# Movement without motion

## the role of body postures in action recognition and understanding

# Overview

Introduction to Body Postures
- The importance of body postures in HCI
- How Action Recognition benefits from Body Postures

Action Recognition and Body Postures
- Excursus: Processing pathways in the human visual system
- An Action Recognition Framework
- Static Body Postures: Cases of Implied Motion?

A Neural Model for Implied Motion
- Structure of the model
- Learning of Actions
- Results / Model Behaviour
- Limitations / Open Questions / Ongoing Work

Future Work
- Stick figures for representation of body postures
- Learn grammars using HHMM

# Why are body postures relevant for HCI

## Some examples containing rich body postures


Nonverbal Communicational Signals:

- Guide attention
- Show interest
- Express agreement
- Express resoluteness
- Show self assurance



# Body postures and Action Recognition

## Why Action Recognition might benefit from body postures

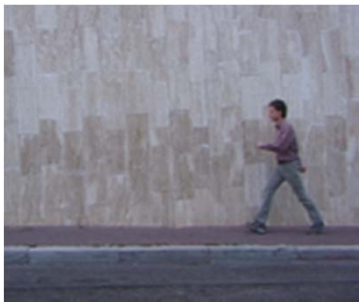
non-articulated

articulated

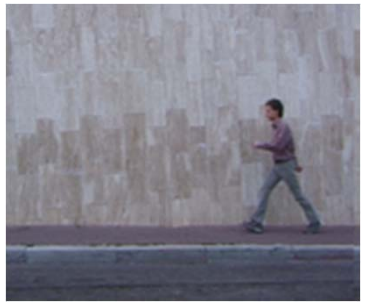
Changes in the body postures are a key property of biological motion.

Certain body postures contain more information about the performed action than others and allow an anticipation of the action.

biological



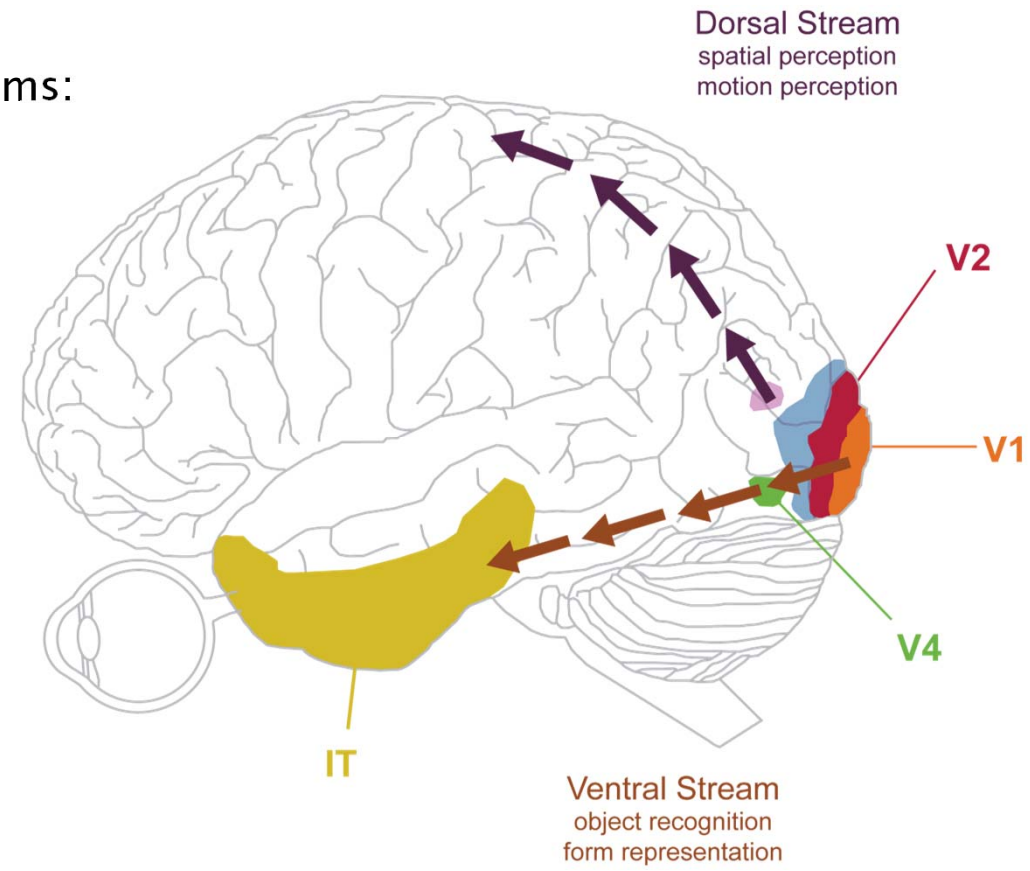
non-biological



# Processing pathways in the human visual system

Two separate processing streams:

- Ventral stream
  - Object recognition
  - Form representation
- Dorsal stream
  - Spatial perception
  - Motion perception

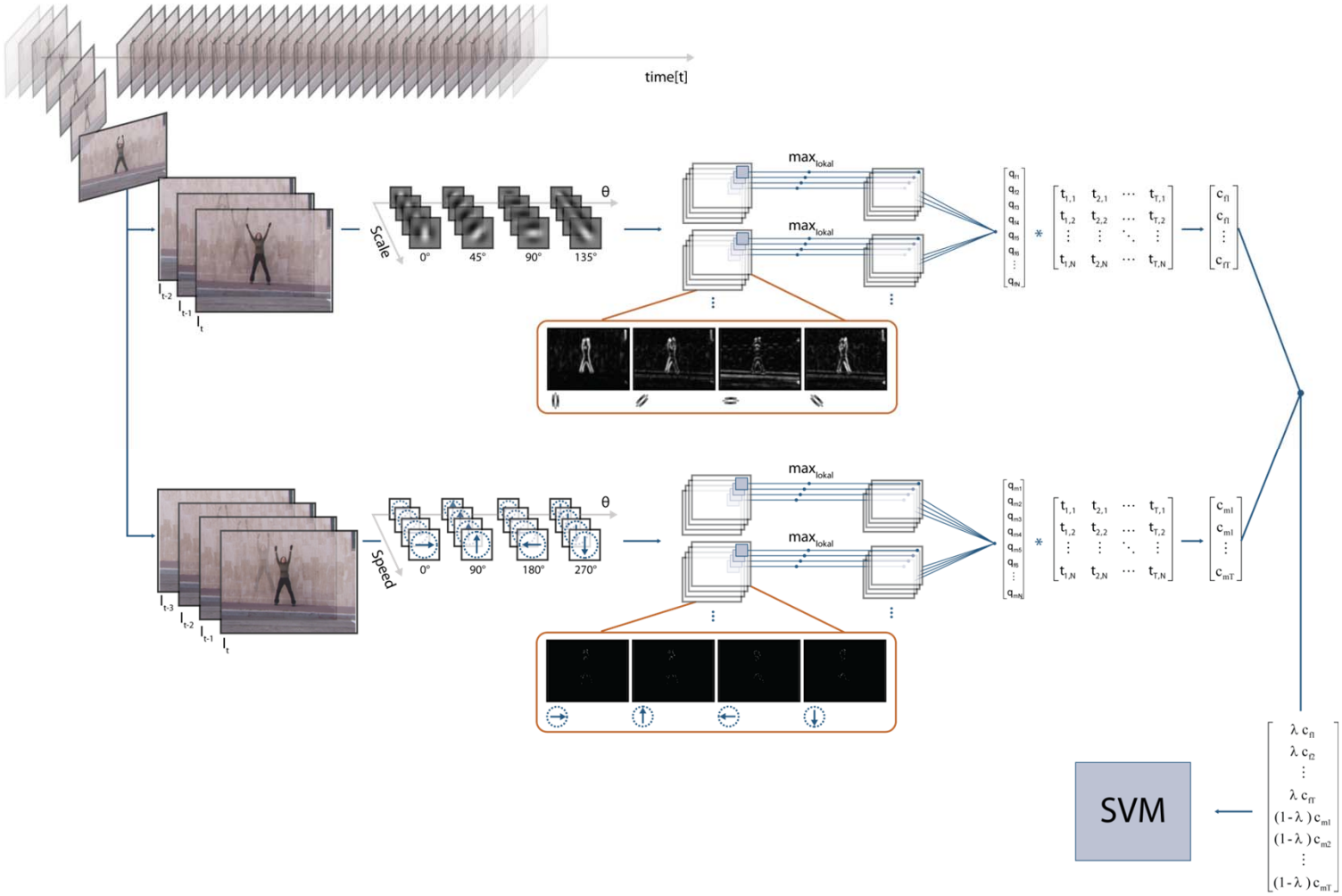



Questions:

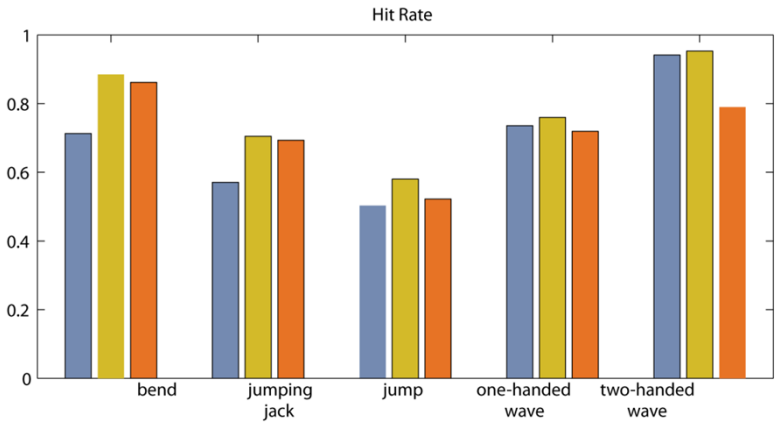
- What kind of information is used for action recognition?
- How (where) do form and motion information interact?

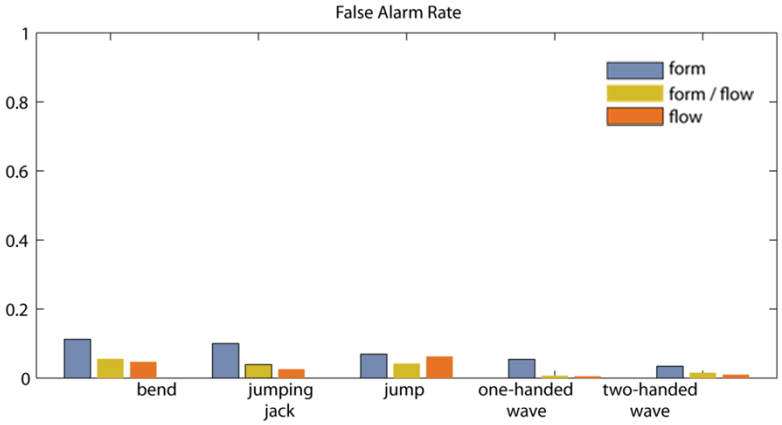
# Action Recognition

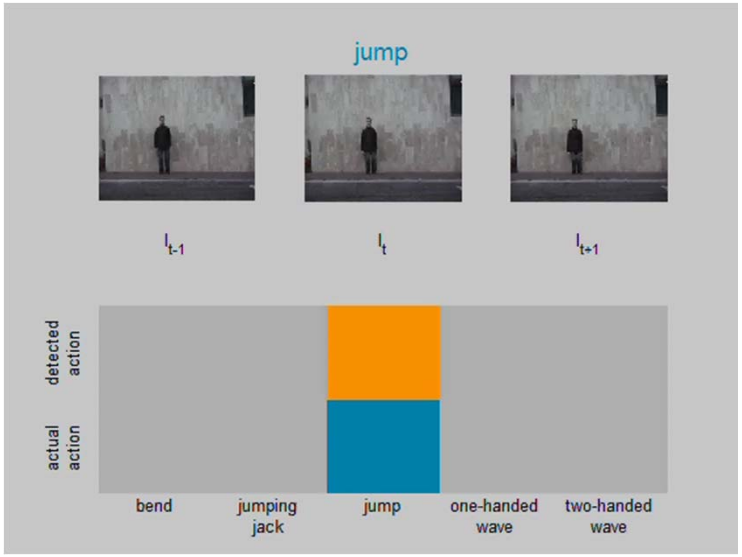
## Combining form and flow information



# Detection Results




Results:

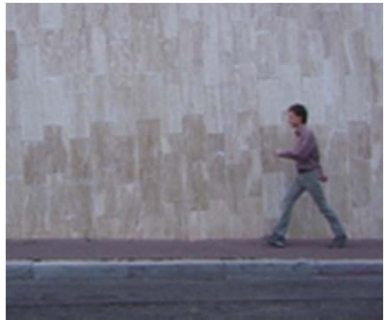
- 9 Persons
- 5 Actions
- 3 frames for one snippet
- Best result for combination of form and motion

Properties:

- Using form (and motion) information
- But not explicitly body postures

# Movement without motion

## Implied Motion

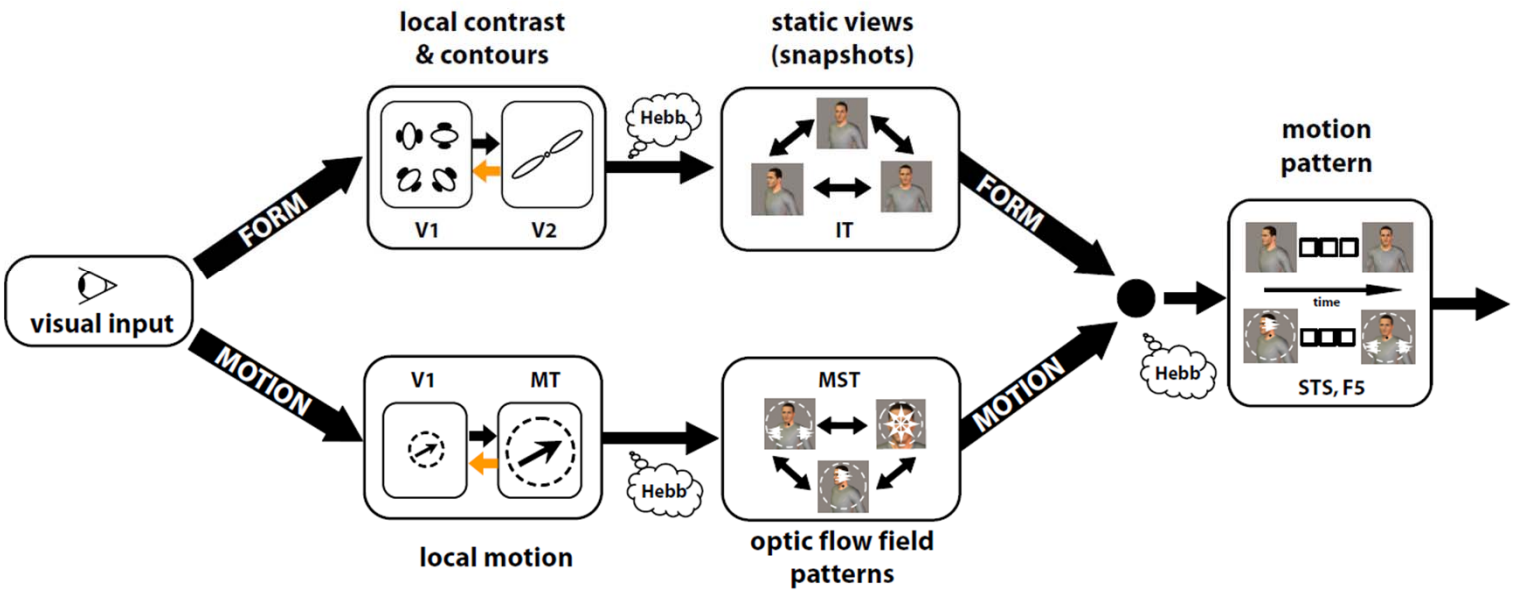


Isolated static stimuli of articulated bodies do not contain any optical flow, but evoke the percept of motion.

There is evidence that cells in area STS responsive to articulated body motions, show activities to static stimuli too [Jellema & Perret, 2003].

# A Neural Model for Implied Motion

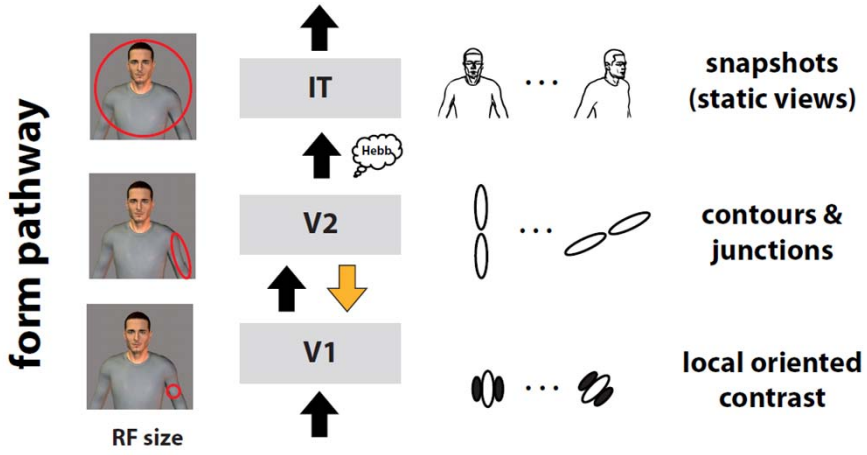
## model structure




- Biologically inspired model for Action Recognition and Implied Motion
- Interaction between the form and motion pathway in model area STS
- Model is trained on image sequences containing biological movements
- Sequence selective cells in STS show increased activities to static stimuly containing snapshots of the sequences

# A Neural Model for Implied Motion

## form processing




Properties

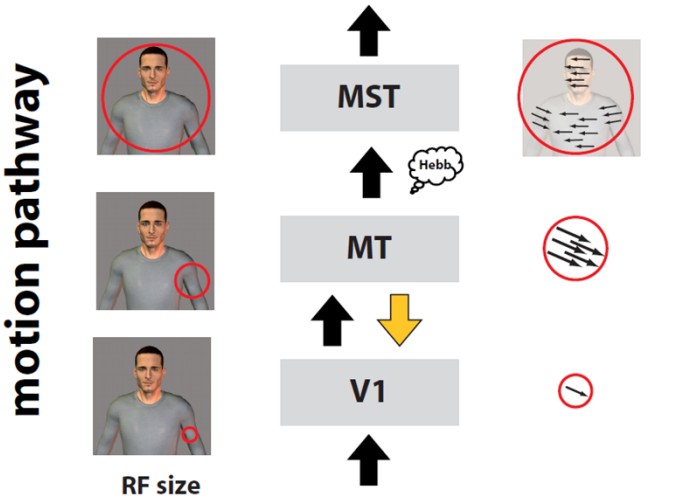
- Feedback between V1 and V2 (Grouping mechanism)
- Unsupervised learning of the IT prototypes [Oja, 1982]

$$\Delta w_{(x,y,\varphi)j} = \eta \cdot \left( A^{V2}_{x,y,\varphi} \cdot A^{IT}_{j} - \left( A^{IT}_{j} \right)^2 \cdot w_{(x,y,\varphi)j} \right)$$


Exemplary output of the different form processing steps.

# A Neural Model for Implied Motion

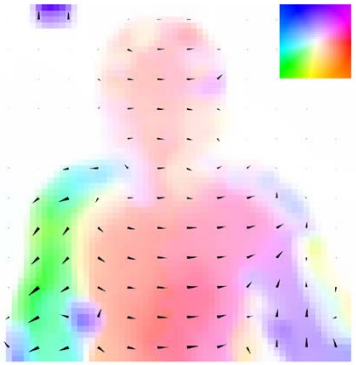
motion processing




Properties

- Feedback between V1 and MT (Grouping mechanism)
- Unsupervised learning of the flow patterns [Oja, 1982]

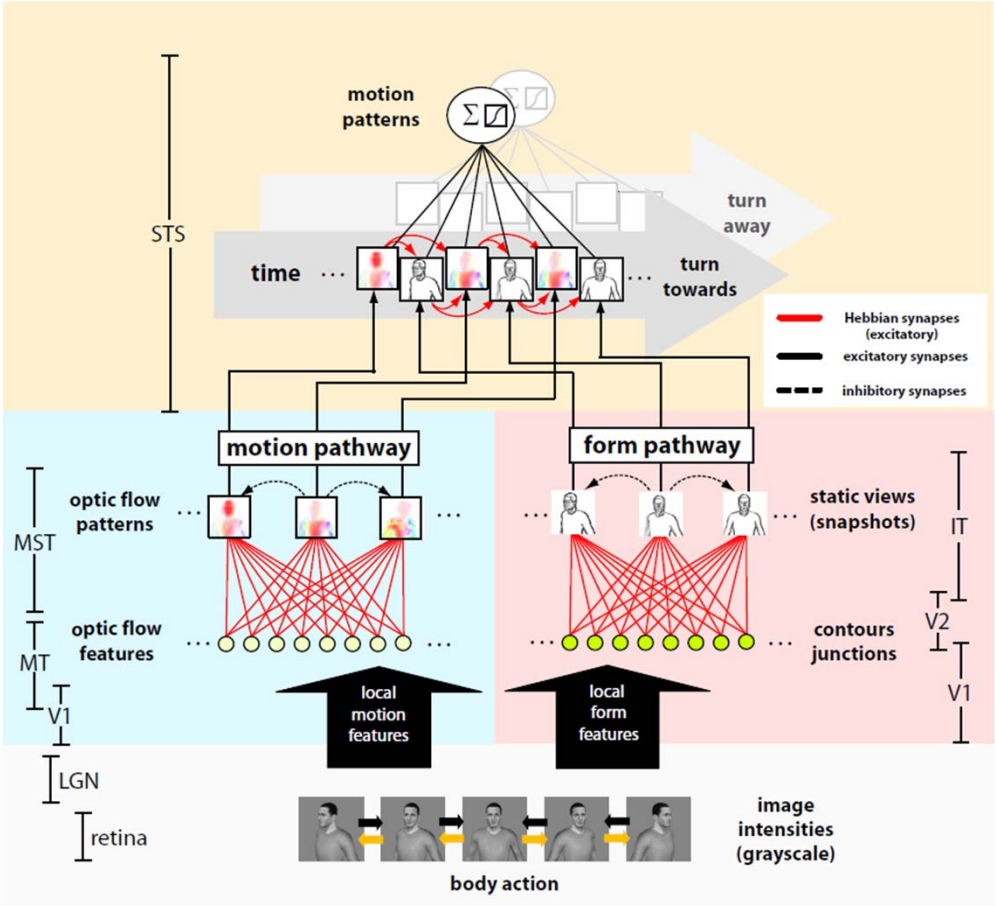
$$\Delta w_{(x,v)j} = \eta \cdot \left( \overline{v}_x^{MT} \cdot A_j^{MST} - \left( \overline{v}_x^{MT} \right)^2 \cdot w_{(x,v)j} \right)$$



Exemplary flow field extracted at model area MT. Hue encodes the direction, saturation indicates the speed.

# A Neural Model for Implied Motion

## model overview




Learning of sequence neurons:

$$\tau_{seq}\frac{d}{dt}A_j^{seq} = -A_j^{seq} + \alpha A_j^{inp} + \beta\sum_{i=1}^{N} w_{ij}^{+} f(A_j^{seq}) - h$$

[Amari, 1972]

$$\tau_w\frac{d}{dt}w_{ij}^{+} = f(A_j^{seq})\left(A_i^{inp} - f(A_j^{seq})w_{ij}^{+}\right)$$

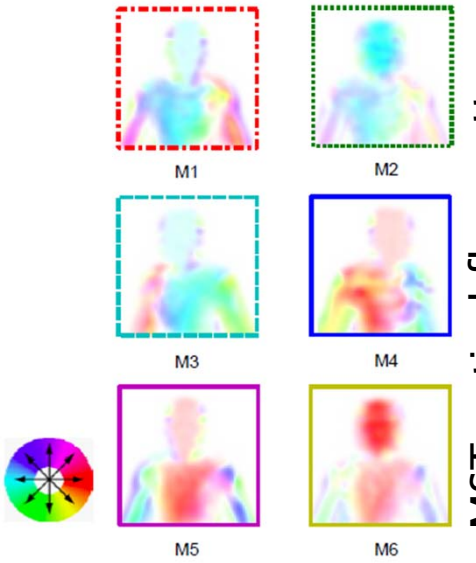
[Oja, 1982]

# A Neural Model for Implied Motion

## results

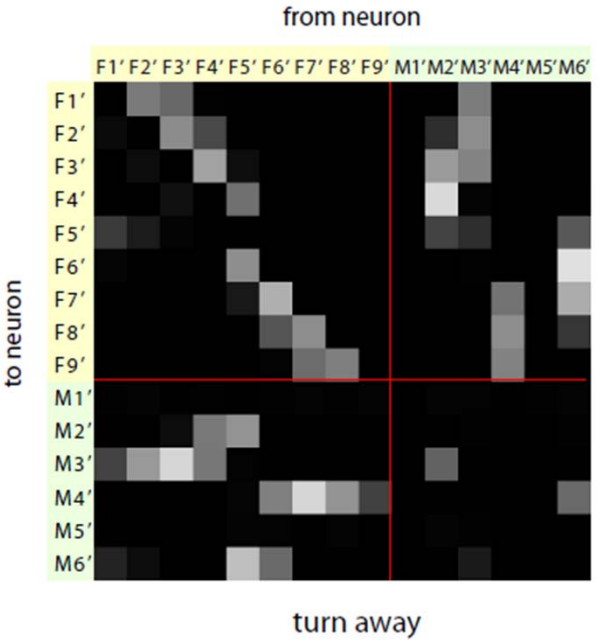
Input

- The model was trained on artificial sequences of a person turning towards and away




MST optical flow patterns


IT form prototypes

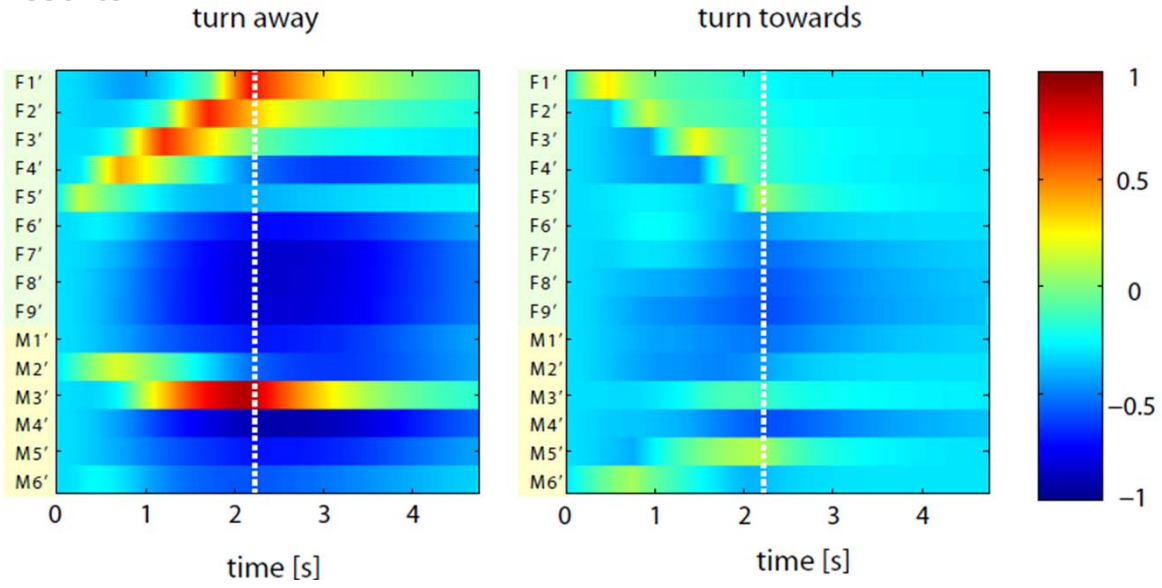



STS Weights

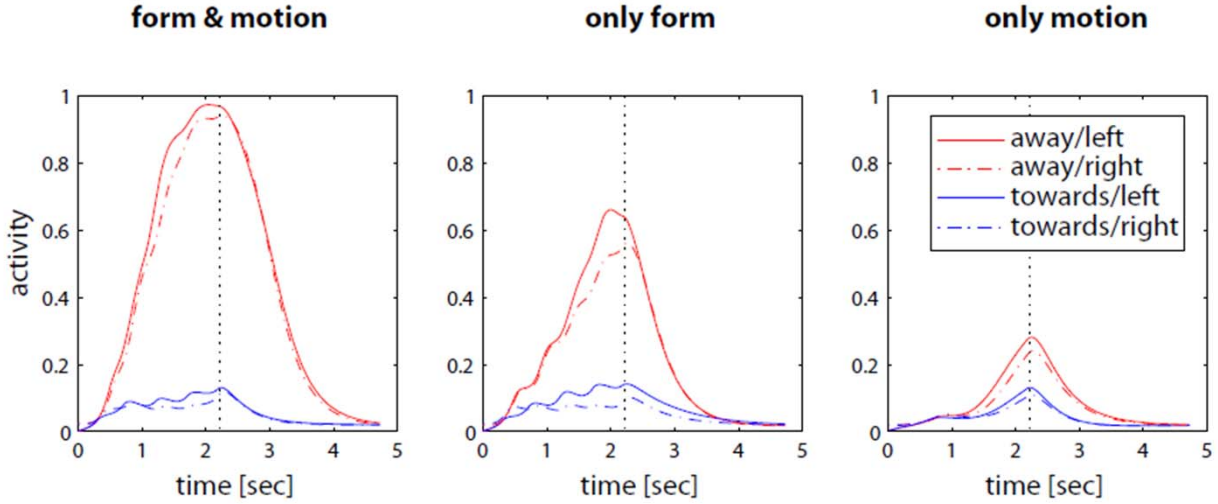
Learned Weights / Prototypes

# A Neural Model for Implied Motion

## results



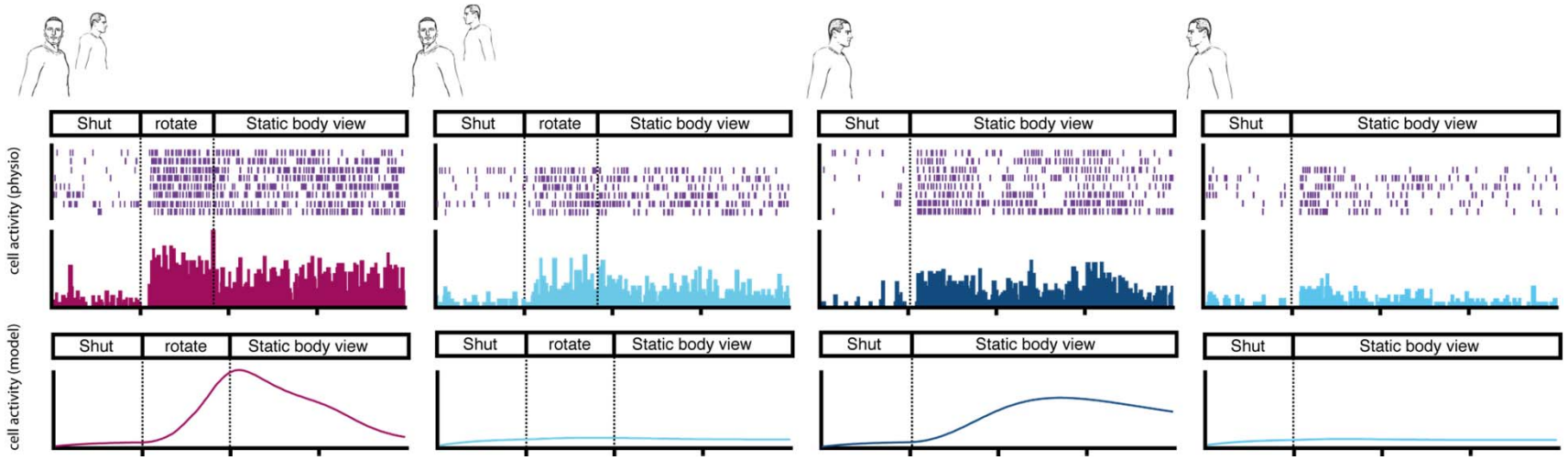

Activations of the sequence selective cells in STS to a “turn away “ sequence.




Activation of a motion pattern selective cell tuned to “turn away“

# A Neural Model for Implied Motion

## results



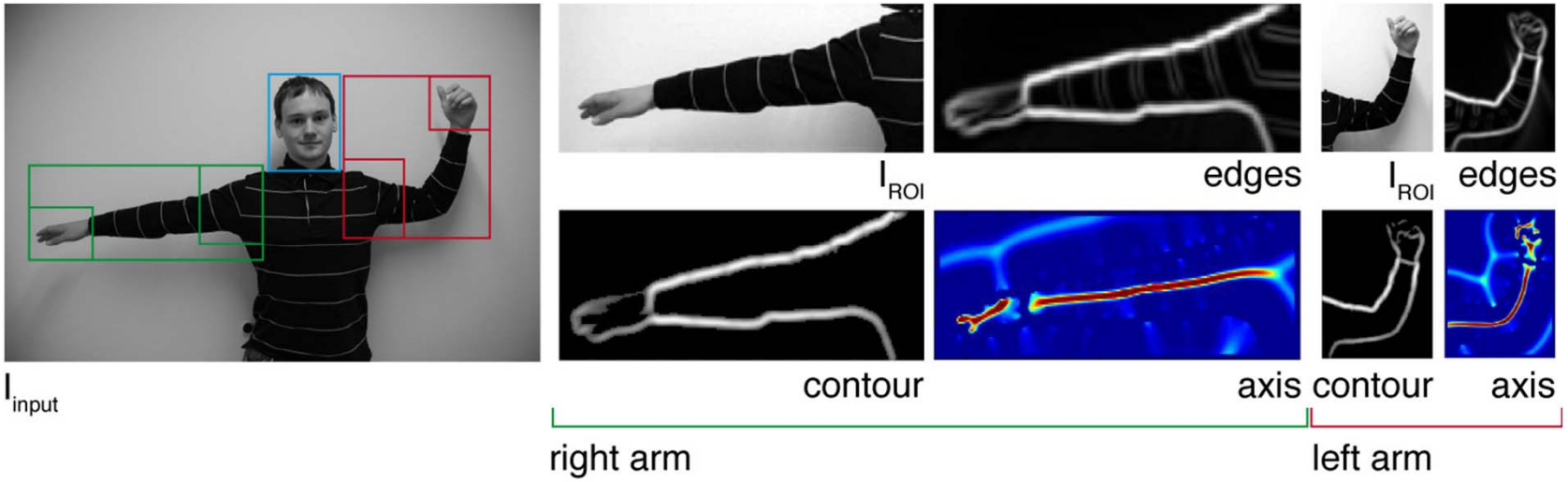

- Successfully reproduced the physiologial data of [Jellema & Perrett, 2003]
- Motion Pattern neurons show increased activity to static input

Limitations / Open Questions

- No explicit representation of articulated body poses
- Feedback mechanisms from STS to MST/MT?
- At the moment just tested with artificial sequences

# Future Work

ideas



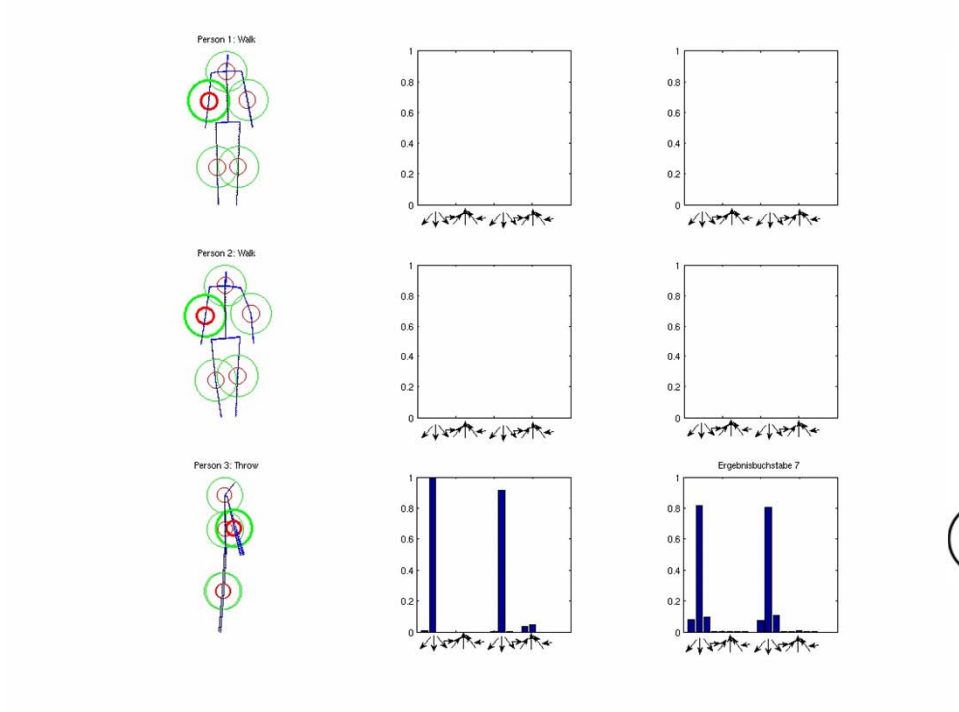

Body Postures:

- Extract stick-figure-like representations using media axis

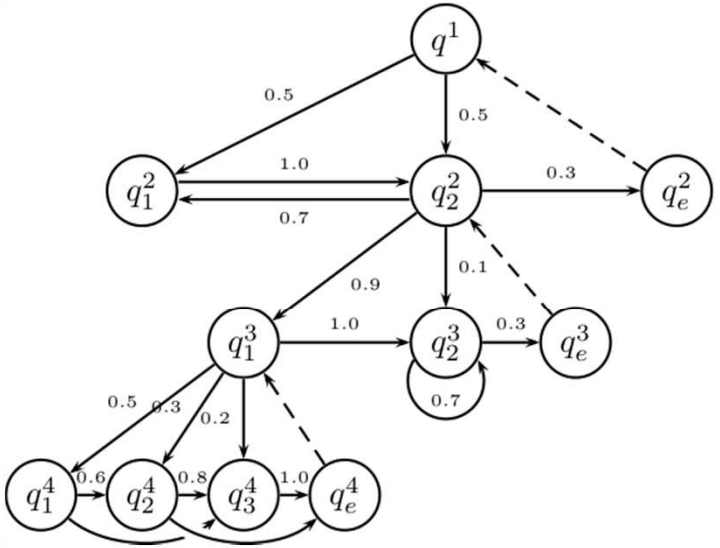
# Future Work

## ideas

Use features of the stick-figures as input to an HHMM for Action Recogntion




Stick-figure & extracted features




HHMM representing one action for one actuator

Thank you for your attention

# Questions?