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# Content Identification and Search in Visual Lifelogs

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CLARITY: Centre for Sensor Web Technologies,
Dublin City University

# Overview

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**What is lifelogging and why bother**

**Visual lifelogging, devices including SenseCam**

**Our work on SC data management, events, event browsing and augmentation**

**Further uses for lifelogging data**

Activity Recognition
Scene Detection
Trajectory Estimation
Incorporating Contextual Information

**Lifelogging - where next ?**

# MM retrieval …

Access to (visual) multimedia is based on metadata from content capture, social tagging and other userg-generated content, or within-frame content based on colour, texture, shape.

Applications in surveillance video, home movies, TV, TV news, etc.

Application is typically to “search for a clip”, or to summarise into something shorter

# Lifelogging

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Lifelogging is about digitally recording your daily life

Such recording takes many forms, from written diaries to Twitter tweets, and our digital world greatly enables automatic lifelogging

Most of what we do can be re-constructed with appropriate access to mobile phone records, computer network access records, credit card records, CCTV records, TV subscription records, in-car GPS records, and so on.

In practice, access to these independent records happens only in cases of investigation, when we forensically re-construct a lifelog

Lifelogging has become known as the term for self-recording, auto-biographical, sousveillance

# Why lifelogging

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## Sometimes its for a reason

| | |
|---|---|
| Work | e.g. security personnel, medical staff, etc. |
| Personal | e.g. diaries, etc. increasing interest in Carbon footprints and energy awareness |

## Sometimes Its medical

Early-stage sufferers of dementia/Alzheimers show results

## Sometimes its for lifestyle analysis

Working with medical practitioners, behaviour analysts and marketing analysts

## Sometimes its for posterity

Recording vacations, family gatherings, social occasions

## Sometimes its because we can

And we're not yet sure what we'll do with it e.g. MyLifeBits

# Visual Lifelogging Devices

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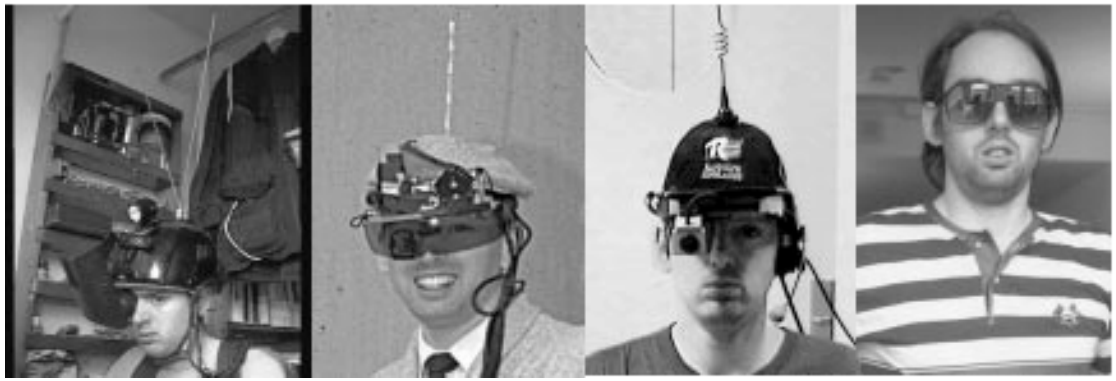
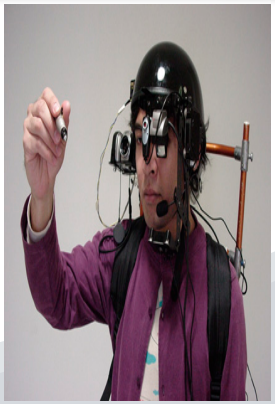
**Much past research focus on miniaturising hardware and increasing battery-life + storage e.g. visual lifelogging domain**



Steve Mann. Wearable computing: a first step toward personal imaging. Computer, 30:25–32, Feb 1997.

TIMELINE

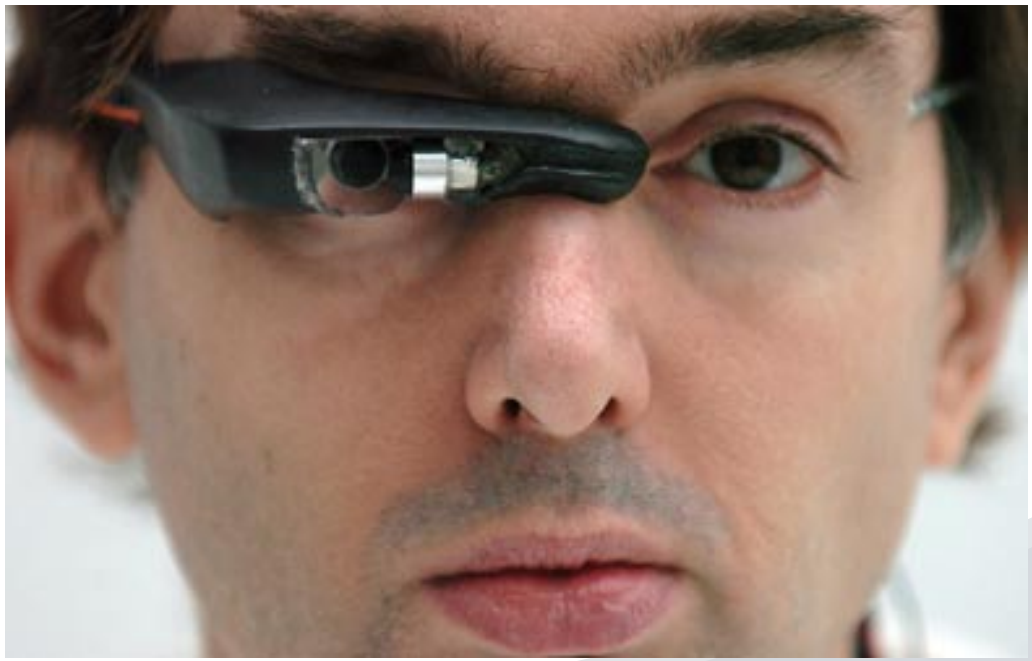


Tano *et. al.* University of Electro-Communications, Tokyo, Japan

Microsoft Research SenseCam

Steve Mann, U Toronto is a pioneer, trailblazer, geek, rights activist, who has become physically dependent on his Eyetap for vision, and has had this validated in court.

His technology is a camera and screen projection directly in front of his left eye.



# Eyetap

**By** Self-assembled (Steve Mann)
**Cost** Variable, recommended to buy Mann's book
**Video projection onto inside of Eyetap glasses**

What about an OTS device re-purposed for visual lifelogging ?

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# Apple iPhone 3GS

**Sensors** GPS, Wifi, Accelerometer, Proximity sensor, compass

… problem is that It looks like an iPhone !

… and worse again …

Problem with these is that they are mobile phones, with add-ons, and always will. Not designed as lifelogging devices so inherent issues of battery and of storage capacity


## Flip Mino HD

**Sensors** No other sensors

Cute, but where does the AV cable go ?

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# Tie Hidden Camera

**By** Brickhouse security
**Cost** $199.95
**Sensors** No other sensors
**Image quality** NTSC, 350 Resolution TV Lines
**Video?** 30fps
**Capacity** AV cable out

The AV camera ? It's a capture and store device, typically 5-8 hours on SD card, attraction of FOV

## Camera glasses

Several models available, $150 upwards

# Other Wearable Cameras

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## Looxie wearable - interfaces to Android

## Helmet cams - extreme sports


# SenseCam / Vicon Revue

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Oct 2009 Microsoft announced licensing SenseCam technology to Vicon, motion capture company from Oxford, UK.

Vicon initially manufacture MSR SC 'clones' which retail at c.£500 each - associated software is the MSR viewer, but point to DCU event-based browser. Started shipping 2010Q1

Vicon engaging clients and customers on what other sensors should be in ViconRevue-2 … GPS, compass, better quality images, etc.

# Why SenseCam?

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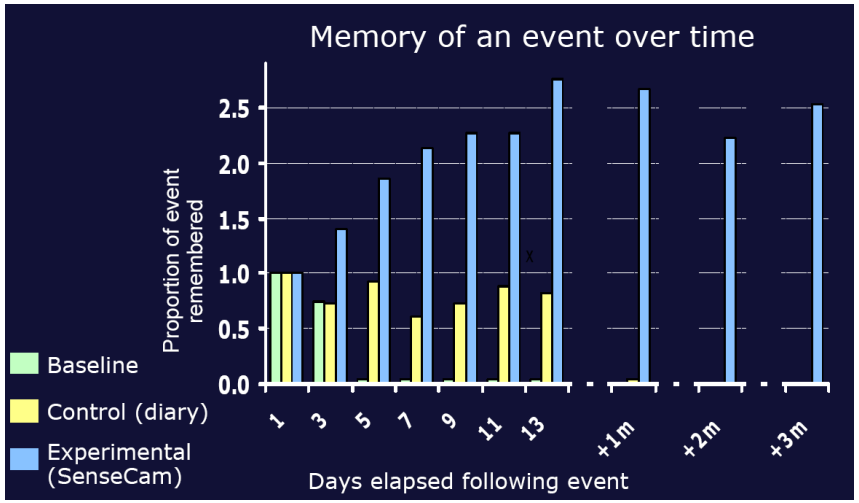


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**Advances for Alzheimer's, Outside the Lab**

By EBEN HARRELL Monday, Feb. 23, 2009

Fancy / Veer / Corbis

They sit demurely in rows of plastic chairs, hands in their laps, awaiting instructions. They have been dressed carefully by their spouses and relatives in ankle-long frocks or neat cardigans, with crisply knotted ties — the overly formal style of the aged.

Related Organizing this unlikely choir is

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**A Memorable Device**

**Wearable cameras offer help to people with memory problems and provide a tool for studying how the brain creates and retrieves personal histories**

It was over drinks at a local pub in the spring of 2006 that cognitive psychologist Martin Conway of the University of Leeds in the United Kingdom first told his colleague Chris Moulin about using a wearable camera for memory research. But it took more than a few pints of beer to convince Moulin that SenseCam, a camera that periodically takes still photos while worn on the user's chest, might be a game-changer in the study of what psychologists call autobiographical memory. Although skeptical of the small device's usefulness, Moulin did finally agree to take one for a test drive.

Or rather, he took it on a test walk. Moulin regularly wore a SenseCam on a series of walks. When he reviewed the images 6 months later, to see how well his memories matched the camera's visual record, Moulin says he experienced an unexpected feeling of "mental time travel." One of the images triggered the memory of the song—Thom Yorke's "Black Swan"—that was playing on his iPod when the image was taken.

Conway says that many SenseCam users likewise report a sudden flood of memories of thoughts and sensations, what he calls "Proustian moments," when they review images taken by the device. SenseCam's images "correspond to the nature of human memory—they're fragmentary, they're formed outside your conscious control, they're visual in nature, they're from your perspective. All these features are very like what we call episodic memory," says Conway.

That's why he, Moulin, and dozens of other researchers have begun to test whether the images can help resolve how the brain handles personal memories. Cognitive experiments, however, represent just one line of inquiry supported by Microsoft Research, the scientific arm of the software giant and the inventor of SenseCam. Medical researchers are also evaluating whether the device can help people with memory problems due to illness or injuries.

In 2004, Narinder Kapur and Emma Berry, neuropsychologists at Addenbrooke's Hospital in Cambridge, U.K., were the first to use a SenseCam for memory rehabilitation work. They found that the device significantly helped Mrs. B, an elderly woman with memory problems due to brain damage from an infection. Mrs. B normally forgot events after 3 to 5 days, and even keeping a diary that she periodically reviewed helped her remember events for only about 2 weeks. But when she regularly reviewed SenseCam images of events, she could recall more details—and her memories persisted for months after she ceased reviewing the past images. Encouraged by that data, Kapur says he and Berry grew hopeful that "periodic, regular review of visual images of personal events ... really does help long-term [memory] consolidation."



**Shooting in the rain.** The SenseCam (*left*) snaps dozens of wide-angle, low-resolution images from chest level on even a short walk.

They and others are getting a chance to test that hypothesis. After the pair reported the results from Mrs. B, Microsoft Research decided to provide more than $550,000 in funding to seven research groups, most of them focusing on people with memory problems, and to loan hundreds of cameras to other scientists. SenseCam has "very obvious applications in a whole range of clinical disorders," says one of the grant recipients, psychologist Philip Barnard of the University of Cambridge.

**Personal black boxes**

SenseCam grew out of a Microsoft Research project that aimed to create a "black box for the human body" which would record data that doctors might find useful if a person were in an accident, says Ken Wood of Microsoft Research Cambridge. In 1999, computer scientist Lyndsay Williams, then also at the same lab, suggested adding a camera to the device so it could double as a memory aid for mundane tasks such as finding lost keys.

In 2002, Kapur heard then-Microsoft CEO Bill Gates mention the project in a talk. Because his hospital is just a few miles from Microsoft Research Cambridge, it was easy enough for him and Berry to suggest using SenseCam prototypes for patients with memory problems due to Alzheimer's or brain injuries.

Clinicians who work with such people have typically focused on helping them with their prospective memory, i.e., remembering tasks to be completed in the future, such as keeping appointments. For this, the best aids are still simple tools such as checklists and alarm clocks. But for patients with difficulty recalling past events, clinicians have had little to offer beyond diary-keeping, a task many people, such as Mrs. B and her husband, complain is onerous.

In contrast, SenseCam records images passively, permitting a person to go about their day without interruption. The latest version is about the size and weight of a clunky mobile phone and appears to observe the world through two unmatched eyeballs. One is a passive infrared sensor, tuned to trigger the camera whenever another person passes by. The other is a wide-angle camera lens, set to capture most of the user's field of view. The device is also equipped with an ambient light sensor that triggers the camera when its user moves from one room to another, or goes in or out of doors. The camera can also be set to snap an image if the sensors haven't triggered a photo after an arbitrary number of seconds. A typical wearer might come home with 2000 to 3000 fragmentary, artless images at the end of a day.

It may be just those characteristics of the SenseCam images that make them so useful for memory rehabilitation and research, Kapur







REUTERS

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**RPT-UPDATE 1-Microsoft camera deal powers OMG share jump**

Thu Oct 15, 2009 10:16am EDT

(Refiles to add missing word, paragraph 4)

* OMG signed a licence with Microsoft

* Camera to help people with Alzheimer's Disease

* Shares up more than 26 pct, a top riser on AIM

(Adds details)

LONDON, Oct 15 (Reuters) - British firm OMG (OMG1.L: Quote, Profile, Research, Stock Buzz) announced it had received licensing from Microsoft (MSFT.O: Quote, Profile, Research, Stock Buzz) to launch a small digital camera aimed at helping people with memory loss, boosting its shares on Thursday.

Called Revue, the camera is intended to be worn around a person's neck, recording everything they do and serving as a memory aid for people with Alzheimer's Disease.

"Memory is very visually indexed... and this device is really just trying to help an

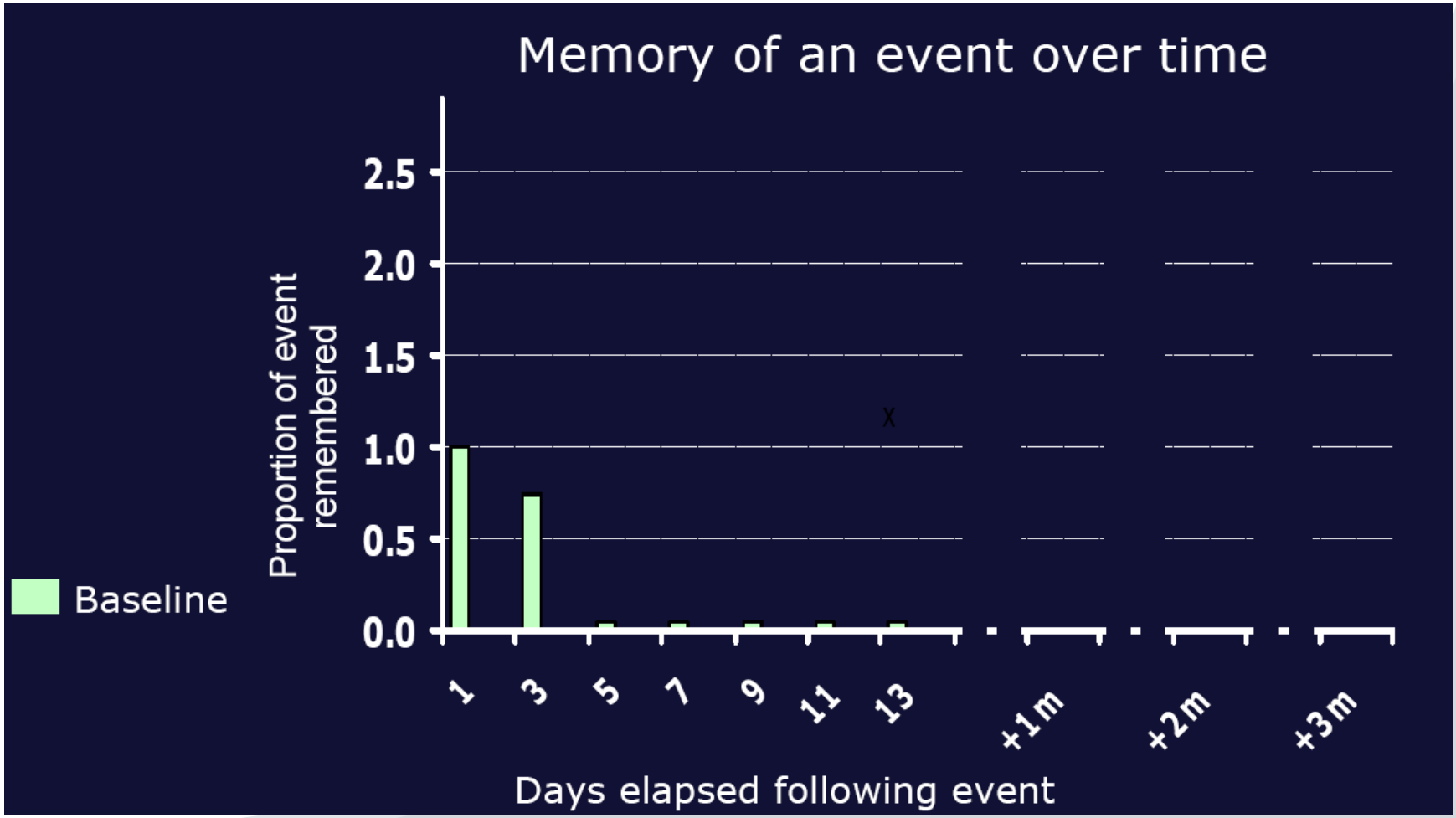
# SenseCam - what for ?

Preliminary Study carried out by Cambridge Memory Clinic, Addenbrooke's Hospital

Initially, a 63 year old, well-educated married woman, with limbic encephalitis (usually has no memory a few days after an event)

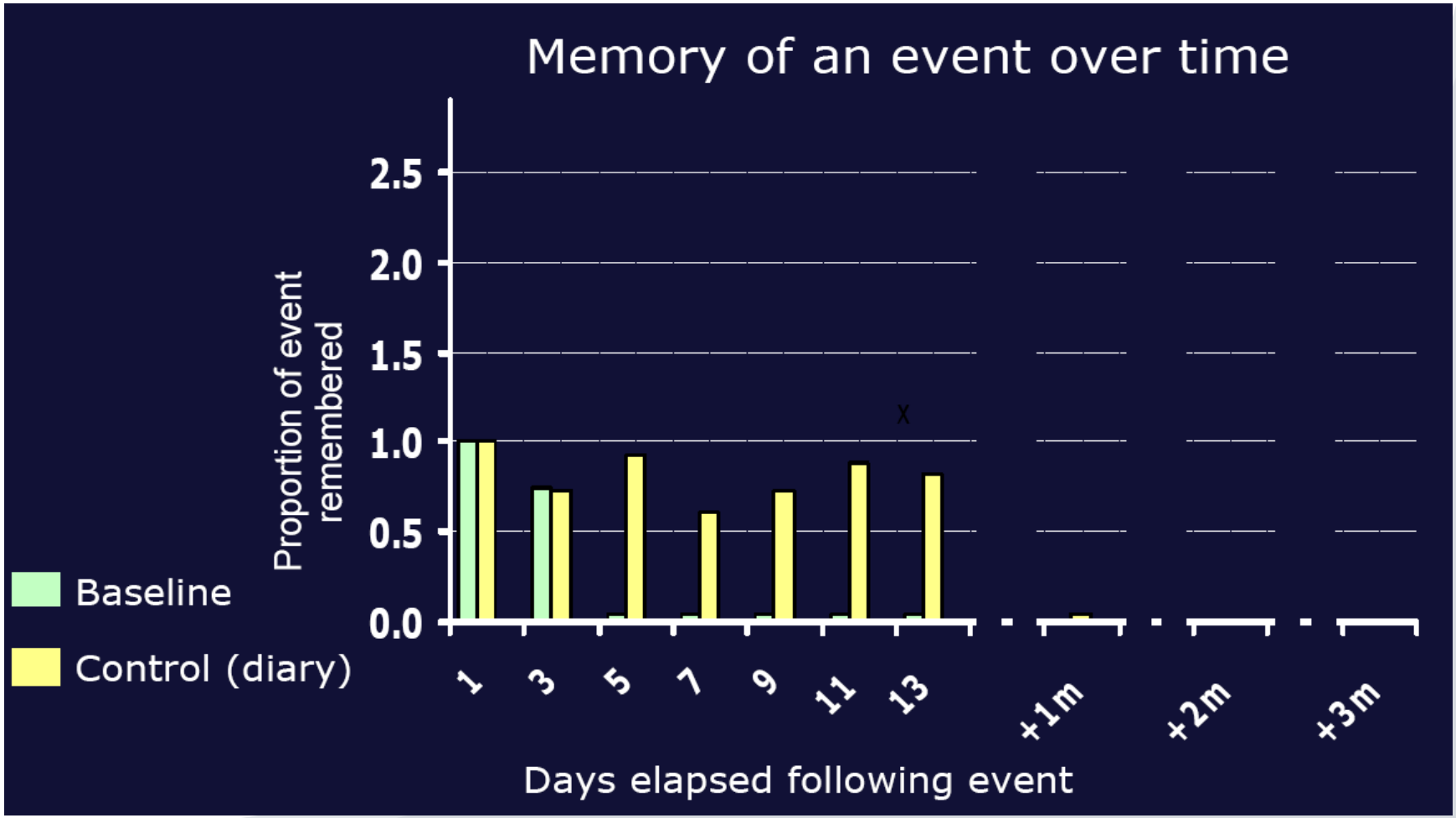
Attends events along with her partner

# Addenbrooke's: SenseCam Work



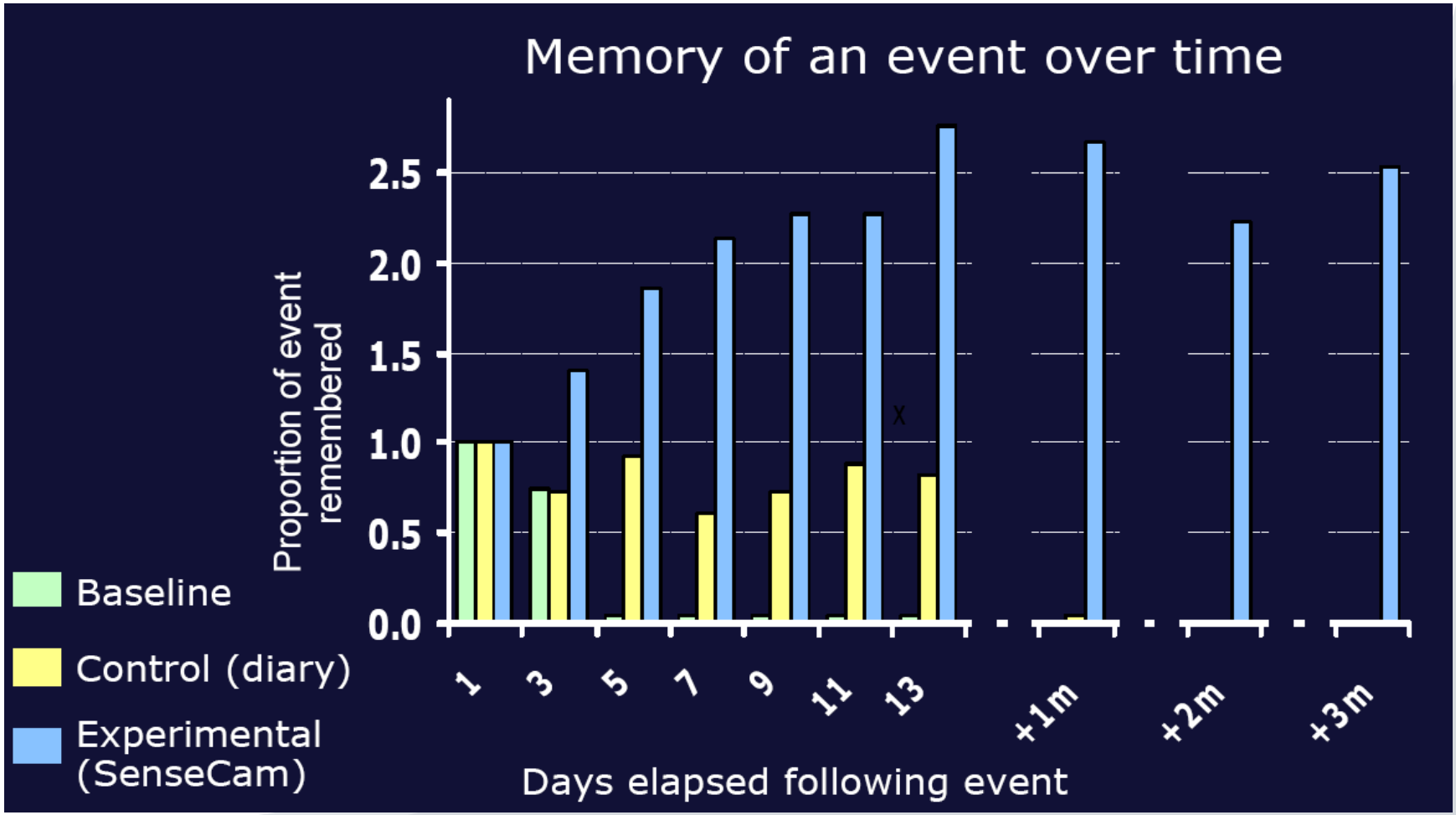

Microsoft Research Cambridge presentation: http://research.microsoft.com/~shodges/presentations/UBICOMP_senseCam.pdf

# Addenbrooke's: SenseCam Work




Microsoft Research Cambridge presentation: http://research.microsoft.com/~shodges/presentations/UBICOMP_senseCam.pdf

# Addenbrooke's: SenseCam Work




Microsoft Research Cambridge presentation: http://research.microsoft.com/~shodges/presentations/UBICOMP_senseCam.pdf

# Memory Prosthesis

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Microsoft Research sponsor much work on clinical trials of SenseCam/Revue as a memory prosthesis

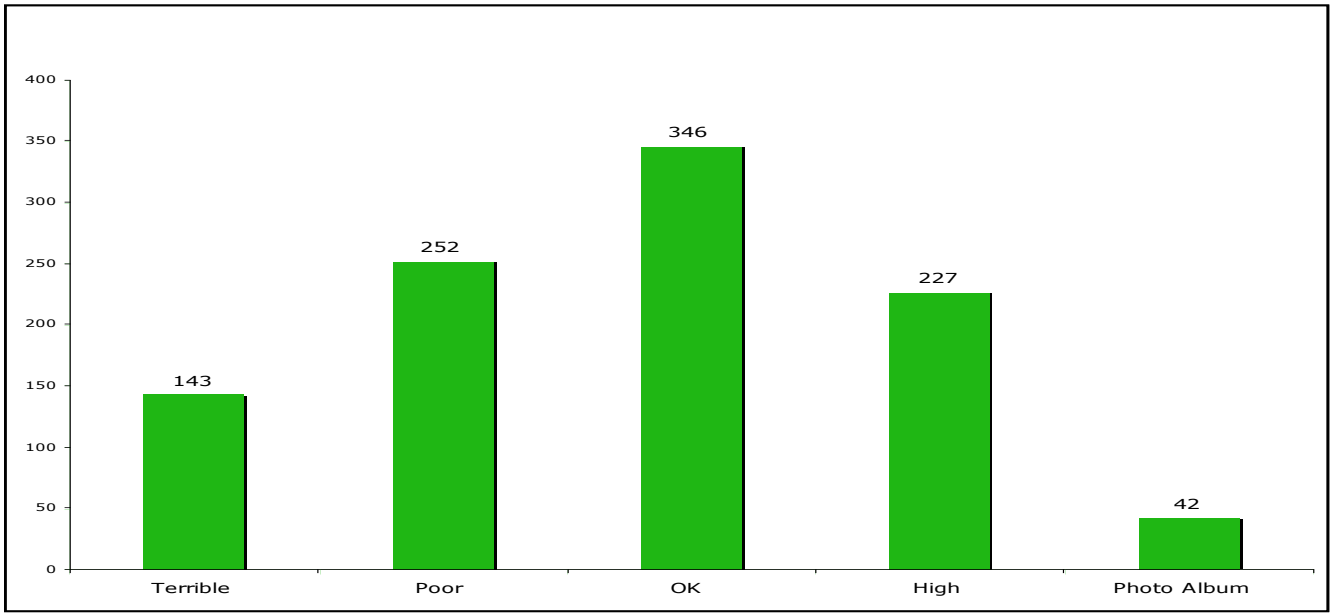
Because these are clinical trials, they take time, but results are very encouraging for short-term recall

This makes intuitive sense and most wearers can experience these short-term Proustian moments of memories flooding back

# Our SenseCam Data

- **We have almost 30 years of collective SC data**
- **One user wears SC for over 5 years, all day**
  - Each with GPS position
- **Experiences:**
  - Most people don't notice camera
  - Those that do always remember !
  - Most people don't mind the camera
  - Have been spotted/greeted by people who have heard about the 'guy with the camera'

# SC Image Quality




- 40% of images are of low quality
- Many "boring" images of mundane tasks

Over last 5 years we've developed techniques for SenseCam data management, initially without user input or direction

We've now developed this into MM data management, leveraging it for several other applications

# Our Take…

Our initial purpose of managing a visual lifelog is to take people to images which trigger recall, but now gone beyond this

To effectively provide memory retrieval cues using images, memory science says we need to automatically:

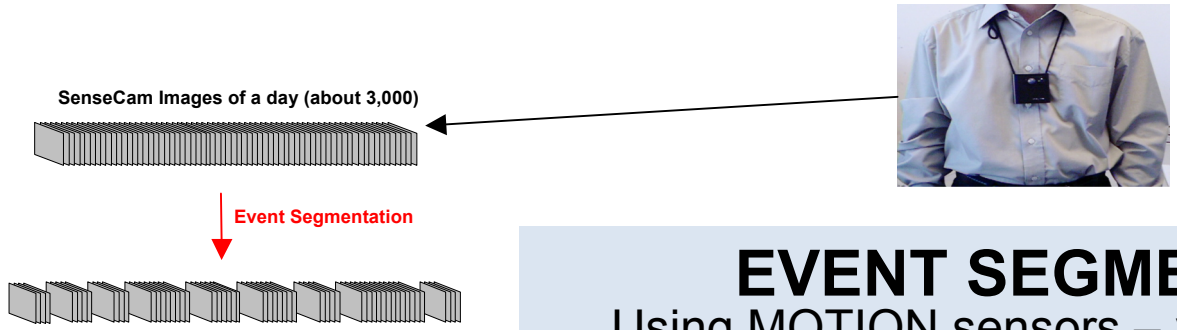
- *Group similar images into distinct "events"*
- *Suggest more "interesting/distinctive" events*
- *"Associate" related events*
- *Provide potentially additional retrieval cues from other sources*

# A. Event detection …

We automatically detect events throughout the day of the wearer.

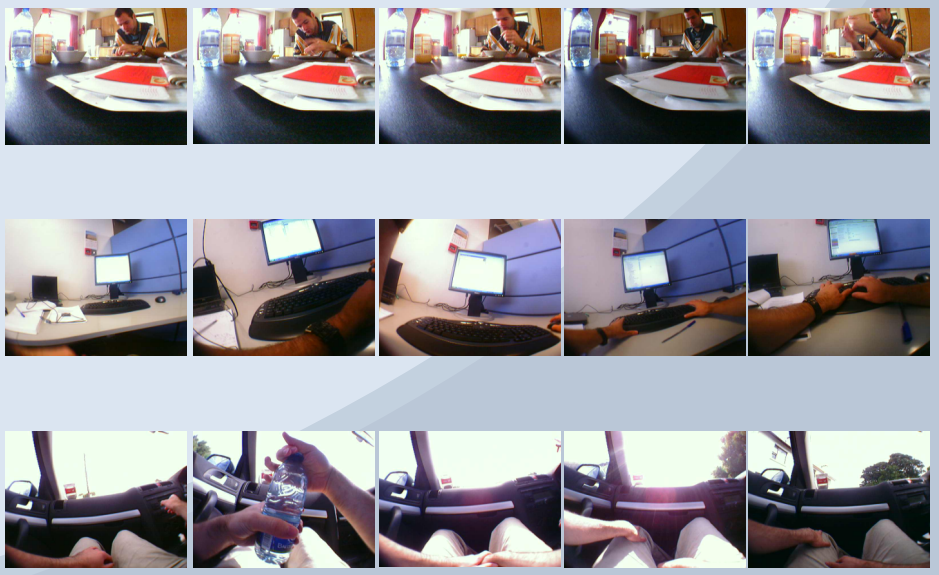
We initially used image differences (SBD-like) but now use changes in SC light readings, accelerometer, gyroscopic movement, etc., i.e. the contexts

# Daily Browser Overview




## EVENT SEGMENTATION

Using MOTION sensors – very quick & accurate



# Selecting Event "Keyframe"

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SenseCam Images of a day (about 3,000)

Event Segmentation

Event-Event Comparison within the Multi-day Event database

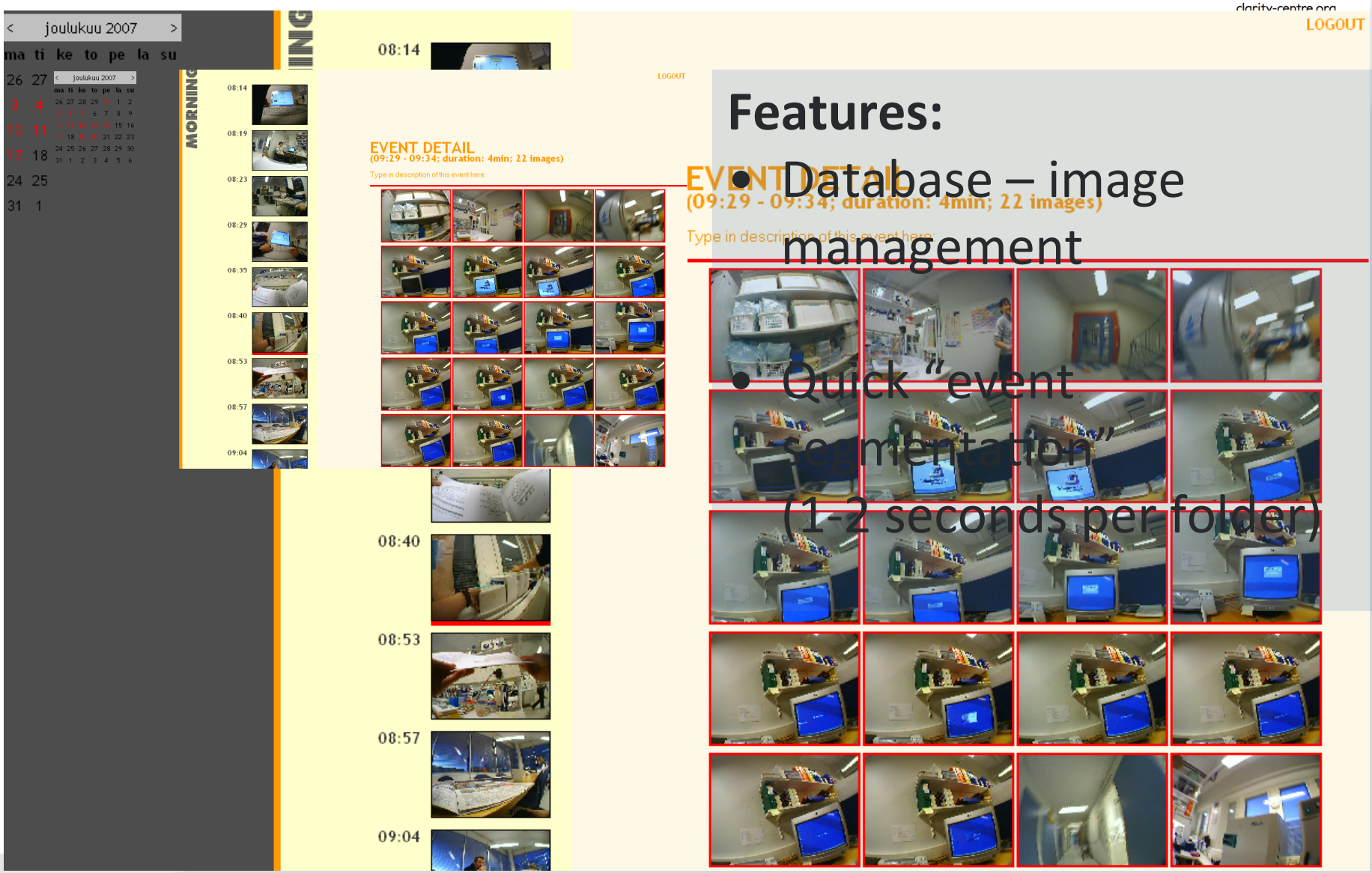
Day -1
Day -2
Day -3
Day -4
Day -5
Day -6

Event database containing last 7 days' Events

Best QUALITY image around MIDDLE of event

Landmark Image Selection

# Released Software




## Features:

- Database – image management
- Quick "event segmentation" (1-2 seconds per folder)

# Event Segmentation S/W

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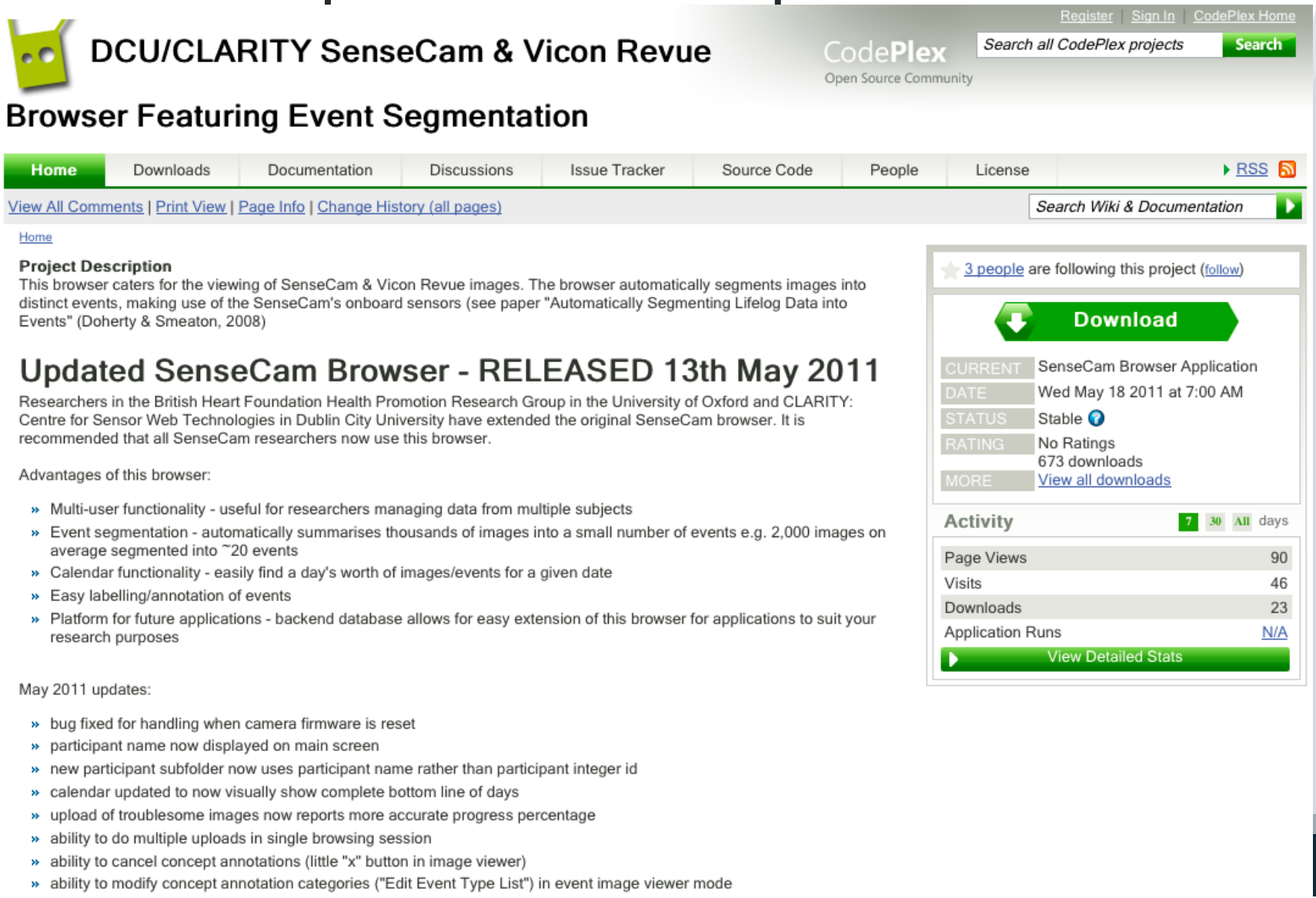
- **Available as open source from Codeplex**



DCU/CLARITY SenseCam & Vicon Revue Browser Featuring Event Segmentation

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**Project Description**
This browser caters for the viewing of SenseCam & Vicon Revue images. The browser automatically segments images into distinct events, making use of the SenseCam's onboard sensors (see paper "Automatically Segmenting Lifelog Data into Events" (Doherty & Smeaton, 2008)

## Updated SenseCam Browser - RELEASED 13th May 2011

Researchers in the British Heart Foundation Health Promotion Research Group in the University of Oxford and CLARITY: Centre for Sensor Web Technologies in Dublin City University have extended the original SenseCam browser. It is recommended that all SenseCam researchers now use this browser.

Advantages of this browser:

- Multi-user functionality - useful for researchers managing data from multiple subjects
- Event segmentation - automatically summarises thousands of images into a small number of events e.g. 2,000 images on average segmented into ~20 events
- Calendar functionality - easily find a day's worth of images/events for a given date
- Easy labelling/annotation of events
- Platform for future applications - backend database allows for easy extension of this browser for applications to suit your research purposes

May 2011 updates:

- bug fixed for handling when camera firmware is reset
- participant name now displayed on main screen
- new participant subfolder now uses participant name rather than participant integer id
- calendar updated to now visually show complete bottom line of days
- upload of troublesome images now reports more accurate progress percentage
- ability to do multiple uploads in single browsing session
- ability to cancel concept annotations (little "x" button in image viewer)
- ability to modify concept annotation categories ("Edit Event Type List") in event image viewer mode

3 people are following this project (follow)

Download

| | |
|---|---|
| CURRENT | SenseCam Browser Application |
| DATE | Wed May 18 2011 at 7:00 AM |
| STATUS | Stable |
| RATING | No Ratings<br>673 downloads |
| MORE | View all downloads |

Activity — 7 30 All days

| | |
|---|---|
| Page Views | 90 |
| Visits | 46 |
| Downloads | 23 |
| Application Runs | N/A |

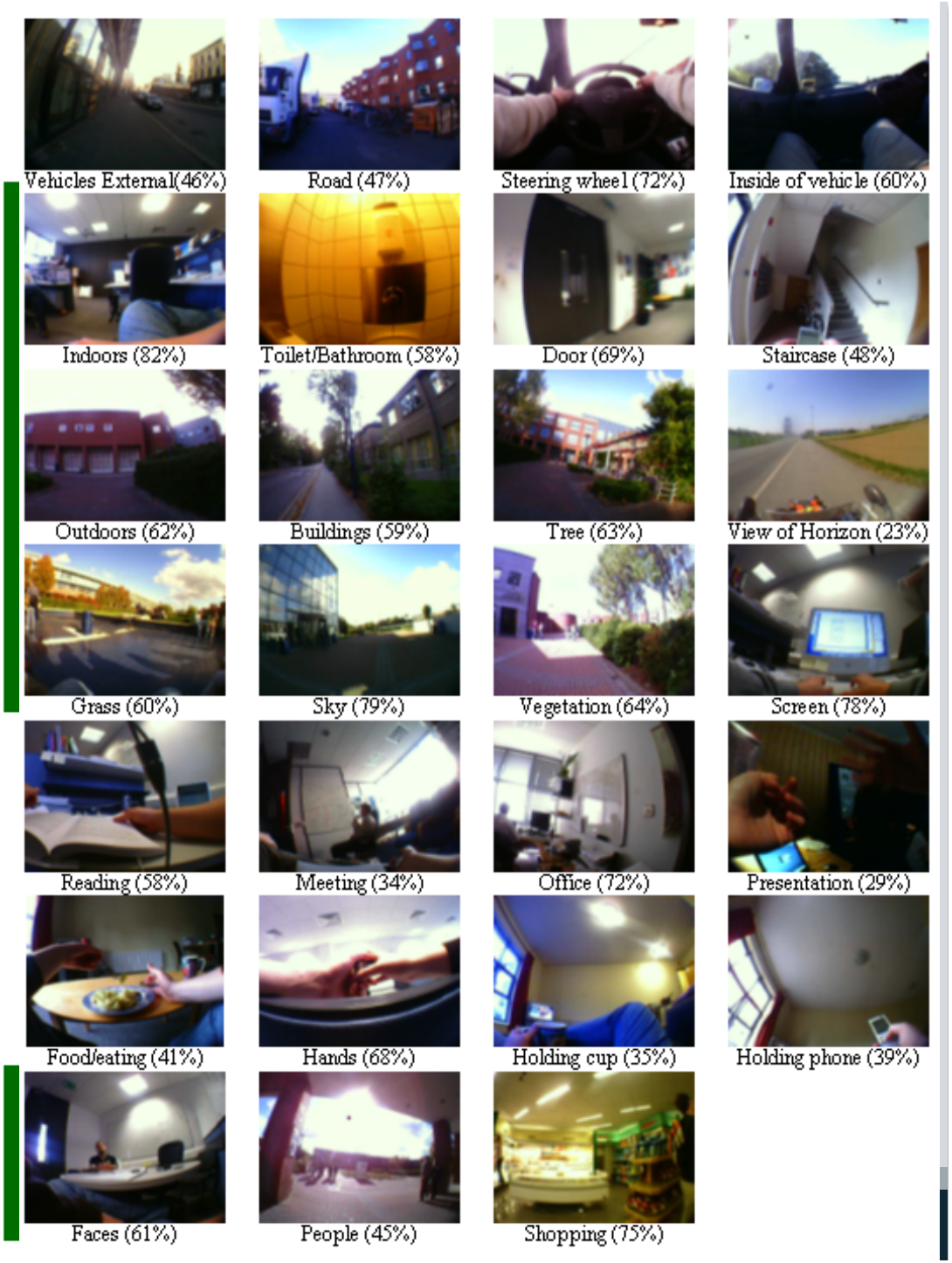
View Detailed Stats

# B. Concept Detection

27 “concepts” defined

Outputs manually judged on ~95k images (5 users)

Automatic detection



# Detector accuracy

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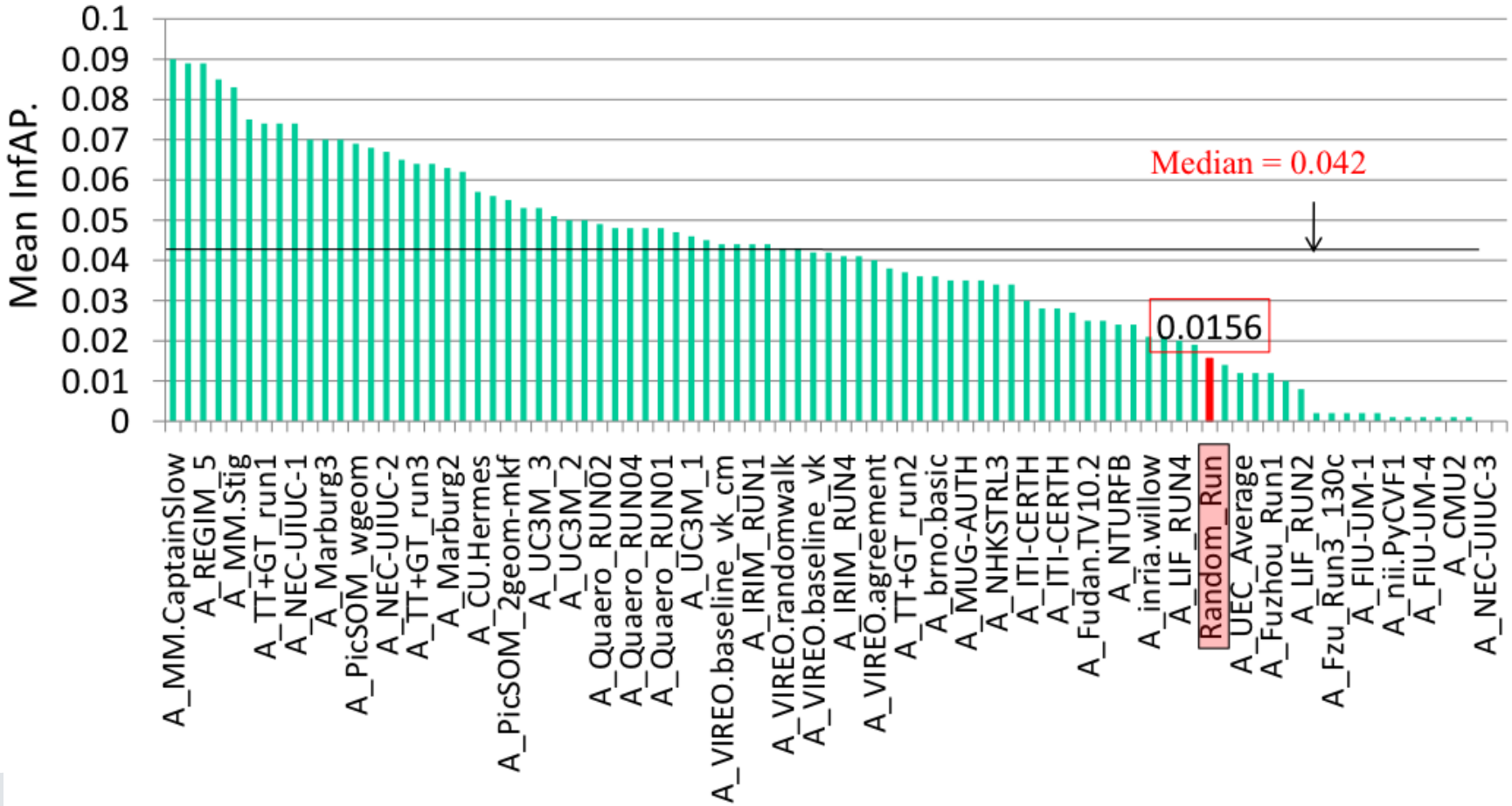
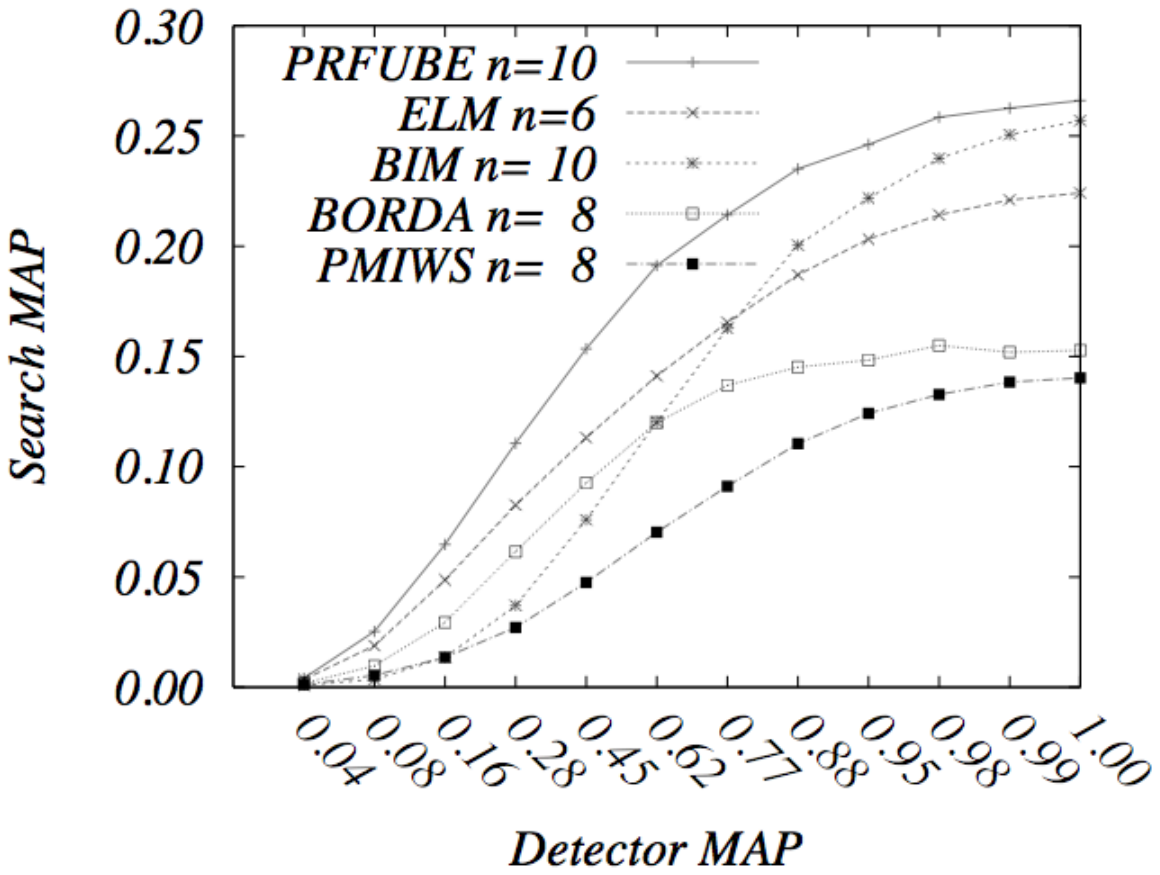
## Category A results (Full runs)



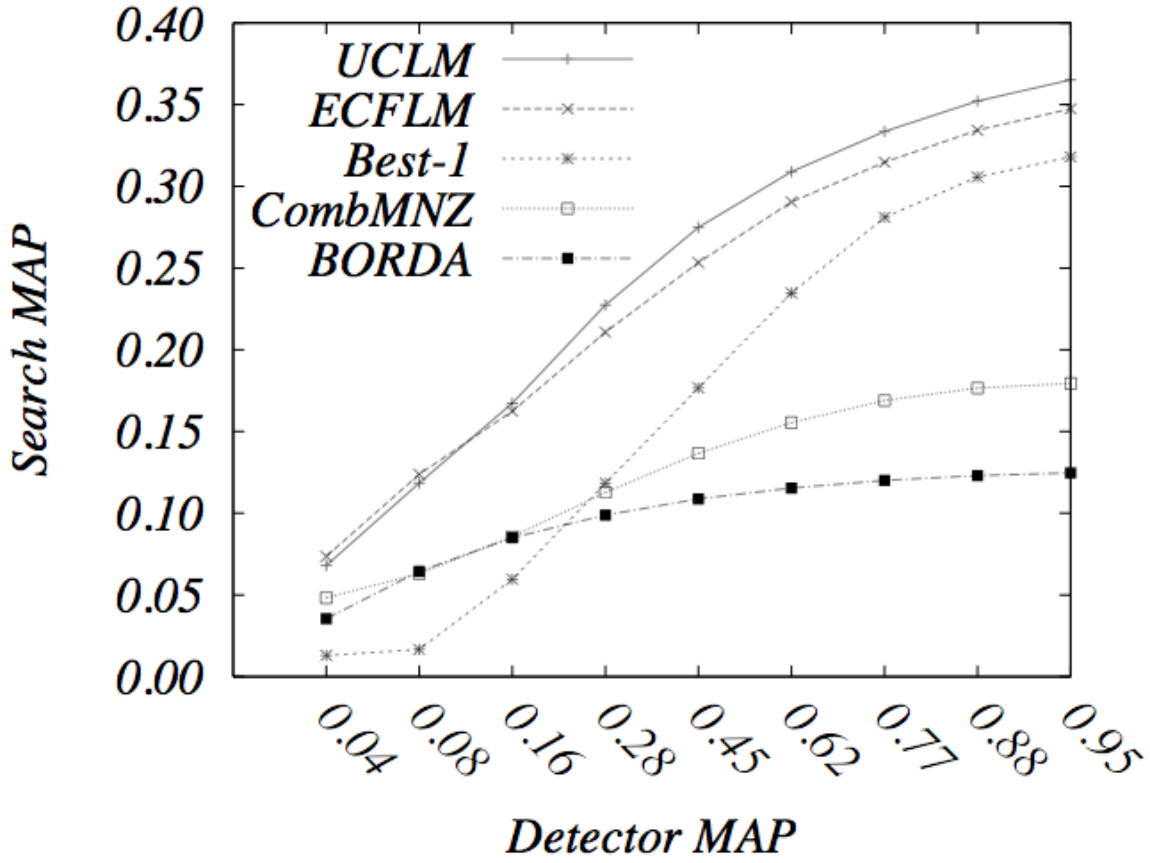
# Detector accuracy

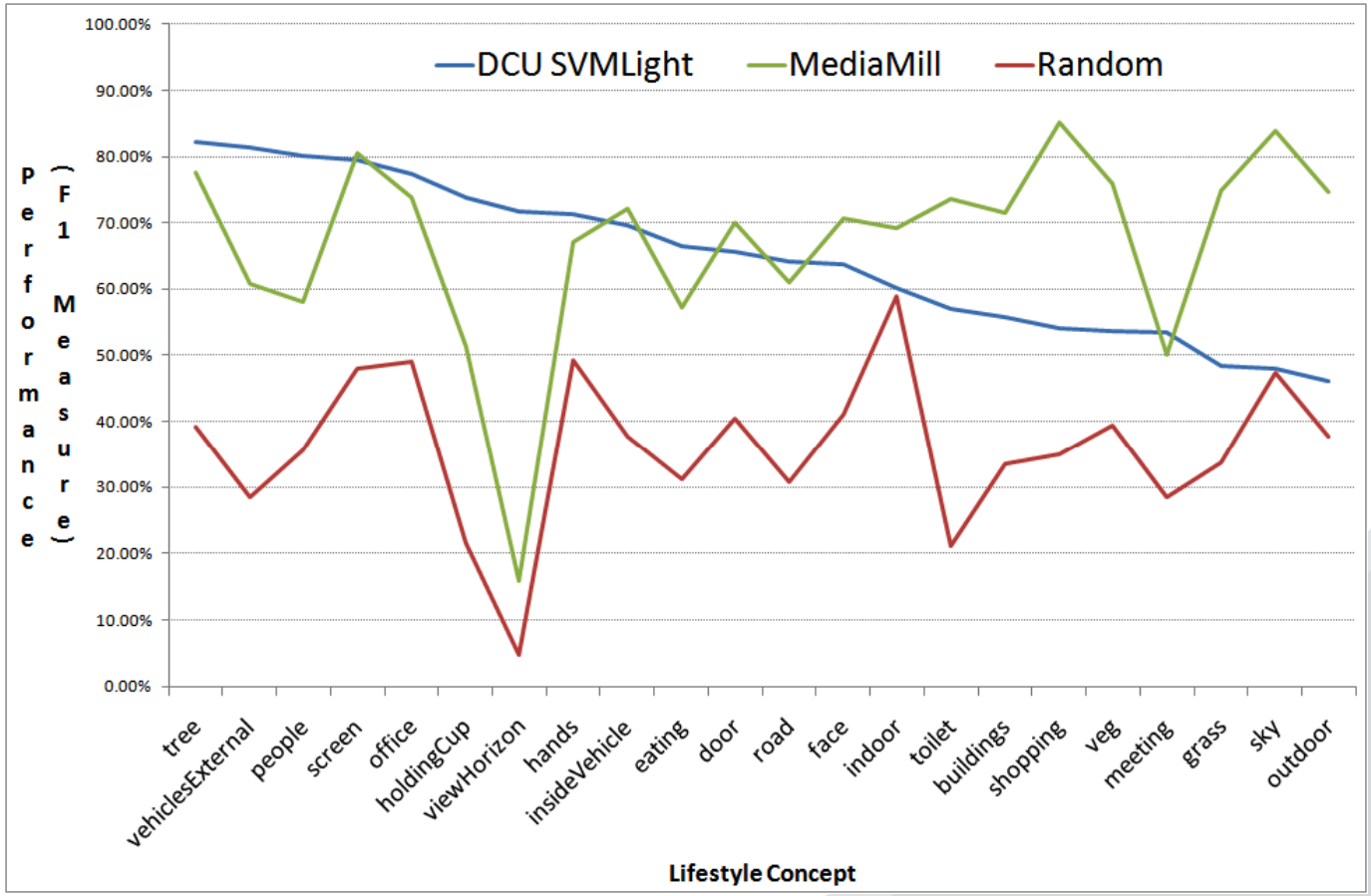
Work with Robin Aly on concept detector accuracy vs. shot retrieval



# Detector accuracy

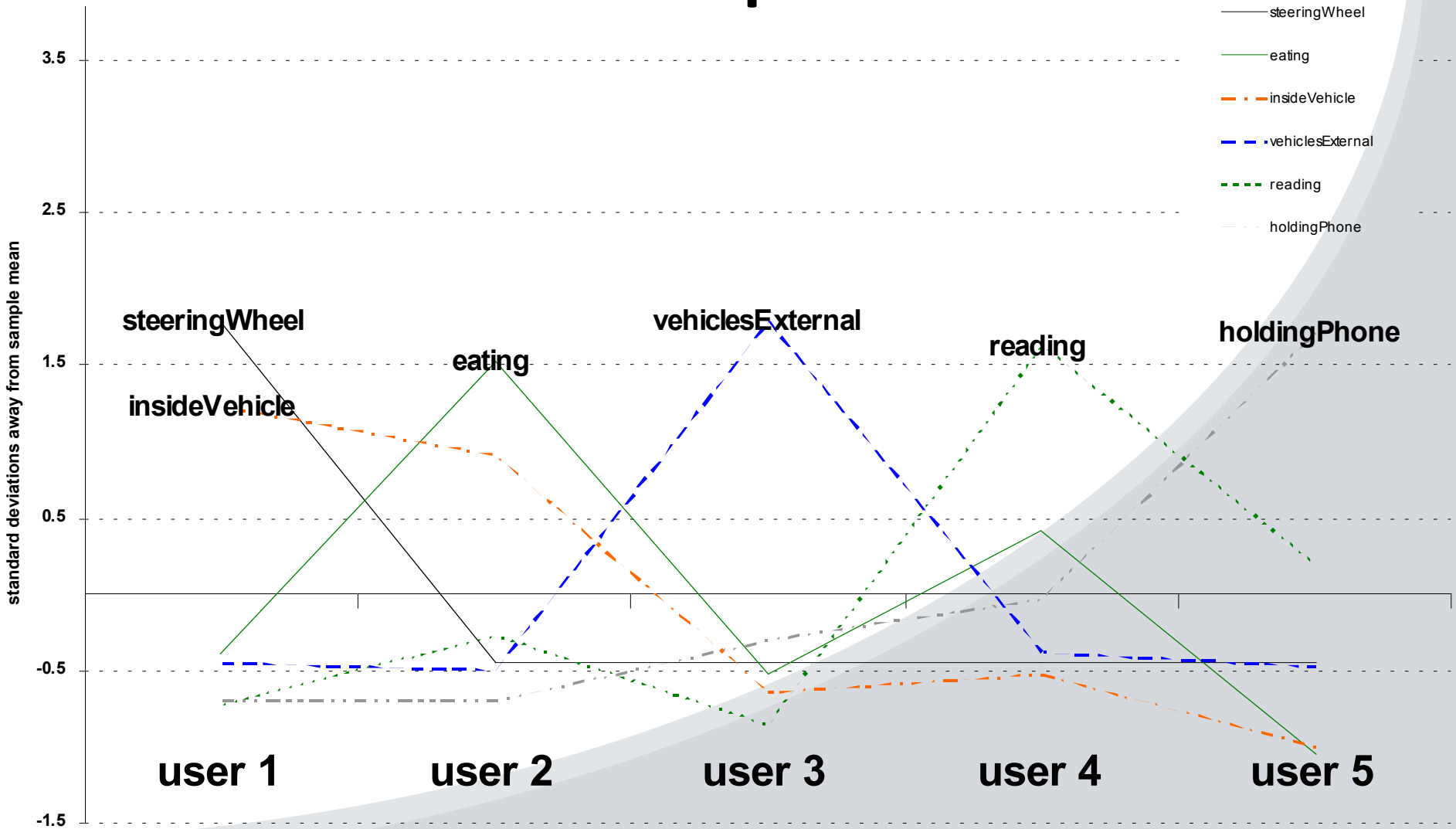
Work with Robin Aly on concept detector accuracy vs. segment retrieval






Concept identification accuracy of our system (avg. 65%) vs. state of the art (68%)

# Comparison of Lifestyle Within Social Groups



# Lifestyle comparison

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We've extended this lifestyle-based-on-distribution-of-concepts to tests with 36 users from 4 'groups' and they cluster

Now working with ethnographers and geriatricians to explore lifestyle comparison, within and across peers, pre- and post- some intervention

Also coupling with other lifelogging data sources, e.g. domestic energy usage

# C. Activities from SC Data

We've analysed the SC accelerometer data with a view to 'learning' underlying human activities.

Sitting, lying down, driving, walking …

Built a training set, manual annotation.

Used a SVM to train then test performance.

# Sitting/Standing = 75% accurate

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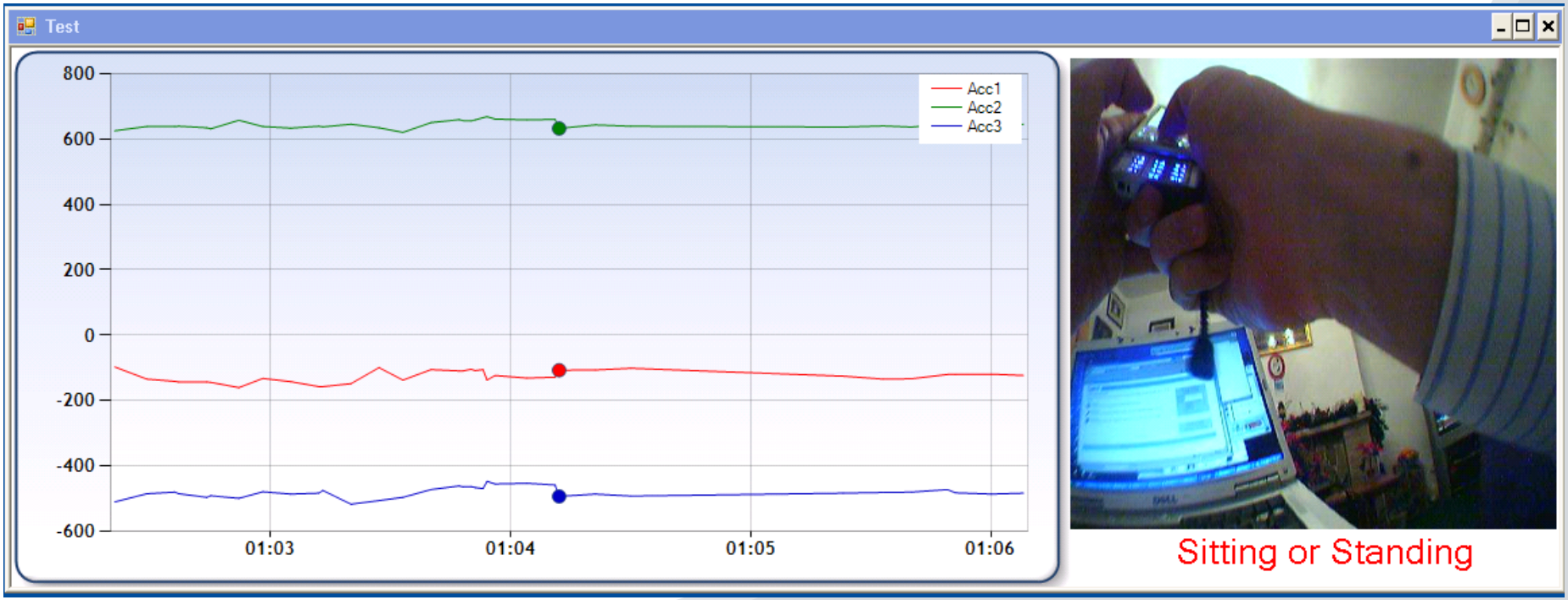
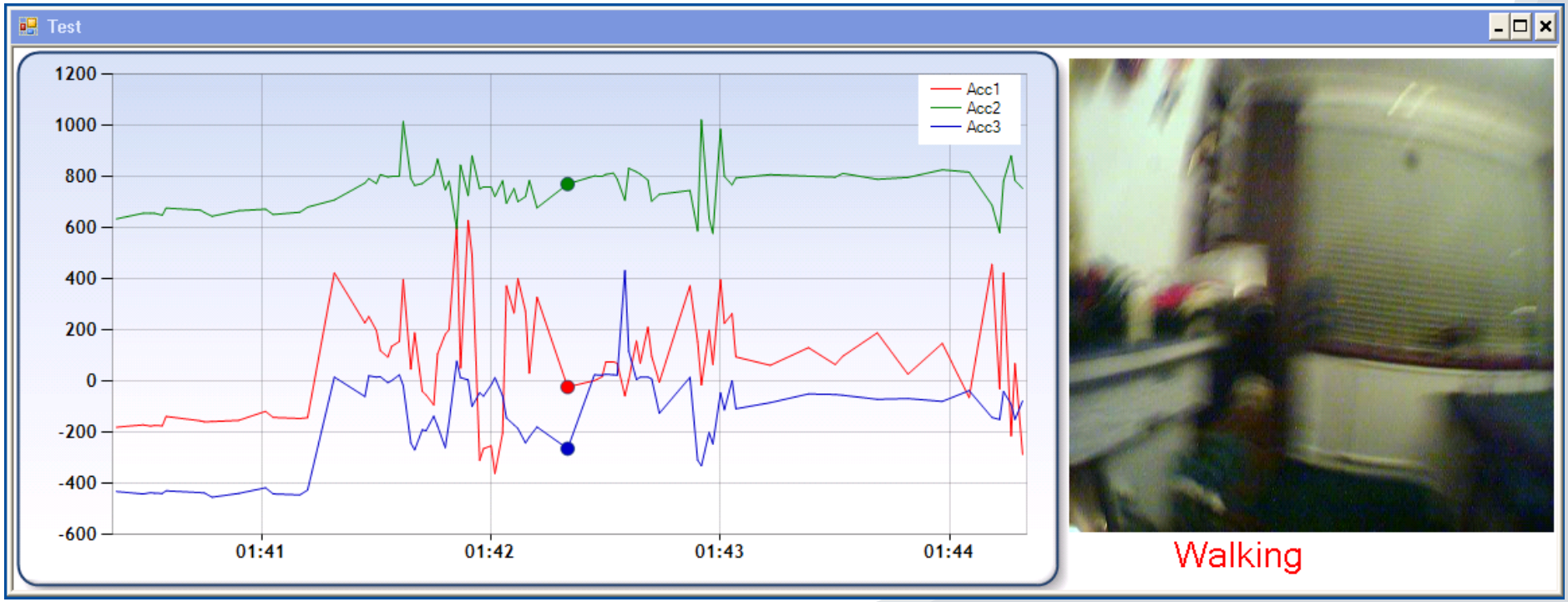
Using a range of classifiers: Logistic Regression, Naïve Bayes, J48, SVM, etc.

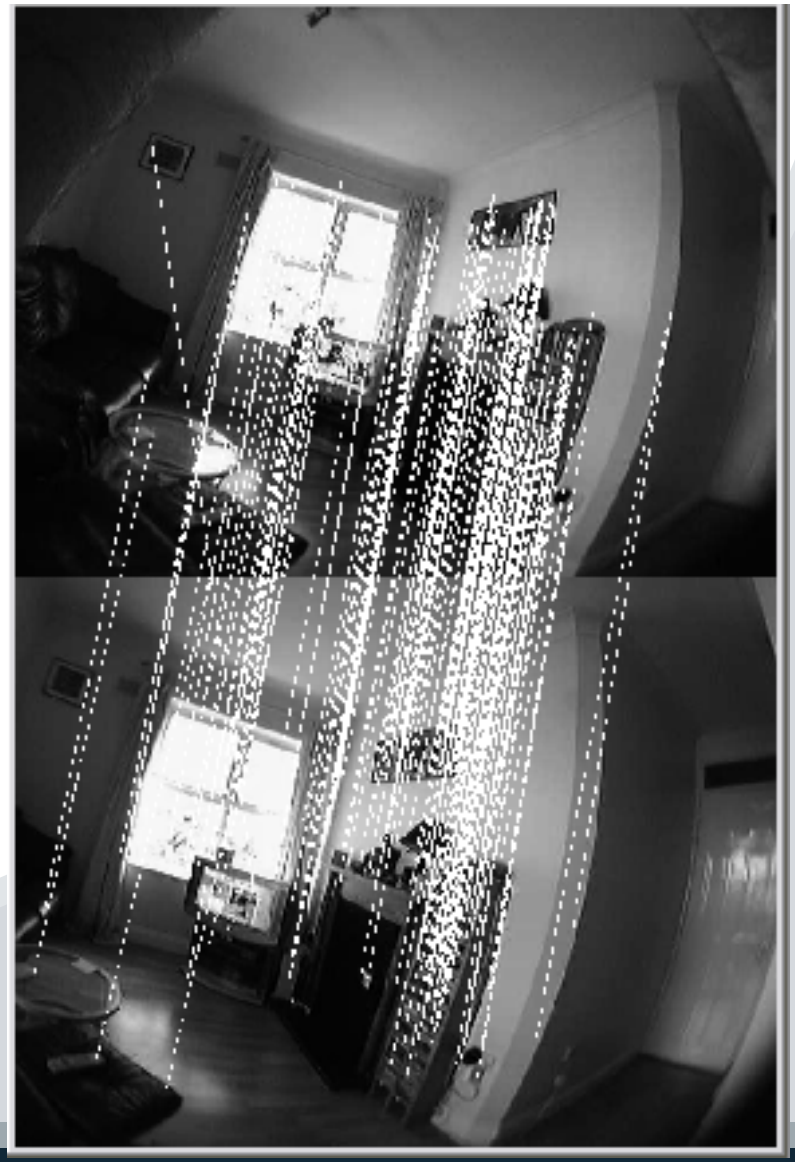


# Walking = 77% Accurate



# Driving = 88% Accurate

# D. Known location detection



# Location Detection – In the Park

# Trajectory Estimation

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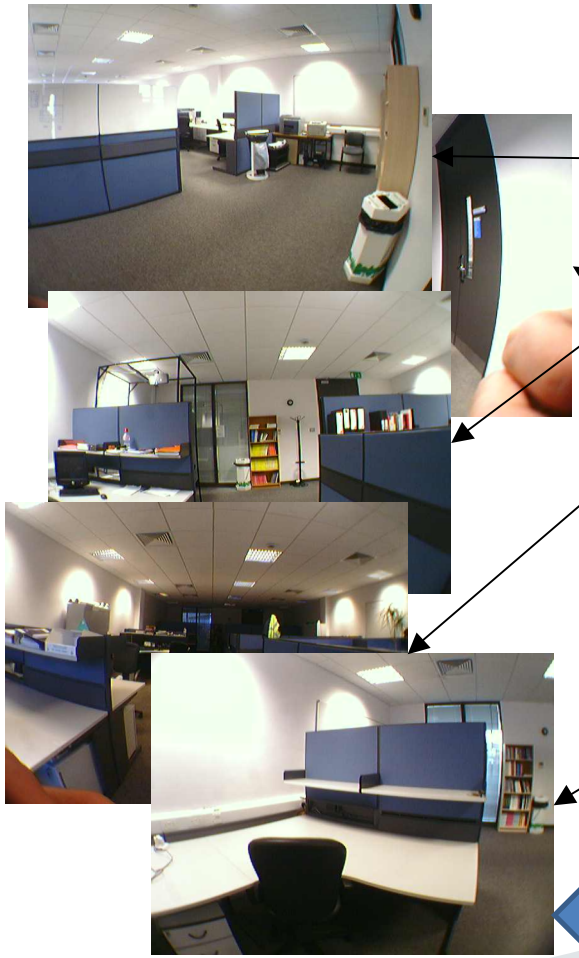
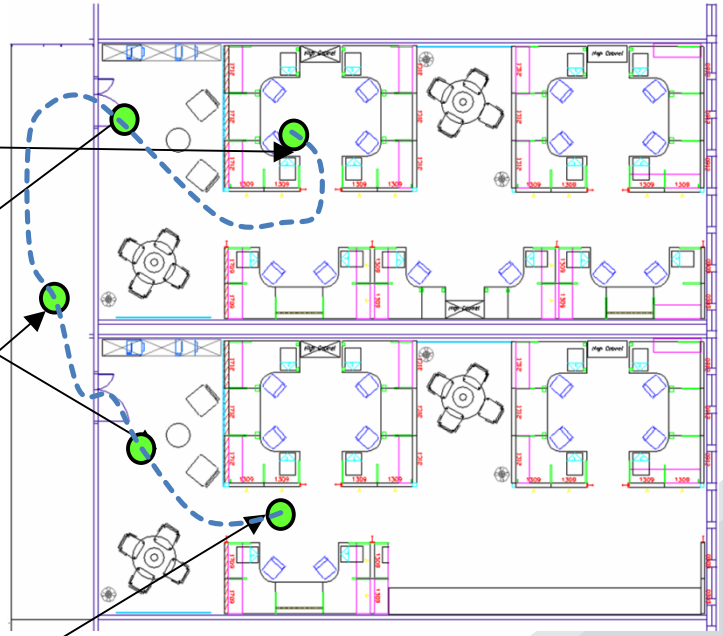


A User's Images



Area Map

Location Database Matching

# Trajectory Estimation Results

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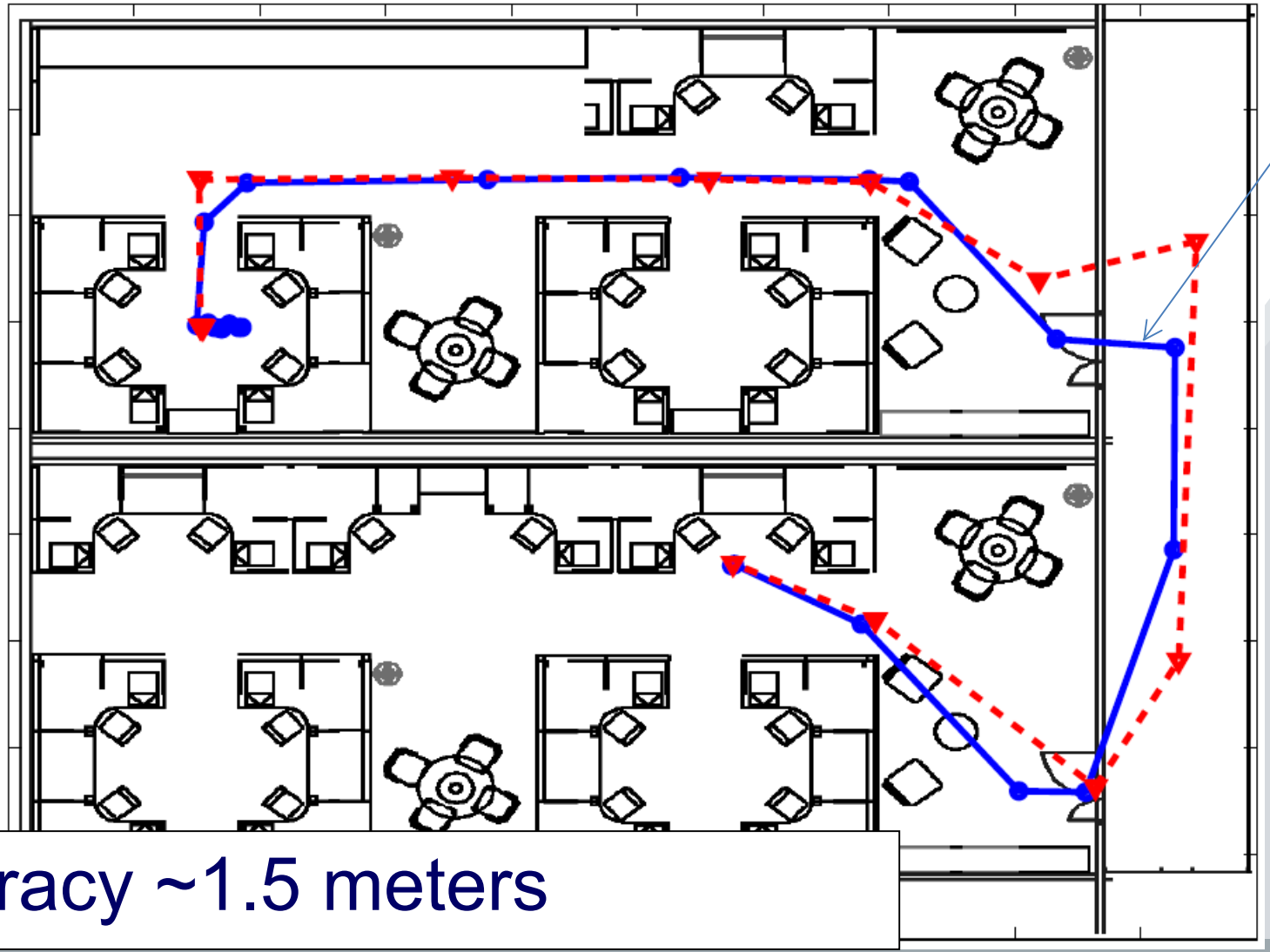
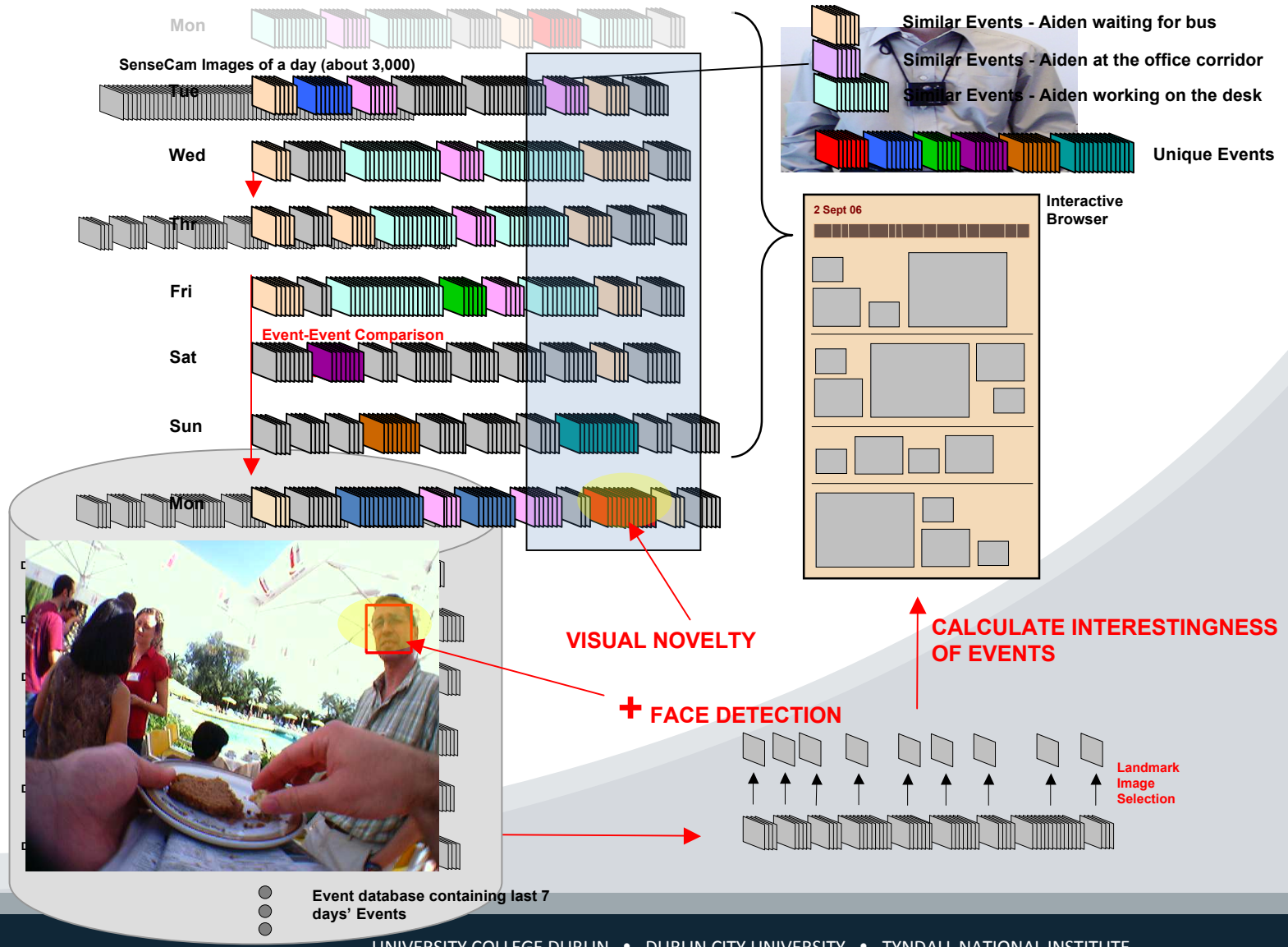



Accuracy ~1.5 meters

# E. Event Novelty & Augmentation



# Event augmentation

Here's a SenseCam picture of Aiden at a pier in Santa Barbara, CA.

If he has GPS he can search for other pictures in the same location…

# Event augmentation – more cues

- He receives the following “geotagged” images…
- Then after some processing on text associated with these images we get many more images, and even YouTube videos at times too!







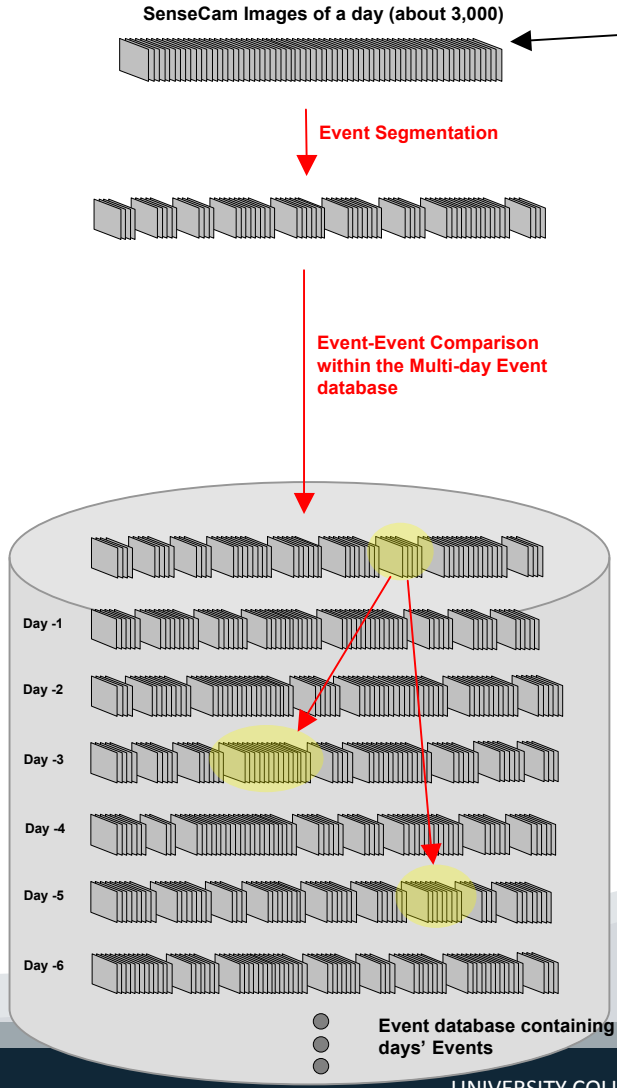

# Event Augmentation

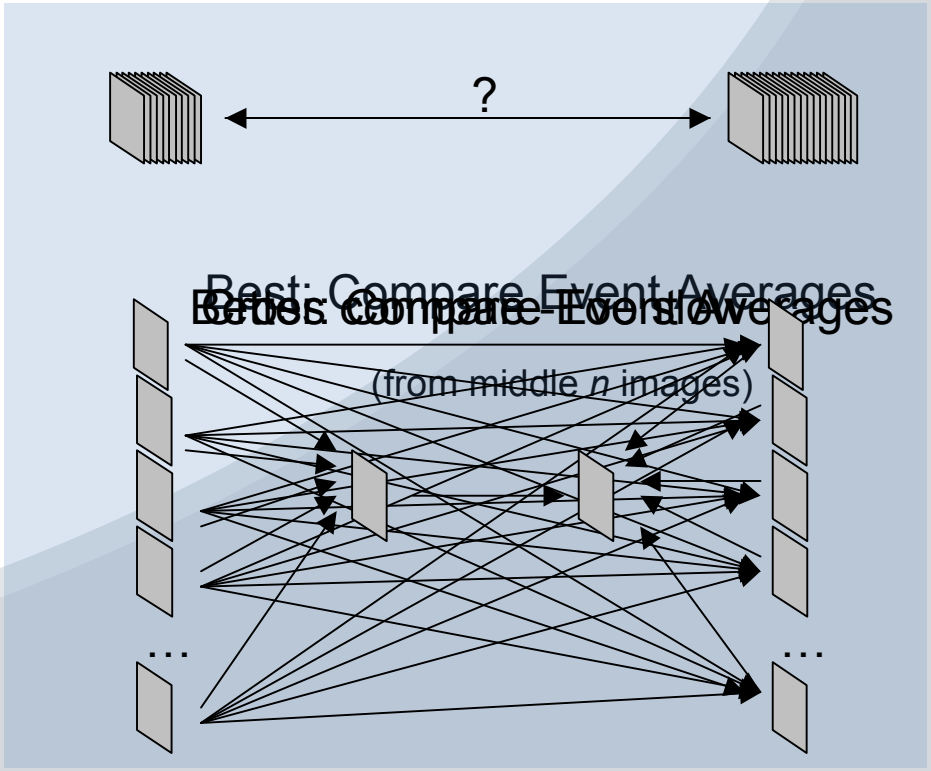
Operational from 6 image sources, tested and evaluated with users.

Bringing the threads together … event segmentation, keyframe selection, event importance, event searching, and event augmentation …

… we have a system to manage a lifelog

# Visual Search Facilities



# My Visual Diary with SenseCam

hlee: 76,430 photos (25 days)

MY ACCOUNT | SIGN OUT | ABOUT

## CALENDAR

MAY 2006

| S | M | T | W | T | F | S |
|---|---|---|---|---|---|---|
| 30 | 1 | 2 | 3 | 4 | 5 | 6 |
| 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| 21 | 22 | 23 | 24 | 25 | 26 | 27 |
| 28 | 29 | 30 | 31 | 1 | 2 | 3 |
| 4 | 5 | 6 | 7 | 8 | 9 | 10 |

DURATION ▶

## CAPTION SEARCH

## WEEKLY SUMMARY

Selected day is shown below in the context of whole week. Move mouse curosr over to see other similar Events in the week

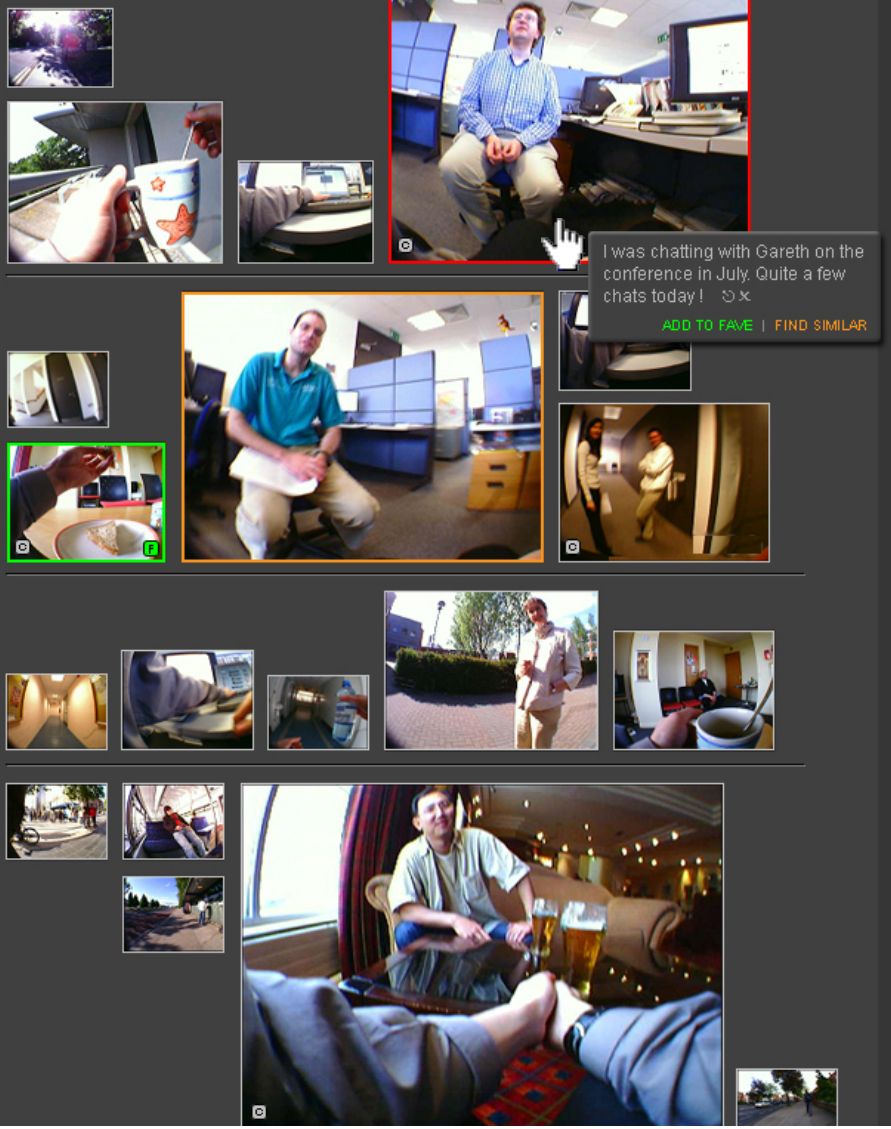
S
M
T
W
T
F
S

## 29 May 2006

19 EVENTS

Drag the slider bar to adjust the number of Important Events

0 am | 6 am | 12pm | 6pm | 0am



I was chatting with Gareth on the conference in July. Quite a few chats today !

ADD TO FAVE | FIND SIMILAR

## My Favourite Events

**25** Favourite Events are shown below. Click on the photo to replay all photos within the Event.

| 1 | 2 | 3 |

Sort by: TIME | SIMILARITY | #PEOPLE

16:20 (Duration: 08m 43s)
14 APR 2006 ▶

13:45 (Duration: 14m 05s)
14 APR 2006 ▶

10:02 (Duration: 23m 56s)
13 APR 2006 ▶

14:39 (Duration: 15m 30s)
12 APR 2006 ▶

11:25 (Duration: 06m 21s)
12 APR 2006 ▶

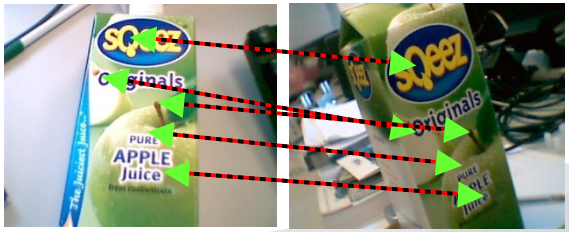
09:52 (Duration: 01m 03s)
12 APR 2006 ▶

# F. Advanced Image Matching

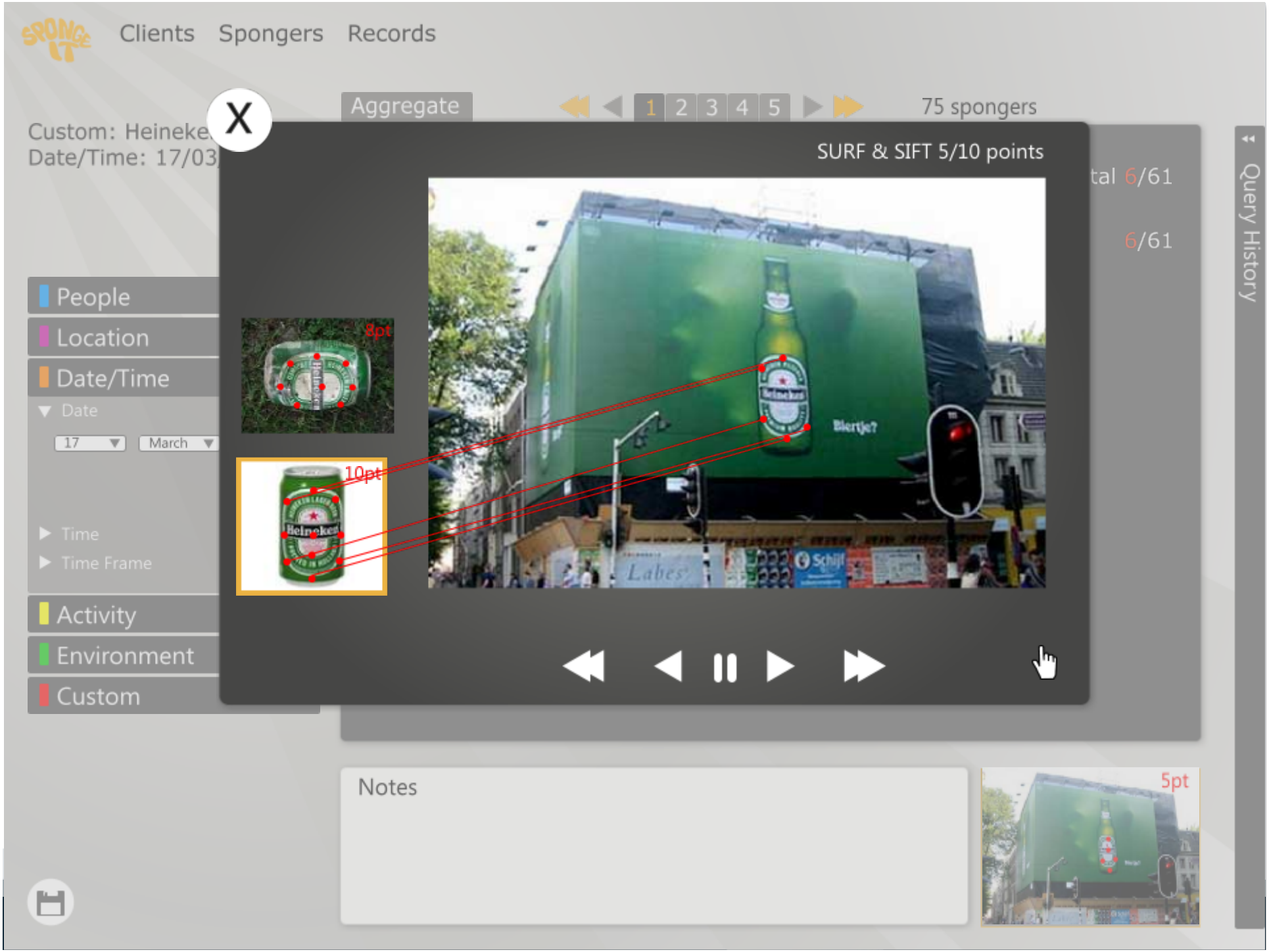

SURF feature are extracted

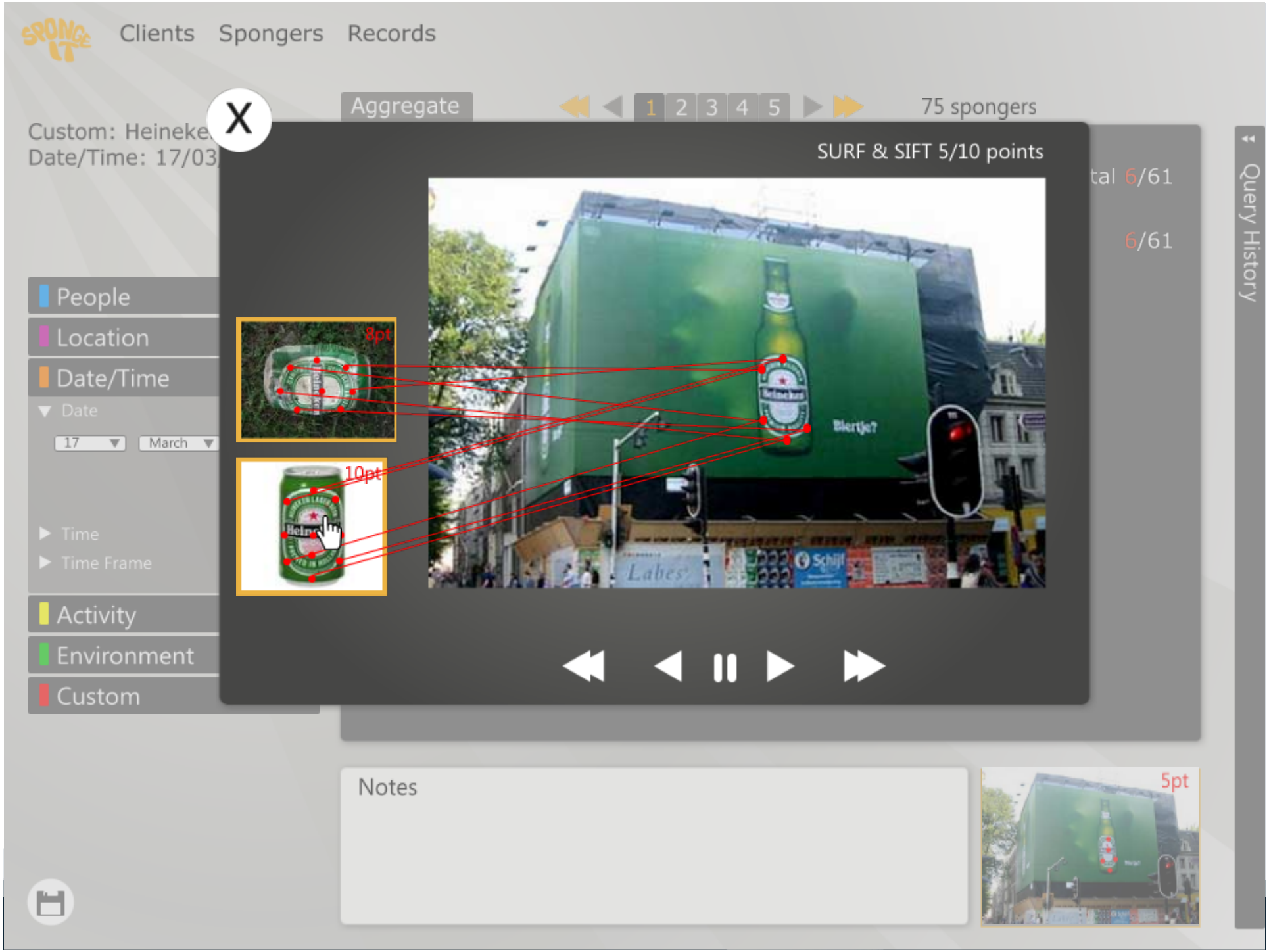
Each feature point casts a weighted vote for multiple database images

Votes are accumulated & the best match is found



Bi-directional Match Verification & re-ranking of Top results


Clients
Spongers
Records
Aggregate
1 2 3 4 5
75 spongers
Custom: Heineke
Date/Time: 17/03
X
SURF & SIFT 5/10 points
8pt
10pt
People
Location
Date/Time
Date
17
March
Time
Time Frame
Activity
Environment
Custom
tal 6/61
6/61
Query History
Notes
5pt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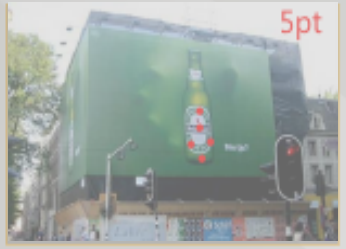

# What do we DO !

CLARITY
clarity-centre.org

There are a lot of visual lifelog capture devices

We have a lot of tools at our disposal …
- Event segmentation, similarity and augmentaiton;
- Concept detection and distribution;
- Activity classification;
- Known location detection;
- Logo and other object detection

We can combine the tools for different applications, for example …

# What do we DO !

CLARITY
clarity-centre.org

Work with memory scientists on what makes things memorable, assess recall of healthy subjects with and without memory prosthesis.

Work with caregivers on visual lifelogging for early stage dementia and Alzheimer's

Work with ethnographers on lifestyle analysis, ultimately leading to to lifestyle analysis as a tool to measure interventions (pre- and post-)

Work with healthcare professionals to re-establish contexts for events in the past

Work with market analysts on measuring exposure to brands

# Specific work

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clarity-centre.org

An 82 yo otherwise healthy and active male living independently at home wore (2) gait recorders and SenseCam for a one-month period

Most of the time he was at home but with frequent trips to shops, etc.

Subject has a recent history of falls and was open and receptive to trying new technology

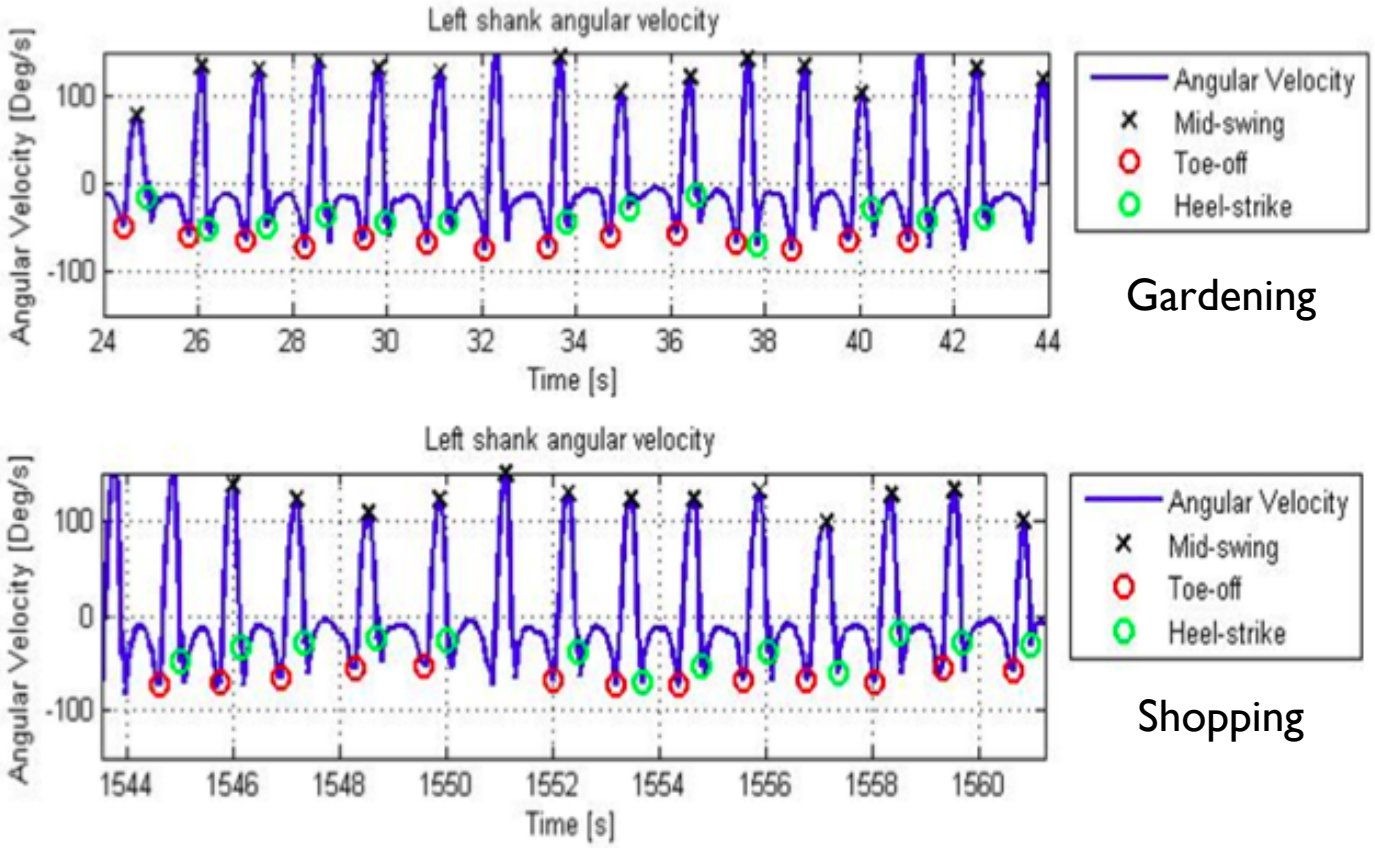
# Specific work

We can monitor the gait of a wearer using the SHIMMER platform.


The SHIMMER can incorporate wireless ECG, EMG, GSR, accelerometer, gyro, PIR, tilt and vibration sensors.

Working with the wearer afterwards, a health professional can analyse data and diagnose, but a difficulty is re-creating context

# Comparison of Right Shank Sagittal Angular Velocity




**Differing natural environments can result in different walking patterns or differences may be due to differences in floor surface or cognitive challenge posed by surrounding stimuli.**

**How to determine this ? Dialogue with wearer but sometimes this is difficult.**

James Smith

Age: 67

Retired in 2008

Co-habiting with wife

4 April 2011

07:26 – 21:40

◀ April 2011 ▶

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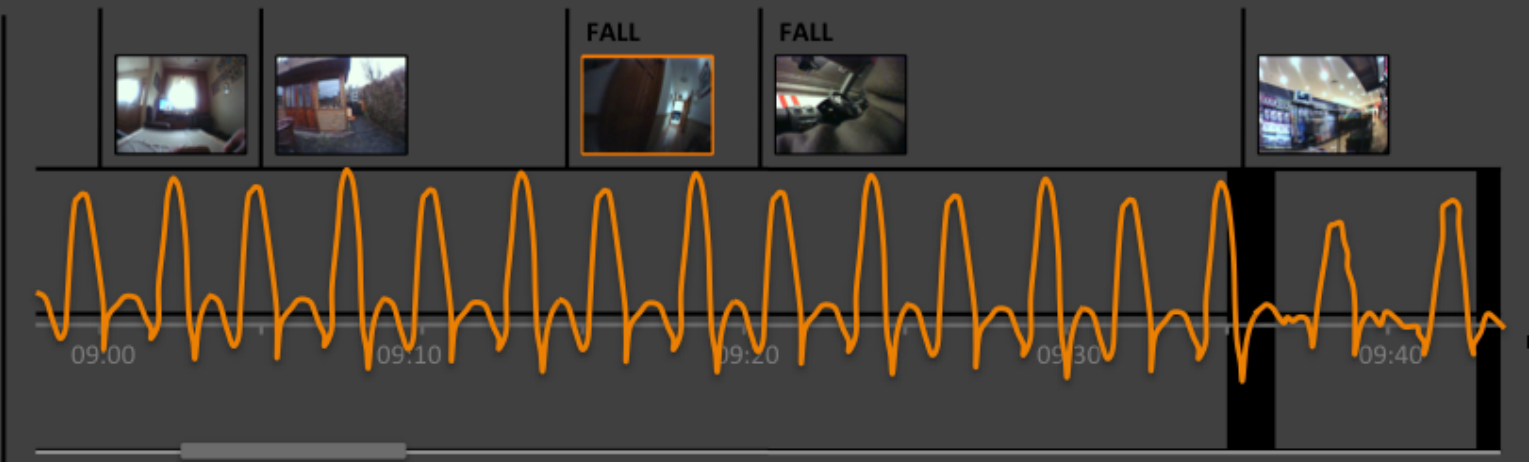


| | |
|---|---|
| Duration | 16 hrs |
| Events | 38 |
| # Possible falls | 3 |
| # Images | 1,435 |
| # Notes | 7 |

NOTES

Change in gate could be due to reduced lighting.

shimmer

VICON

SENSOR

# Conclusions

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Visual lifelogging is a rich and varied source of applications for content-based operations

Capture, storage, etc. technologies are sorted, the challenges are in managing lifelog data

Many of these re-use the technologies already developed in our field

The novelty comes at the intersection between our field, and others

Biggest challenge probably comes in integrating the varied sources of lifelogging data, both explicit and indirect