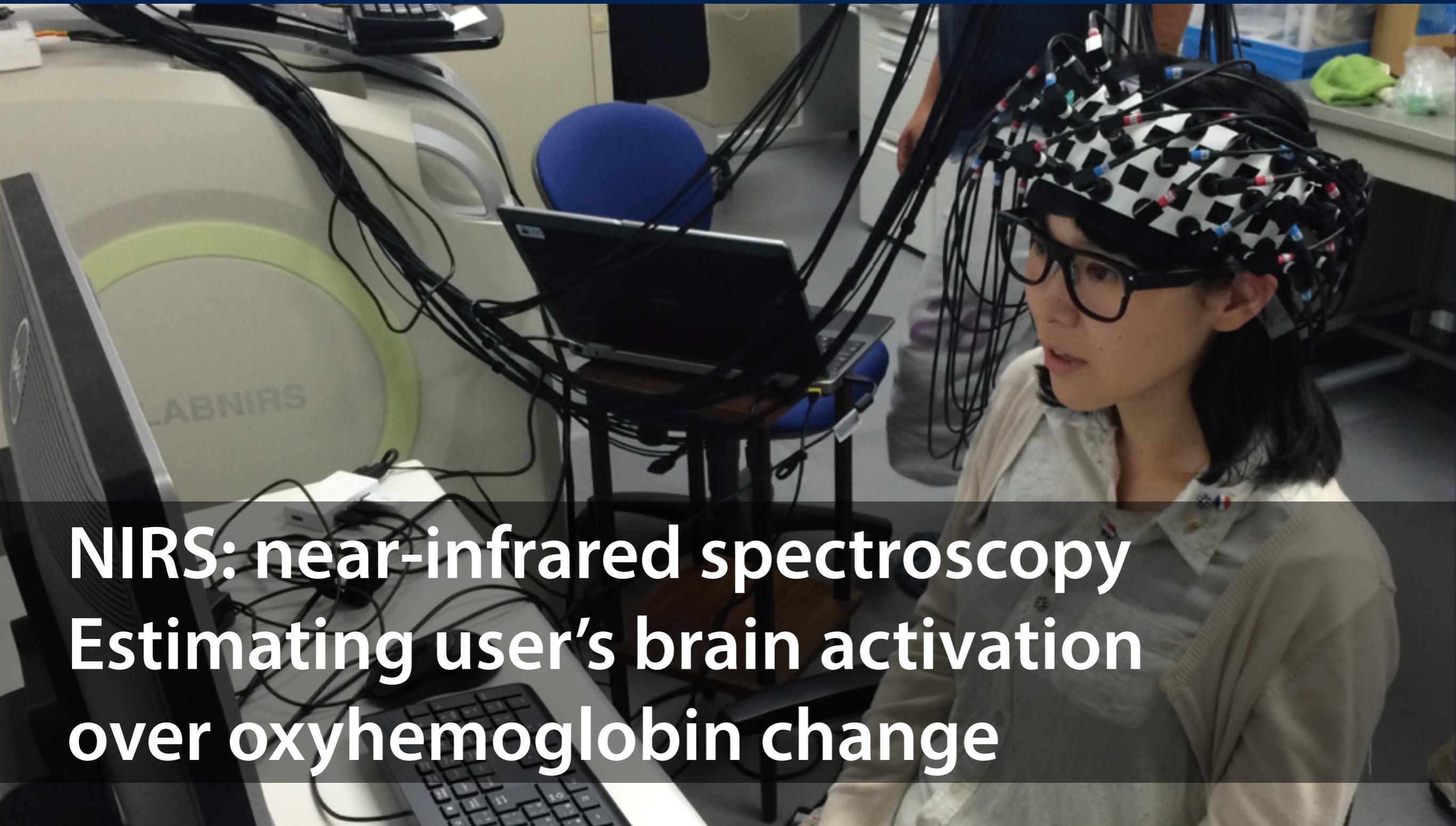
30 min

Novel

News

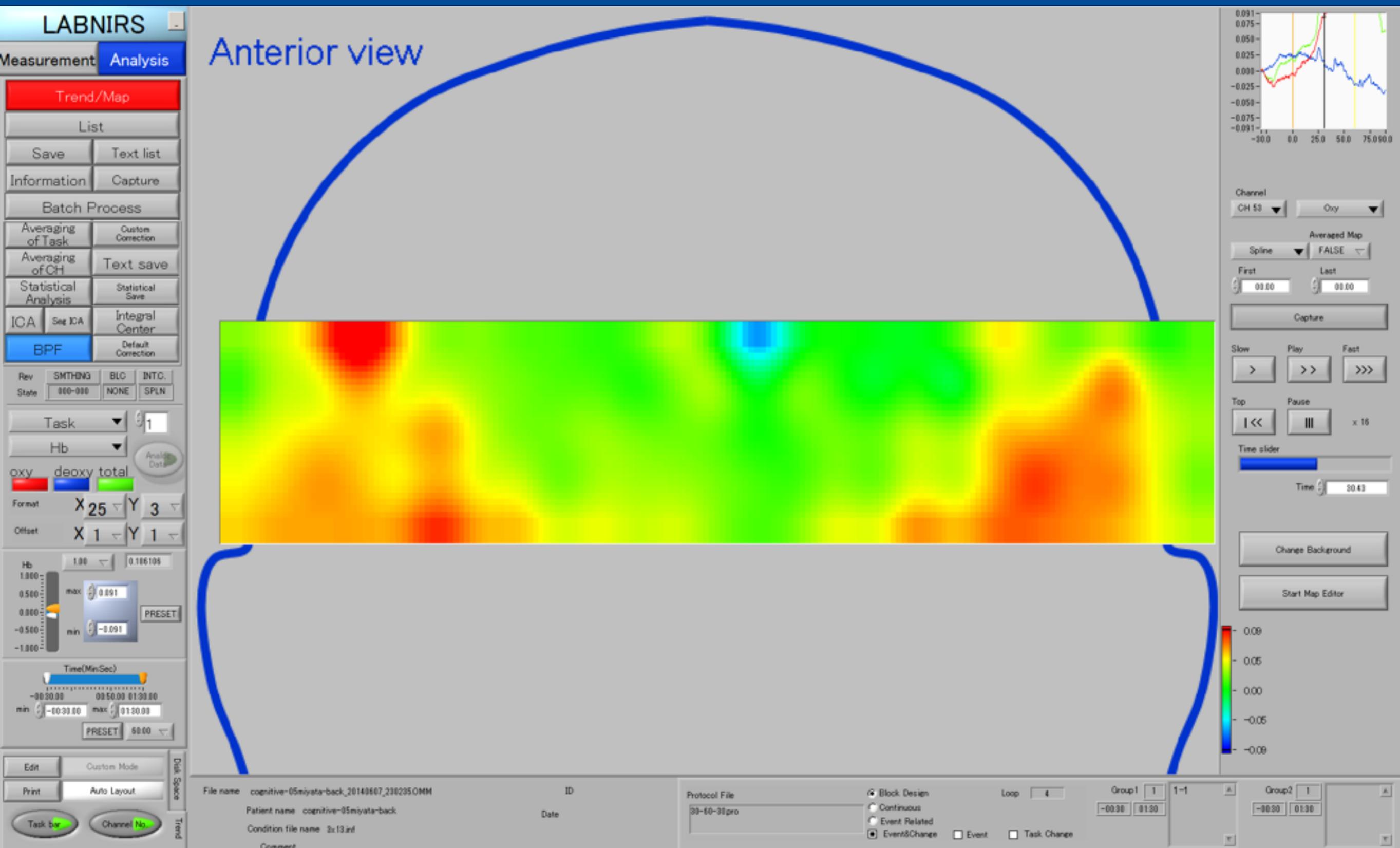
Science Papers

Enabling Technologies: brain activation sensing



**NIRS: near-infrared spectroscopy
Estimating user's brain activation
over oxyhemoglobin change**

FNRIS



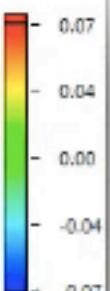
Firefox 00:00:18:1
file:///C:/Users/View X/Desktop/app/reading/lv1.html

Google

Originally scheduled to open in November of this year, the new museum and its facilities will now open on March 1 next year. Hawas said the delay was due to the unexpected challenges of moving the nation's treasures from across the country to the new museum in a safe manner. 'We did not expect that the transfer of some larger artifacts and sculptures would be so difficult. But we don't want to rush the process and risk damage to any of our nation's treasures.'

According to the article, why was the opening rescheduled?

- a. There were problems relocating some items.
- b. There were insufficient funds to complete the building.
- c. There was a problem caused by government policy.
- d. there was a security system malfunction.



Enabling Technologies: brain activation sensing

brain activation during dual n-back problems

work load

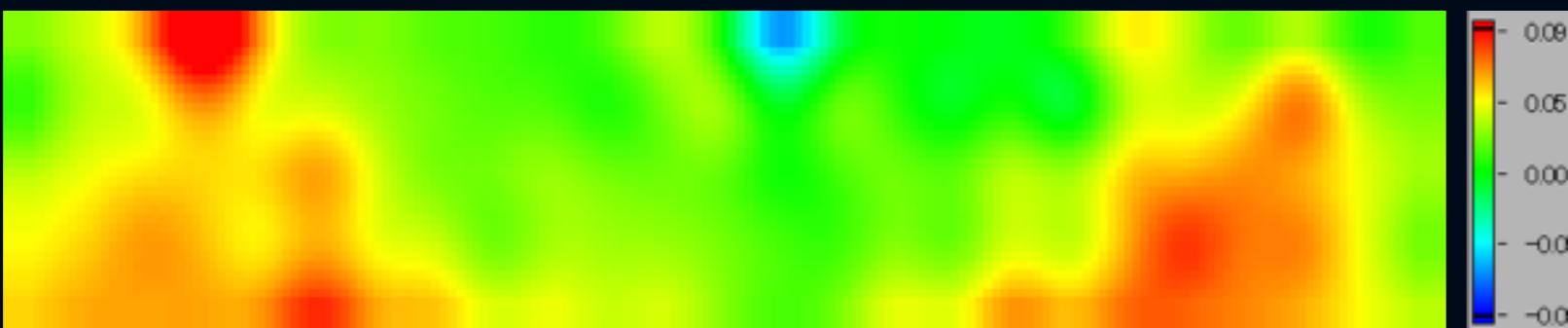
1-back



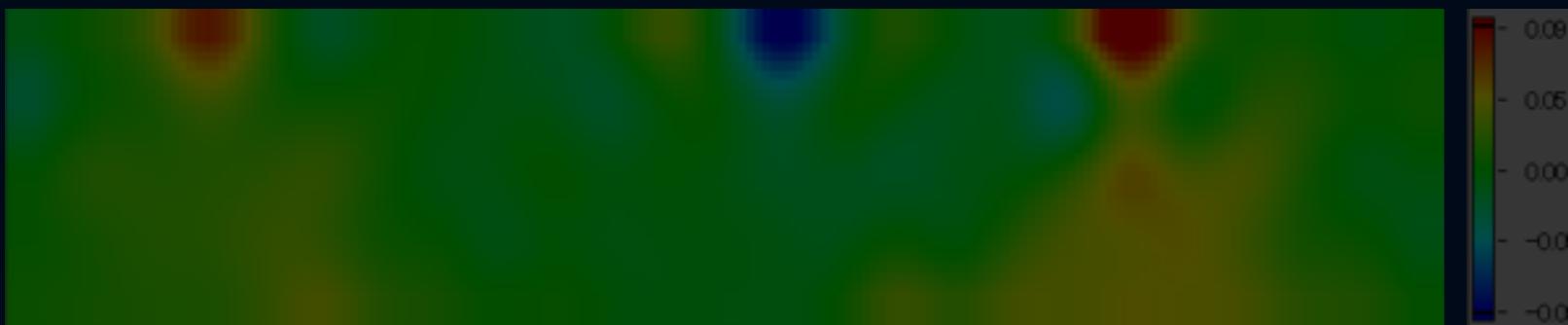
2-back



3-back



4-back



In Summary

previous centuries:

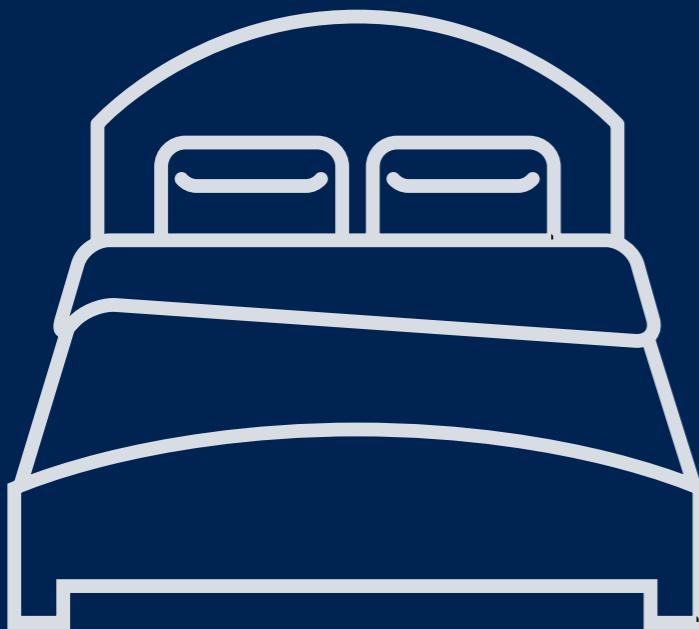
faster

higher

more comfortable ...



www.nih.gov/science/brain/
\$3 billion for ten years



www.humanbrainproject.eu
\$1.9 billion for ten years

Last centuries: trying to overcome our physical limitations ...

Now: overcoming our cognitive limitations.

THANKS TO ...

*Yuji Umea, Yuta Sugiura, Masahiko Inami, Masa Inakage,
Kazutaka Inoue, Masato Kimura, Rina Kanno, Oliver Amft,
Koichi Kise, Masakazu Iwamura, Motoi Iwata, Yuzuko Utsumi,
Andreas Dengel, Andreas Bulling, David Bannach, Takumi Toyama,
Tsutomu Terada, Seiichi Ushida, Stephan Sigg, Christoph Schuba,
Cody Sumter, Paul Lukowicz, Bernhard Sick, Jingyuan Cheng,
Kamil Kloch, Gerald Pirkl, Albrecht Schmidt, Michael Beigl,
Niels Henze, Alireza Sahami, Tilman Dingler, Bastian Pfleging,
Dawud Gordon, Till Riedel, Ulf Blanke, Yusuke Sugano,
Hans Gellersen, Christian Weichel, Anton Dollmaier,
Gernot Bahle, Josef Neuburger*

SPECIAL THANKS TO

*the students who do the work ...
(alphabetic order)*

Ayano Okoso

Eria Chita

Hiroki Fujiyoshi

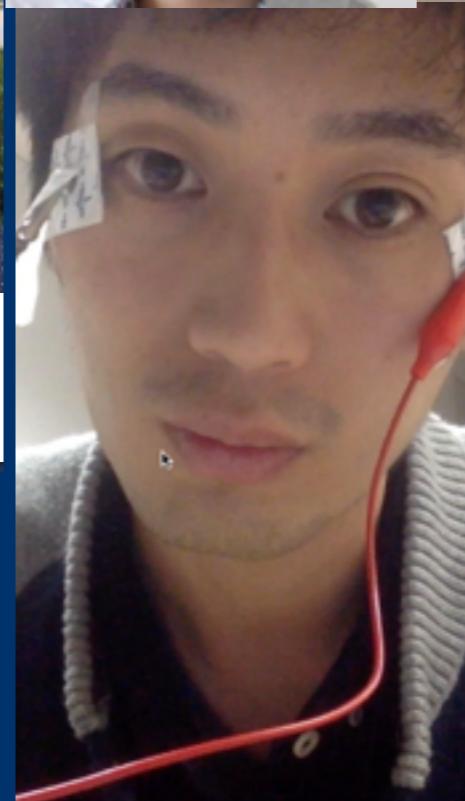
Katsuma Tanaka

Kazuyo Yoshimura

Masai Katsutoshi

Mizuki Matsubara

Shoya Ishimaru



QUESTIONS, REMARKS, VIOLENT DECENT?



<http://kaikunze.de/>



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kai@kmd.keio.ac.jp

github.com/kkai



Shamless Advertisements:

Augmented Human 2015, Singapore

Pervasive Health 2015, Istanbul

*FOSS Asia 2015, 13th-15th March,
Singapore*

Superhuman Sports Committee

<http://superhuman-olympic.org>

