Eye Tracking and EMA in Computer Science

Computer Literacy 1 Lecture 23
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Topics

- Eye tracking definition
- Eye tracker history
- Eye tracking theory
- Different kinds of eye trackers
- Electromagnetic Articulography (EMA)
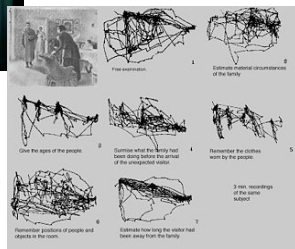- Praat - free software to analyse speech in Phonetics

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Eye Tracking

- Eye tracking the process of measuring either the point of gaze or the motion of an eye relative to the head
- An eye tracker is a device for measuring eye positions and eye movements

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Eye Tracking history in a nutshell

- Eye tracking and how we know it today was established by A. Yarbus in the 50s
  - One example of his work is that he showed that the task given to a subject has a very big influence on the subject's eye movement
- In the 1980's Just and Carpenter formulated their "Strong eye-mind hypothesis"
  - This hypothesis states that when a subject looks at a word or object, they also process it cognitively for exactly the same time they're looking at it

Eye Tracking Theory

- In the late 90's Hoffman published his finding that visual attention is always slightly (100 - 250 ms) ahead of the eye

Eye Tracker

- An eye tracker measures rotations of the eye

Different Eye Trackers

- Three different kinds:
  - One kind uses an attachment to the eye (like a contact lens) with an embedded mirror or magnetic field sensor. This eye tracker is very accurate in its measurements but very uncomfortable for the subject
  - The second category uses contact electrodes which are placed near the eyes. The most common variant here is the electro-oculogram (EOG) and is based on the fact that the eye has a standing electrical potential

Third kind

- The eye tracker which is quite common uses a non-contact optical method. Usually infra-red light is reflected by the eye from the eye and sensed by a video camera or an optical sensor. Information of eye rotation is then extracted by analysing changes of reflection

Eye tracking vs Gaze tracking

- If you are eye tracking or gaze tracking depends on what kind of eye tracker system is being used; a head mounted or table mounted one
  - Head mounted means eye in head angle is being measured
  - Table mounted means gaze angles are measured

Where do you use eye tracking

- Cognitive science
- Computer usability
- Translation Process Research
- Virtual Reality
- Communication Systems for Disabled
- Etc …

From eye tracking to articulation

- Articulatory research
- Electromagnetic articulography (EMA)
- PRAAT: Software doing phonetics by your computer

Articulatory Research

- Needed in Computer Science for speech recognition
- You can use two different approaches to collect data in articulatory research
- EPG = Electropalatography
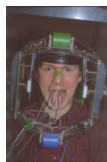- EMA = Electromagnetic articulography

EPG

- EPG uses a thin artificial palate to measure tongue-palate contact during an utterance
- Contact of the tongue with any of the 62 electrodes embedded in the palate completes an electrical circuit, and tongue-palate contact is registered

EMA

- In EMA electromagnetic transducers are mounted in a helmet worn by the subject
- The transducers induce a current in coils placed on the articulators
- The strength of the current is used to locate the position of the articulators
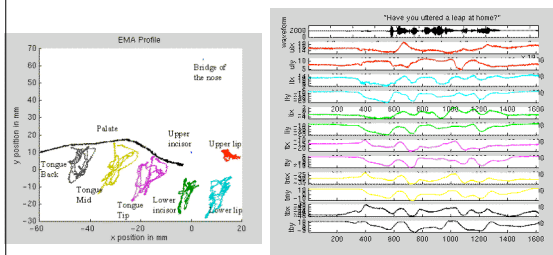

How does EMA work

- Each of the transducers fixed on the helmet produces an alternating magnetic field at different frequencies
- The alternating magnetic field induces an alternating current in the sensors, much like in a transformer and allows one to obtain the distances of each sensor from the transducers
- It is then possible to calculate the XY coordinates and measure, store and display the positions of the sensors
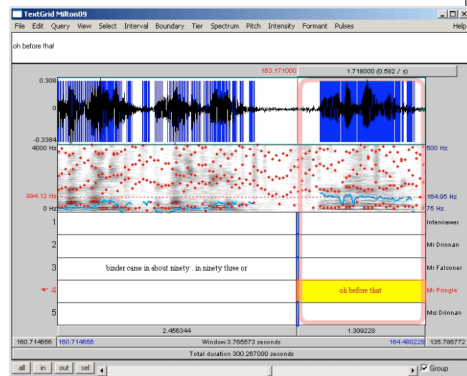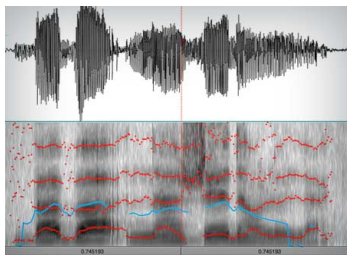
EMA profile

PRAAT

- Praat (Dutch for "talk") is a software to analyse speech in Phonetics
- It also supports speech synthesis and articulatory synthesis (e.g electrical vocal tract analogues)
- Developed by Paul Boersma at the University of Amsterdam
- Free software
- Runs on Unix, Mac and Windows

Sound pattern and Spectrogram in PRAAT

Key points

- What does an eye tracker measure
  - Rotation of the eyes
- What the difference between eye tracking and gaze tracking
  - Head mounted or table mounted eye tracker
- Eye tracking is used in cognitive science, computer usability, etc…
- For speech recognition we need to analyse spoken utterances, how is this done:
  - We measure positions of articulators we need current and sensors
  - Praat is a free software that enables us to annotate and analyse speech very thoroughly