Automated Management of More than One Million LifeLog Images

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&
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Overview

- **Introduction to LifeLogging**
- Segmentation of Images into Events
- Retrieval of Similar Events
- Determining Important Events
- System Demo
- Augmenting LifeLog Images
- Collaborative Work
- Other Work
- Conclusions

Who am I?

- Graduated from University of Ulster in ’05 BSc (Hons) Computing Science
- Work placement with DuPont
- 3rd year PhD student funded by IRCSET
- Recently received Microsoft Postgraduate Research Scholarship

Centre for Digital Video Processing

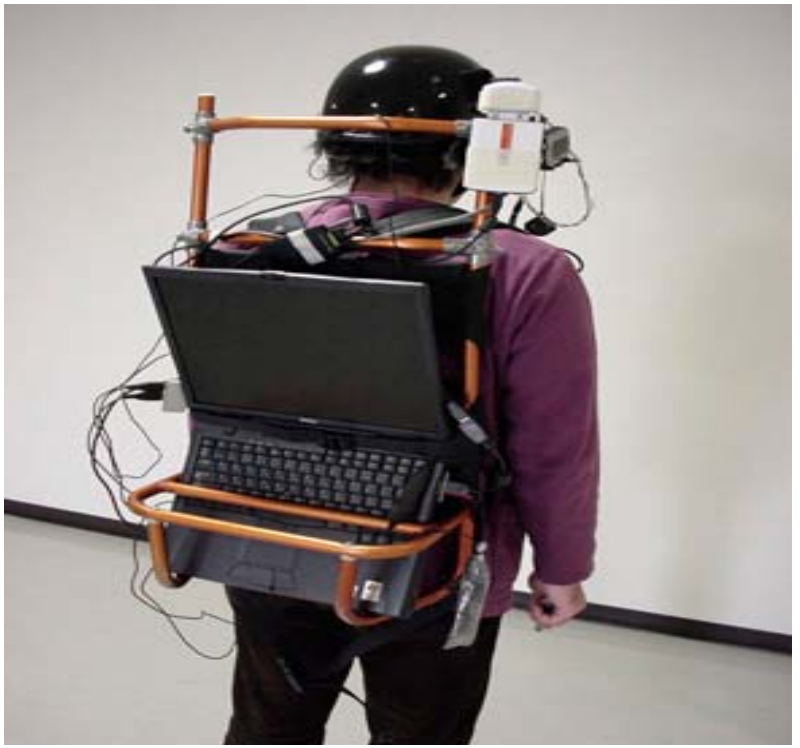
- Headed by Prof. Alan Smeaton
- 3 faculty members, 14 post-docs, 23 PhD students, 4 RAs, 3 support staff
- Focus on multimedia information retrieval
- Now investigating the area of lifelogging

Lifelogging

- Lifelogging is about recording daily life, digitally
- Sometimes its for a reason,
  - work … e.g. security personnel, medical staff,
  - personal … e.g. diaries, etc.
- 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 lifelogs, e.g. MyLifeBits

Lifelogging Devices

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



Lifelogging Devices

- Lin & Hauptmann, Carnegie Mellon, PA, USA

SenseCam

- SenseCam is a Microsoft Research Prototype
- Multi-sensor device
  - Colour camera
  - 3 accelerometers
  - Light meter
  - Passive infrared sensor

- 1GB flash memory storage
- Smart image capture ~3 images/min
- Since April 2006 we've had two SenseCams … recently have received 5 more

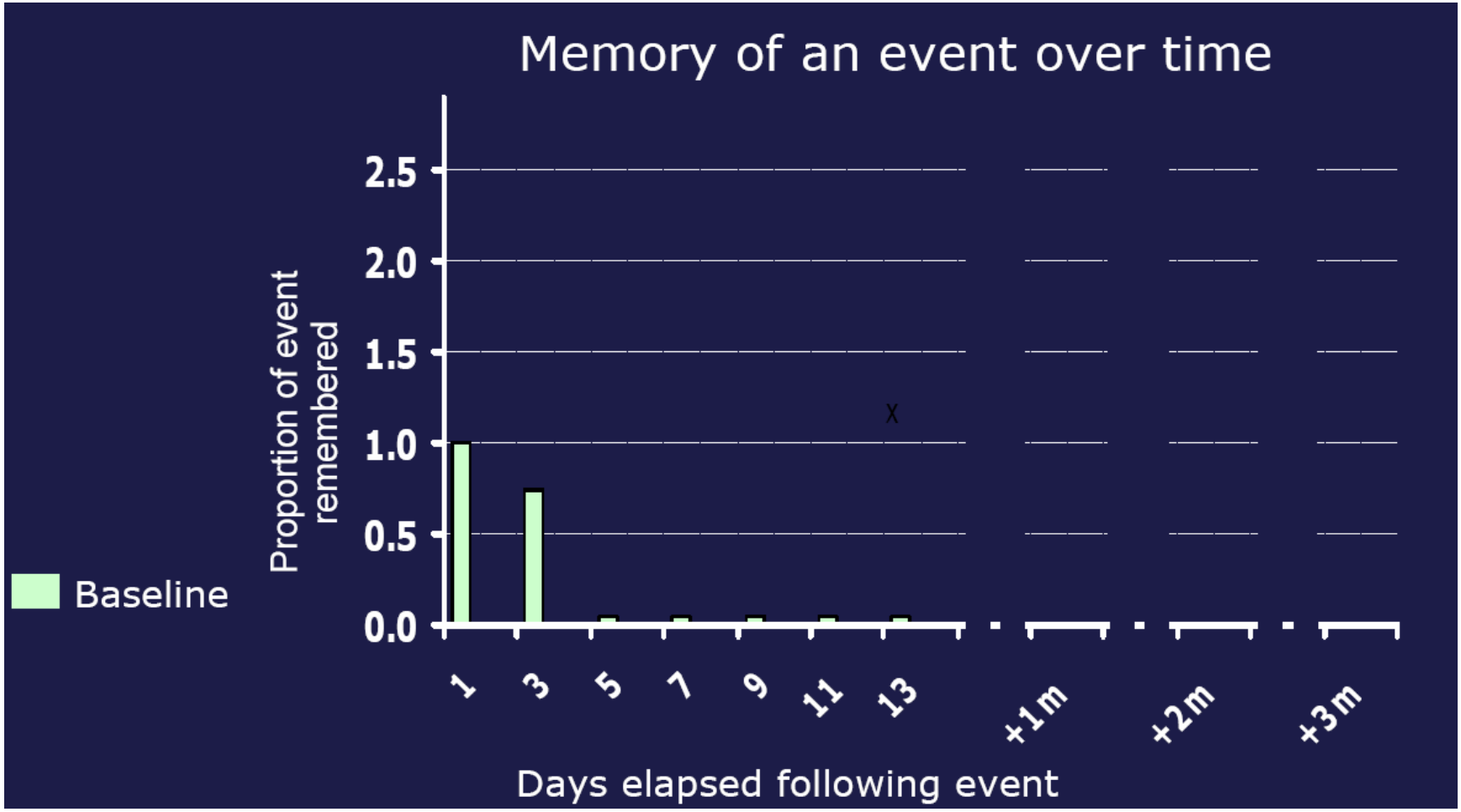
How to Review Images?

- Make a 2 minute movie of your day!

Lifelogging Aiding Memory

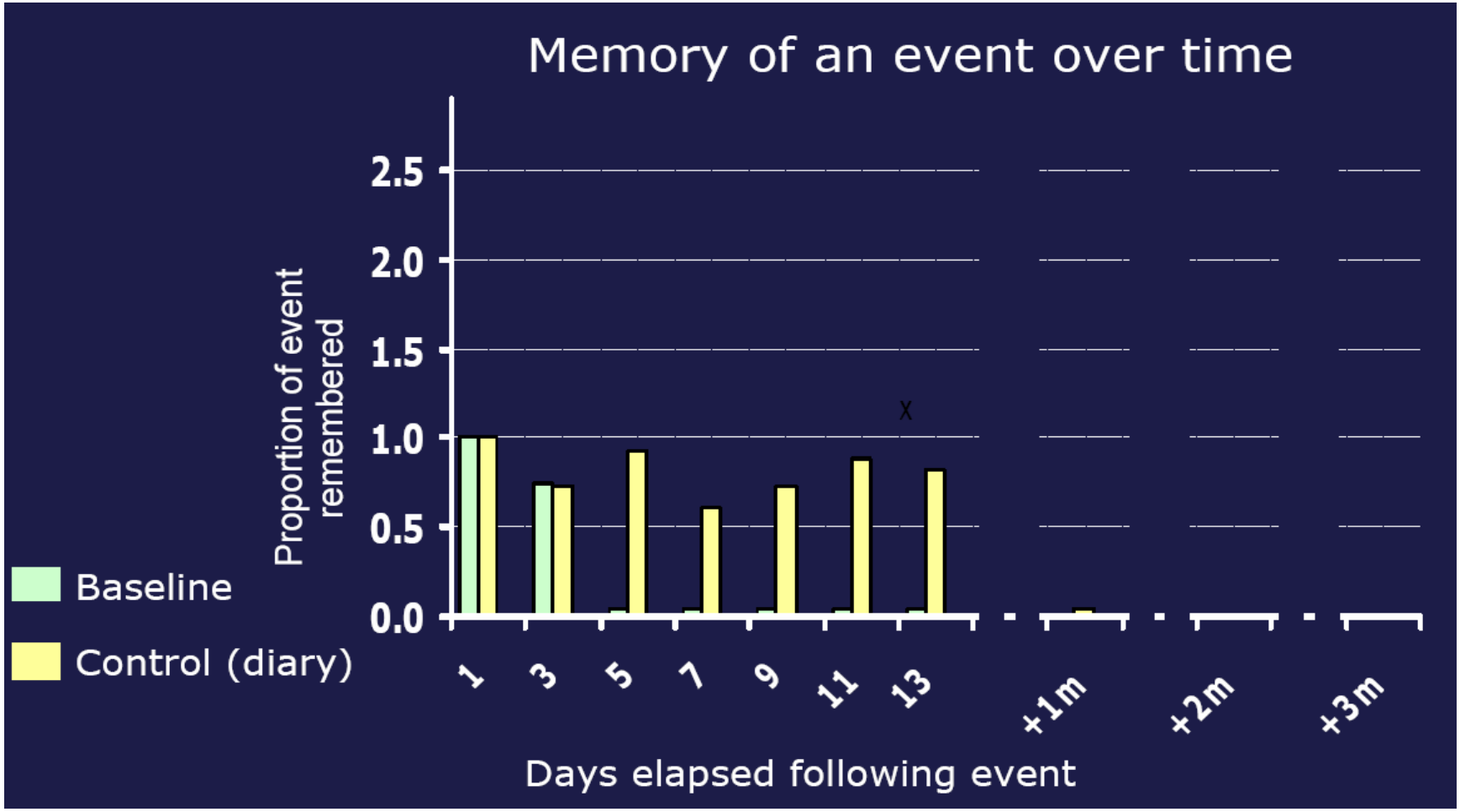
- Preliminary Study carried out by Cambridge Memory Clinic, Addenbrooke's Hospital
- 63 year old, well-educated married woman, with limbic encephalitis (usually has no memory a few days after an event)
- Each day her husband would ask her what she would remember from an event, and then talk her through it using SenseCam images afterwards
- A few days later, the same process would be repeated for that event

SenseCam as a Memory Aid



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

SenseCam as a Memory Aid



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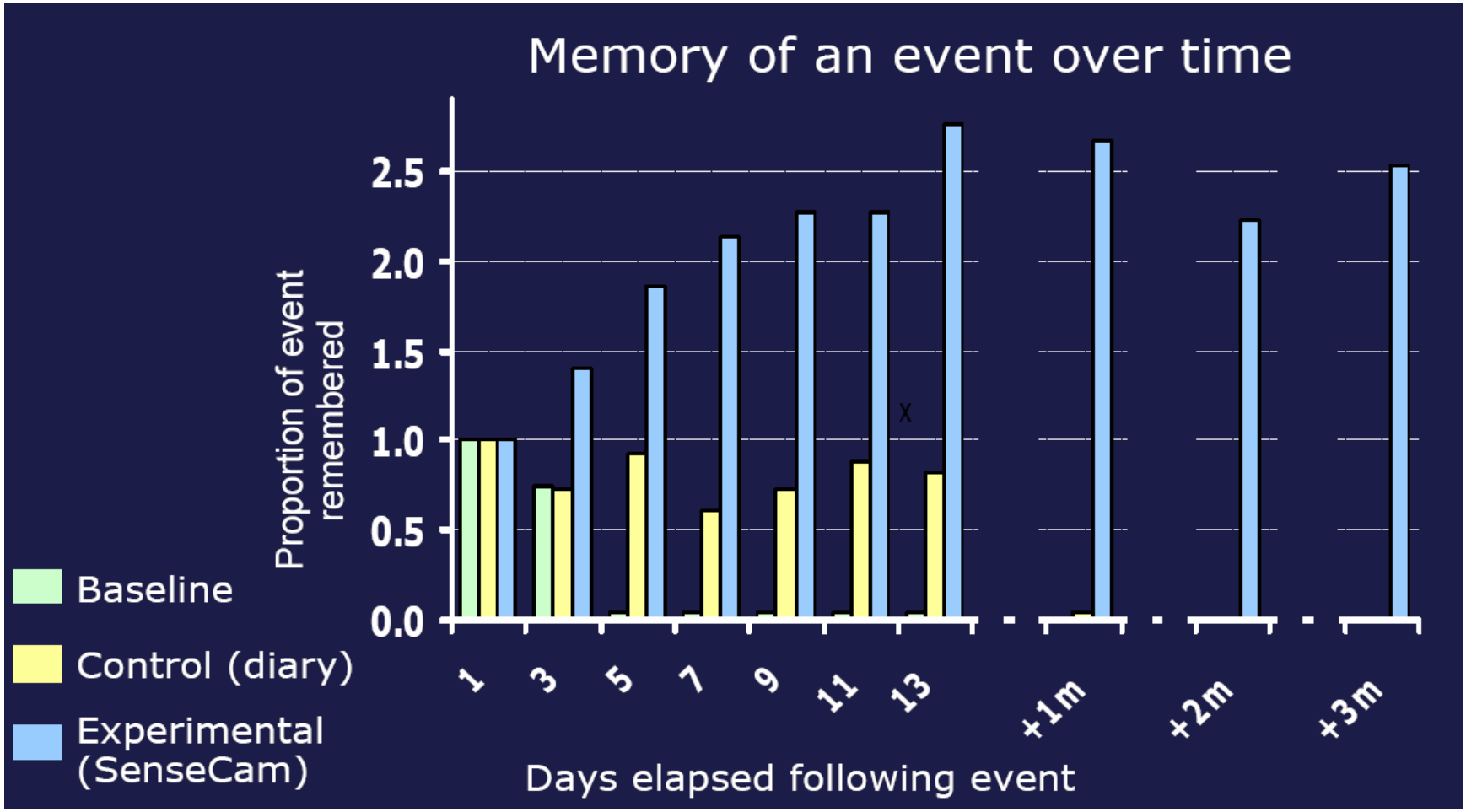
SenseCam as a Memory Aid

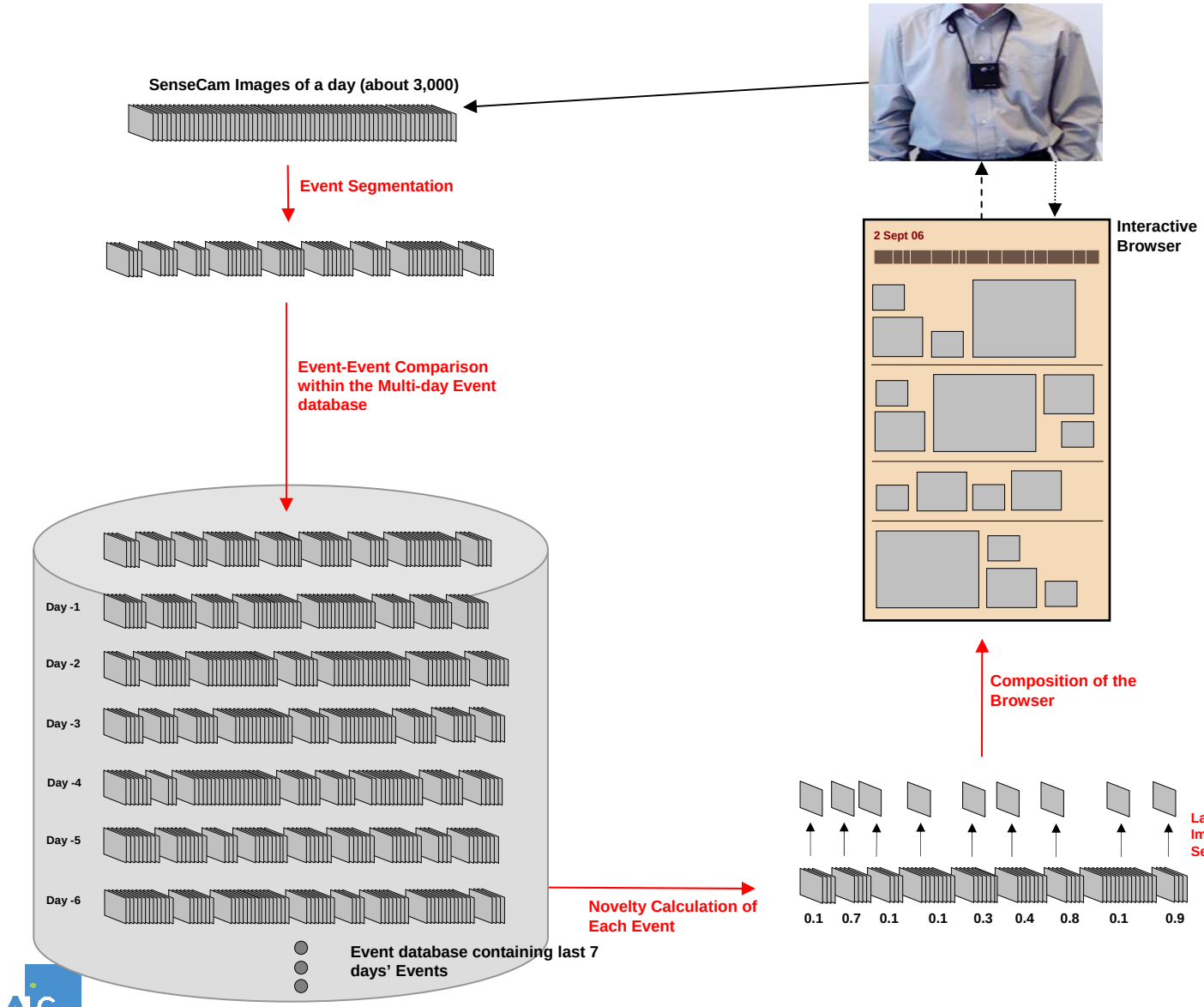


Microsoft Research Cambridge presentation: http://research.microsoft.com/~shodges/presentations/UBICOMP_senseCam.pdf

Require Intelligent Summarisation

- Playing a movie of one's day takes too long to review

Daily Browser Overview



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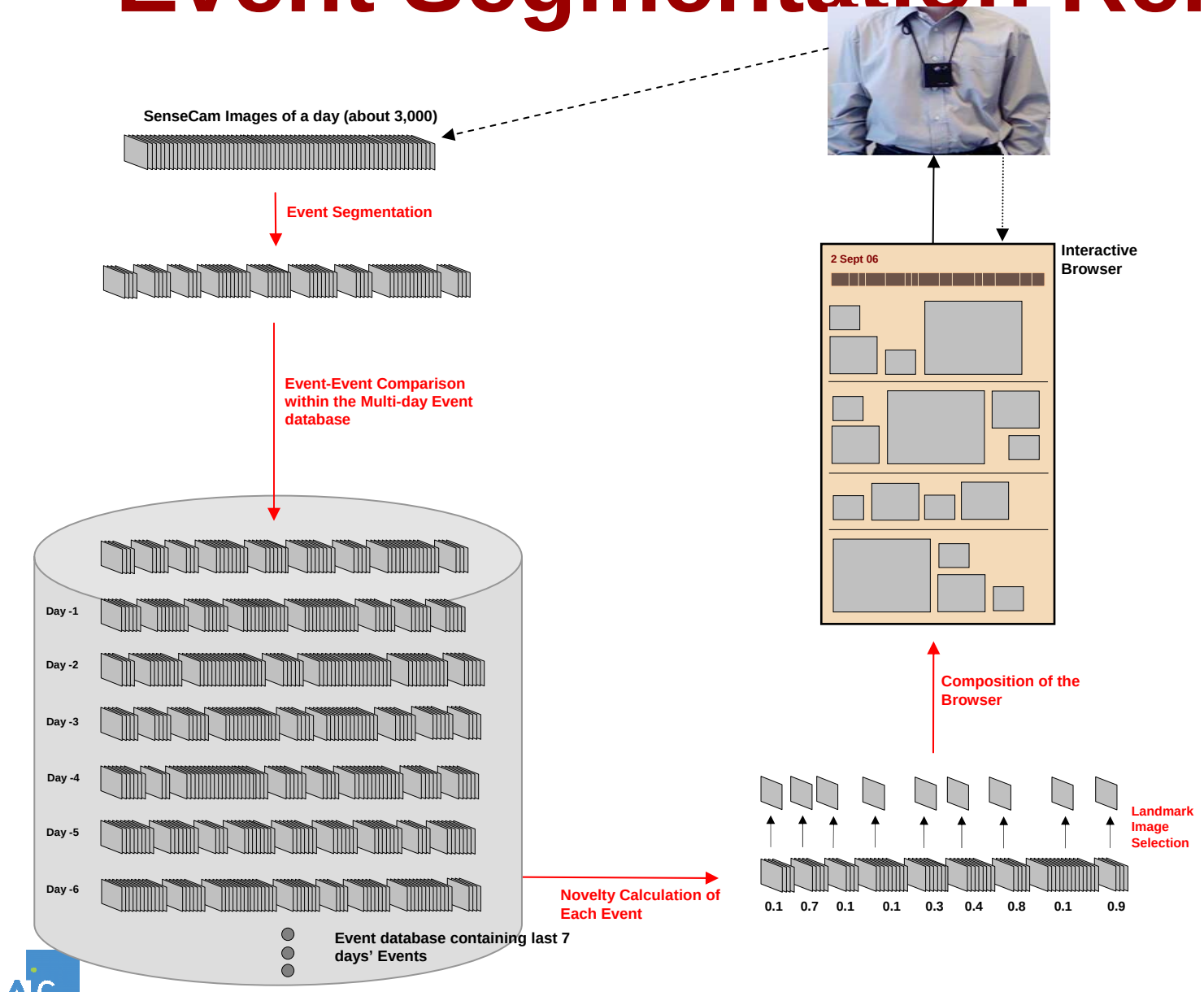
Event Segmentation Reminder



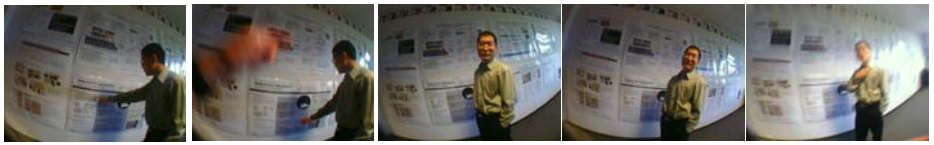
Sample Activities

Breakfast

Work

Car

Talking to colleague

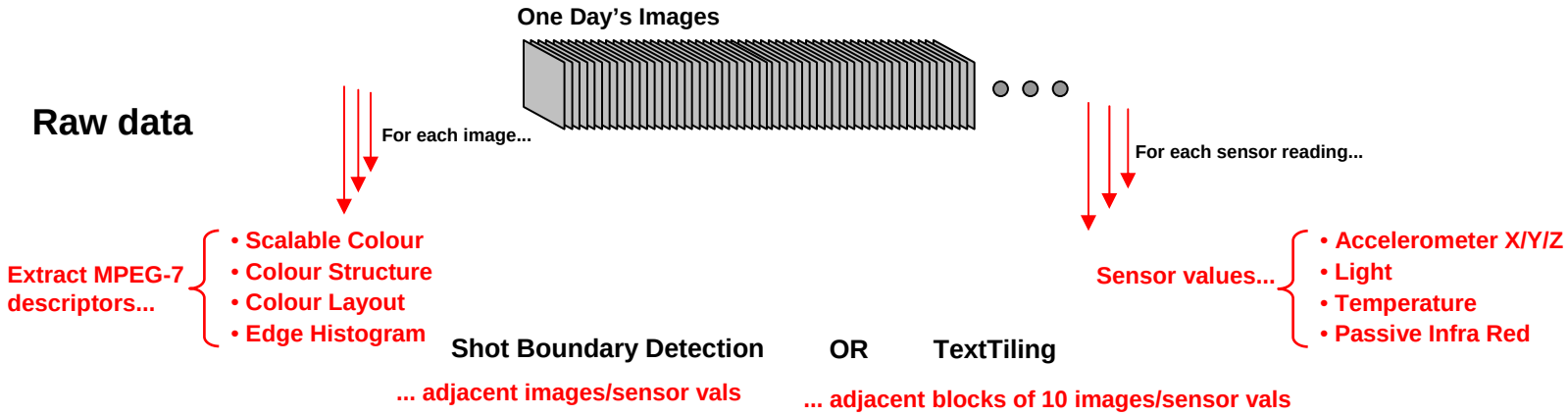


Airplane

Talking to friend

Event Segmentation

1. **Raw data**

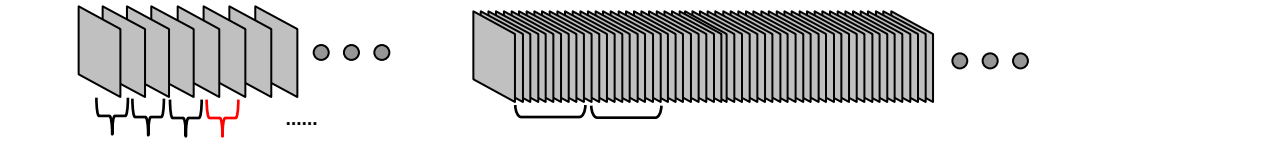


2. **Similarity matching**

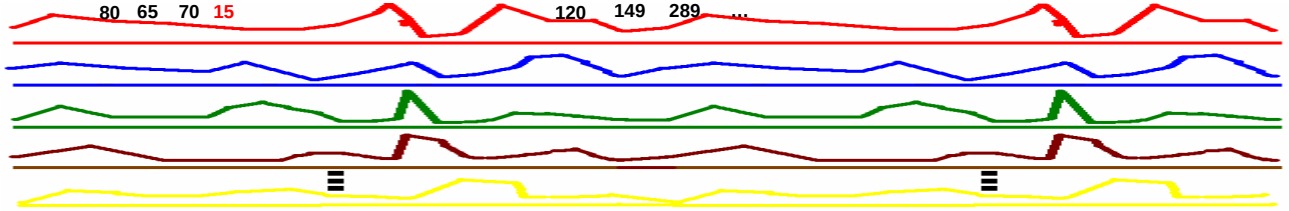
Shot Boundary Detection OR TextTiling

... adjacent images/sensor vals

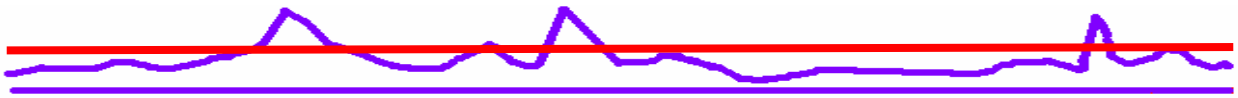
... adjacent blocks of 10 images/sensor vals



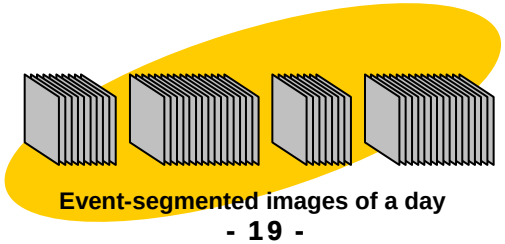
3. **Normalisation & Data fusion**



4. **Thresholding**



5. **Events**



Event Segmentation Expts.

- How well does it work?
- Work is already published at RIAO'2007 conference (1 user and 25k images)
- Recently completed extensive experiments with 5 different users wearing SenseCam for 1 month each (total = 270k images)
- Each user groundtruthed their own data
- Data divided into training and test sets with over 3,000 different combinations evaluated

Event Segmentation Expts.

- From groundtruth we noticed:
  - Average of 1,785 images per user per day
  - Average of 22 events groundtruthed per day
- 2 Approaches Recommended:
  - Most accurate (include image MPEG-7 features)
  - Quick segmentation (sensor values only)
- Performance:
  - RIAO (f score = 0.40)
  - Sensor only (f score = 0.60)
  - Image + Sensor (f score = 0.62)

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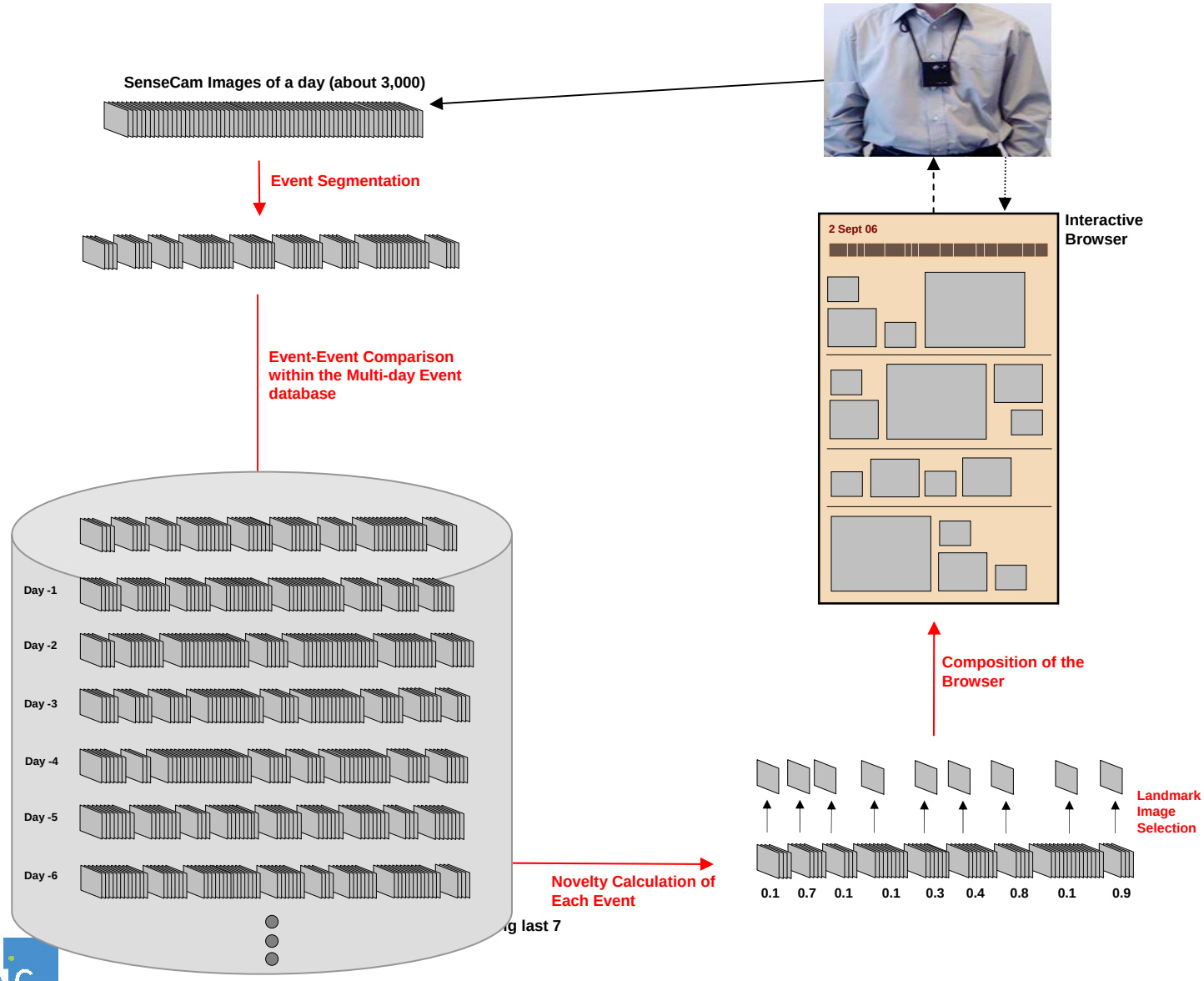
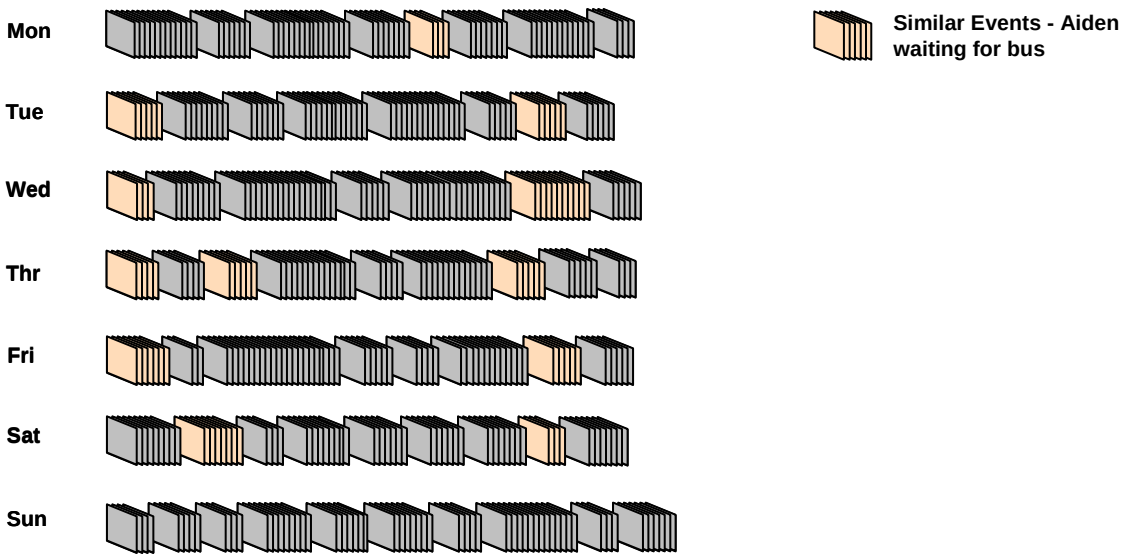
Retrieval Reminder



Finding similar events



- How to represent/model events that consist of many images?
- How to compare events against each other?
- What sources of information to use? How to combine them?

Event Retrieval Expts.

- How well does it work?
- Recently completed extensive experiments with 5 different users wearing SenseCam for 1 month each (total = 270k images) … corresponds to 3,286 events
- 10 queries selected for each user e.g. driving, at work, eating, talking to friend, etc.
- 13,399 pooled judgements made on relevance of events to query events
- Queries divided into training (60%) and test sets

Event Retrieval Expts.

- 1,000 combinations investigated in training phase
- Overall accuracy of top 5 returned documents is 63% … (top 10 is 52%)
- Overall MAP score of 0.3608
- Query scores ranging from 0.0057 (Hyowon on public transport) to 0.9415 (Michael at work on his PC)

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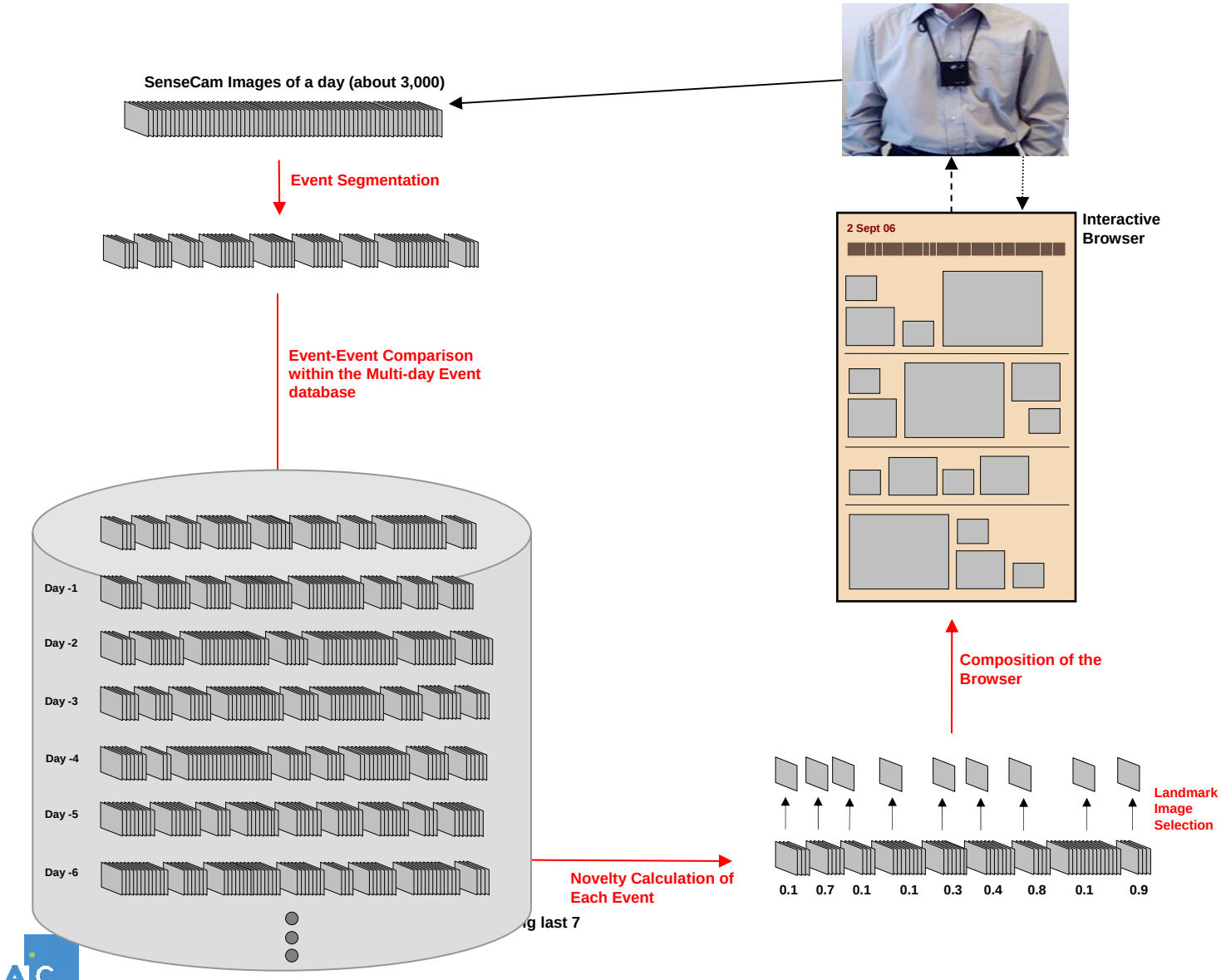
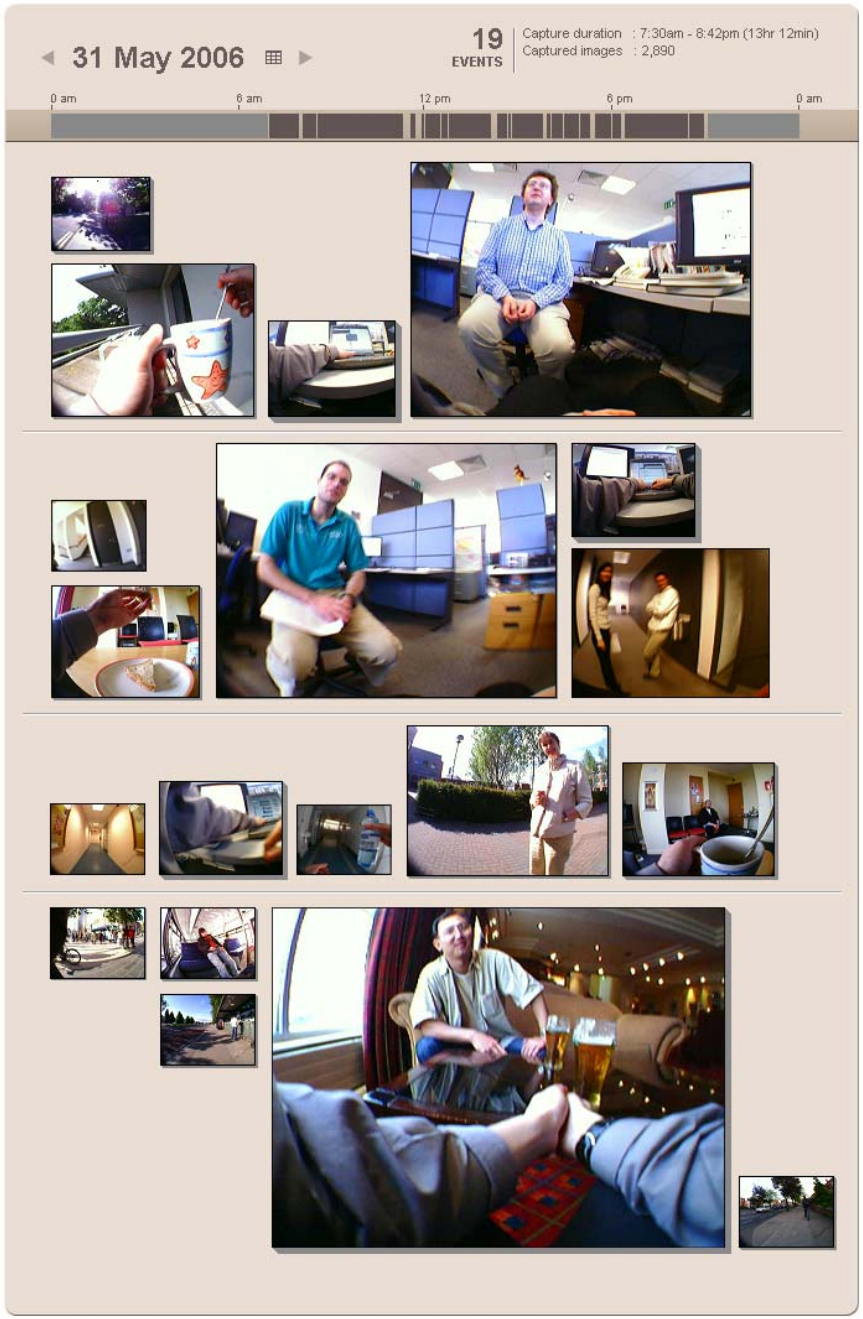
Importance Reminder





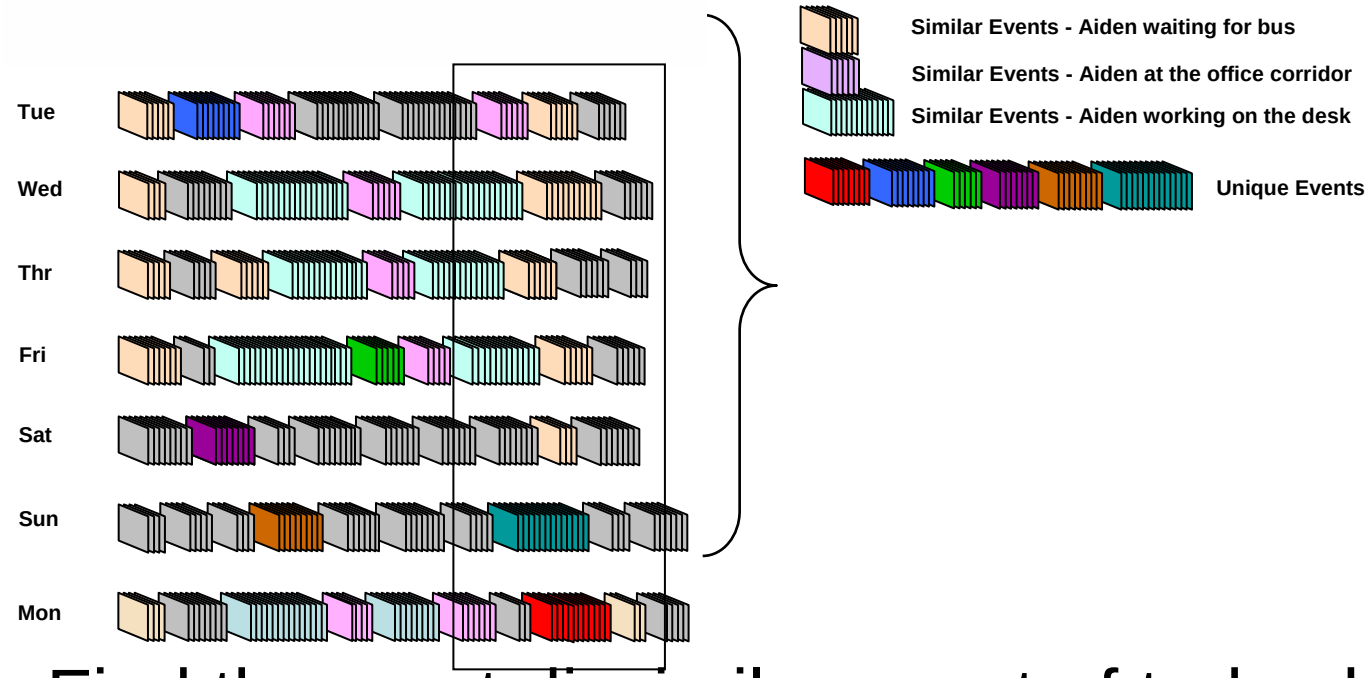
Importance

- Greater emphasis is placed on important events
- Routine/mundane events can be hidden

Automatic Face Detection

- Trained on set of 1,758 SenseCam images
- SenseCam images are low quality
- Accuracy = 63%

Novelty to Detect Event Importance



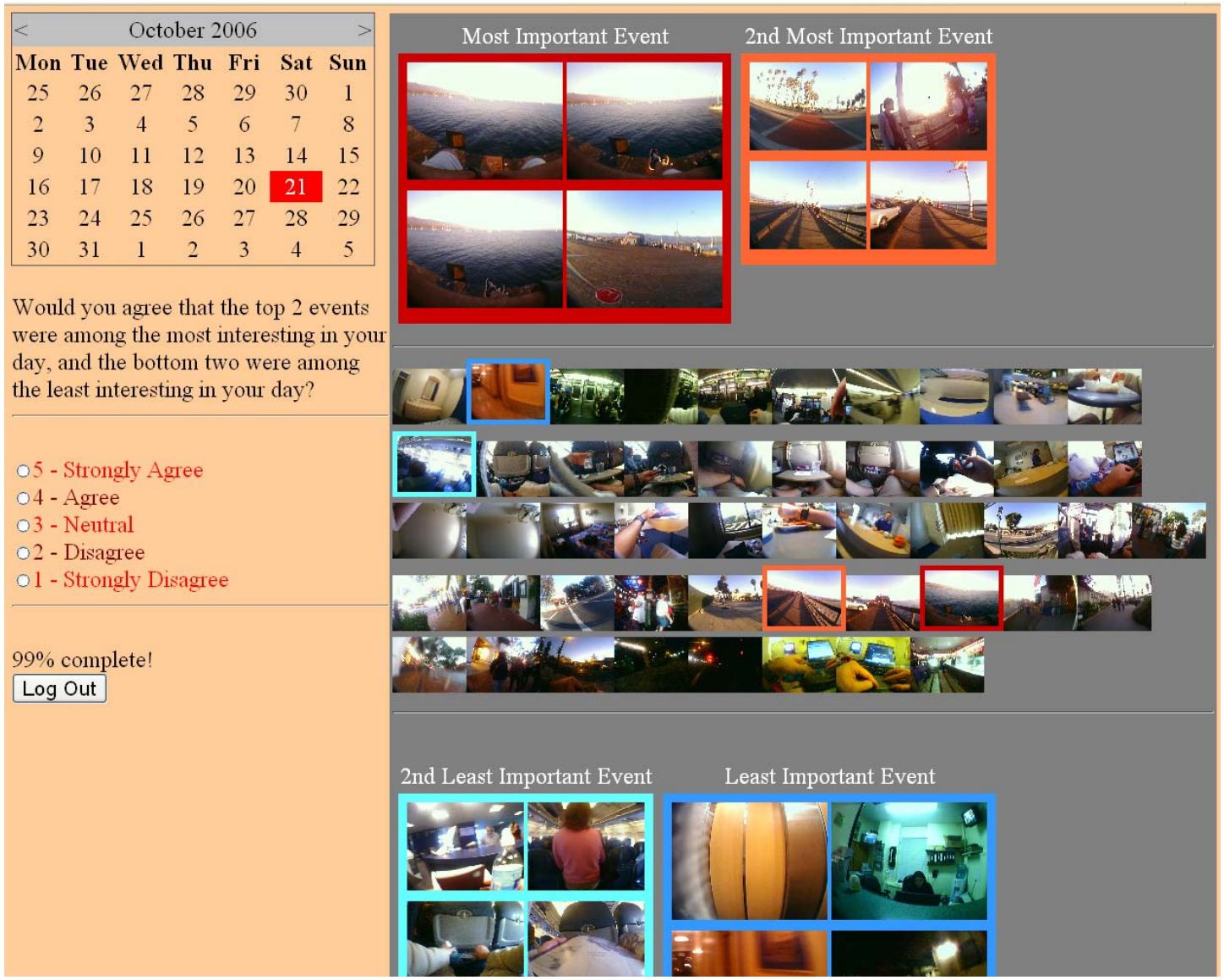
- Find the most dissimilar event of today by taking the previous 6 days into account.

- Also for any event, we only look at how novel it is with respect to events around the same time from other days

Event Importance Expts.

- How well does it work?
- Recently completed extensive experiments with 3 different users wearing SenseCam for 4 weeks each (total = 176k images)
- 83 days of data collected in total, with 8 different approaches evaluated … giving 664 judgements

Importance Evaluation App.



Event Importance Expts.

- 3 final approaches evaluated:
  - Face Detection Only (current state of art)
  - Novelty Only
  - Face Detection + Novelty

- Face Detection + Novelty performs at least as well as state of art 80% of the time, and 4% better overall

- Face Detection good at highlighting most important events

- Novelty good at detecting routine events

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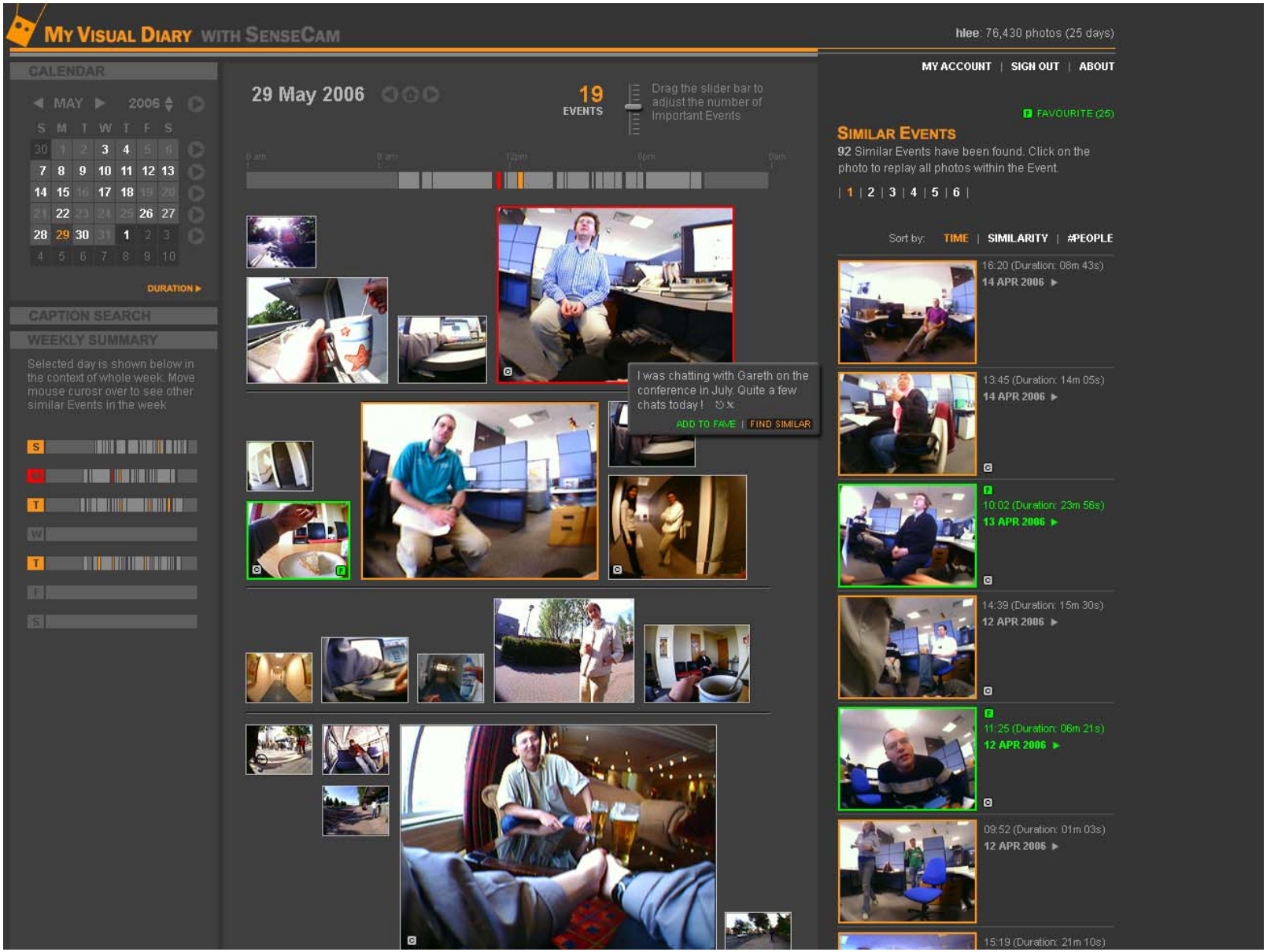
System Demo


MY VISUAL DIARY WITH SENSECAM
hlee: 76,430 photos (25 days)
MY ACCOUNT | SIGN OUT | ABOUT
CALENDAR
MAY 2006
DURATION
CAPTION SEARCH
WEEKLY SUMMARY
Selected day is shown below in the context of whole week. Move mouse cursor over to see other similar Events in the week
29 May 2006
19 EVENTS
Drag the slider bar to adjust the number of Important Events
I was chatting with Gareth on the conference in July. Quite a few chats today !
ADD TO FAVE | FIND SIMILAR
FAVOURITE (25)
SIMILAR EVENTS
92 Similar Events have been found. Click on the photo to replay all photos within the Event.
| 1 | 2 | 3 | 4 | 5 | 6 |
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
15:19 (Duration: 21m 10s)

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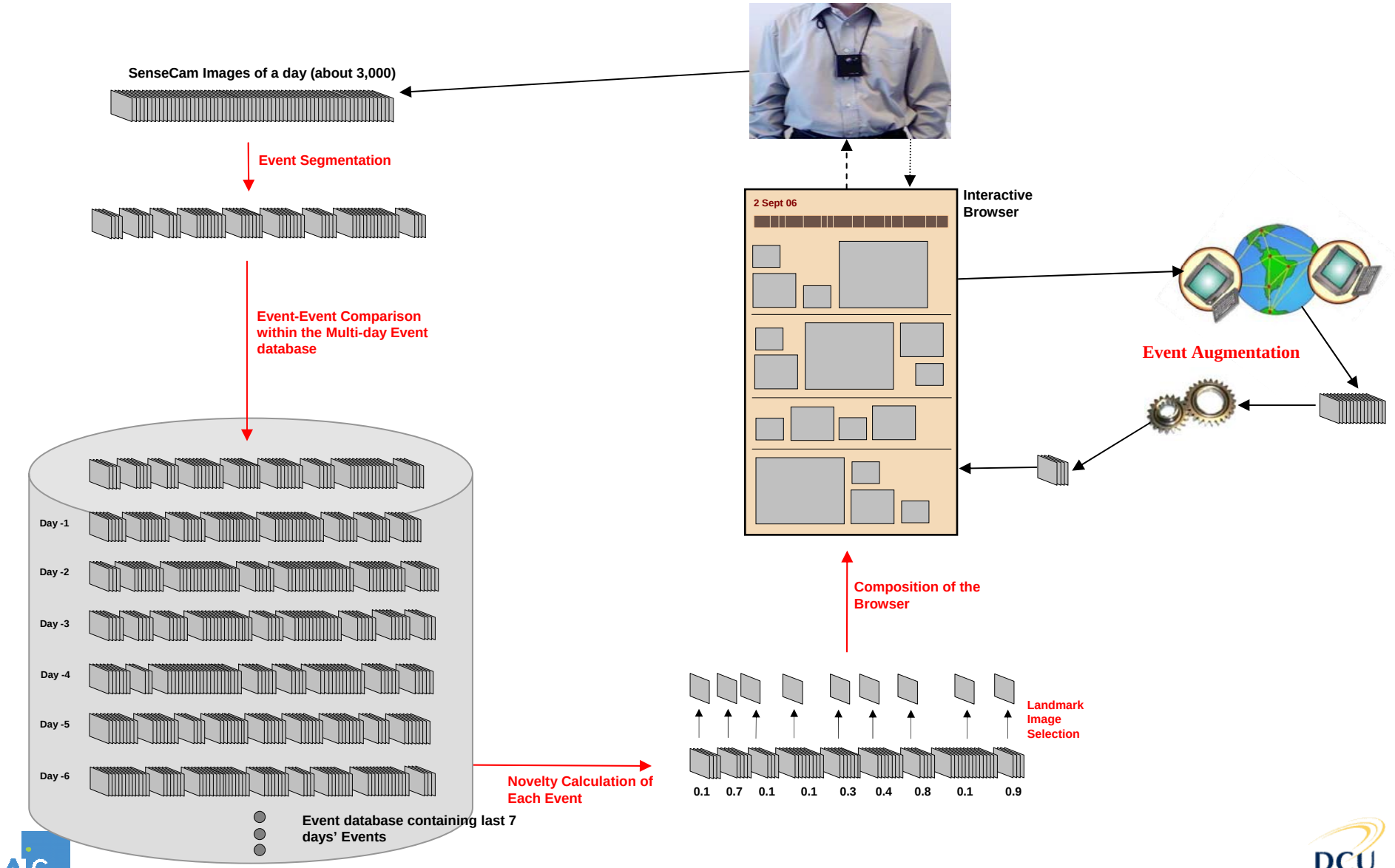
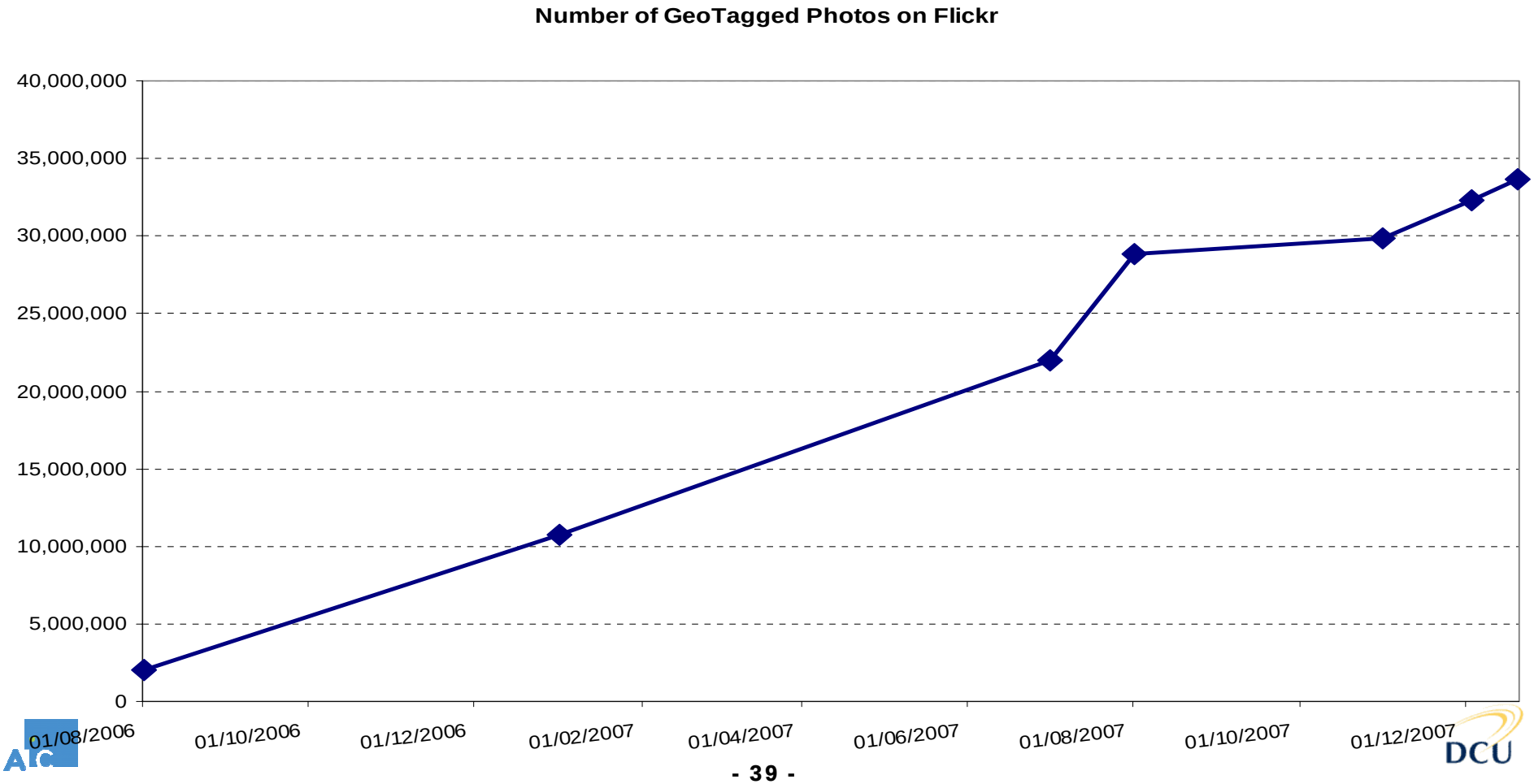


Event Augmentation

- Augment low-quality SenseCam images with high quality images from external sources



Event Augmentation – Croke Park

Here's an image from a SenseCam after a big match in Croke Park, Dublin. We'd really like to see other people's pictures of this match.

Let's search by location…

Event augmentation – Croke Park

- Receive the following pictures…
- Then filter out to just those results from the same day










Event augmentation – Santa Barbara

Here's a SenseCam picture of a building that I like from the pier in Santa Barbara, CA.

Again I search for other pictures in the same location…

Event augmentation – Santa Barbara

- I receive the following pictures…
- Then I filter out to just those results that are visually similar

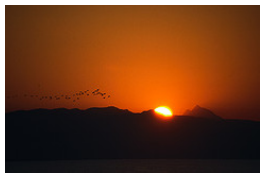
Event augmentation - Chalkidiki

Here's an image from my SenseCam at a beach in Chalkidki in Greece. I'd really like to see other people's pictures of this beach

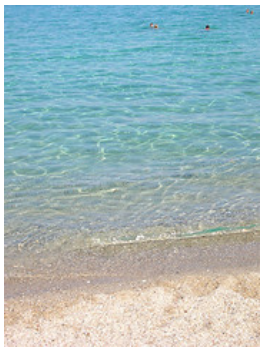
Therefore I search by location firstly…

Event augmentation - Chalkidiki

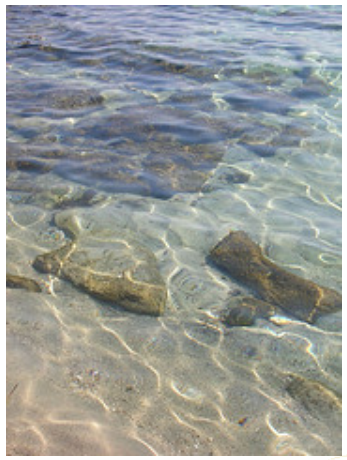
- I receive the following pictures…
- Then I filter out to just those visually similar results









Event augmentation – New York

Here's an image from my SenseCam looking towards the Statue of Liberty in New York. I'd really like to see other people's pictures that are similar

Therefore I search by location firstly…

Event augmentation – New York

- I receive the following pictures…
- Then I filter out to just those visually similar results









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1. Columbia University, New York

- 1 week research visit to LabROSA audio processing group of Prof. Dan Ellis
- Gathered SenseCam and audio data over a 10 day period
- Columbia segmented data into events based on audio
- We segmented this data into events based on image and sensor features and also included Columbia audio output
- Collaborative event segmentation paper accepted in RIAO conference, Pittsburgh.

2. UCLA DietSense Project

- Overview
  - To have users wear N95 phones like SenseCam devices

- Why?
  - To allow participants in dietary studies easily audit their diet
  - To allow health care professionals easily browse and annotate large sets of images

2. UCLA DietSense Project

2. UCLA Collaboration

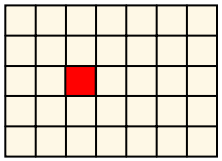
- UCLA DietSense
  - Problem of too many images been taken per day
- Our SenseCam project
  - Segment many images into more manageable events

2. UCLA Project Goals

- CENS in UCLA
  - Provide us with “Campaignr” software
    - Automatically takes image every 30 seconds
    - Also GPS, Bluetooth, and motion data

- CDVP in DCU
  - Get people to wear N95 phones like UCLA people
  - Using image processing, provide:
    - A segmentation solution, ala SenseCam event processing
    - Browser, for UCLA to use

DUBLIN CITY UNIVERSITY



Breakfast

Lunch

Dinner

MORNING

8:25 AM

8:21 AM

9:35 AM

9:42 AM

9:53 AM

AFTERNOON

12:11 PM

1:23 PM

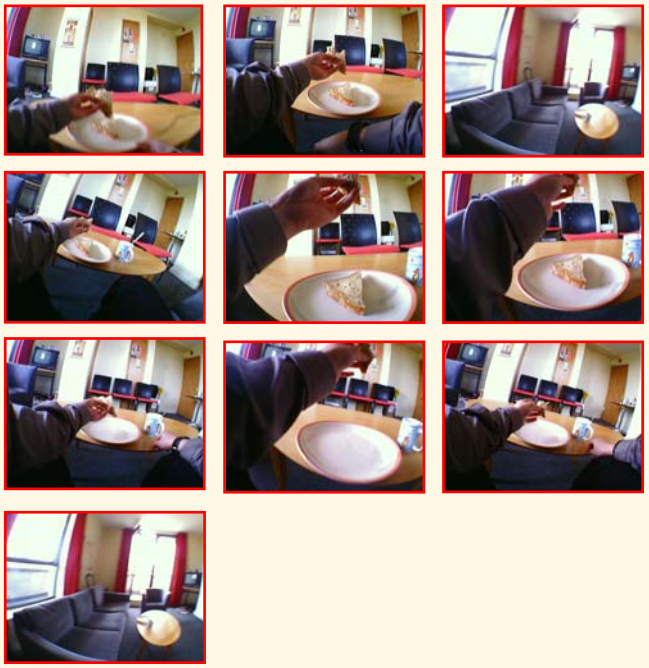
2:02 PM

2:45 PM

3:49 PM

BREAKFAST

9:42 – 9:53am (11 min)



3. University of Tampere

- Department of Information Studies of Prof. Kalervo Järvelin
- Tampere PhD student shadowing medical researchers … goal is to learn their task-based information access
- We provide SenseCam plus event browser tool
- Collaboration involves analysing the effectiveness of SenseCam as an ethnographic tool

3. University of Tampere

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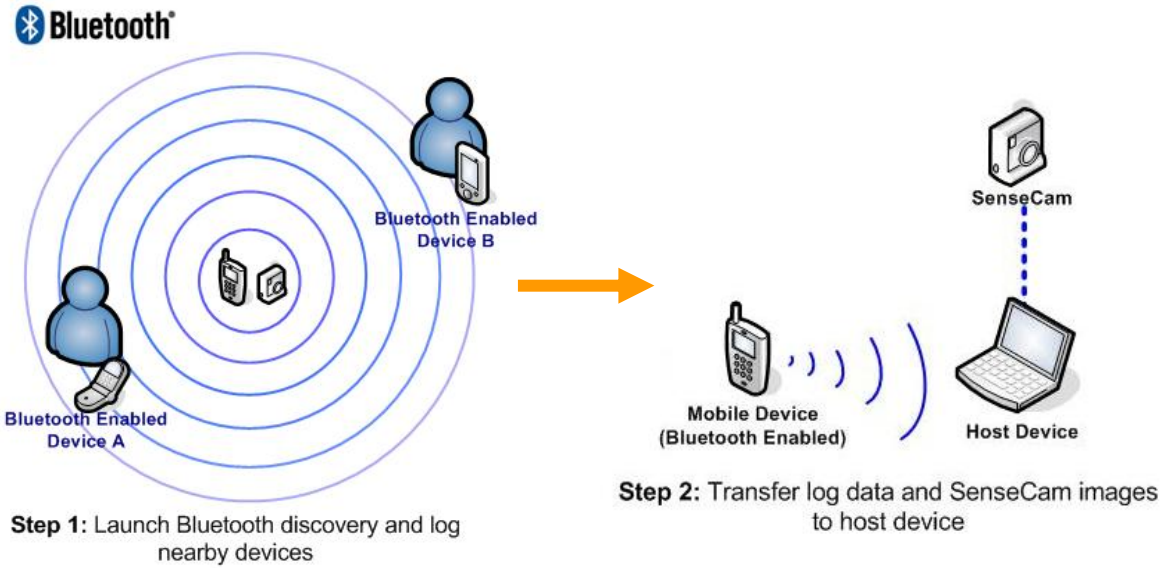
Retrieval using Bluetooth + GPS

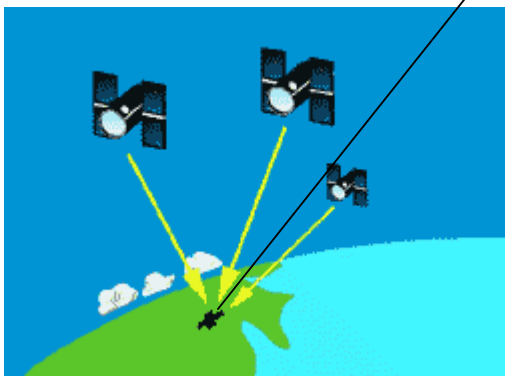


- Growth of Bluetooth devices expected to increase from 140 million in 2005 to 583 million by 2009, *Gartner Research*

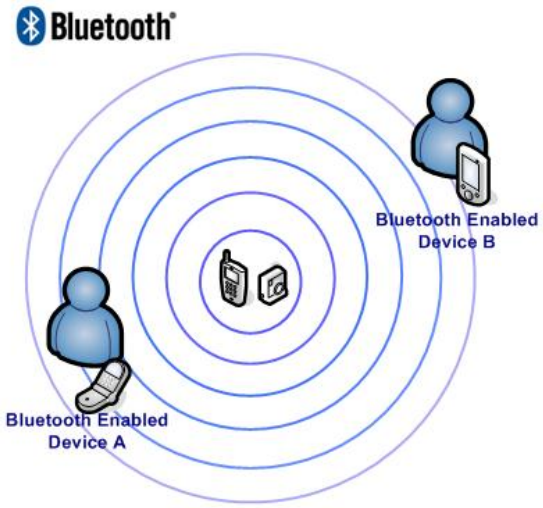
- Unique H/W address of each Bluetooth device means people can be associated to a particular device

  e.g. 00:00:3A:69:89:A8 = Barry

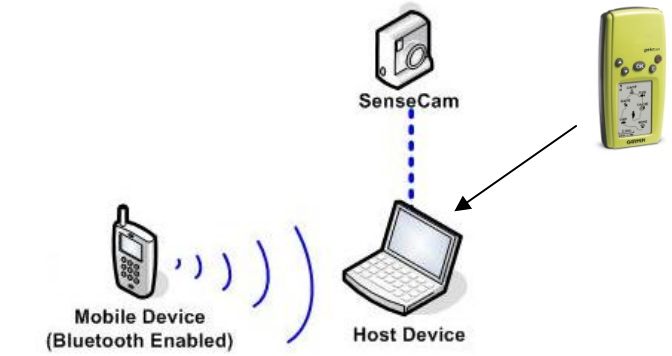
Retrieval using Bluetooth + GPS



Experimental set-up – data collected



Step 1: Launch Bluetooth discovery and log nearby devices



Step 2: Transfer log data and SenseCam images to host device

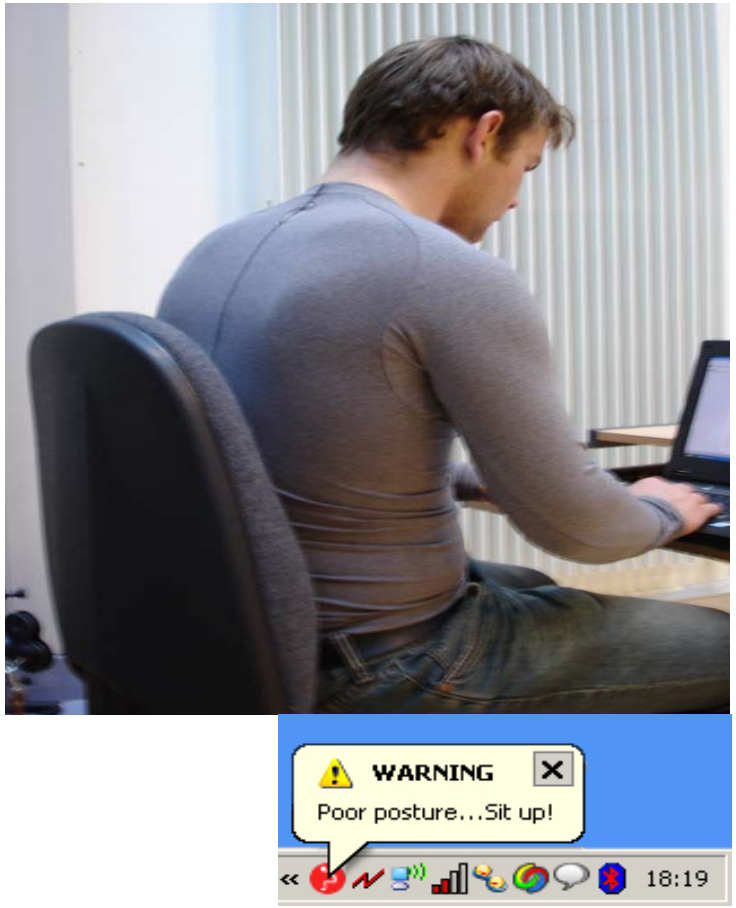
- 1 user; 28,000 images; 350 events; 28 days
- Images segmented into events using image and sensor features as detailed earlier
- 10 events randomly selected from dataset
- Judgments made by SenseCam wearer on top 10 returned results by each system

Retrieval using Bluetooth + GPS

- Bluetooth and GPS are very encouraging information sources to retrieve similar Lifelogging events

- In future it will be necessary to combine these sources with other existing sources of information content

Summer Project - Posture Monitoring



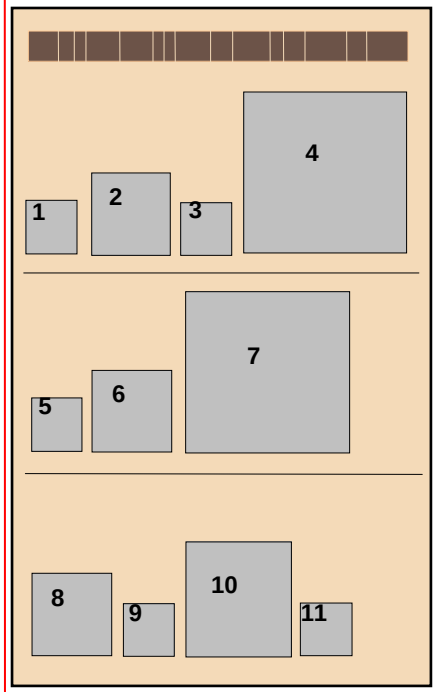
- When to record posture?

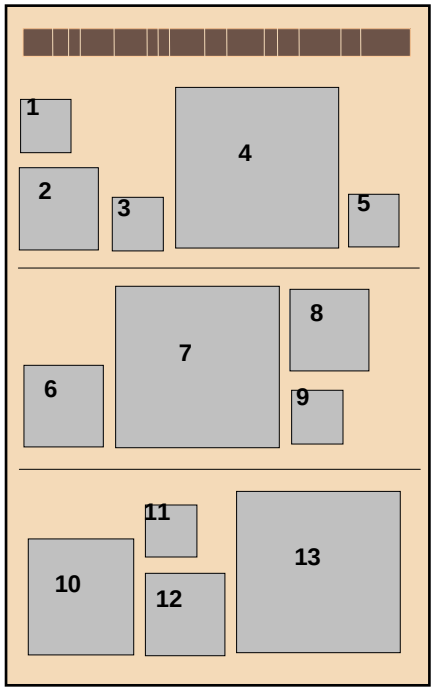
- Identify optimal (combination of) SenseCam sensors to classify SVM into sitting/not sitting

- Optimal sensor was accelerometer Y-axis.

Summer Project – Manga Interface

To reduce empty space:
packing algorithm...





Conclusions

- Introduction to the concept of Lifelogging
- Past research in the field was predominantly hardware+storage based
- Only now considering the retrieval challenges

Conclusions

- Extensive work complete in segmenting images into distinct events
- Retrieval of similar events and highlighting important events done
- Future Work: Augmenting FlickR images … and so much more (biometrics, bluetooth, etc.)!

Thank You

further information:

http://www.computing.dcu.ie/~adoherty

http://www.cdvp.dcu.ie/SenseCam