Please download programs
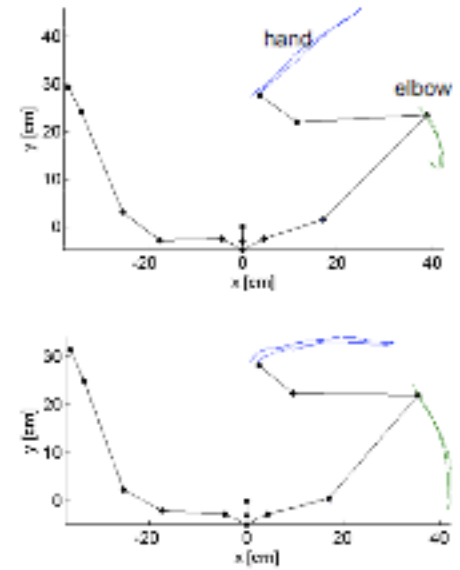
**AudioVideoAnalysis
& VideoAnalysis
from
https://www.uio.no/english/research/
groups/fourms/software/
and video
http://www.michaelschutz.net/images/
asaDocument/marimbaTimbre.mp4**

Sofia Dahl

Motion data and analysis

After today you should be able to…

…give examples of approaches and technologies that can be used to record and analyze movement in music performance.
…evaluate pro's and cons of different techniques depending on aim of study and general context.
…describe basics of video based analysis and its limitations

How can we measure and describe musicians' movements?

Firstly: In order to measure something, we need to be sure of what it is we want to measure. What is the "MOVEMENT" itself?

Define!

How can we measure and describe musicians' movements?

- Technology for recording /capturing movement
- Descriptions of Movement
  - McNeill – gesture and speech
  - Laban movement analysis
- Tools for annotations and analysis

What technologies can we use?

electromagnetic   sensor-based motion capture

Sofia Dahl sof@create.aau.dk

mechanical   sensor-based motion capture

(From Jensenius, 2013)

inertial   sensor-based motion capture

Surface
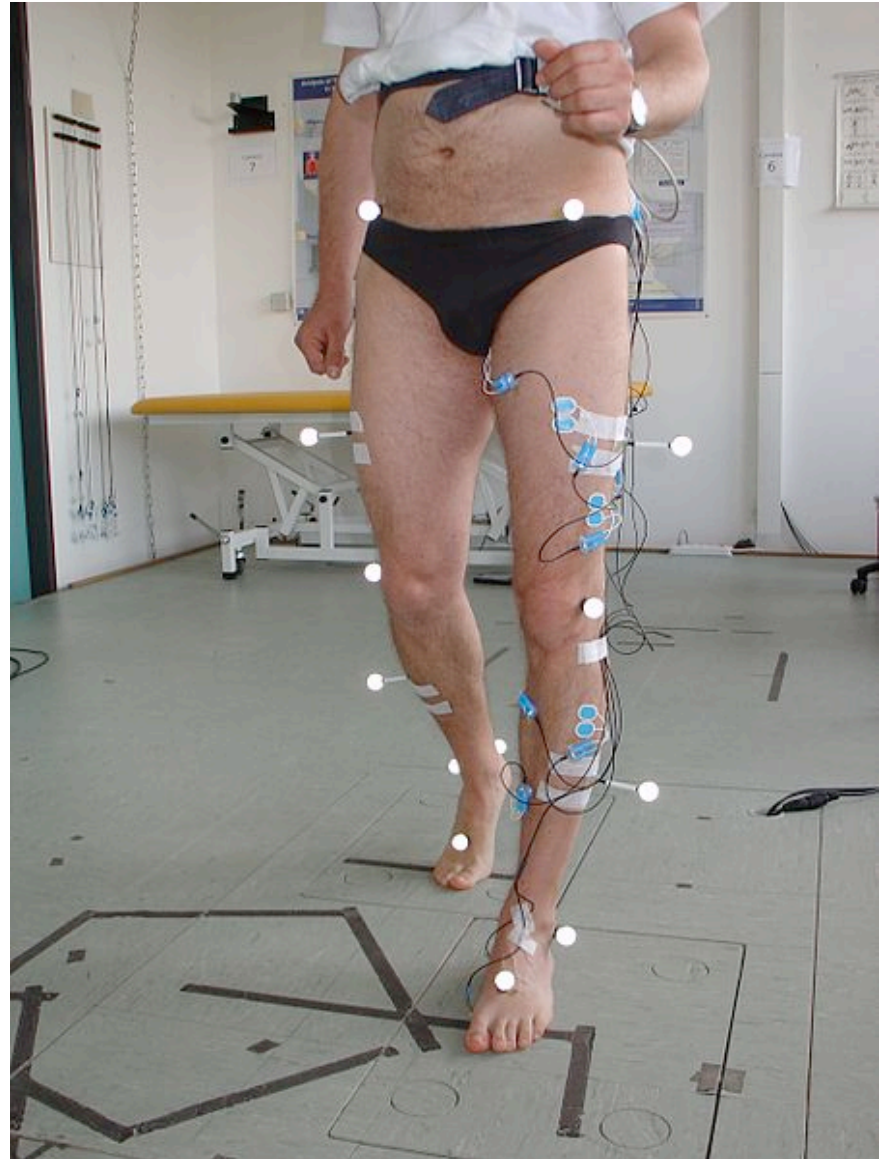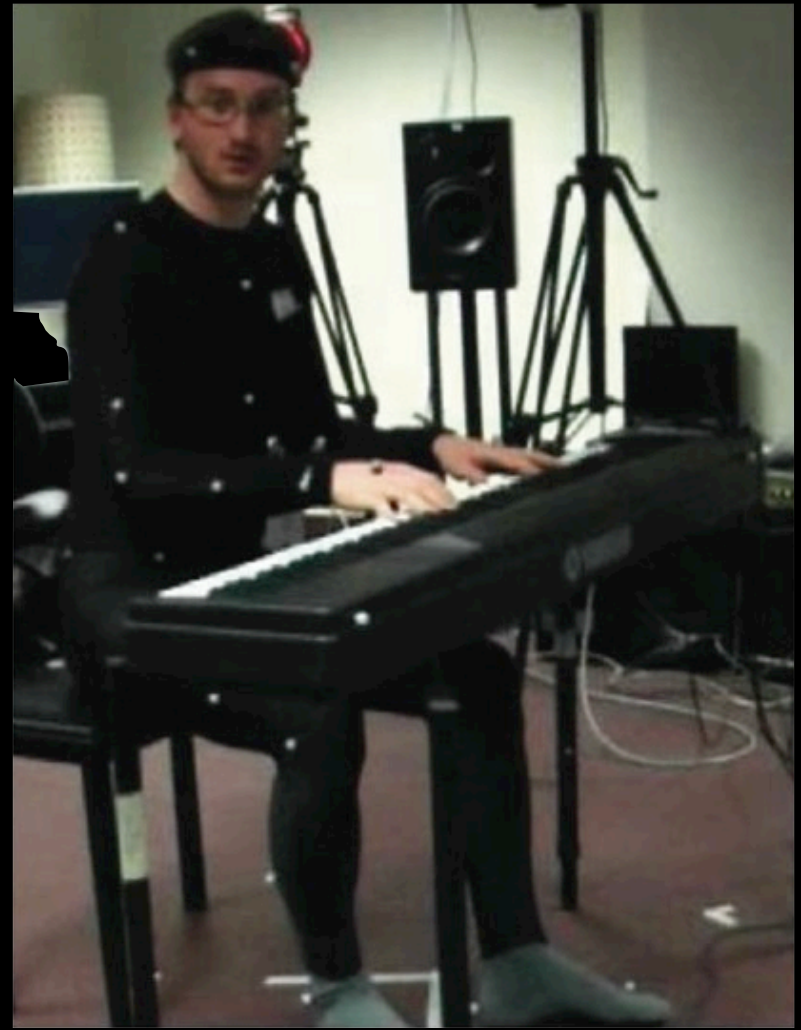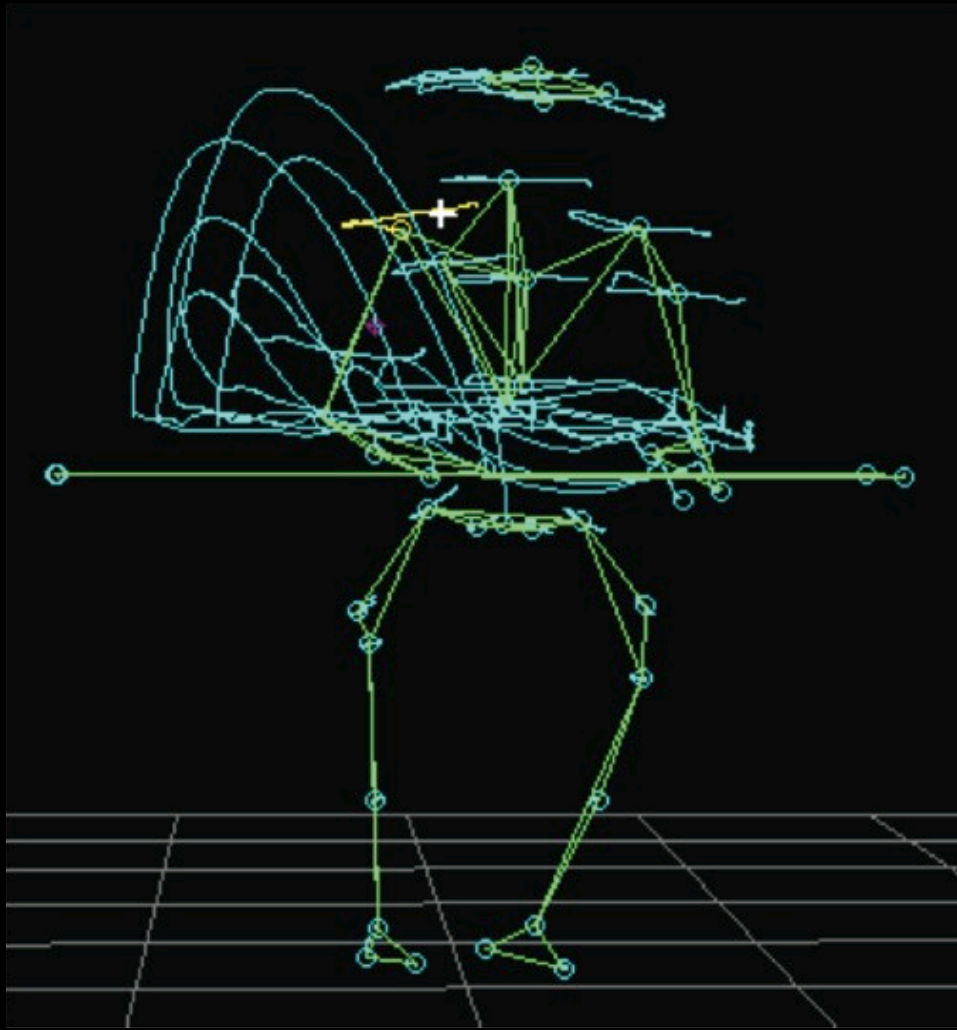electromyography
- Muscle activity

Other examples
of physiological
measures of movement?

Optical tracking techniques

-    tracking using
     multiple cameras

optical infrared marker-based motion capture

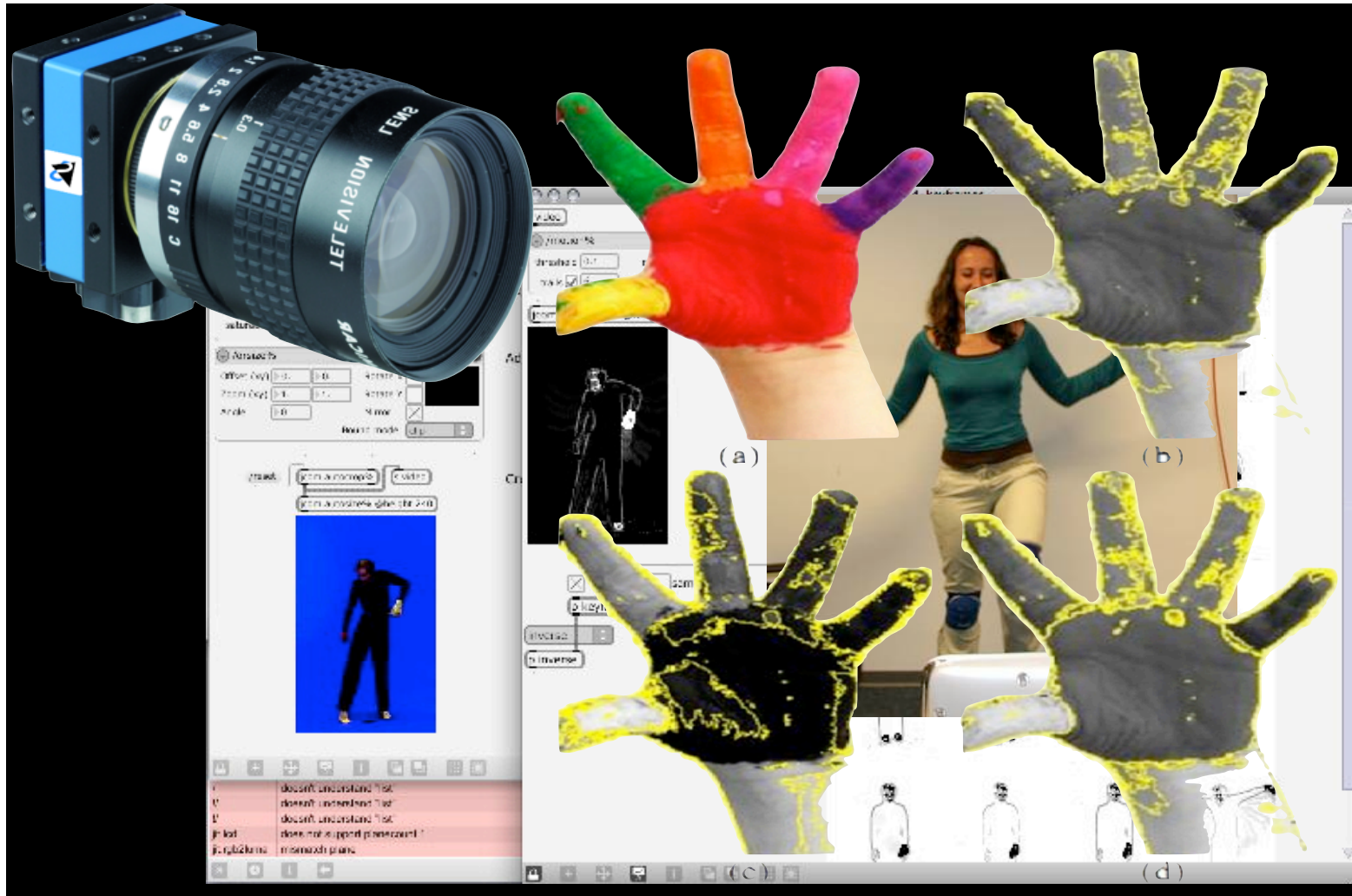Sofia Dahl sof@create.aau.dk

Markerless tracking with
(limited) depth estimation

Image processing techniques allow movement detection and tracking from single camera images based on colour tracking and filtering.

(From Jensenius, 2013)

Optical (visual)

Optical (infrared)

Inertial

Electromagnetic

Mechanical motion capture

Physiological

(From Jensenius, 2013)

How to evaluate the available options?

- Depends on the price, the setting and type of motion.

What is the need for

  - precision?

  - speed?

  Are markers intrusive?

  Are light conditions stable?

	Inertial/ magnetic	Mechanical	Electro-magnetic	Optical (visual)	Optic (infrared)	Physiological
+	- flexible - small	- flexible - small	- resolution - identification - absolute	- flexible - no cables - no markers - accessible	- speed - resolution - # markers	- indirect motion sensing
–	- relative	- relative	- cable - short range	- 2D - speed - resolution - identification	- markers - calibration - identification	- indirect motion sensing

(From Jensenius, 2013)

How can we classify and describe movements?

- Qualitative
- Quantitative

Repetition: Functional categorization of players' movements

1. Sound-producing movements:

- Primarily for the production or modification of notes

    (Conveying intention and expression through the resulting sound events)

2. Communicative movements:

- Directly expressing intentions of the performer to observers and co-performers.

3. Sound-facilitating movements

- Movements not directly related to, but *supporting* the production of notes,

4. Sound-accompanying movements

- Movements not involved in sound production but follow the music or made in the response to sound.

(See Godøy & Leman, 2009)

Repetition: Space

- ACTION space
- Where in the space do different types of movements occur?

Ancillary, sound-accompanying, and communicative

Sound-producing

Sound-modifying

Examples from classifying gestures in speech

McNeill: "Kendon's Continuum"

Gesticulation => Speech Linked => Pantomime => Emblems => Sign Language
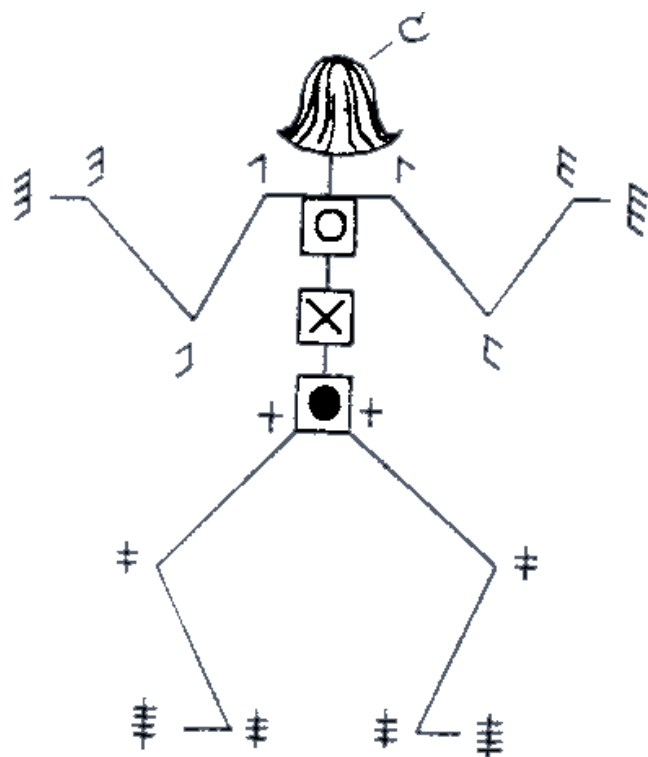
Increase in how movements show language properties

DECREASE in being obligatory accompaniment to speech

Example, what kind of category is this?
http://www.youtube.com/watch?v=kS21T_p0pNA

Laban Notation

- Rudolf Laban (1879-1958)

Six Fairy Variations | Variation 3 – FALLING CRUMBS | Prologue, Sleeping Beauty

Choreography by M. Petipa, reconstructed by Mary Skeaping
Labanotation by Ann Hutchinson

The encircled measure numbers correspond to the numerals in parentheses of the music.

Laban Movement Analysis

- ## EFFORT
  - Space   (Direct   ----   Flexible)
  - Weight   (Light   ----   Strong)
  - Time   (Sustained ----   Quick)
  - Flow   (Free   ----   Bound)

  …combinations give rise to different "effort actions"
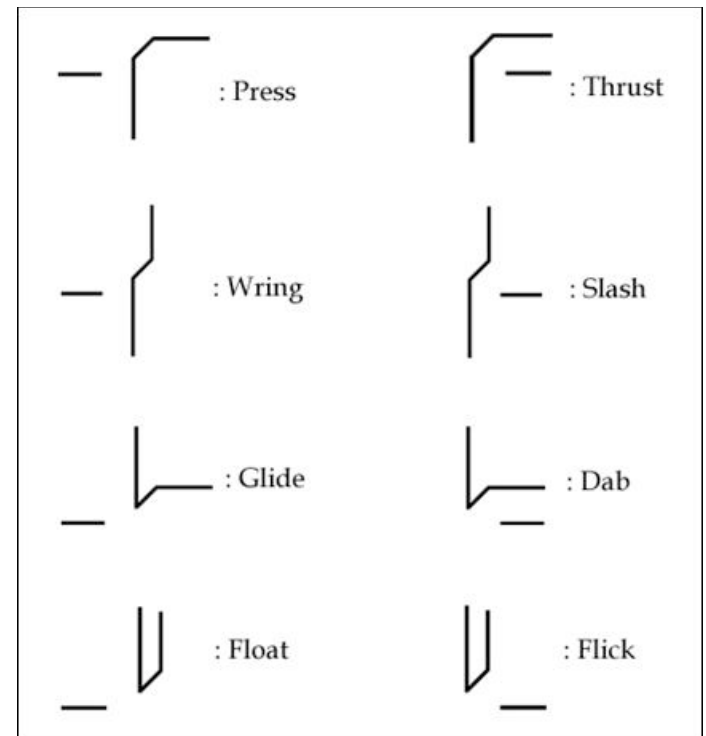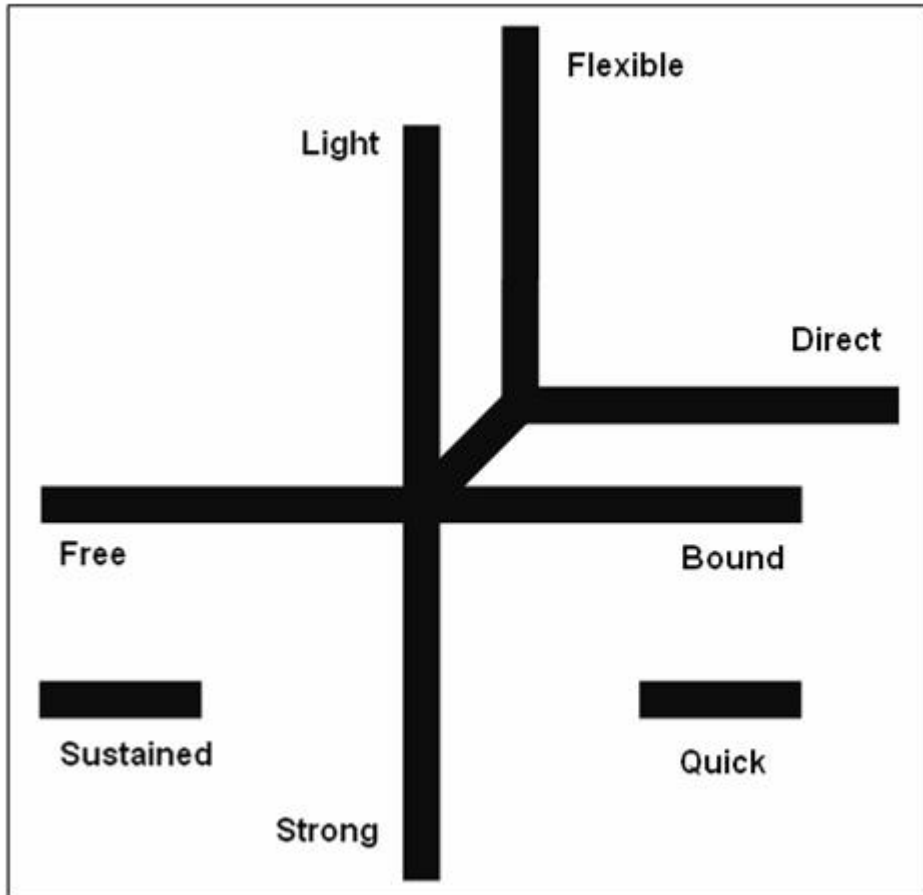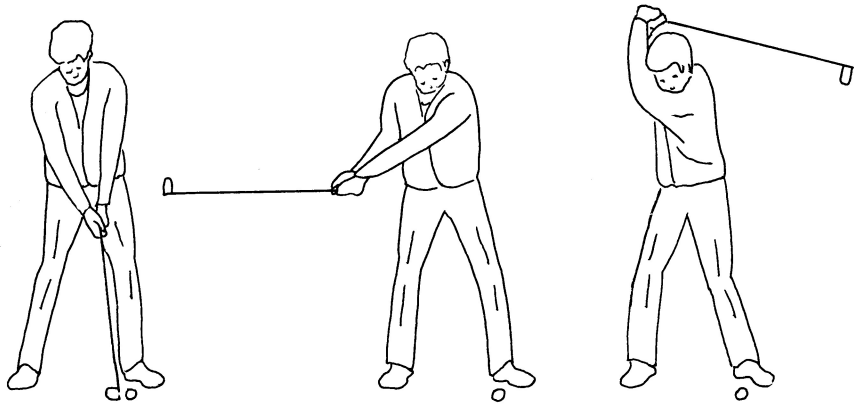
Examples of effort actions used in theatre training
http://www.youtube.com/watch?v=GrAyNodiXg4

From images to quantitative data

Time series pictures
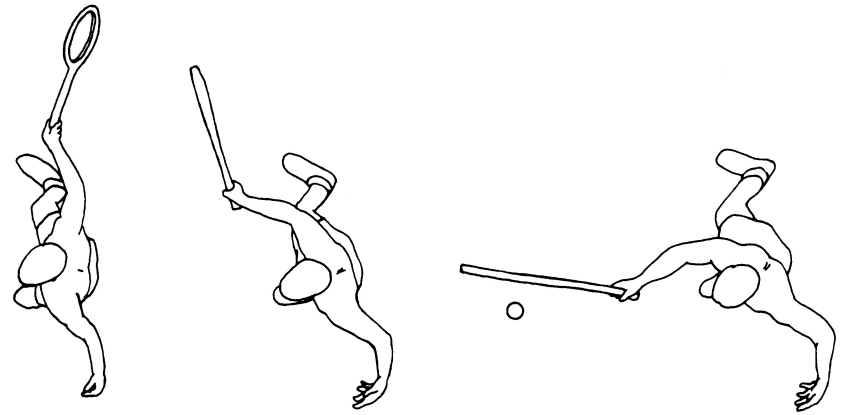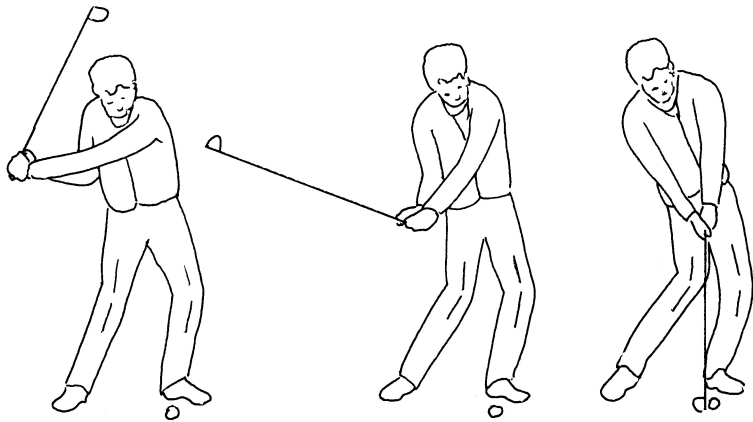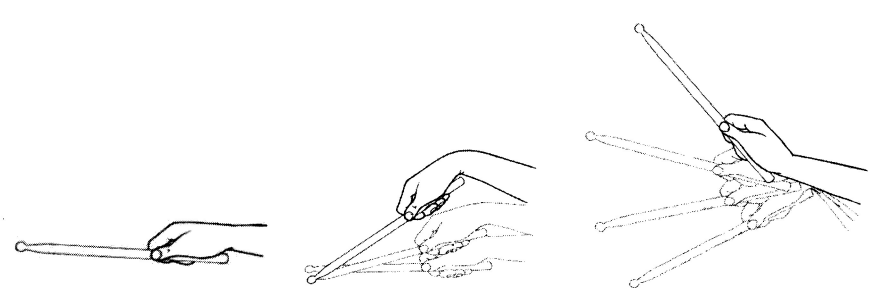
Capturing still images from video to measure
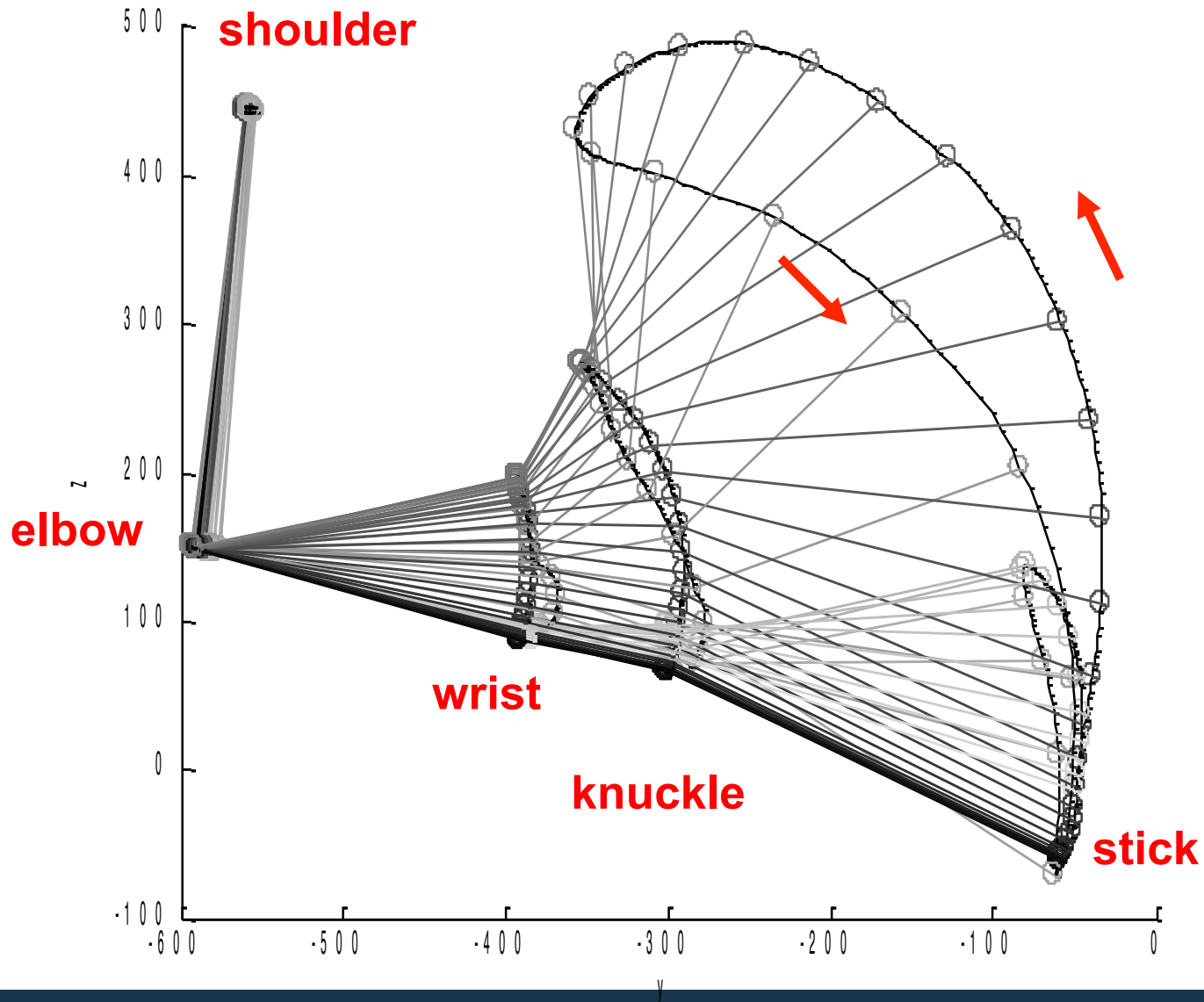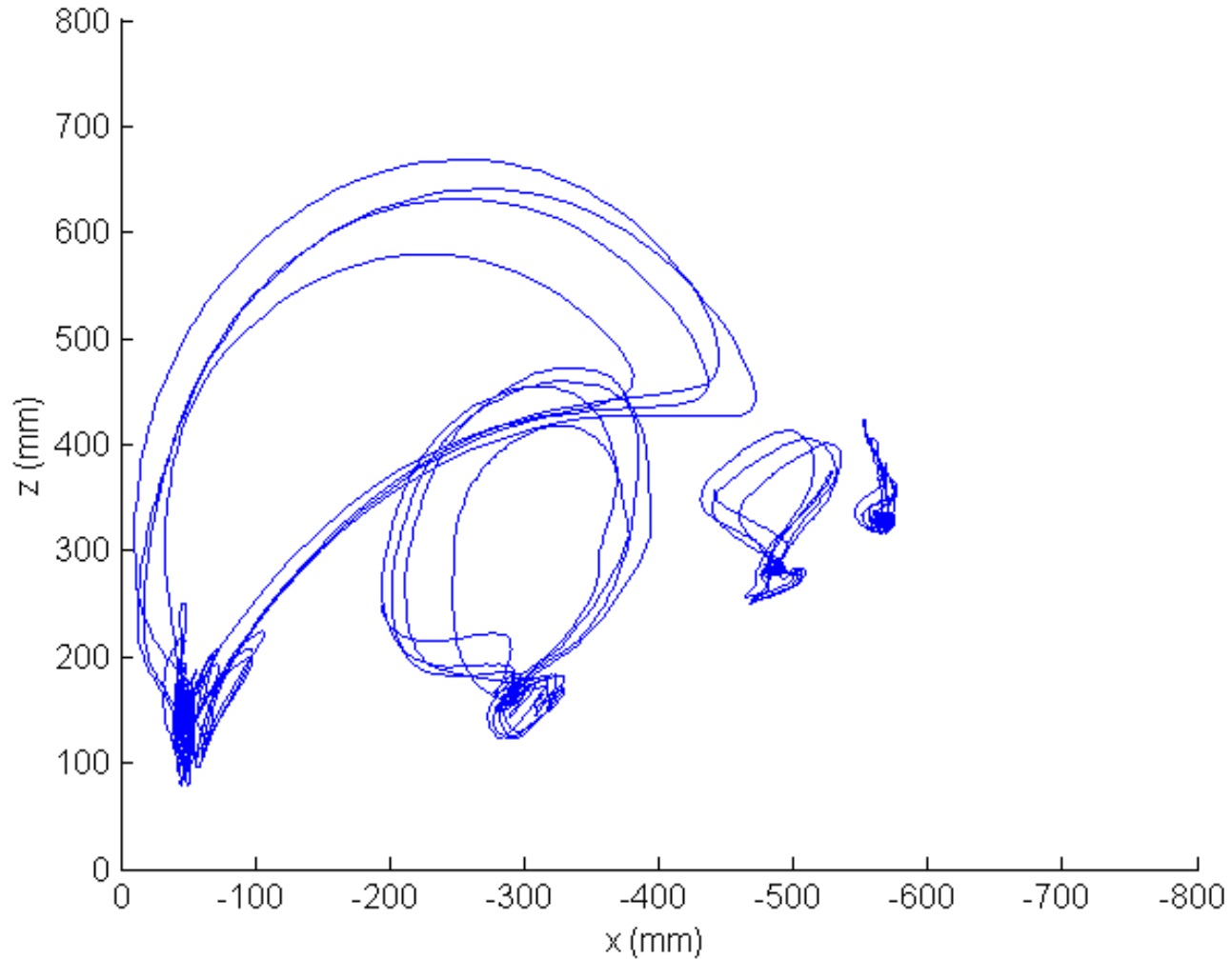

(From Jensenius, 2013)

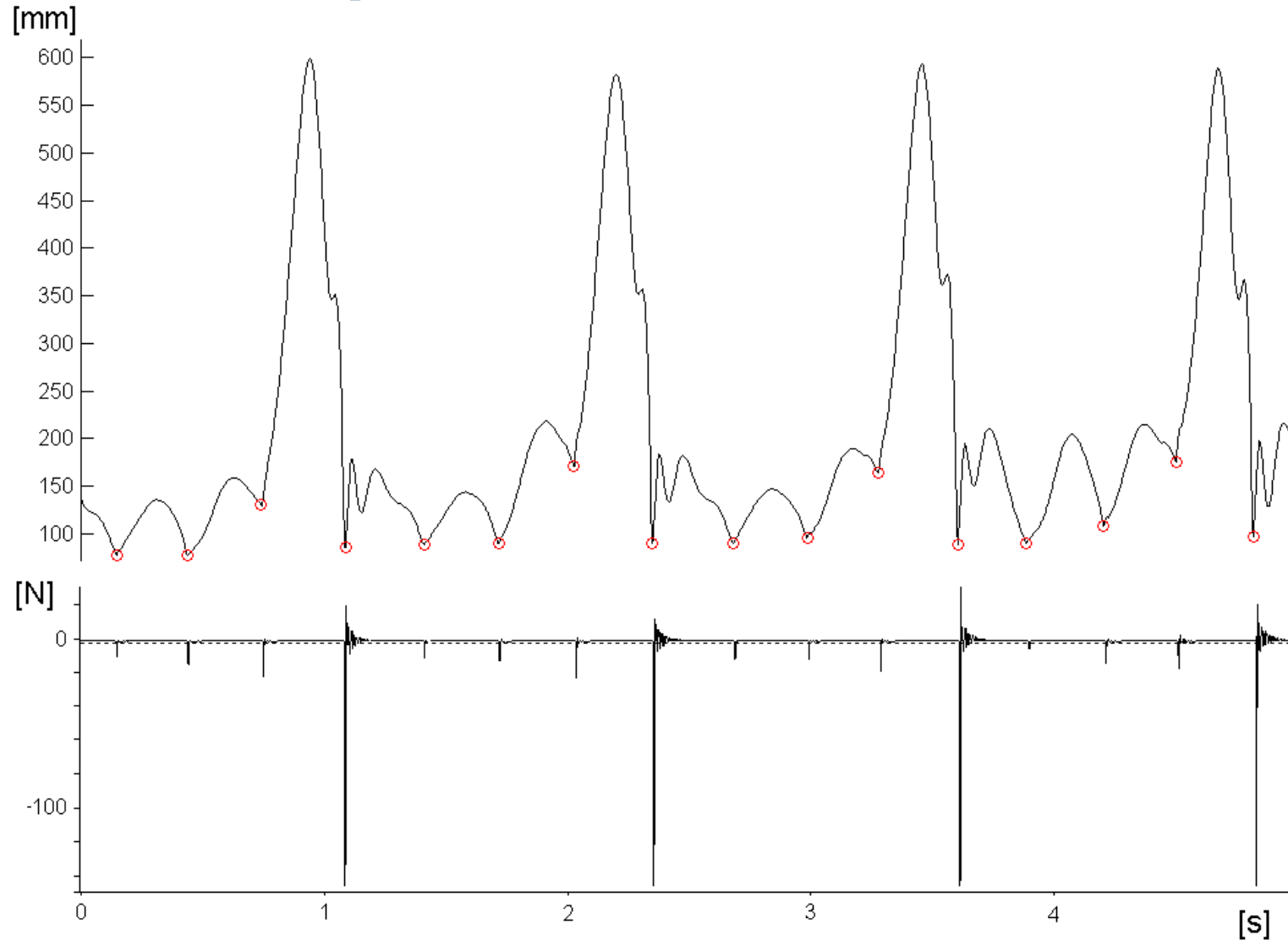# Video fotage in front of measuring grid
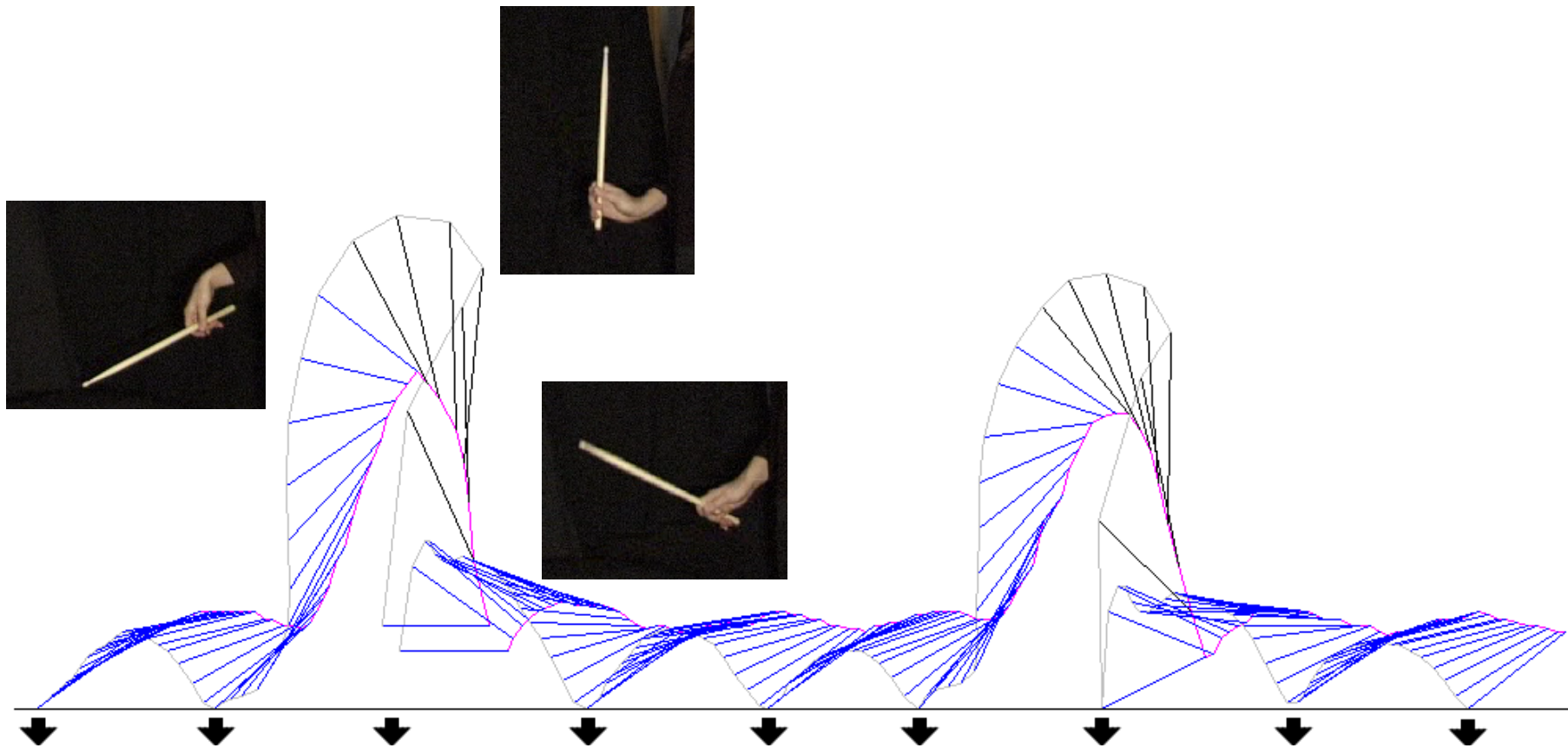
Stick figure from Motion Capture data
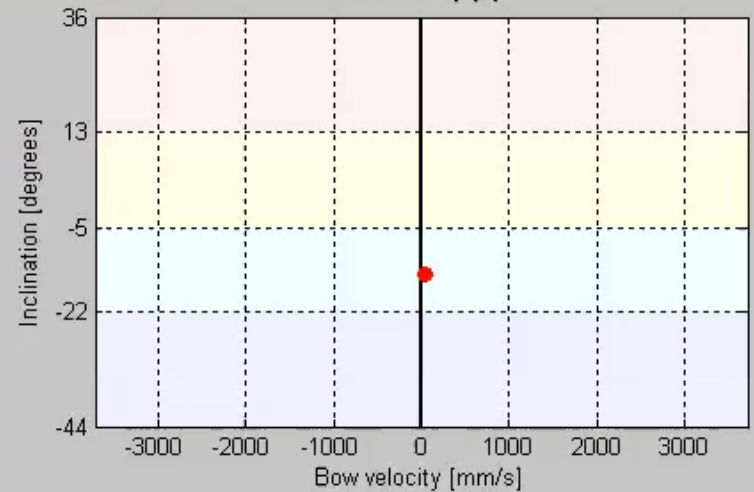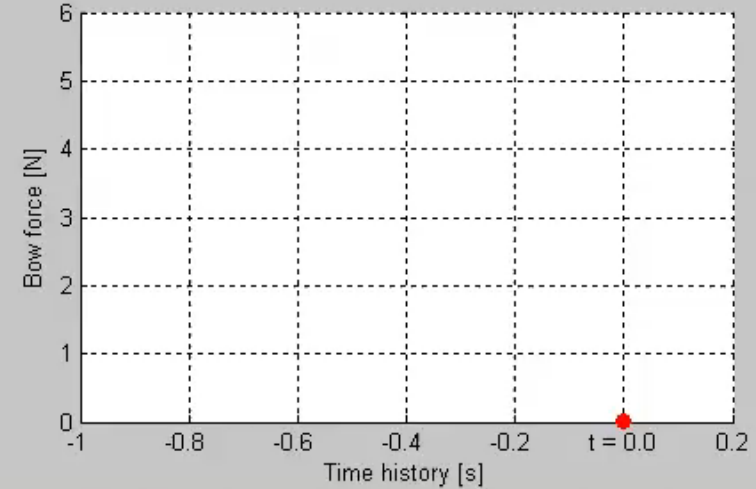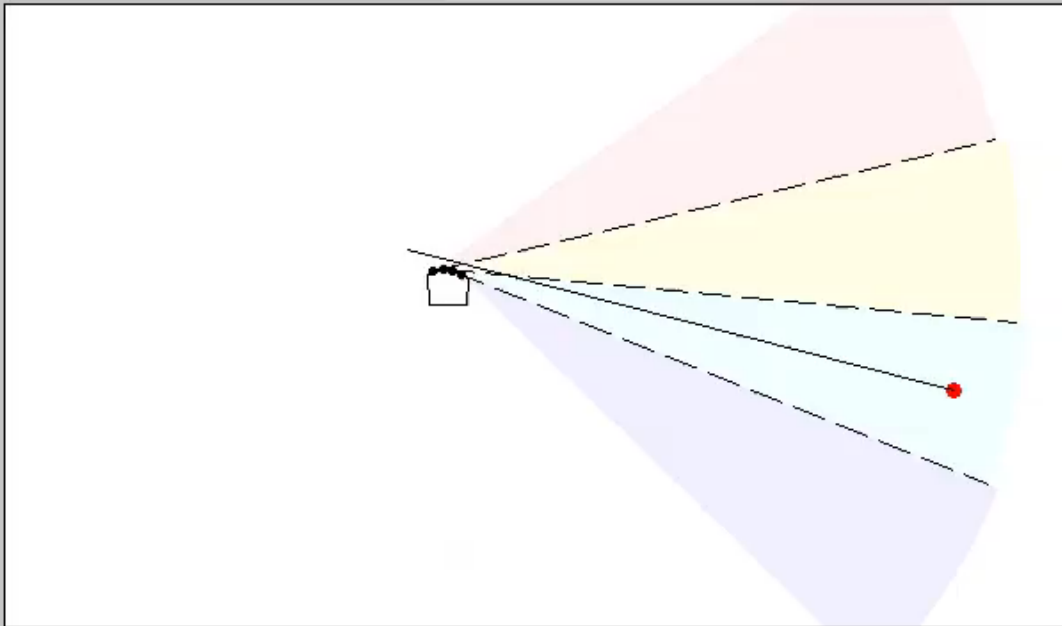
Motion capture data
Whole limb motion trajectory

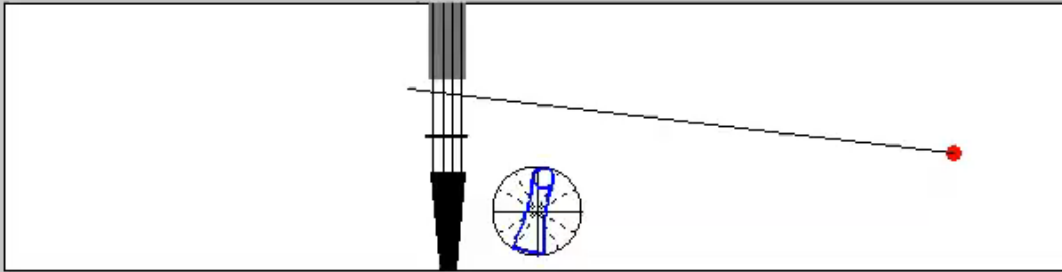# Vertical component only with force data

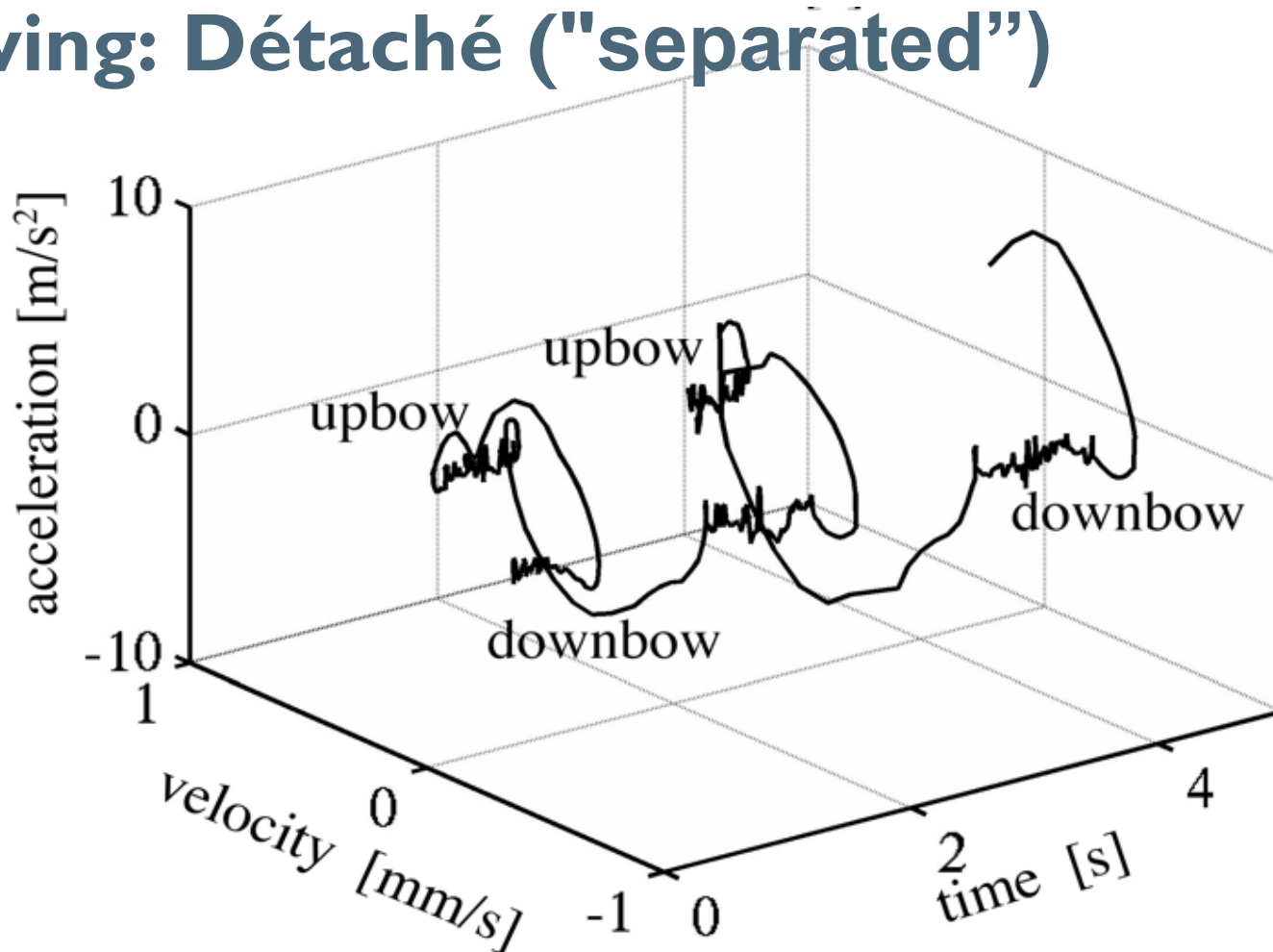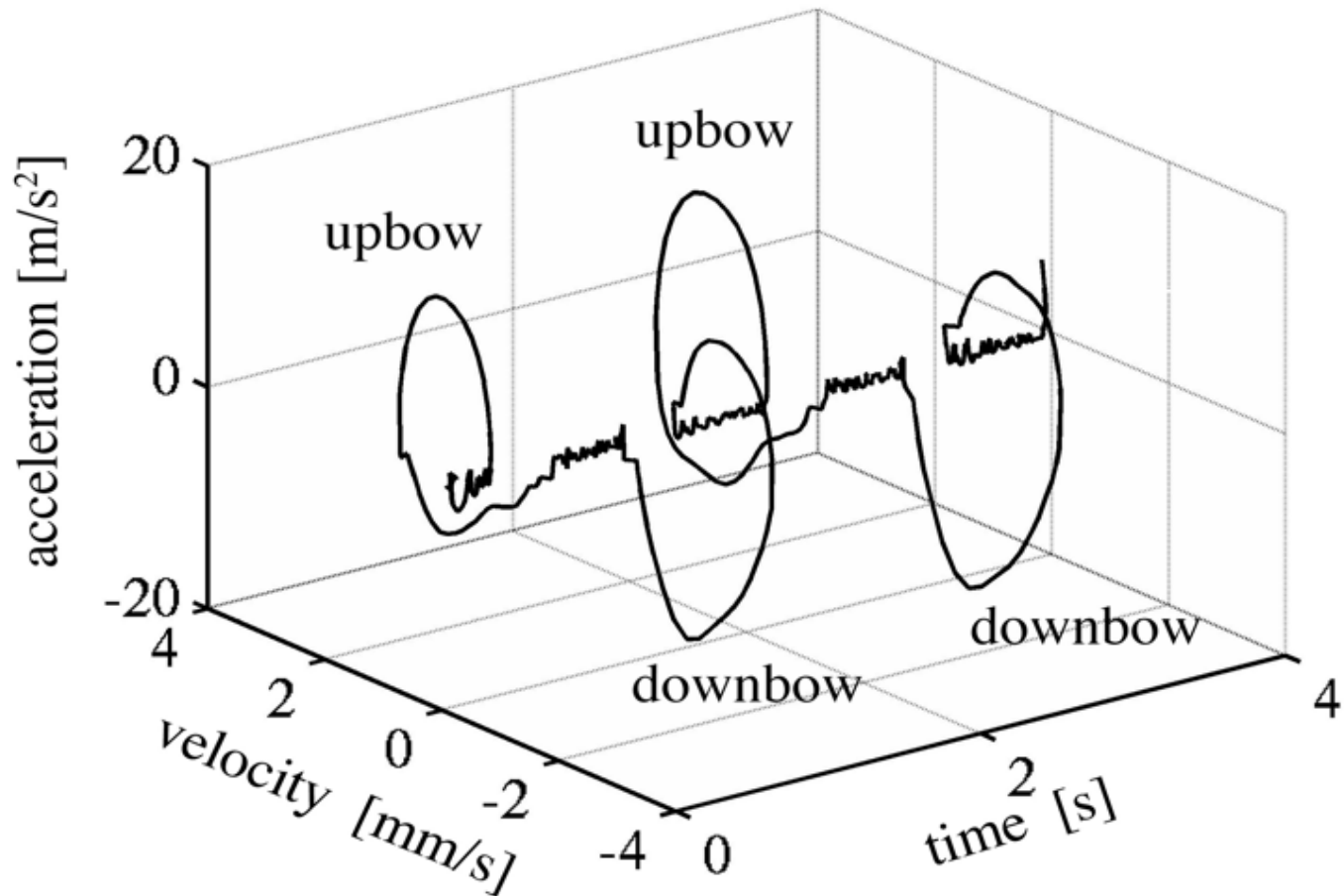# Movement and force measurement in violin playing

Bowing: Détaché ("separated")
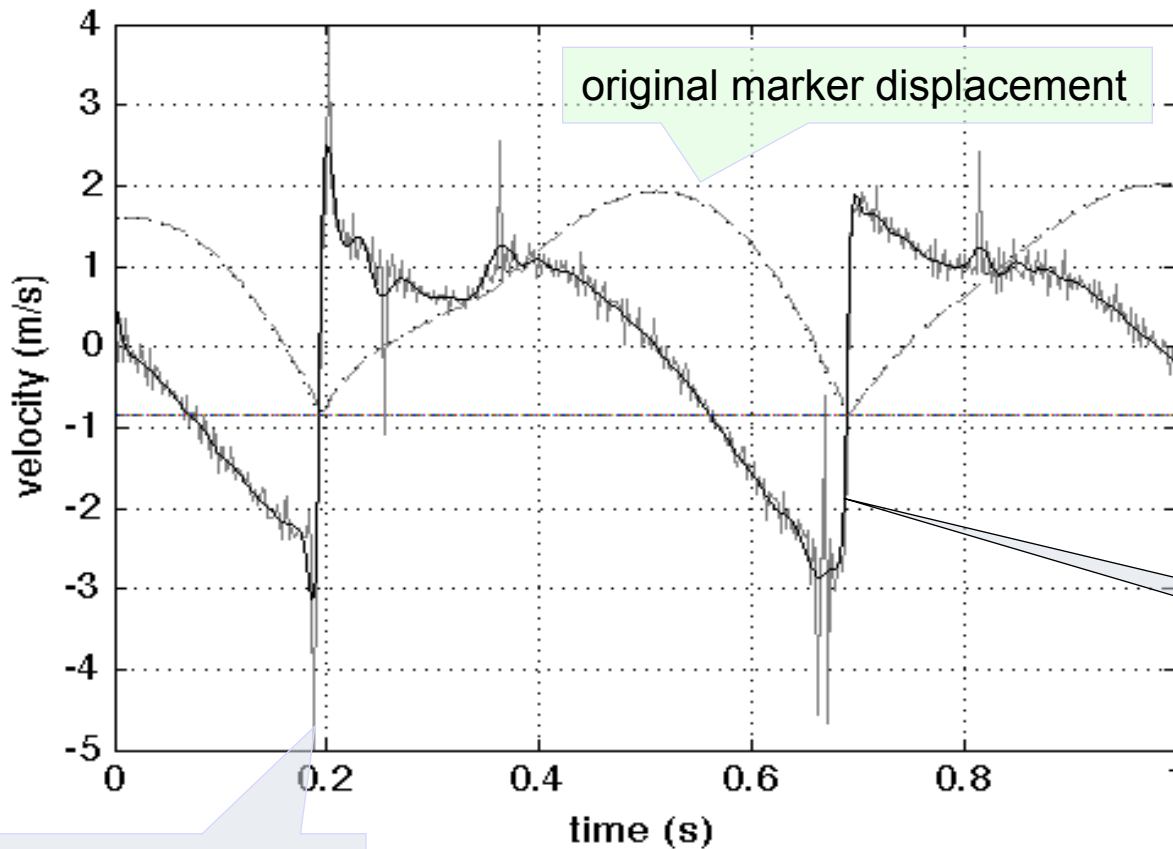

(Bild: Rasamimanana & Bevilacqua; Ton:Young)

Bowing: Martélé ("hammered")

(Bild: Rasamimanana & Bevilacqua; Ton:Young)

Velocity from motion data

original marker displacement

Even little noise in capture data gets amplified when calculating the velocity!
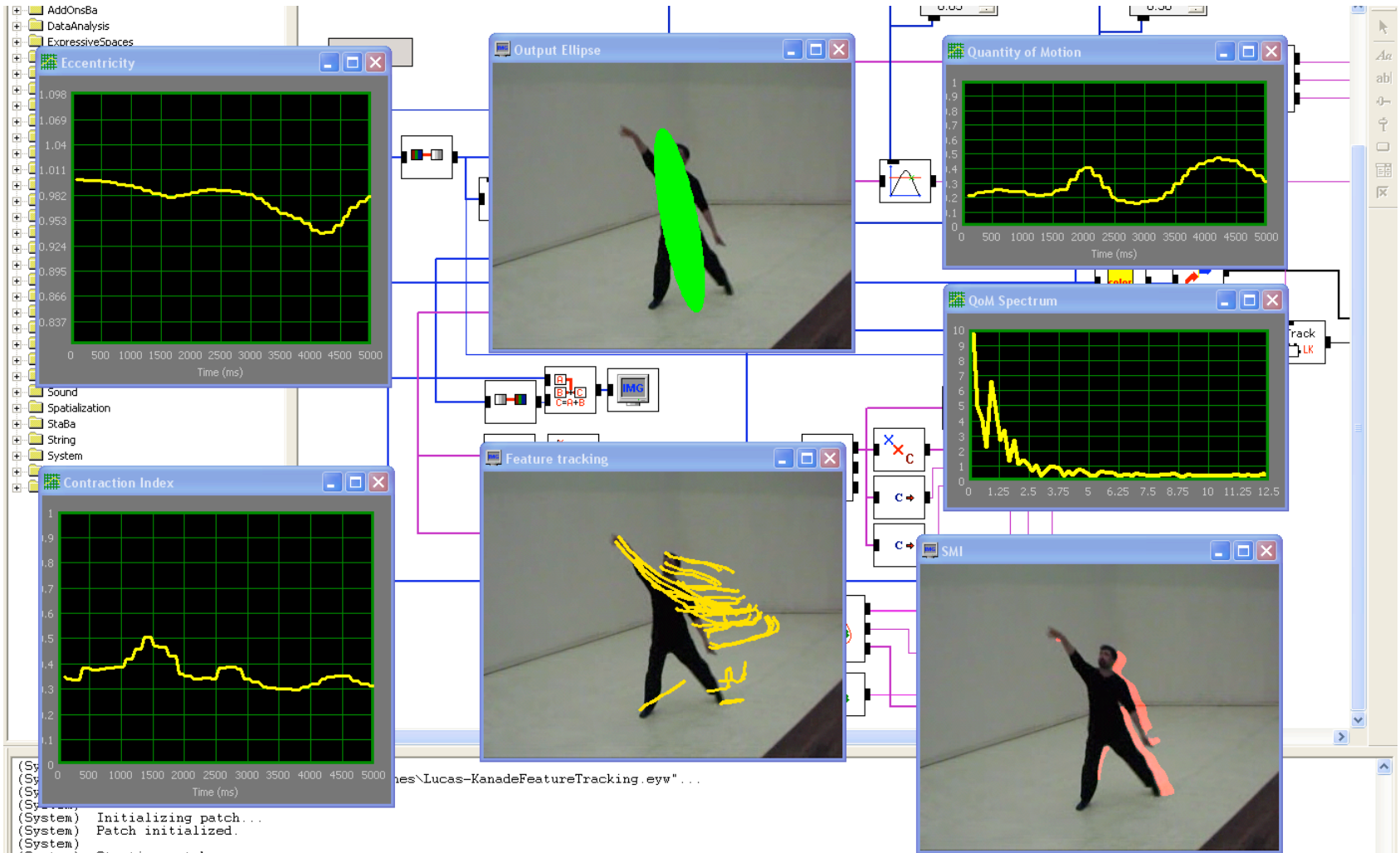
filtered velocity

calculated velocity

A second derivative (acceleration) is even noisier!

Tools for movement analysis (music applications)

- Video annotations
  - Anvil http://www.anvil-software.org/
  - Video Note Taker http://videonotetaker.sourceforge.net/
- EyesWeb
  - http://www.infomus.org/eyesweb_ita.php
- MAX/MSP and Jitter http://cycling74.com/
  - Jensenius: Musical Gestures Toolbox, AudioVideoAnalysis and more
  - https://www.uio.no/english/research/groups/fourms/software/
- Pure data http://puredata.info/
- Open Frameworks http://www.openframeworks.cc/
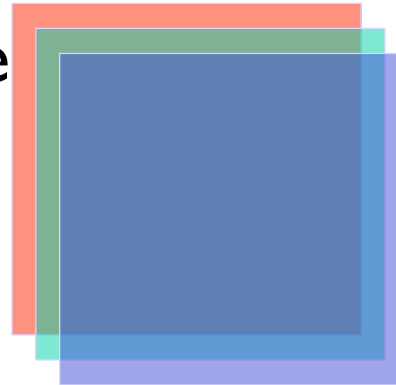 - open source C++ toolkit
- Matlab

Eyesweb

Short on Video format

What is

- Pixel?

- Frame rate?

- Channel?

Typically the video stream consists of three layers

- Each FRAME in the video stream consists of many PIXELS
- The number of images, frames per second, is the FRAME RATE (typically 25 or 30 for video).
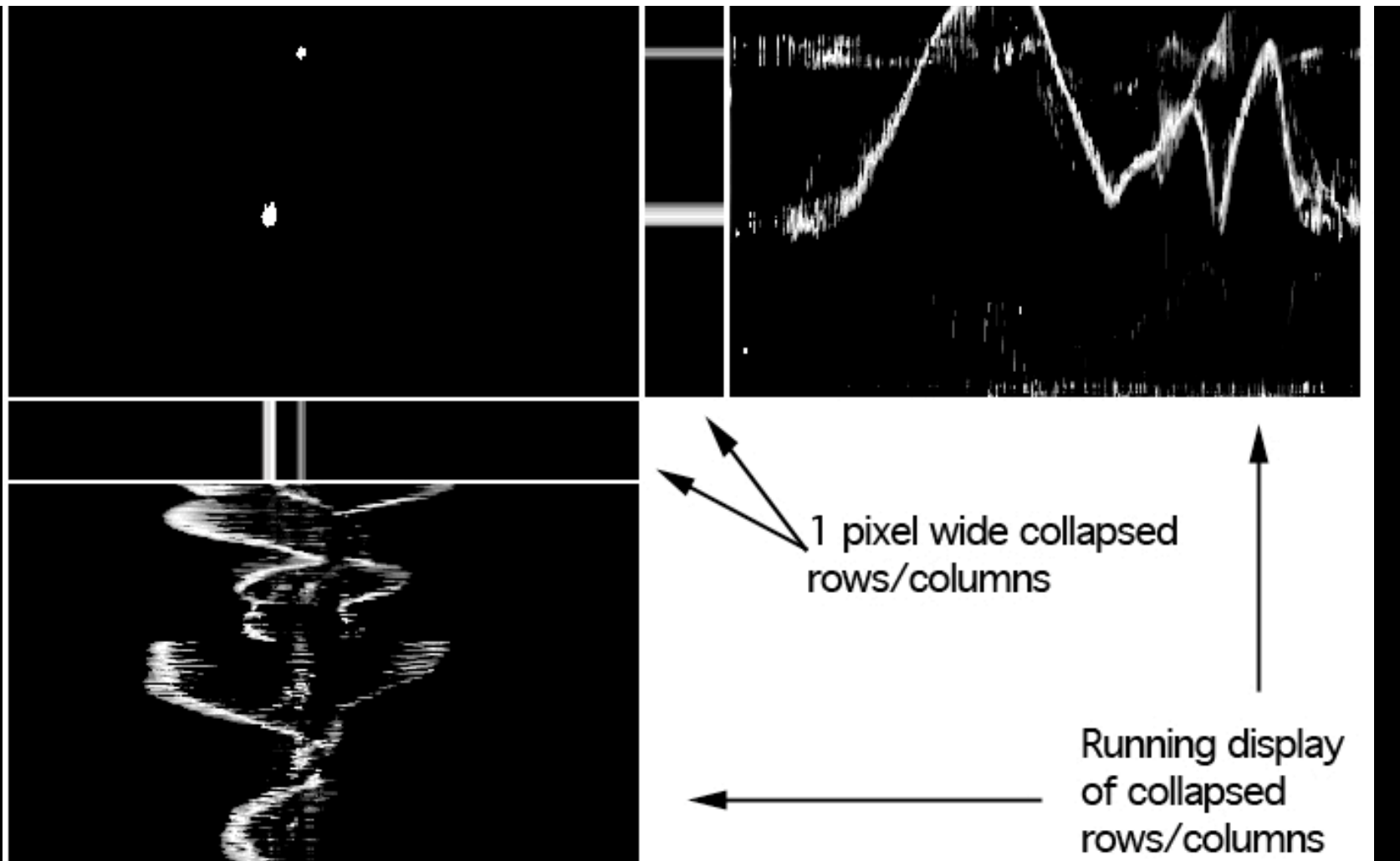- Each PIXEL in the image has three values for the channels: Red Green Blue

- Often we are interested in ONE value, combining the three channels (by averaging, or thresholding)
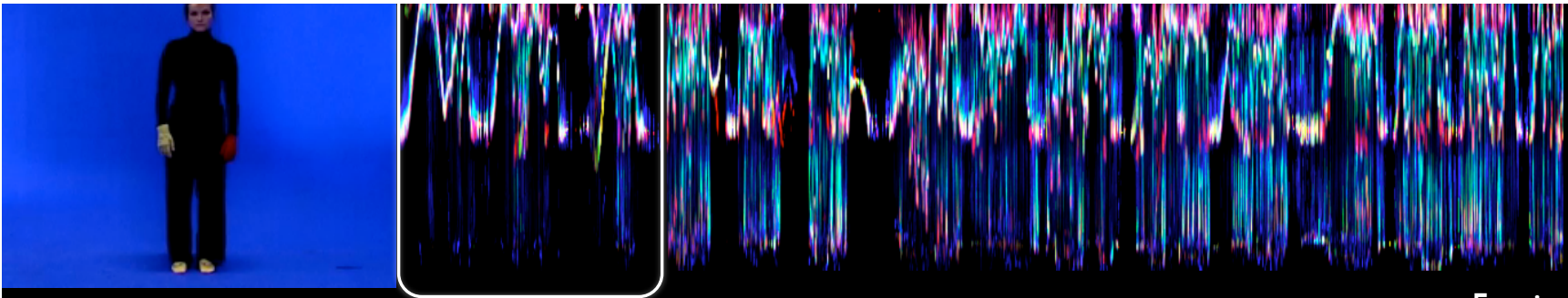
Image subtraction

- The difference between frames can give information about the *change* in the image between frames
  => Information on MOVEMENT

Collapsing the image information

(From Jensenius, 2013)

5 min

Bevegelseskurve

(From Jensenius, 2013)

(From Jensenius, 2013)