Visual Lifelogging: using non-medical images for medical purposes

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• Medical imaging is the technique and process of creating **visual representations of the interior of a body** for clinical analysis and medical intervention.
  – Medical imaging seeks to reveal internal structures hidden by the skin and bones, as well as
  – To diagnose and treat disease.

• Medical imaging also establishes a **database of normal anatomy and physiology** to make it possible to identify **abnormalities**.
  – Although imaging of removed organs and tissues can be performed for medical reasons, such procedures are usually considered part of pathology instead of medical imaging.

• Radiology uses the **imaging technologies** of:
  – X-ray radiography, MRI, CT, UC, endoscopy, elastography, tactile imaging, thermography, PET, SPECT, etc.

• **Anatomical vs. functional**
  – “Invisible light" medical imaging is generally equated to radiology...
  – "Visible light" medical imaging involves digital video or still pictures that can be seen without special equipment (dermatology).
Image-guided Atherosclerotic Characterization and Treatment based on IVUS

Scenario:

- Atherosclerotic plaque - proper to every one!
- Atherosclerotic plaque is invisible in 30% of angiographies!
- IntraVascular Ultrasound (IVUS) images are unique invasive imaging tool to inspect plaque and guide vessel intervention.

![IVUS Images](image)
**Scenario:** One third of people during their life – digestive problems!

**Hypothesis:** Computer Vision and Machine Learning allow to develop an automatic system for categorization of intestine motility to diagnose digestive diseases.
Looking at humans at the ICU: Detection of agitation episodes and neurorehabilitation

**Scenario:** Agitation occurs very frequently in the Intensive Care Unit (ICU), affecting 71% of sedated adult patients during 58% of ICU patient-days.

**Hypothesis:** Agitation detection can be obtained by using RGB-D cameras:
- Human and pose detection
- Head detection
- Motion analysis
- Computer-aided diagnosis

**Application to neurorehabilitation**
**Goal:** to develop tools for memory reinforcing of MCI and Alzheimer people.

To develop, for subjects with MCI, a program-based life-logging captured by a Wearable Camera recording specific autobiographical episodes for stimulating posteriorly episodic memory function known to be deficient in MCI.

To explore the association between changes **in cognitive, functional and emotional outcomes.**
Technology is “running”!

Evolution of life-logging apparatus, including wearable computer, camera, and viewfinder with wireless Internet connection. Early apparatus used separate transmitting and receiving antennas. Later apparatus evolved toward the appearance of ordinary eyeglasses in the late 1980s and early 1990s.

"Quantified Self & life-logging Meets Internet of Things (IOT)", Mazzian Abbas.
Visual life-logging

**Definition**: Visual life-logging consists of acquiring images related to an individual through a wearable camera.

**Benefits**:

- **A digital memory** of people you met, **conversations** you had, **places** you visited, and **events** you participated in.
  - This memory would be searchable, retrievable, and shareable.

- **A 14/7/365 monitoring of daily activities.**
  - This data could serve as a **warning** system and also as a personal base upon which to **diagnosis** illness and to prescribe medicines.

- A way of **organizing, shaping, and “reading”** your own life.
  - A complete archive of your work and play, and your work habits. Deep comparative analysis of your activities could assist your productivity, creativity, and consumptivity.

- To the degree this life-log is shared, this archive of information can be **leveraged to help others** work, **amplify social interactions**, and in the biological realm, shared medical logs could rapidly advance medicine discoveries.
Ethical guidelines for wearable cameras

• **Anonimity and confidentiality:** Researchers coding image data should:
  – not discuss the content with anyone outside of the team,
  – not identify anyone they recognize in the images,
  – be aware of how sensitive the data are.

• **Data encryption:** Confidentiality can be protected by configuring devices and using specialist viewing software to make the images accessible only to the research team (lost devices).
  – Devices should be configured so that data can only be retrieved by the research team. It should be impossible for participants or third parties who find devices to access the images.

• **Data storage:** Collected images should be stored securely and password-protected, according to national regulations.

• **Where is prohibited** to capture images?
Is it feasible to record everything that happens in a person’s life?

The Moore’s Law (1965): “Transistor density that can be etched onto the silicon wafer of a microchip doubles every two years”.

• In 1970, a disk to store 20 MB was the size of a washing machine and costed 20,000$.

• Today a TB (one trillion bytes) costs a 100$ and is the size of a paperback book.

• By 2020 a TB will cost the same as a good cup of coffee and will probably be in your cell phone.

• 100$ will then buy around 250 TB of storage, enough to hold tens of thousands of hours of video and tens of millions of photographs.
  – This should satisfy most life-loggers’ recording needs for an entire life.

• In fact, digital storage capacity is increasing faster than our ability to pull information back out.
  – From 2000 it became trivial and cheap to sock away tremendous piles of data.

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The hard part is no longer deciding what to hold on to, but how to efficiently organize it, sort it, access it, and find patterns and meaning in it.

This is a primary challenge for the engineers that will fully unleash the power of Total Recall.

• Given a wearable camera,

• what we want:
Wealth of life-logging data

• We propose an energy-based approach for motion-based event segmentation of life-logging sequences of low temporal resolution.

• The segmentation is reached integrating different kinds of image features and classifiers into a graph-cut framework to assure consistent sequence treatment.

Complete dataset of a day captured with SenseCam (IMEC, University of Eindhoven, March, 2015)

Choice of device depends on:
1) where they are set: a hung up camera has the advantage that is considered more unobtrusive for the user, or
2) their temporal resolution: a camera with a low fps will capture less motion information, but we will need to process less data.

We chose a SenseCam or Narrative cameras hung on the neck or pinned on the dress that capture 2-4 fps.

Or the hell of life-logging data

100,000 images per month
Towards lifestyle characterization

We want to extract life-logging information about:

- Events
- Activities
- Social interactions, etc..
- Memorable moments
- Personal habits and context
- Lifestyle...
- Healthy lifestyle...

Our egocentric vision research:

- Video segmentation and key-frame extraction
- Motion-based segmentation towards activities recognition
- Human tracking, towards social interaction
- Object recognition
- Daily pattern extraction
- Lifestyle characterization, etc, etc.

What? Where? When? Who?
One of the challenges of life-logging is how to organize the big amount of image data acquired in semantically meaningful segments in order to be able to store them and review later, being able to focus just on the most important aspects.
Event segmentation and key frame extraction
Activity recognition

SenseCam images

ImageNet images
Social interaction analysis
But life-logging is not only useful for memory enhancement!

Towards lifestyle characterization
Life-logging for healthy lifestyle

Characterize and assist healthstyle of people: application to patients with obesity, cardiovascular diseases and diabetes

- Eating pattern
- Quality of diet
- Environmental factors
- Behaviour intervention
Life-logging for wellbeing

Automatically generation of lifestyle patterns and interpretations opens many research questions:

- how to extract **semantic units** related to the lifestyle and their context relation,

- how to **segment life-log data** into meaningful events,

- what are the semantic units that **characterize the lifestyle** of individuals,

- what is their **relation and how the context** affects them,

- how to extract and **characterize lifestyles** patterns,

- what is the **healtstyle**, etc.

**Life-logging used for behaviour intervention. But how to get objective bioarkers?**
Functional MRI as a unique tool to analyze the neural activity of patients.

**Towards:**

- Use fMRI to detect objective biomarkers of obesity.
- Combine visual life-logging and fMRI to follow-up the effect of behaviour intervention.
Conclusions

- Visual lifelogging allows to observe individuals behaviour and thus has multiple applications to different diseases (mental, cardiovascular, metabolic).

- Healthcare, in general, is moving from diagnosis & intervention towards prevention (primary and secondary).
  - What about medical images?

  - What about image-based behaviour intervention of patients?

- Medical imaging health applications -> (medical) imaging health applications.

- The combination of medical images, photographic images and other biosignals (understood as any signal in living beings that can be continually measured and monitored) is a very rich and novel research field with big potential for challenging and not expoitied yet applications.

Thank you! 😊