

Toward a “Cognitive” Quantified Self

Activity Recognition for the Mind

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Overview

Physical Activity Recognition becomes Mainstream

Toward Activity Recognition for the Mind

Focus on Reading Activities

How much/what are you reading?

How much do you understand?

Some Demos (hopefully)



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

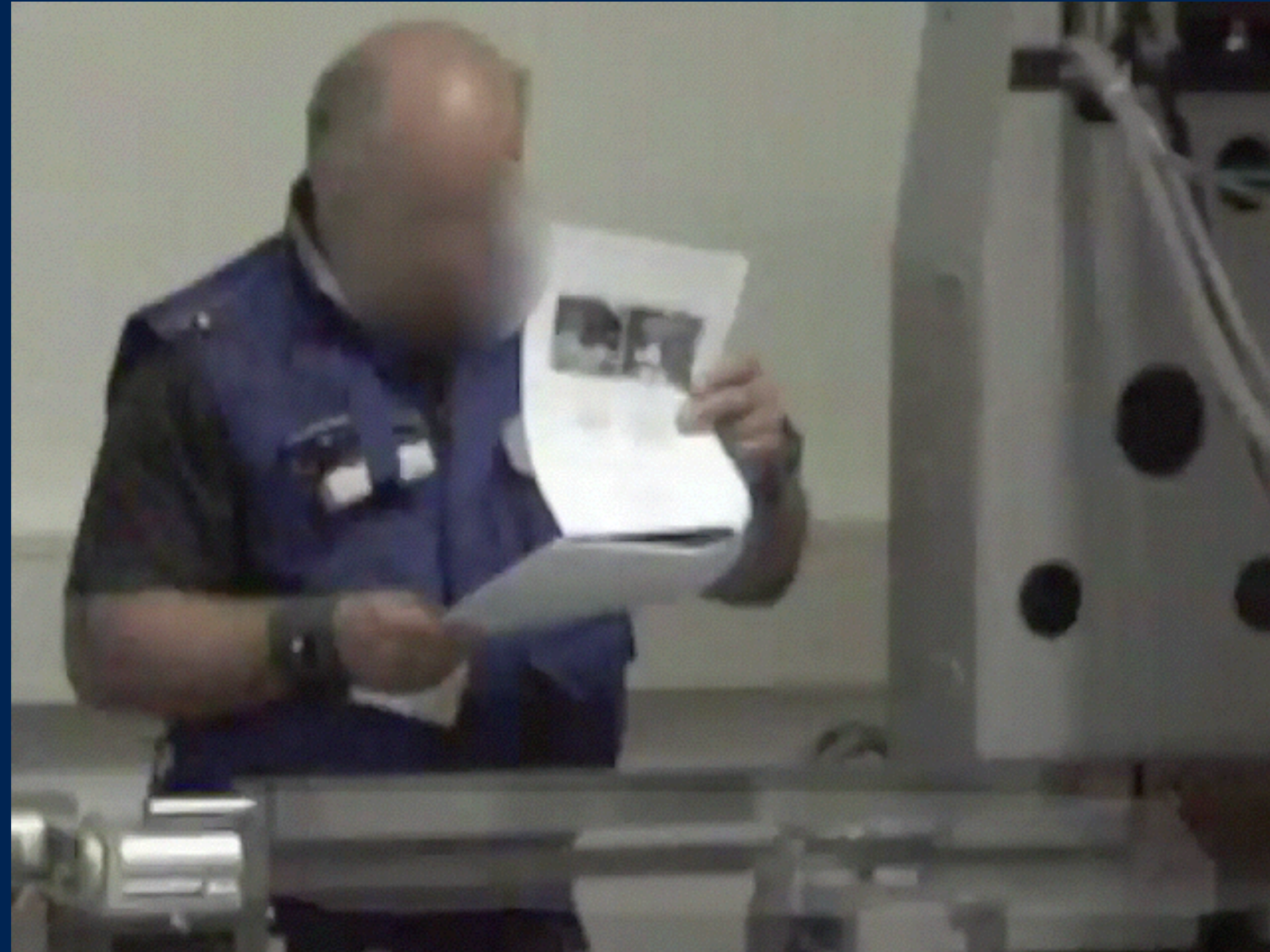
For Computing to become useful in everyday situations,
the interface needs to vanish
as much as possible.

Computing needs to become pro-active

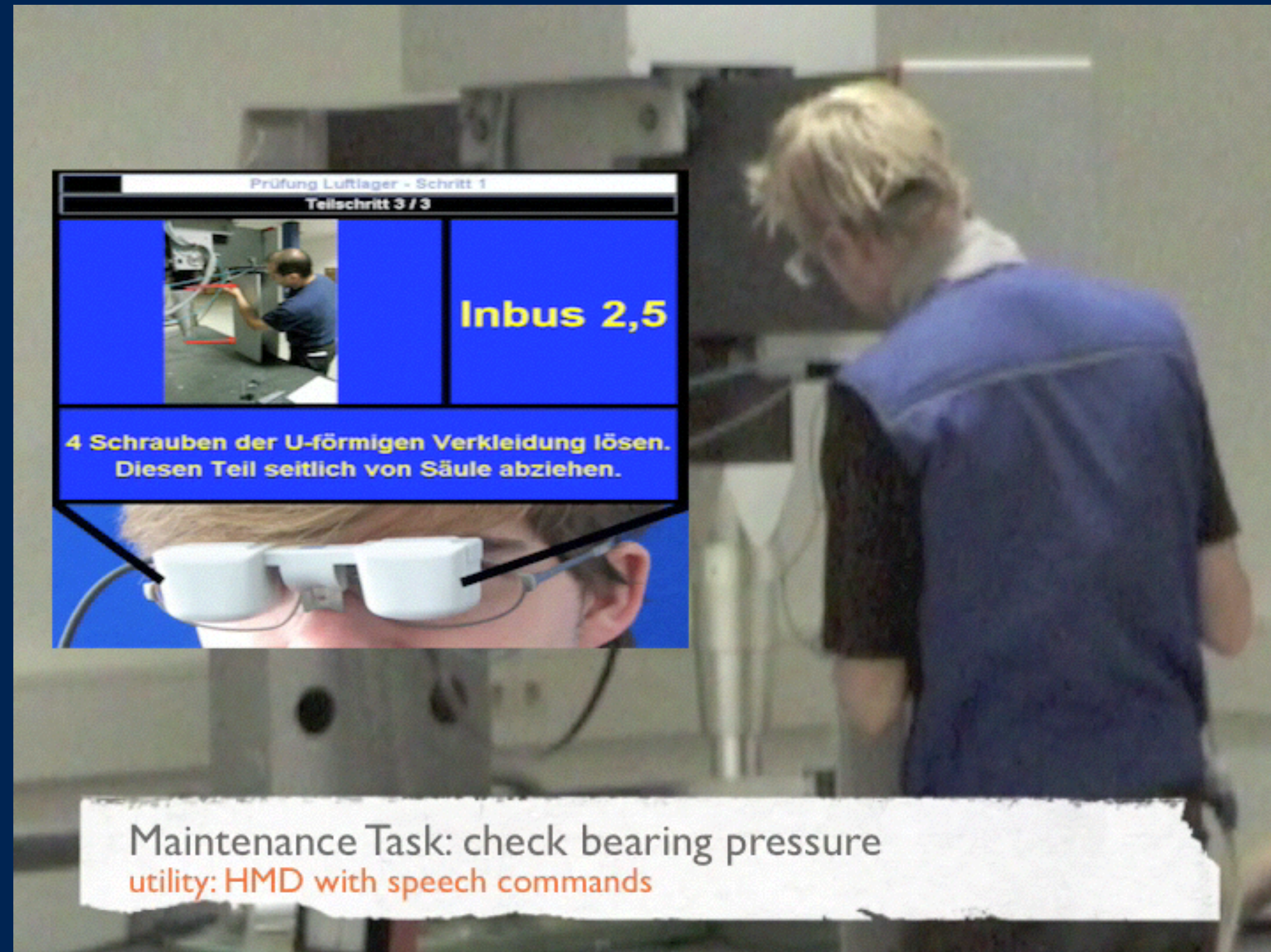
Activity Recognition → Context-Aware Systems



Applications -Maintenance Scenario-



Applications -Maintenance Scenario-



Applications -Maintenance Scenario-



25c3 Talk: About Cyborgs and Gargoyles

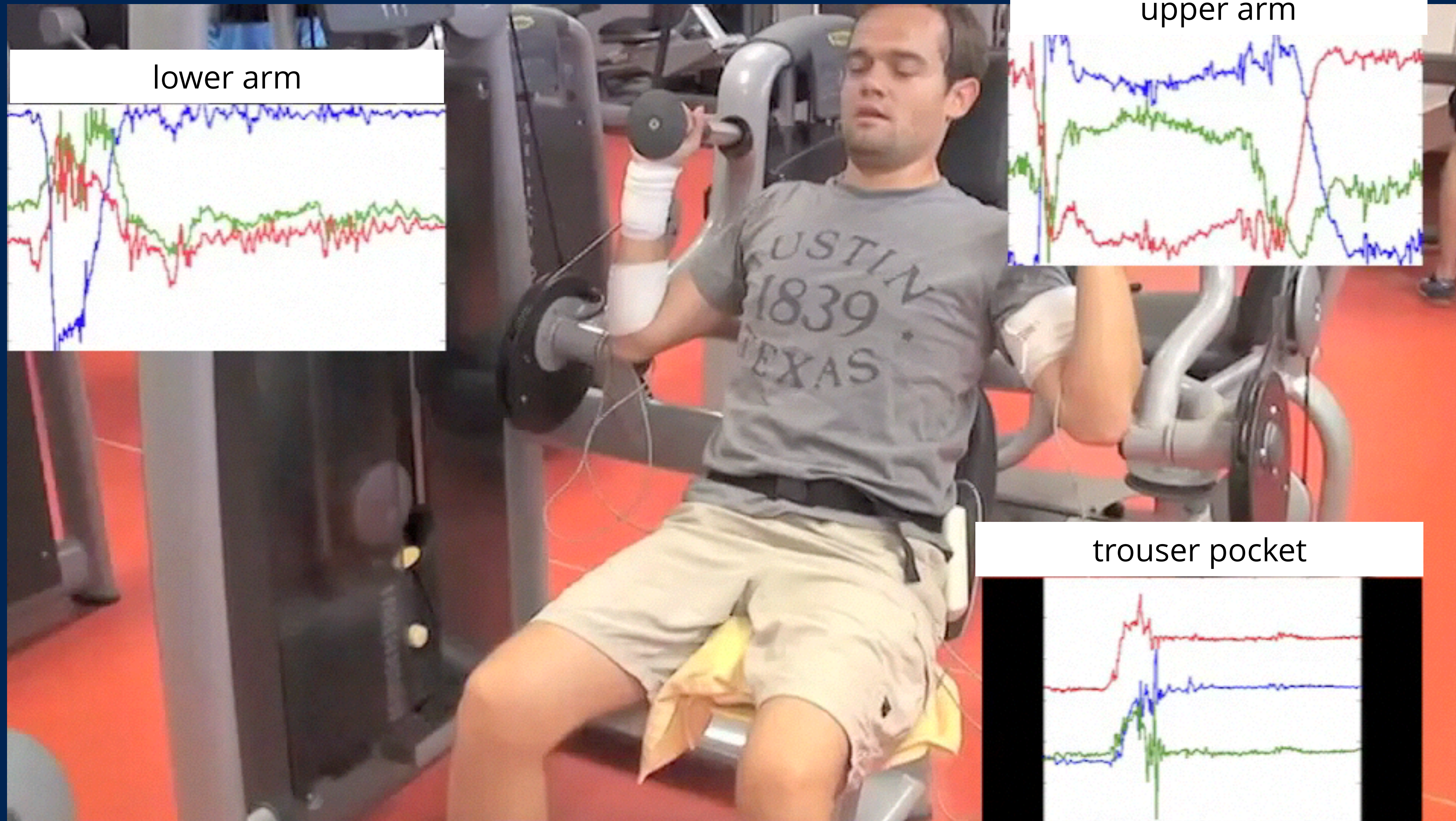
<http://www.youtube.com/watch?v=Jex8z57-tQU>

ZEISS

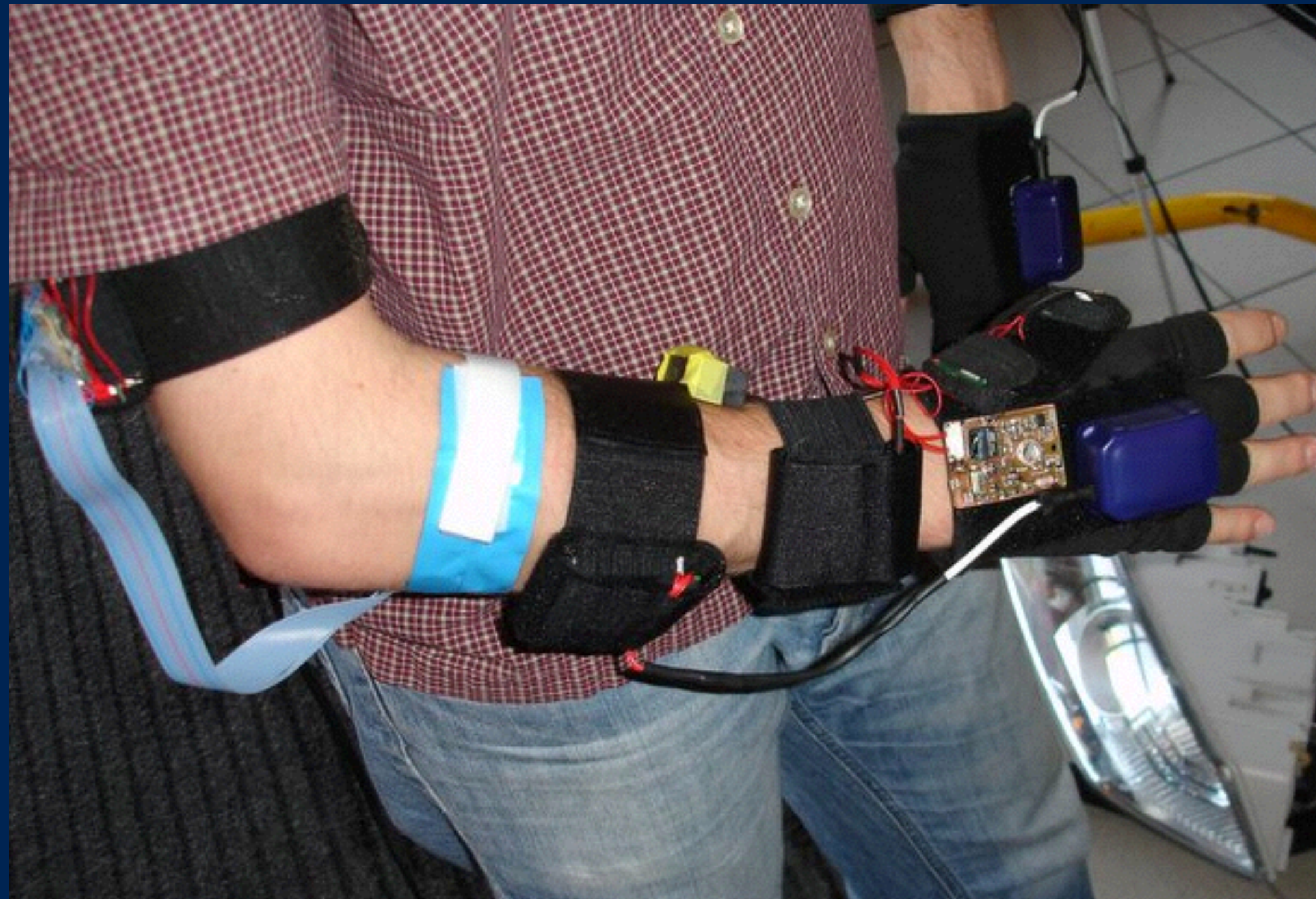
Kai Kunze, Florian Wagner, Ersun Kartal, Ernesto Morales Kluge, Paul Lukowicz: Does Context Matter? - A Quantitative Evaluation in a Real World Maintenance Scenario.

Pervasive 2009, Nara, Japan.

Physical Activity Recognition



However, can you imagine your grandmother wearing sensors?



However, can you imagine your grandmother wearing sensors?

Maybe*



*if you're a PhD. student
working on Wearable Computing

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

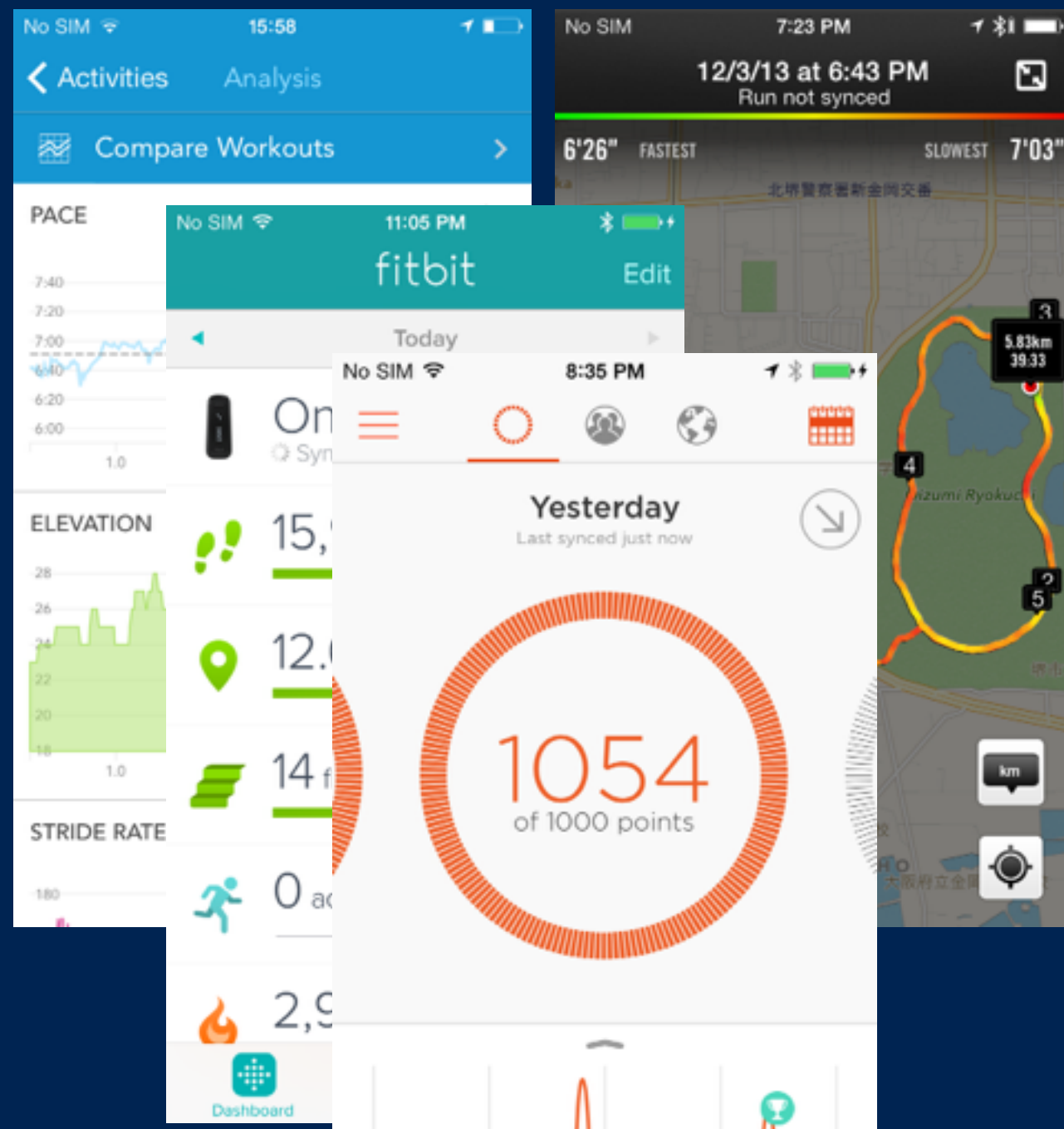
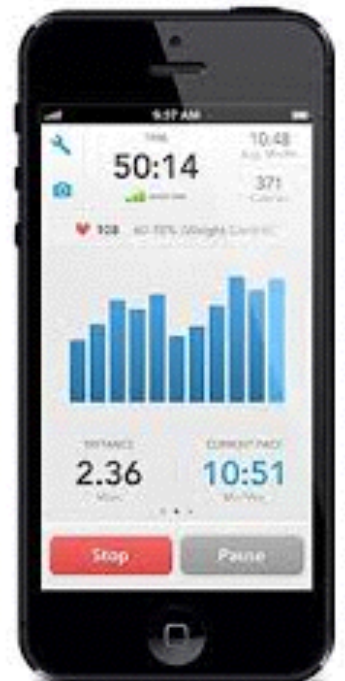
Physical Activity Recognition is becoming Mainstream

Sensors in everyday objects, clothes, accessories ...

We see the first commodity devices tracking physical activity

-> towards physiological sensing

May soon extend to cognitive tasks



NeuroOn



Cognitive Task Recognition

obvious approach: track brain activity directly

drawback: often obtrusive, expensive hardware,

most interesting (wearable etc.):

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

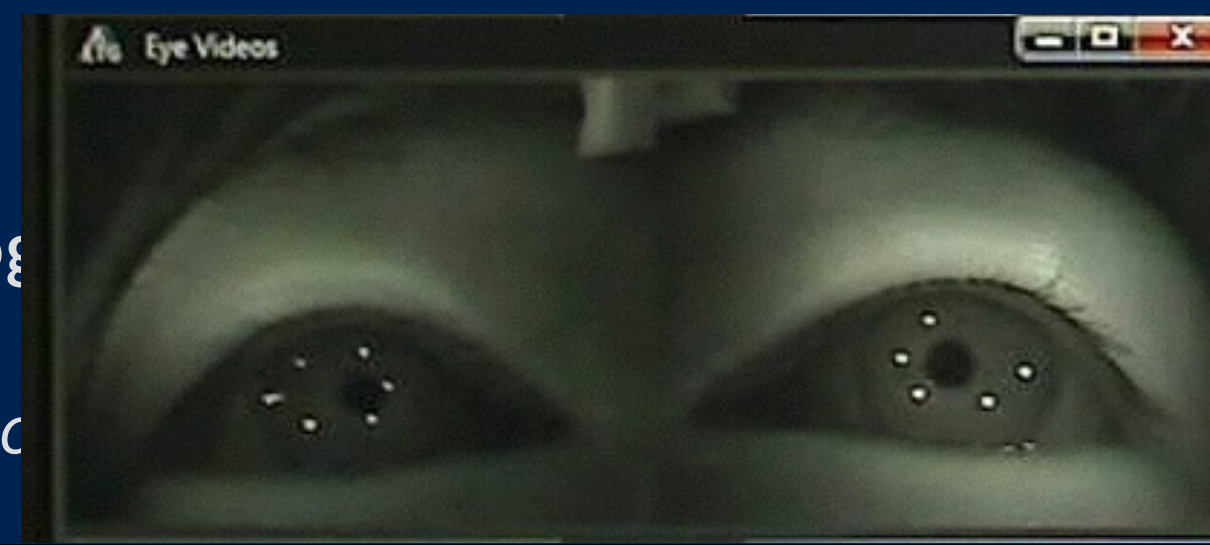
or using secondary sensing:

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*

Tracking Reading Habits

Quantified approach to reading (knowledge acquisition)

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

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

they have been shown to improve physical fitness

very Few In-Situ Studies related to reading[2]



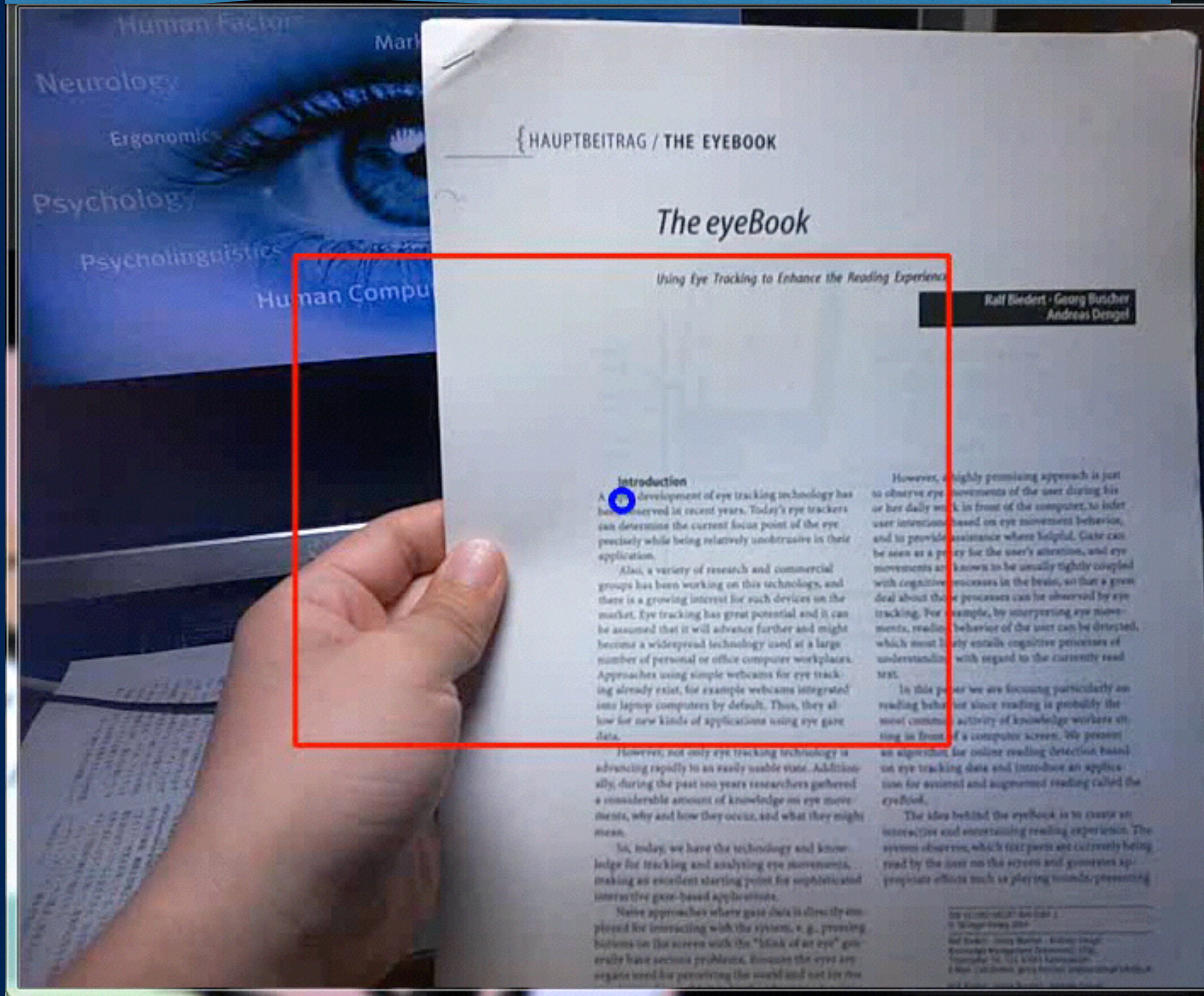
[1] A. Cunningham and K. Stanovich. What reading does for the mind. *Journal of Direct Instruction*, 1(2):137–149, 2001.

[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*

Reading Life Log - Document Image Retrieval and Eye Gaze

Image from Eyetracker

Retrieved page

A screenshot of a digital document page titled "The eyeBook" with a subtitle "Using Eye Tracking to Enhance the Reading Experience" by Ralf Biedert, Georg Buscher, and Andreas Dengel. The page content is similar to the printed version. A red bounding box highlights a specific section of the text. On the right side, there is a metadata panel with the following information:

- Doc ID
- Document Name: itrack35_000
- FPS: 16.67
- Gauss Mask Size: read word
- Word: rapid
- Event: Fixation



Recognized event

How much are you reading?

What are you reading?

How much do you understand?



How much are you reading?

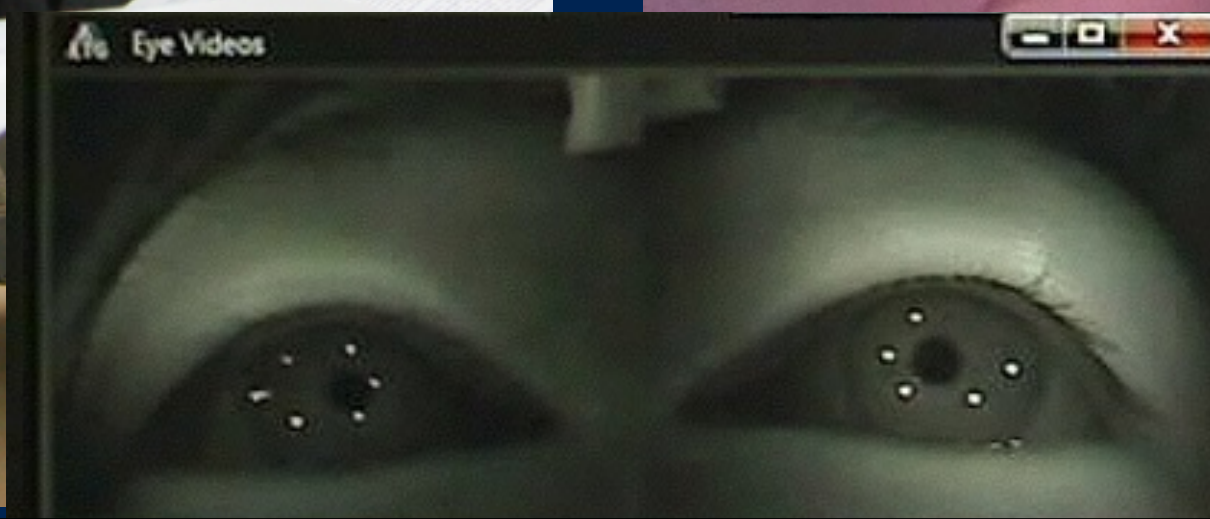
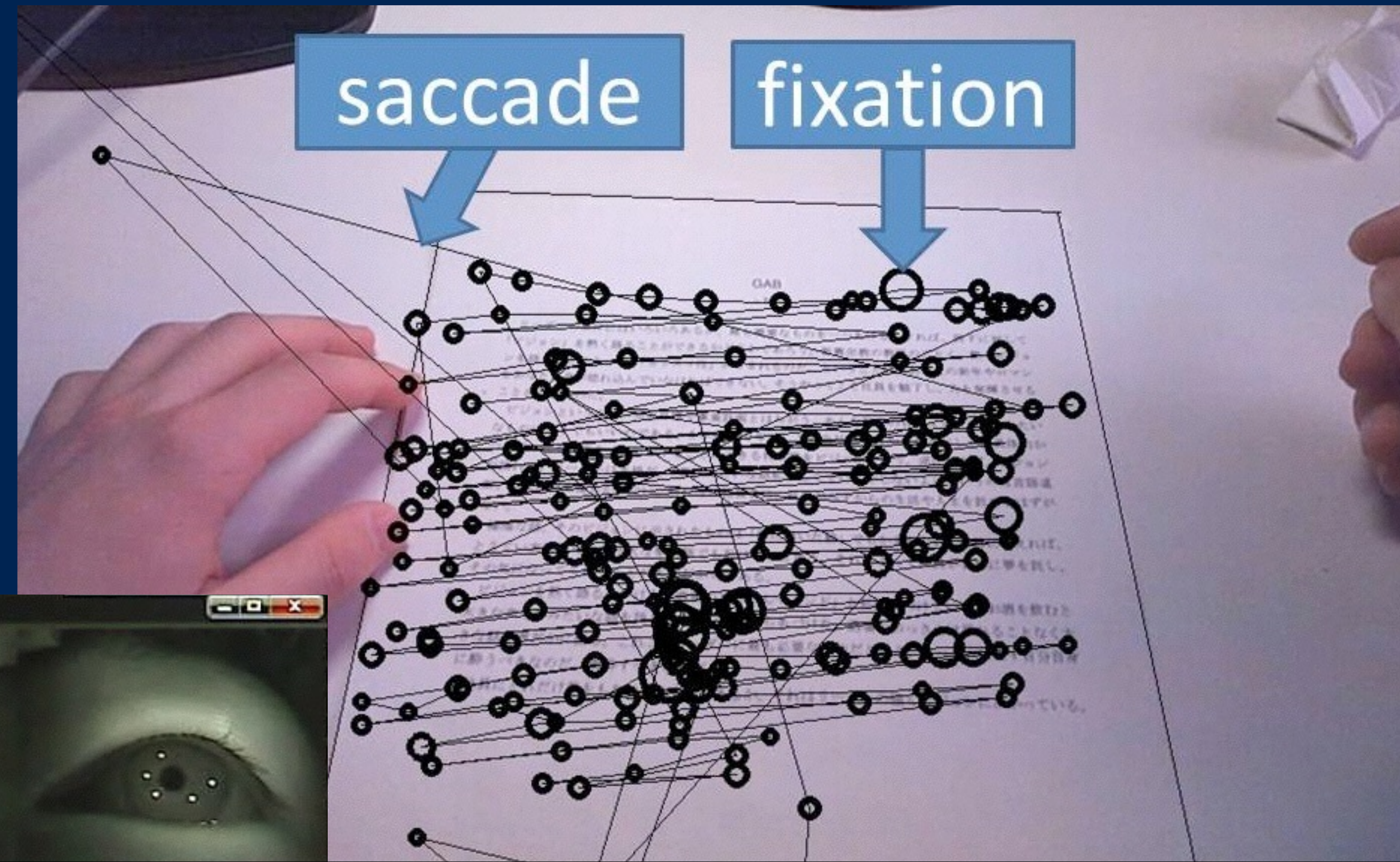
What are you reading?

How much do you understand?



Wordometer

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



Wordometer

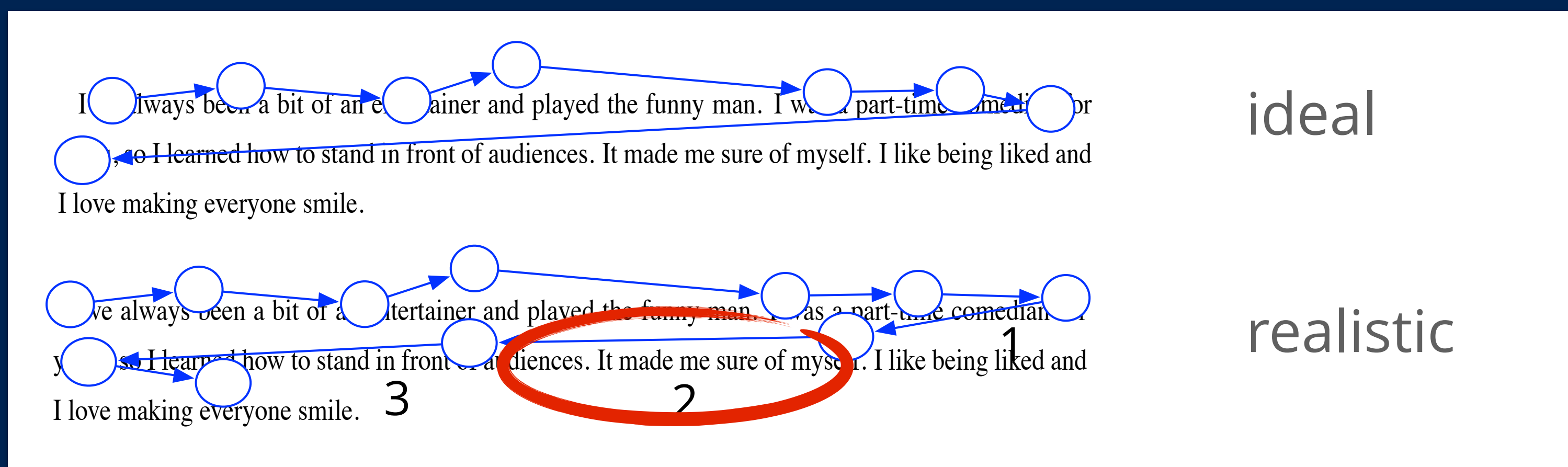
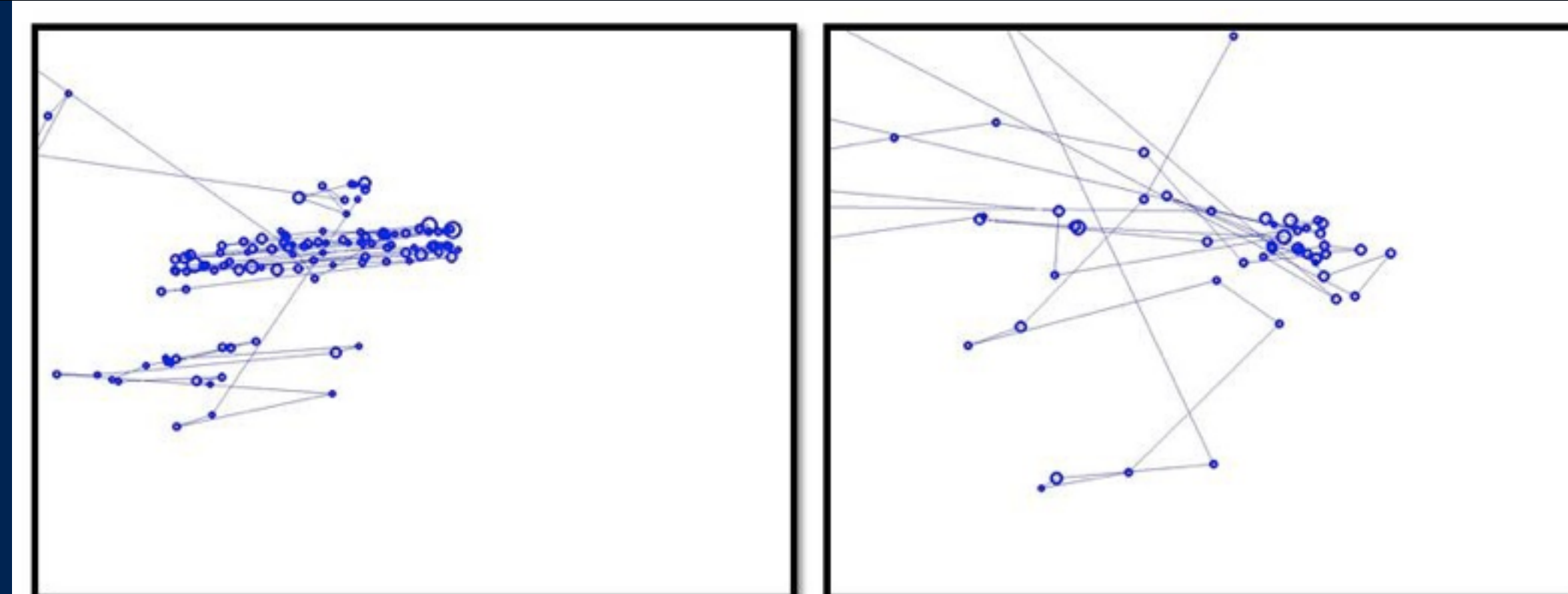
Reading/Not Reading Detection

Estimation of Lines Read

Approximate Word Count (10 users, 14 documents)

with Document Image Retrieval Error: ~8 %

without Document Image Retrieval (only eye gaze) ~ 13 %



ideal

realistic

How much are you reading?

What are you reading?

How much do you understand?



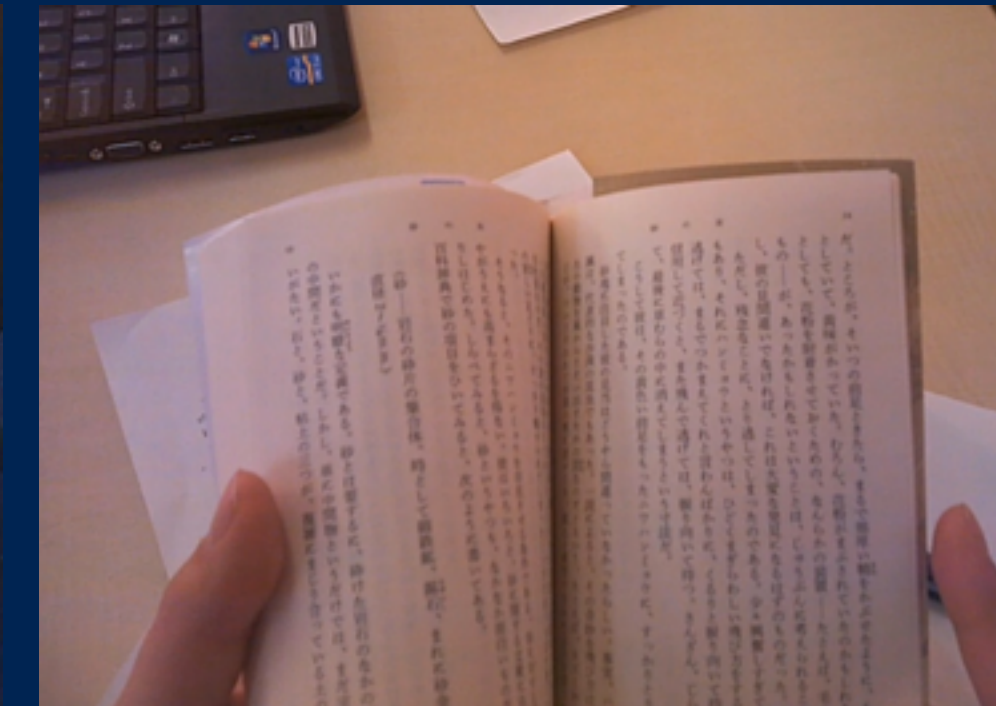
Distinguishing Document Types using Eye Gaze

Recording eye gaze using the SMI mobile eye-tracker of
10 users,
5 document types,
5 environments

Documents differ in text-layout (Yokogaki/Tategaki),
number of images, etc.

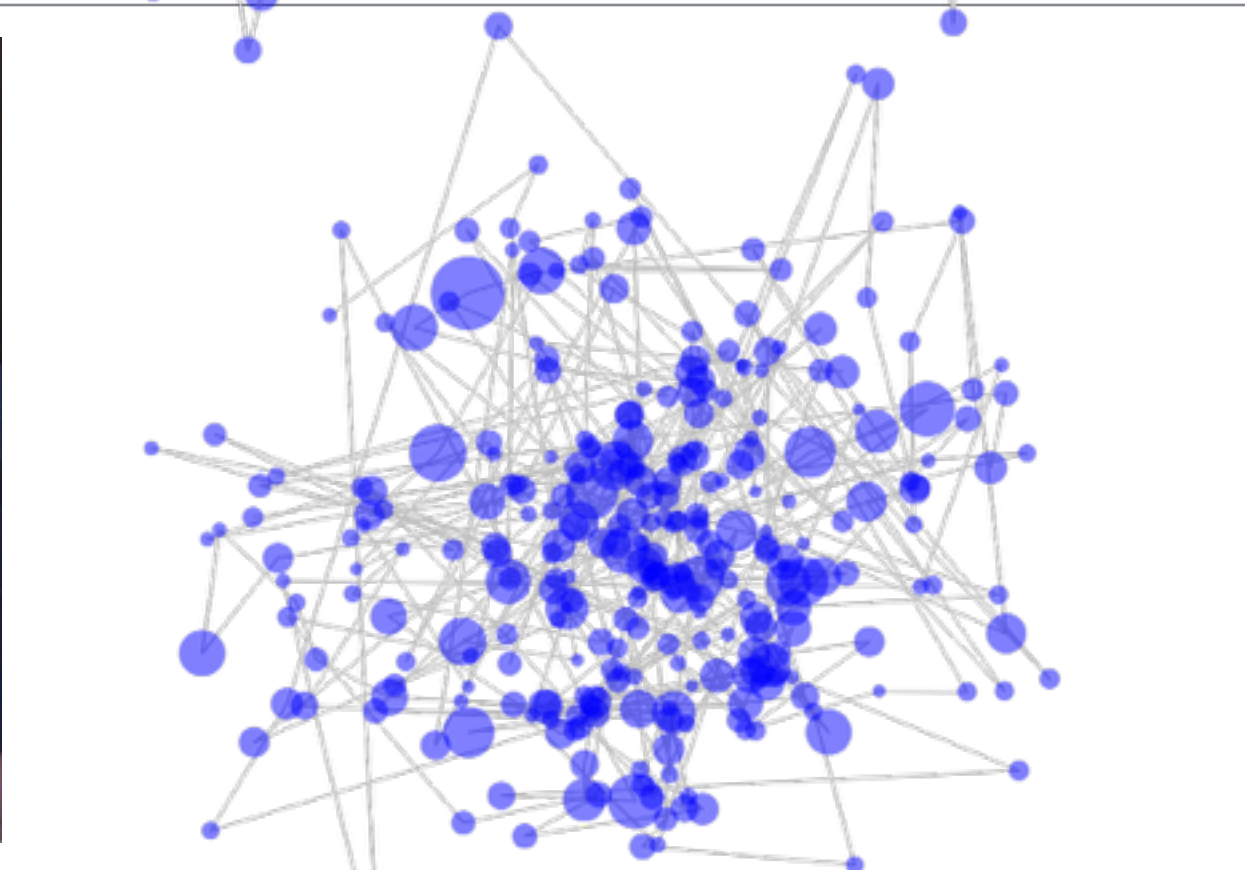
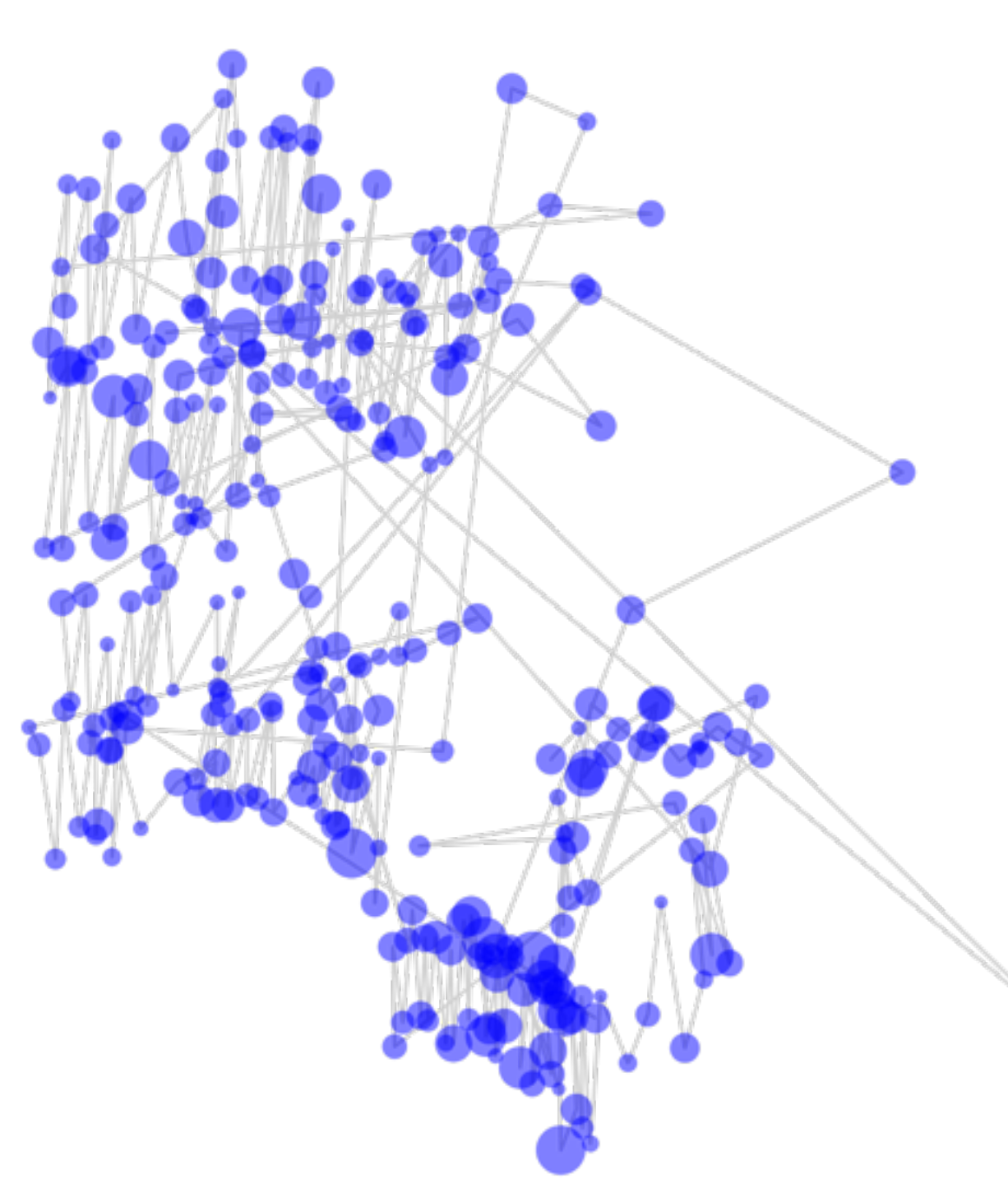
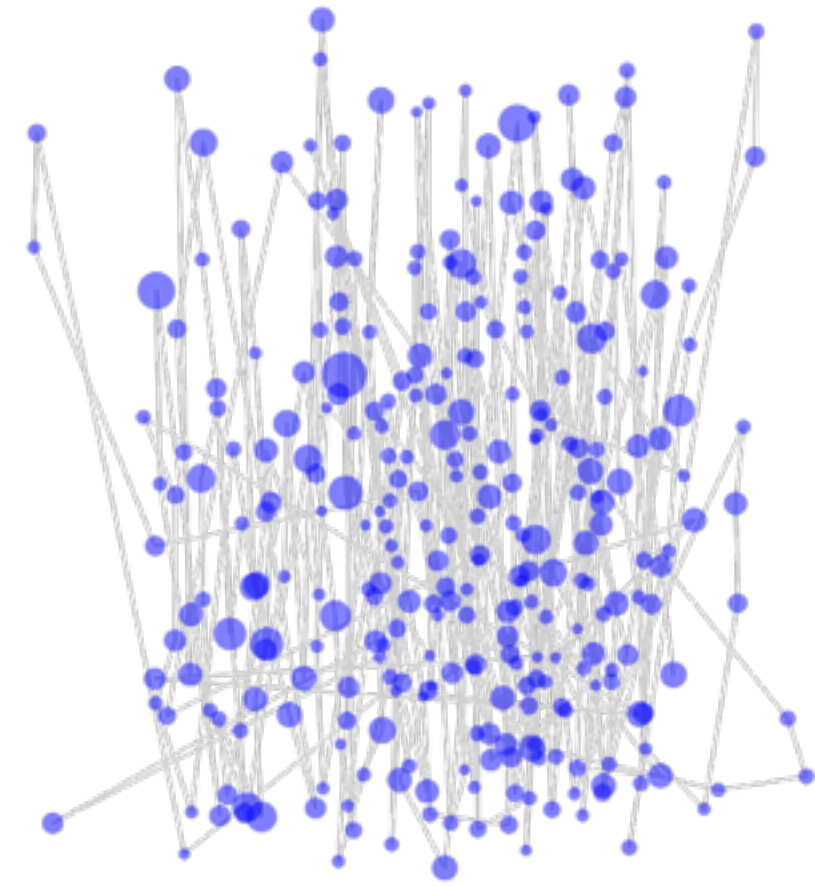
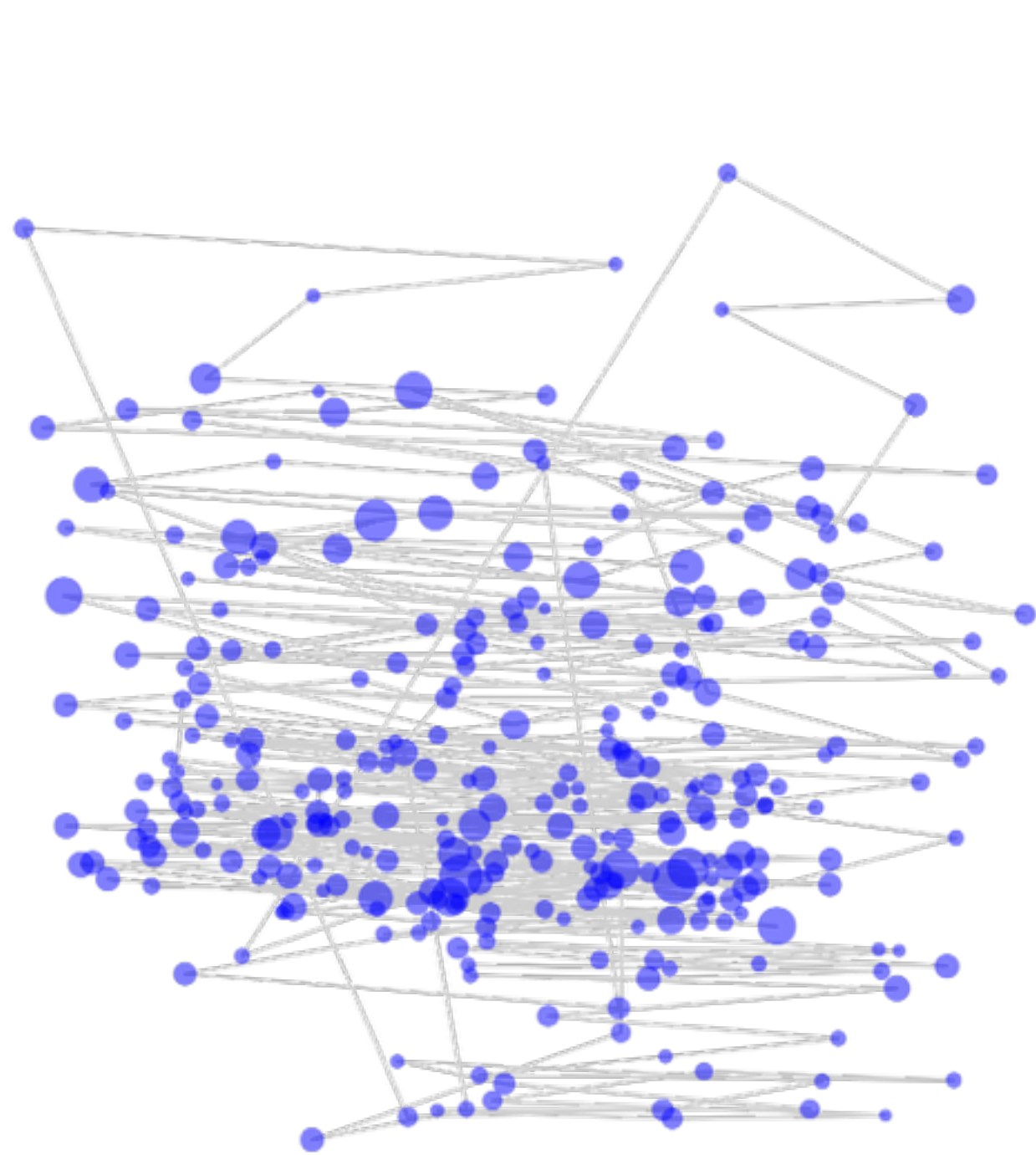
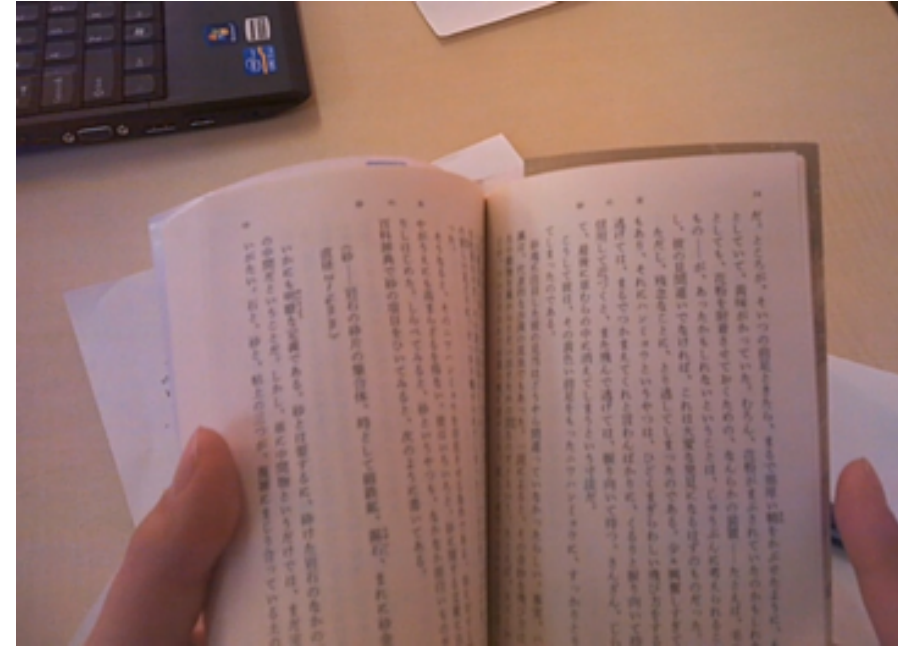
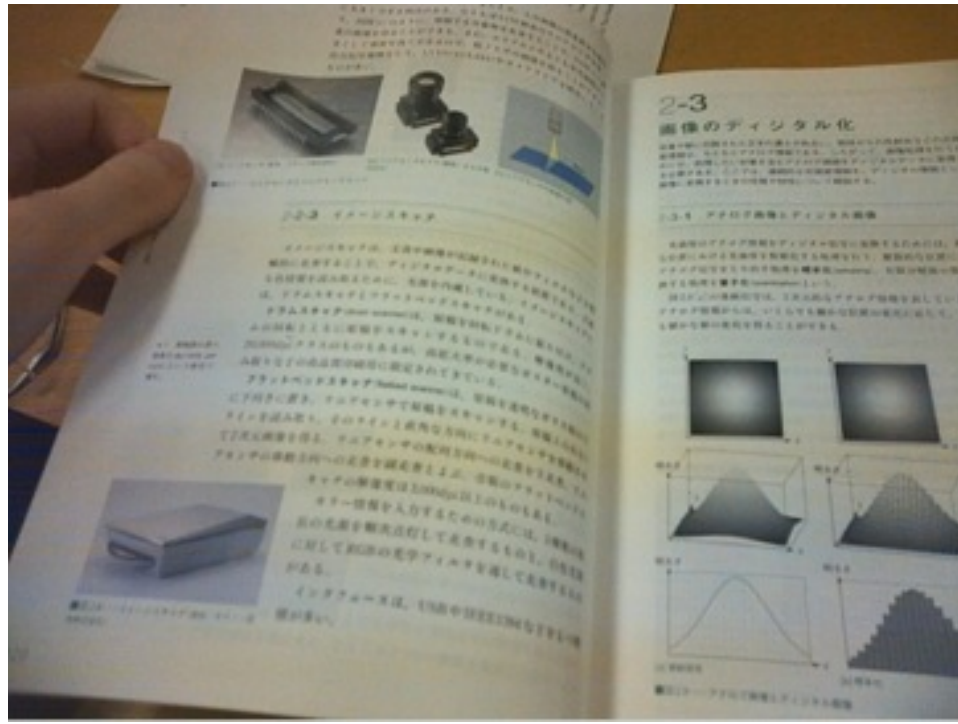
User independent: 74 % (frame -by-frame)

User dependent: 98 %



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.

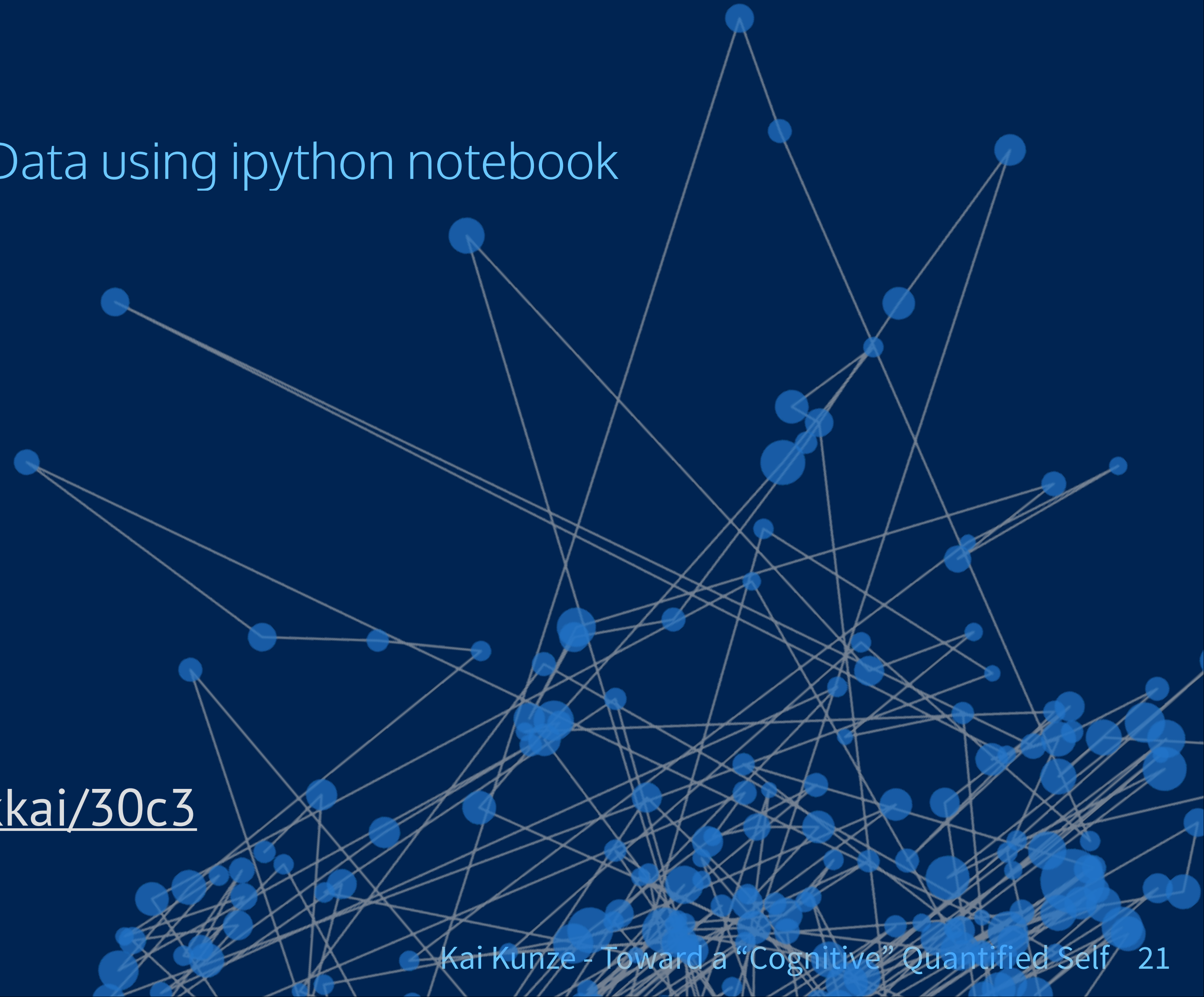
K. Kunze, Y. Shiga, S. Ishimaru, Y. Utsumi, K. Kise. Reading activity recognition using an off-the-shelf EEG — detecting reading activities and distinguishing genres of documents, ICDAR, Washington D.C., 2013.



Demonstration

Exploring Eye Gaze Data using ipython notebook

<https://github.com/kkai/30c3>



Additional Info

<http://ipython.org/>

interesting packages: scikit learn, matplotlib, pandas

easy to install: Scipy Superpack (Mac) <http://fonnesbeck.github.io/ScipySuperpack/>

<https://github.com/ipython/ipython/wiki/A-gallery-of-interesting-IPython-Notebooks>

<https://github.com/CamDavidsonPilon/Probabilistic-Programming-and-Bayesian-Methods-for-Hackers>

advice about programming in machine learning/ activity recognition research:

<http://arkitus.com/PRML/>

<http://www.theexclusive.org/2012/08/principles-of-research-code.html>

https://github.com/kkai/data_intro (with an classification example for motion data)

general paper writing advice:

<http://research.microsoft.com/en-us/um/people/simonpj/papers/giving-a-talk/writing-a-paper-slides.pdf>

How much are you reading?

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Estimating Reading Comprehension

Participants read
a Text Comprehension Section of a
standardized test (TOIEC)

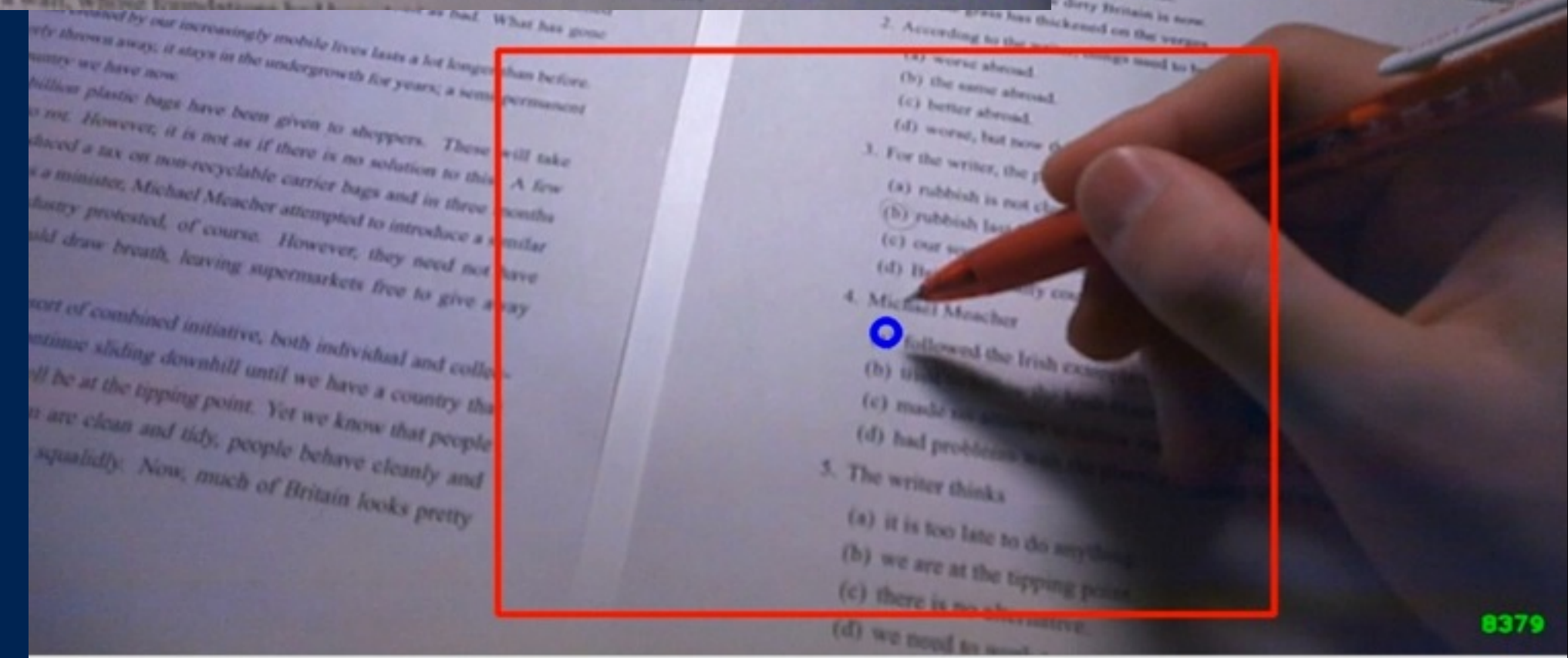
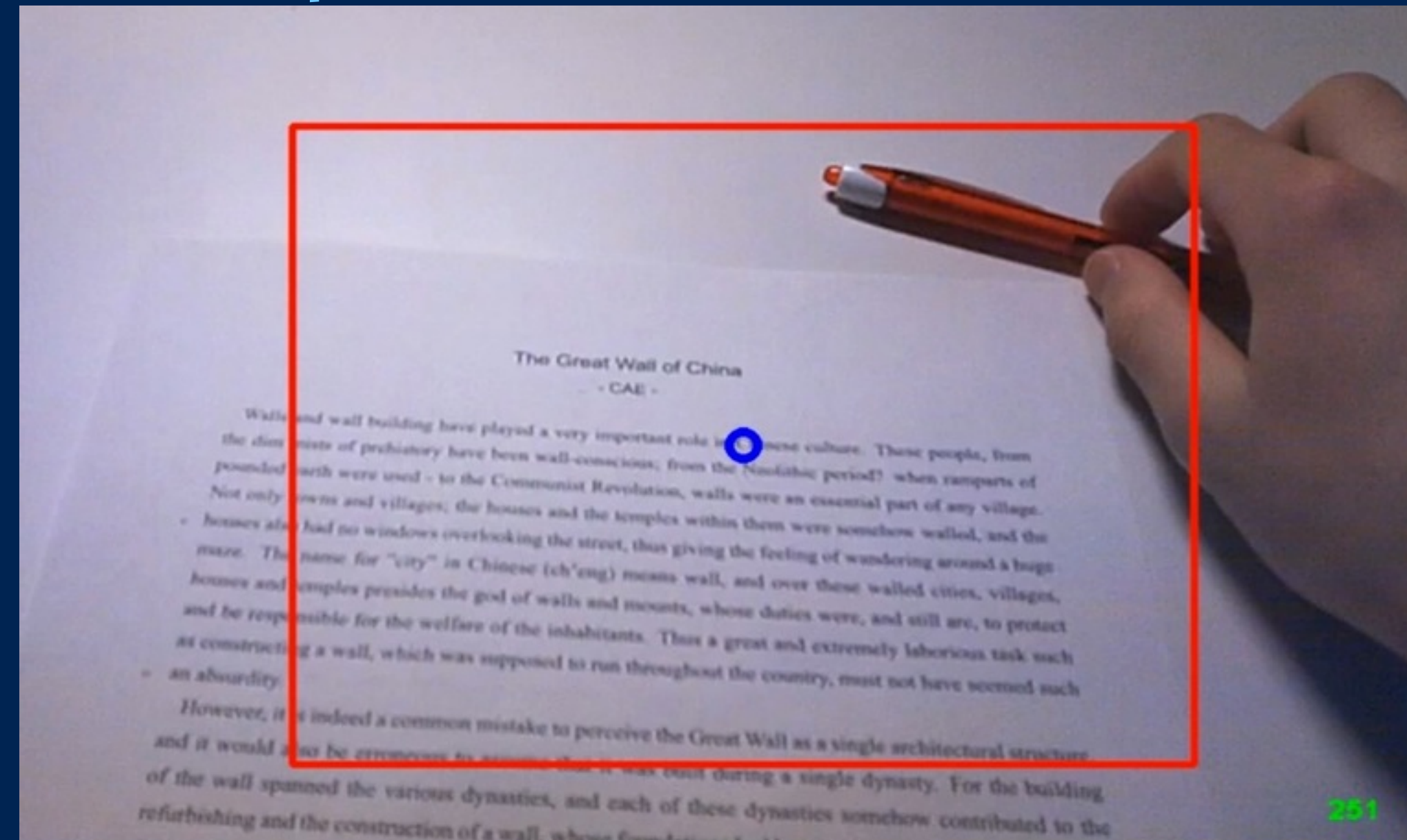
with mobile eye tracker

Answer questions afterwards

Mark difficult words

10 participants

10 text comprehension sections

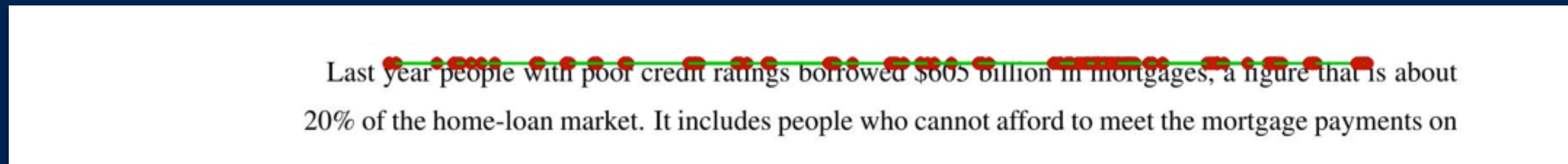
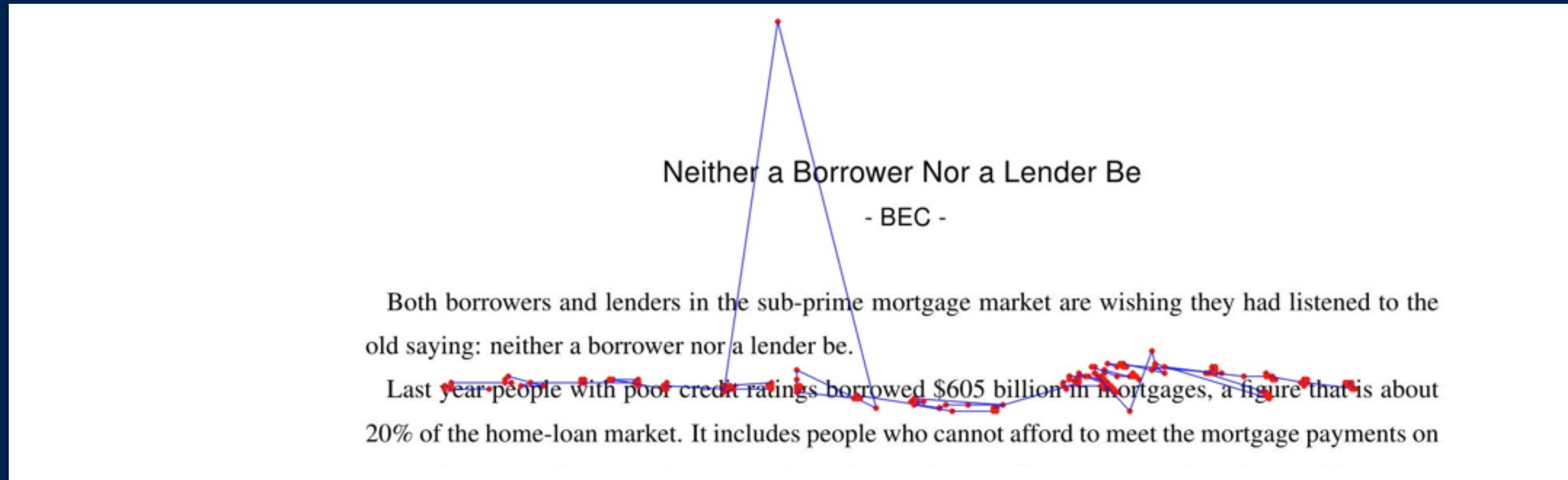


K. Kunze, H. Kawaichi, K. Yoshimura, K. Kise. Towards inferring language expertise using eye tracking. accepted as Work in Progress at ACM SIGCHI Conference on Human Factors in Computing Systems, Paris, France 2013.

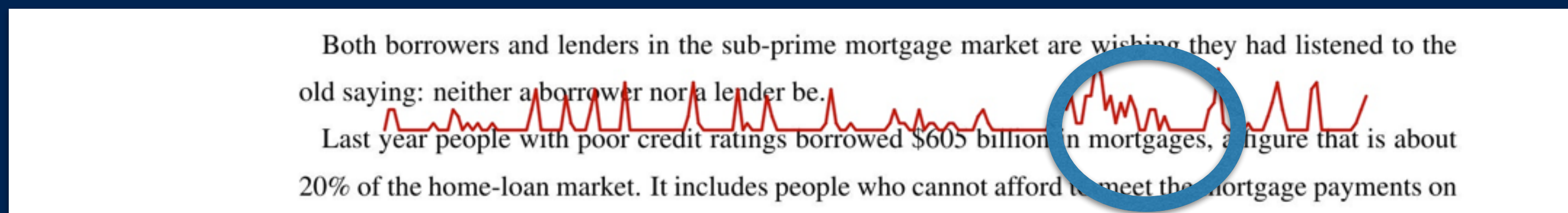
Detecting difficult words



Eye-gaze translated to document coordinate system using LLAH

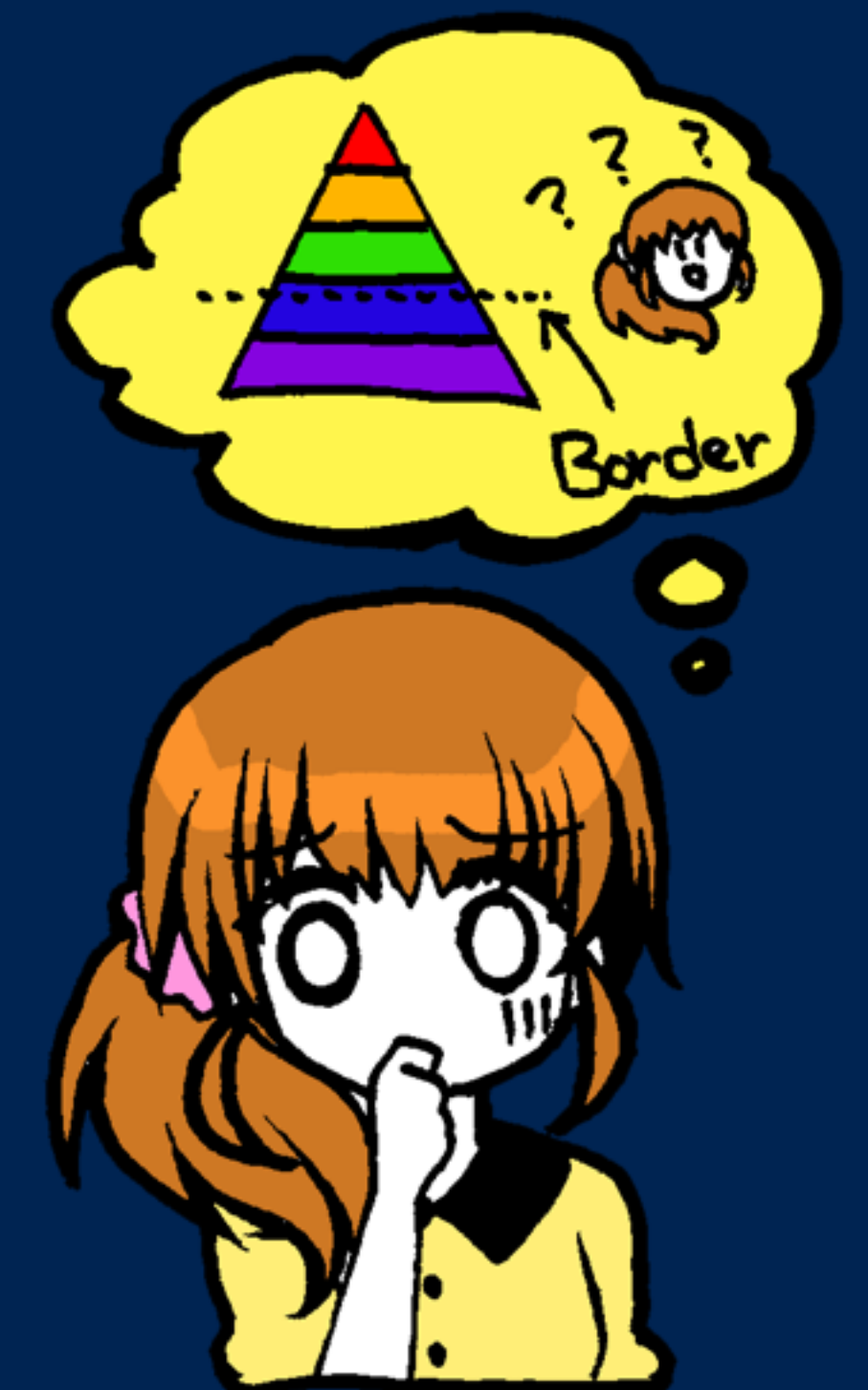
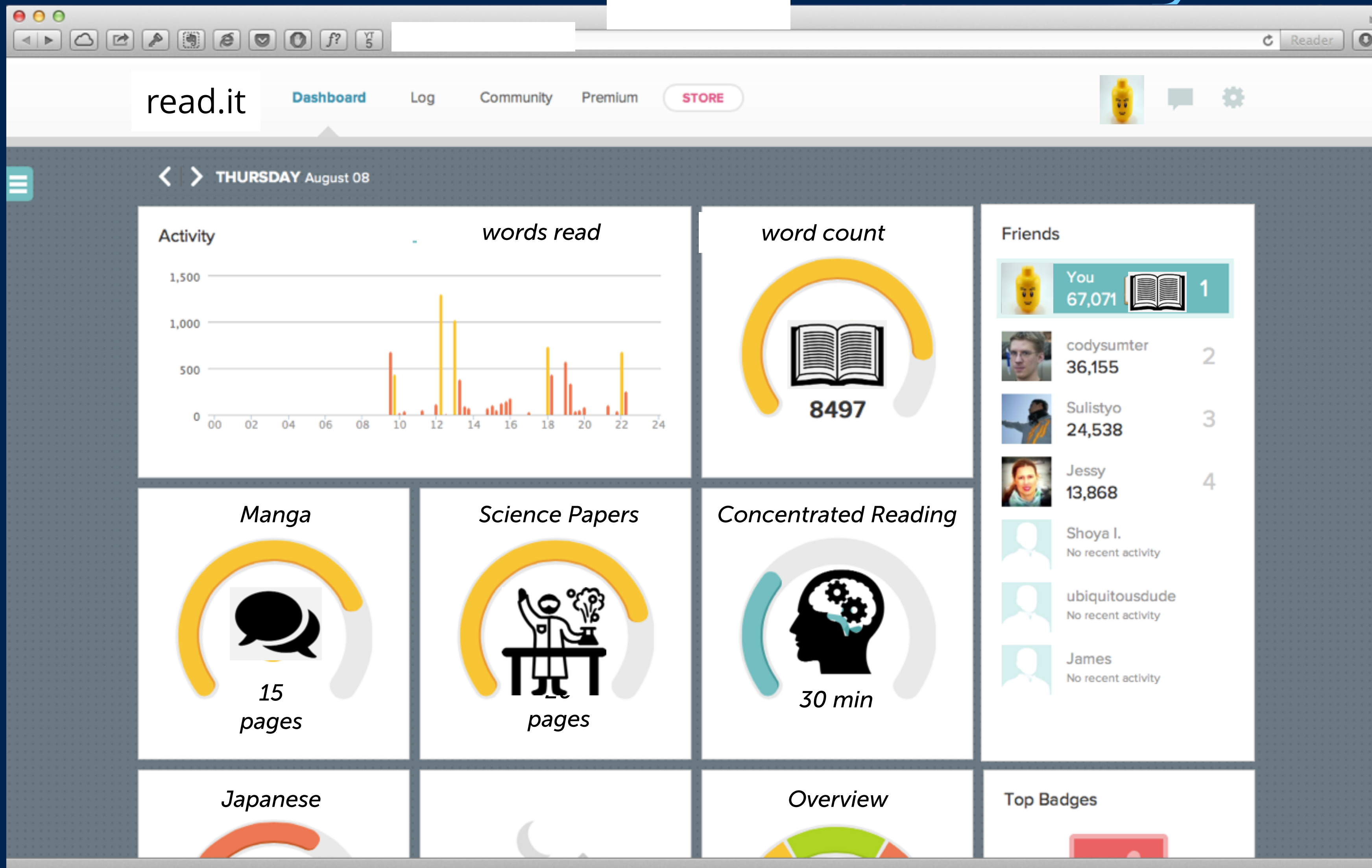


Horizontal projection to a line



fixation histogram

Future Work - Fibit for Reading?



however, eye tracking hardware is expensive ...

Ok, there are some concerns if people want to wear it ...



True, yet might change with the next version of glass ...



Google Glass - Very Hackable Hardware

Warning: you void your warranty and might leave the device in an unrecoverable state!

you can easily get root

installing stock Android/ Ubuntu/ Debian is straight forward

Google provides you with the factory firmware

<https://developers.google.com/events/io/sessions/332704837>

```
adb devices
adb reboot-bootloader
fastboot devices
```

```
fastboot oem unlock
```

```
fastboot flash boot boot.img
fastboot reboot
adb root
adb shell
```

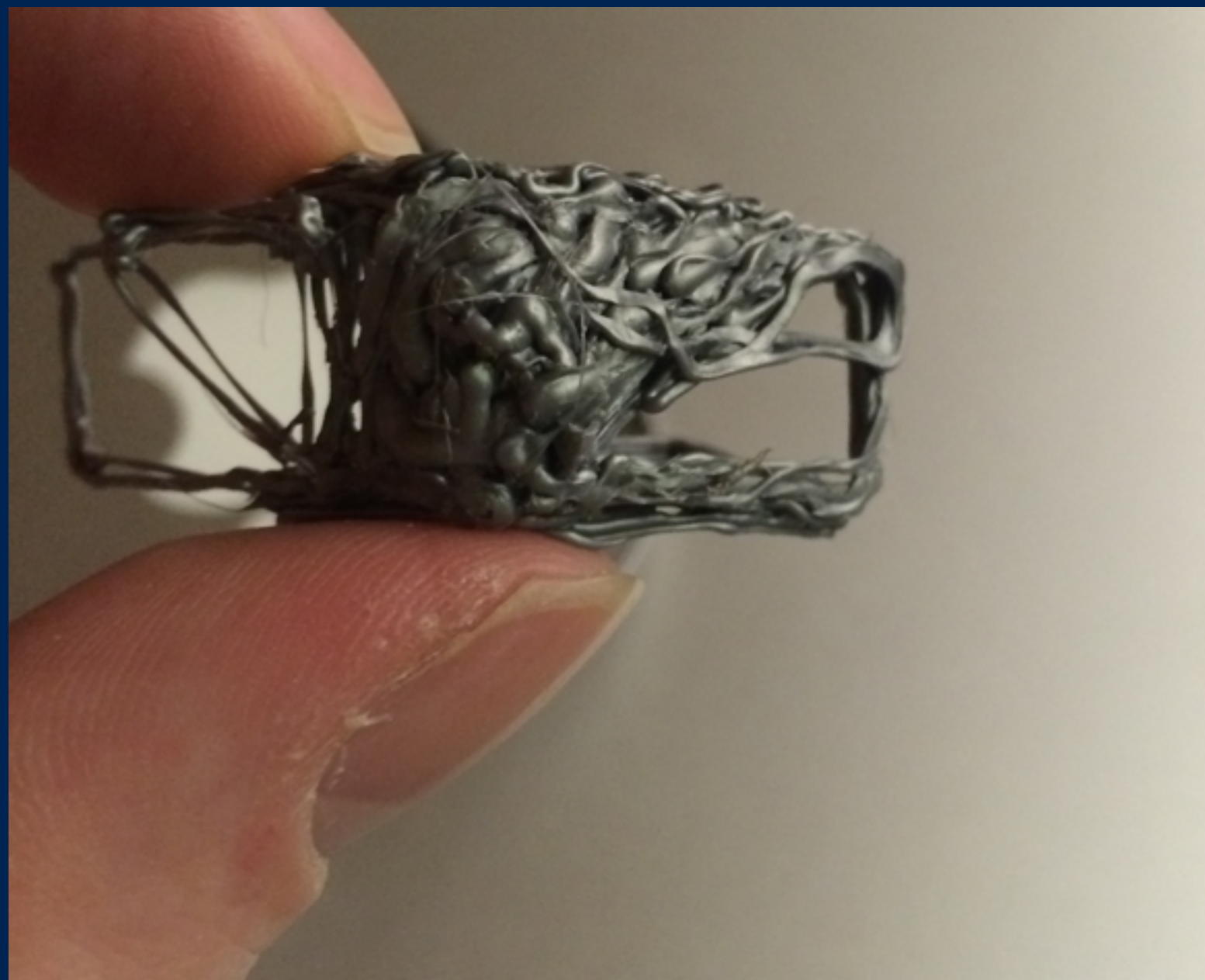
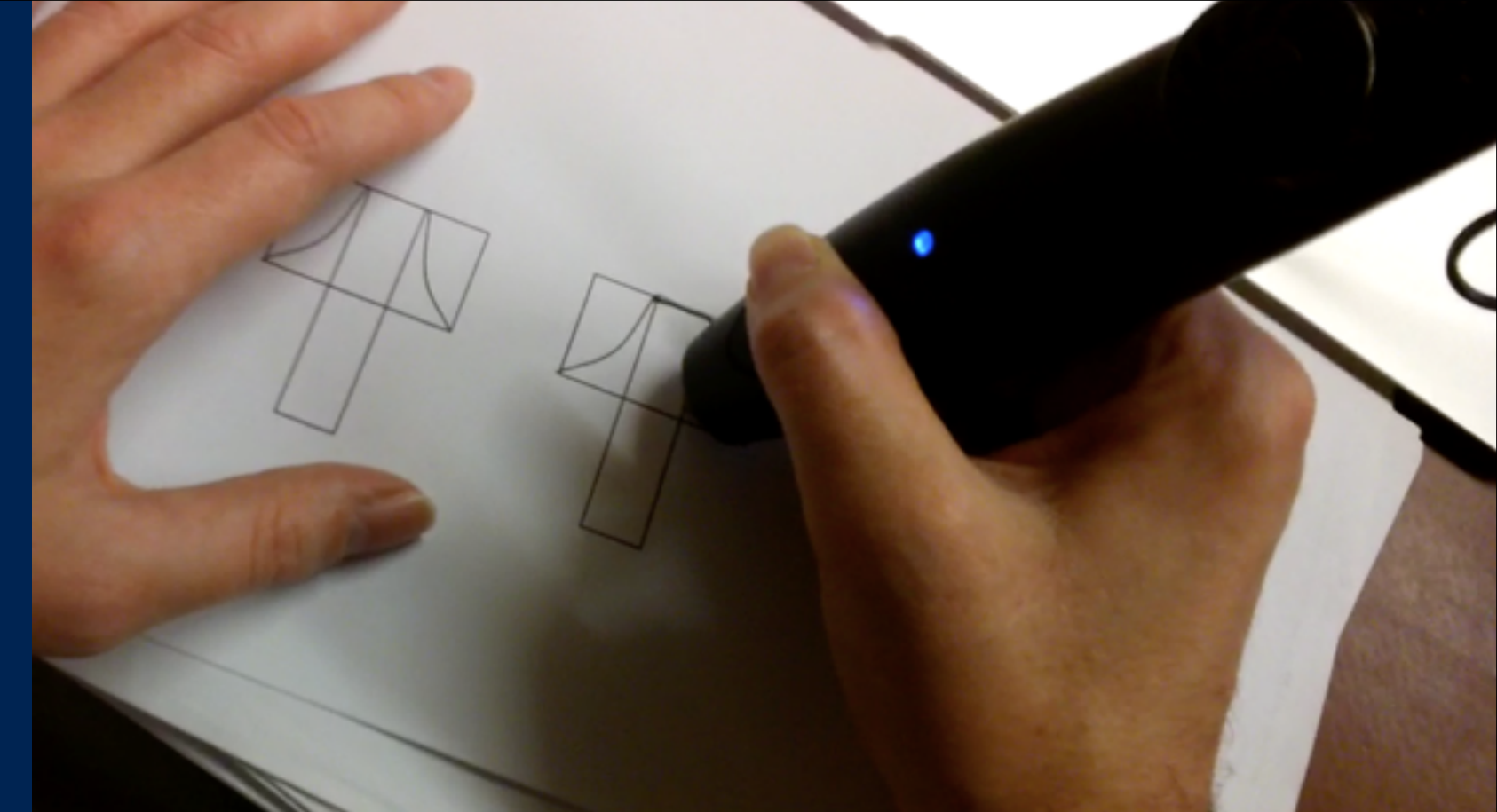
```
fastboot flash boot boot.img
fastboot flash system system.img
fastboot flash recovery recovery.img
fastboot flash userdata userdata.img
fastboot erase cache
```

“Thanks! You are awesome!”



Privacy Enhancement for Glass

Scene Camera why?



a fleece with duct tape might be better ...

<http://kaikunze.de/posts/hacking-glass/>

Demonstration

Blinking with Google Glass



Open Source Eye Tracking Efforts

<http://www.eyewriter.org>

http://blog.brandynwhite.com/new-glass-input-methods_eye-tracking_touch-sensitive-clothing

<https://code.google.com/p/pupil/>

Lukander, Kristian, et al. "OMG!: A new robust, wearable and affordable open source mobile gaze tracker." Proceedings of the 15th international conference on Human-computer interaction with mobile devices and services. ACM, 2013.

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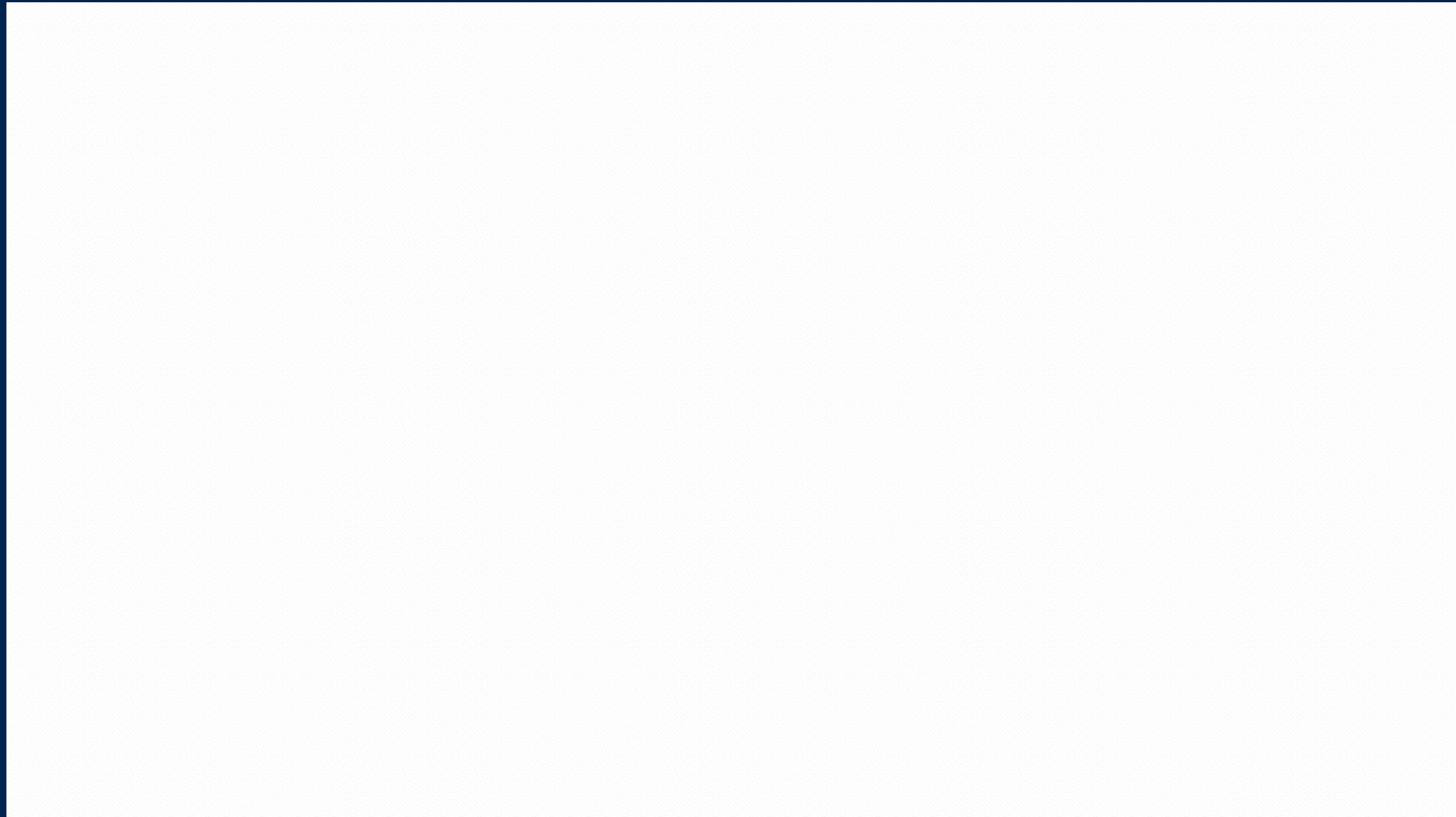
Can't we use commodity devices?

Demonstration

Towards Software Only Eye Tracking



Backup video (in case demo fails ...)



Thanks to

Koichi Kise, Masakazu Iwamura, Motoi Iwata, Yuzuko Utsumi,
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Gernot Bahle, Masahiko Inami, Josef Neuburger

Special Thanks to the Students (who actually did the work)

Katsuma Tanaka

Shoya Ishimaru

Wakana Suzuki

Kazuyo Yoshimura

Hitoshi Kawaichi

Yuuki Shiga

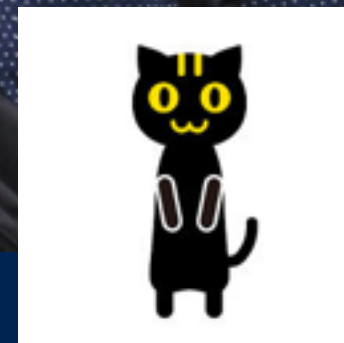
Riki Kudo

Ayano Okoso

Hiroki Fujiyoshi

Mizuki Matsubara

Olivier le Bas de Bouclans



“Viel Spass am Gerät!”



Questions, Remarks, Violent Dissent?

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kai.kunze@gmail.com

“30c3”, “Speed Reading App” or “Eye Gaze Python” in Subject Line

shameless advertisements:

Augmented Human 2014, Kobe

<http://bit.ly/augmented2014>

Paper Deadline: Jan 11, 2014

Conference: March 7-9, 2014

Gait for iPhone5s

Step Counter for Introverts

<http://kaikunze.de/Gait/>



“Viel Spass am Gerät!”