Biomechatronics

Delft University of Technology
Course 2006-2007
(Wb 2432)

Frans van der Helm

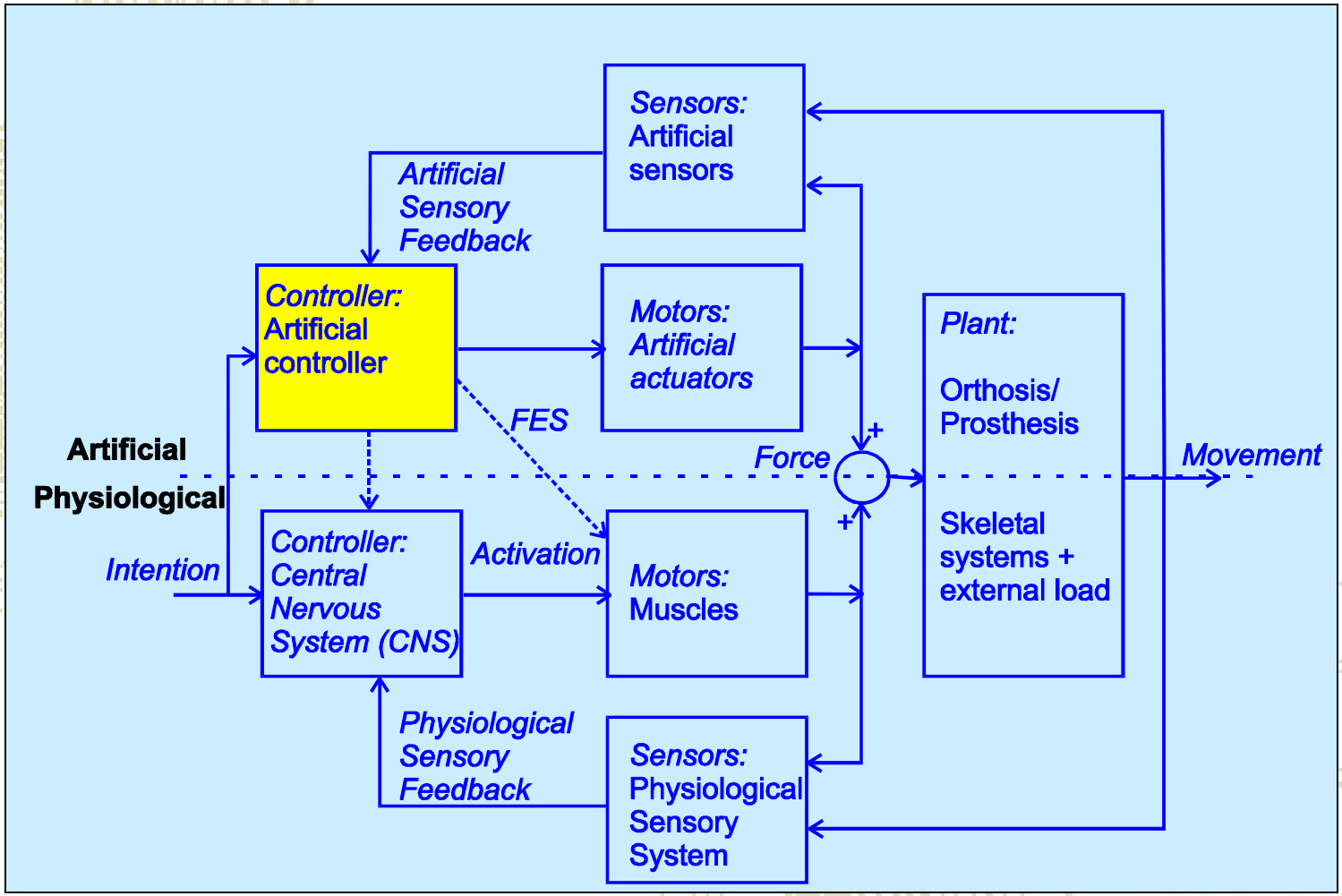
Lecture 13

Artificial motion control

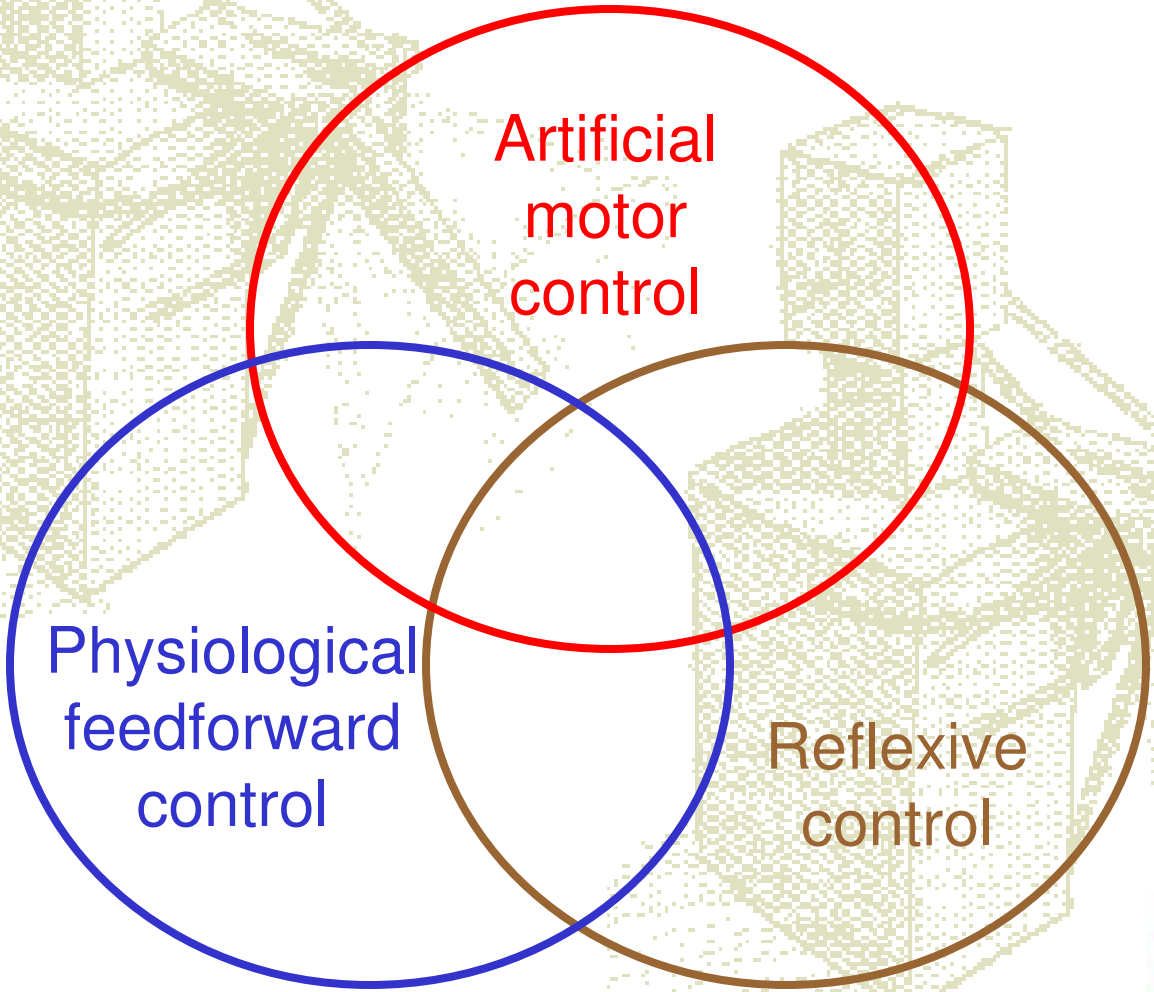
Contents

- Artificial motor control
  - Full artificial control
  - Modulation of natural control system
- Model of human controller
  - stability analyis
  - limitations and adaptation
- Supervisory control situations
  - supervisor over automated control loops

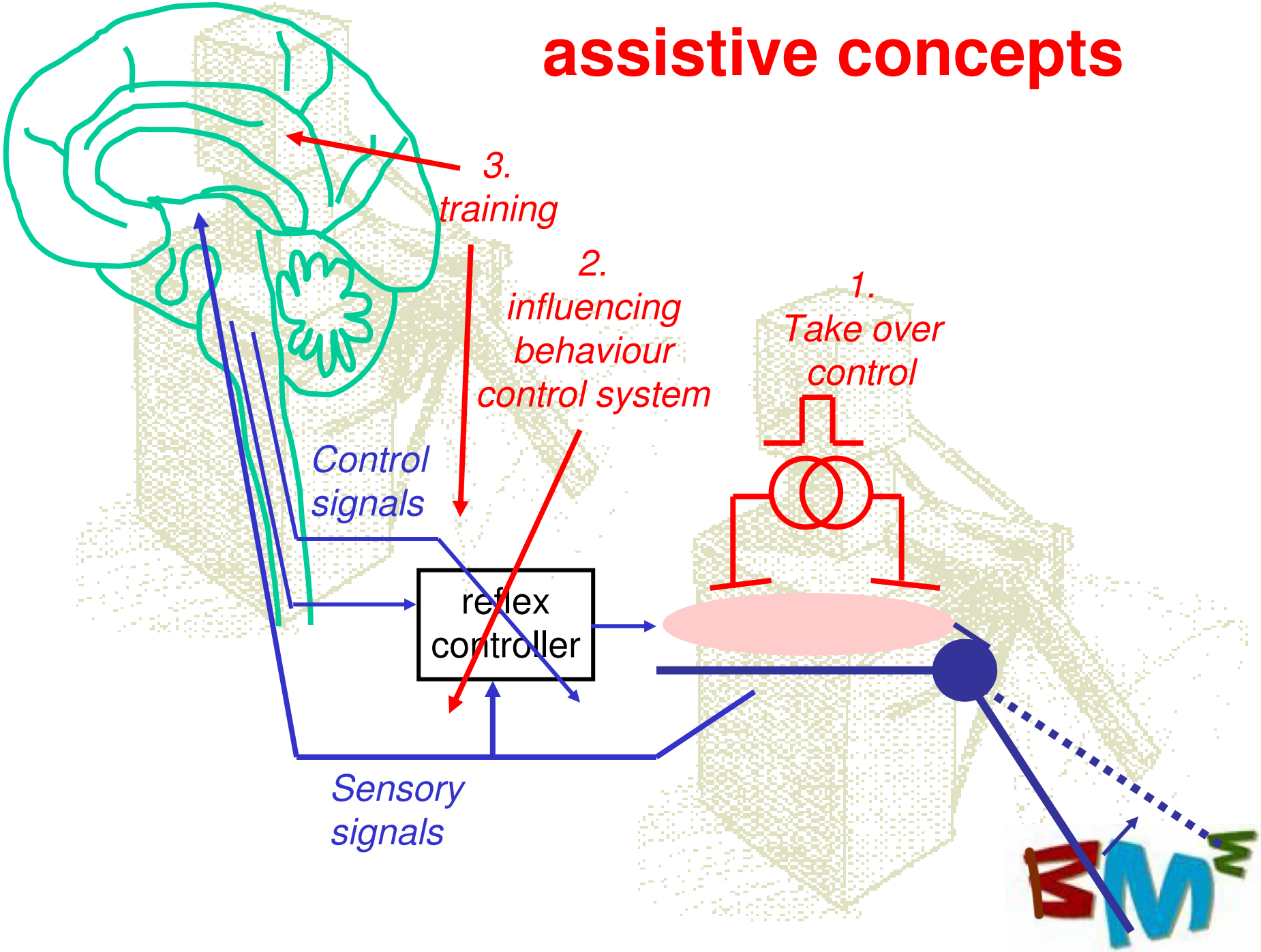
artificial motor control



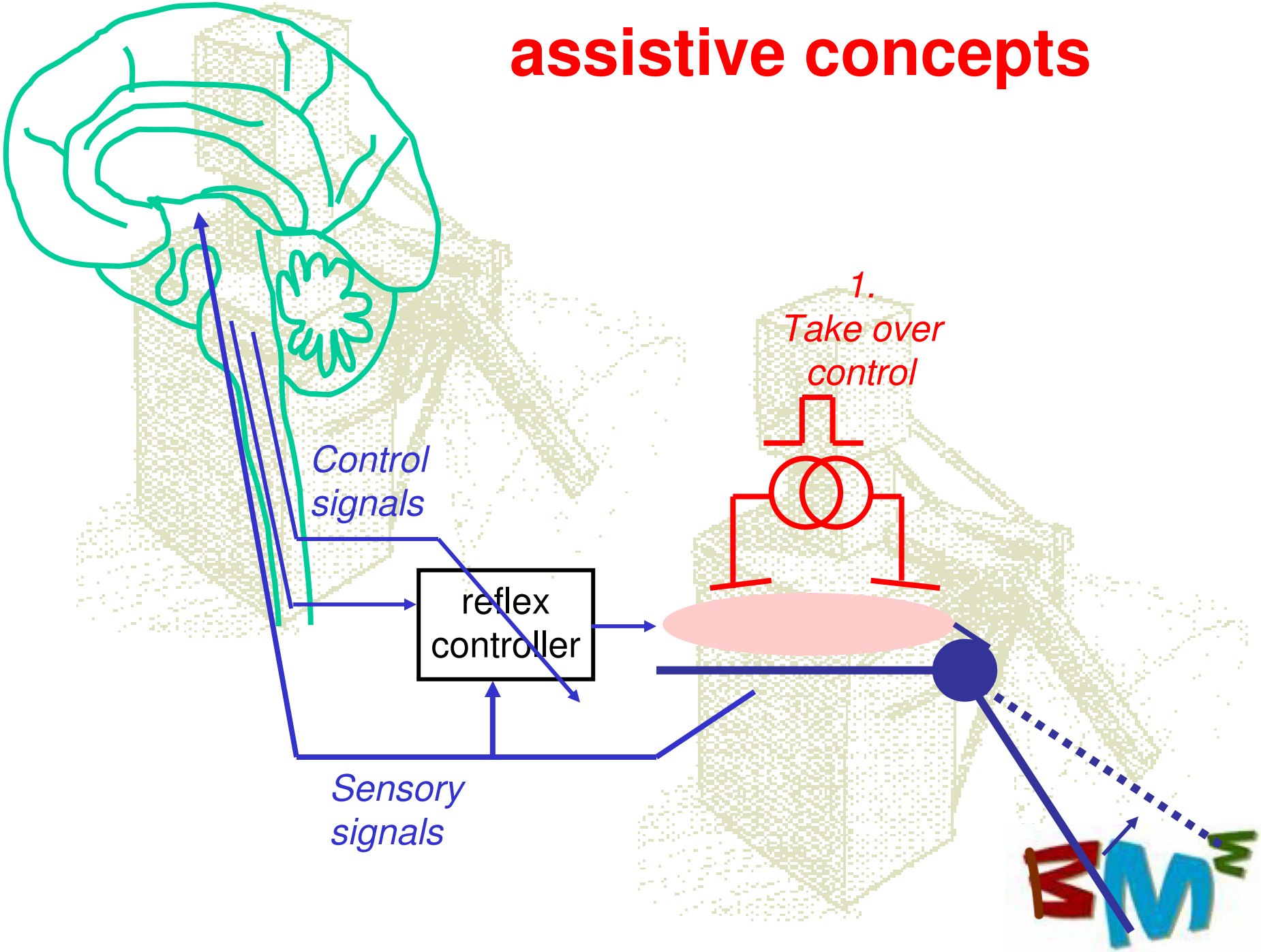
artificial motor control interacts with physiological control



assistive concepts

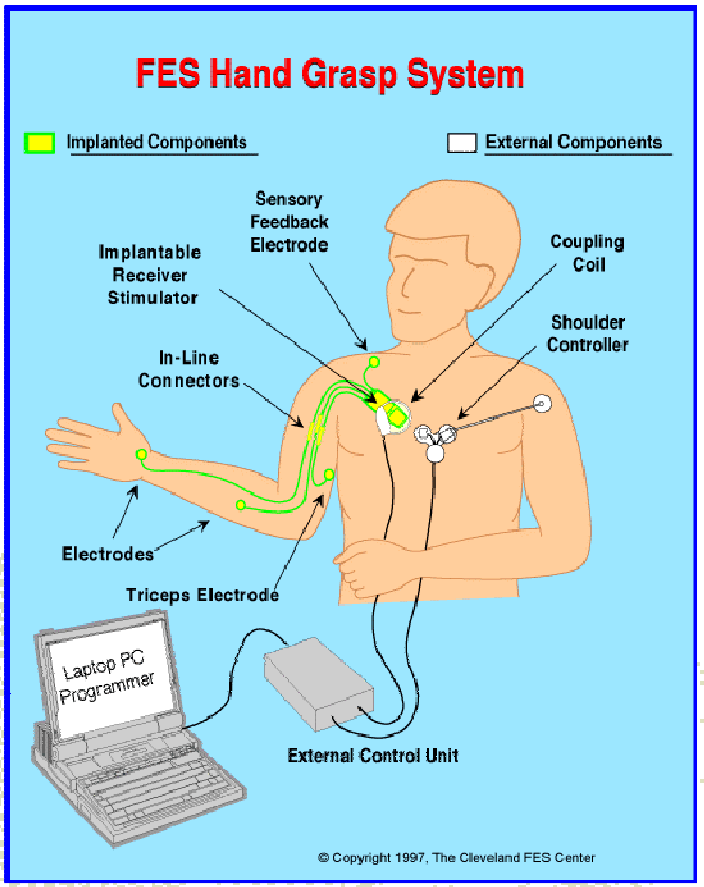


assistive concepts



Take over control

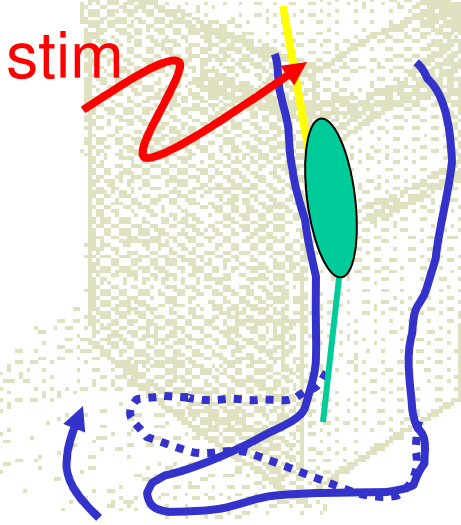
Bionic glove
Dr. Prochaska, Edmonton

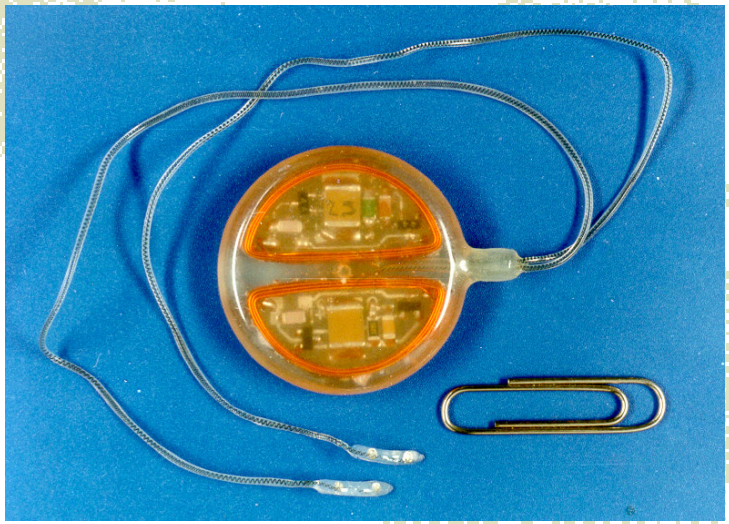


Cleveland FES Center

Take over control

2 channel stimulator for drop foot



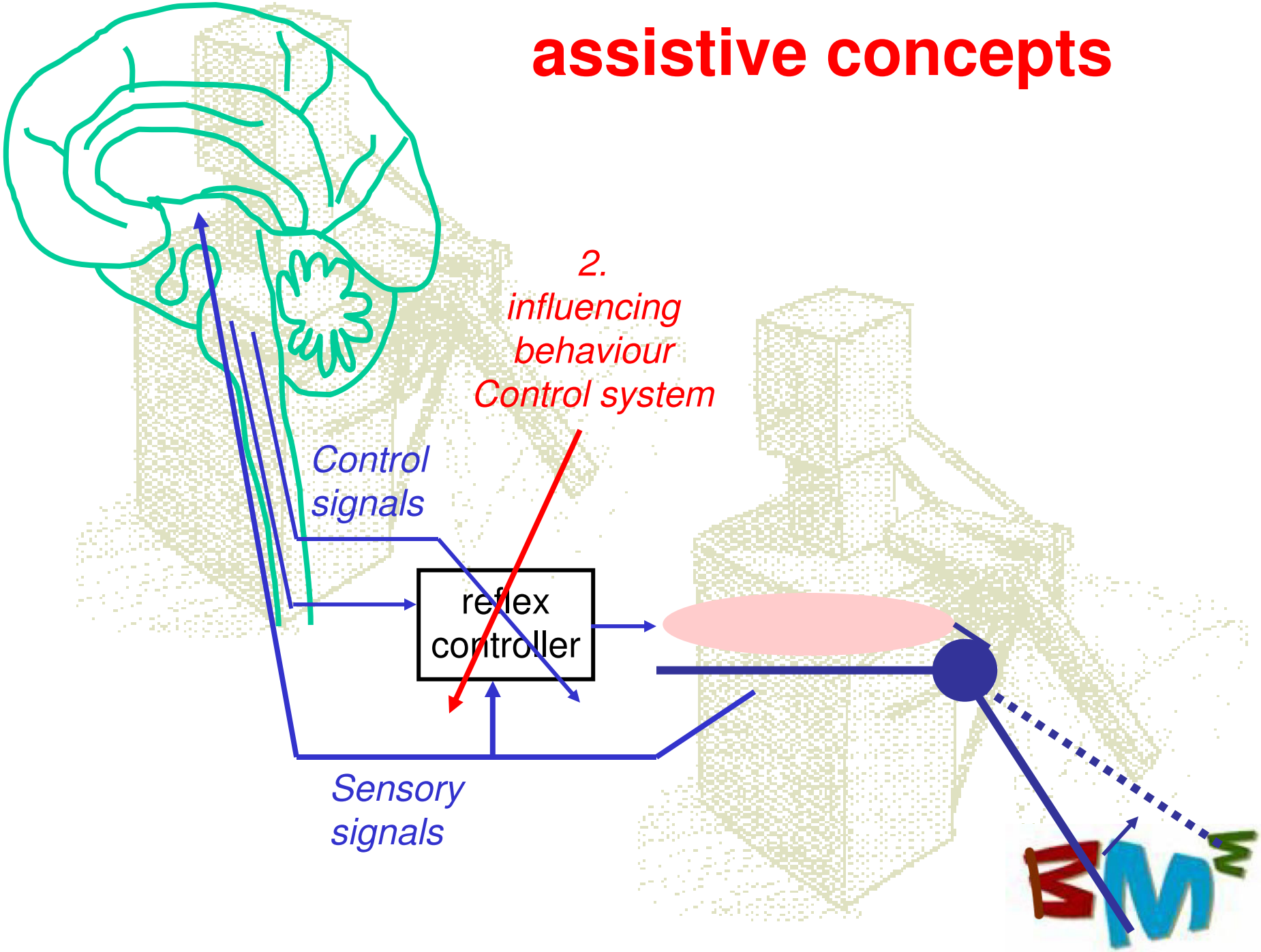


RRD: Dr. Hermens
Dr. Kenney
Dr. Nene
UT: Ing. Bulstra
Dr. Holsheimer
Verloop
MST: Dr. v.d. Aa
Dr. Buschman

Take over control

FES for complete spinal cord lesion

assistive concepts



Influencing behaviour control system

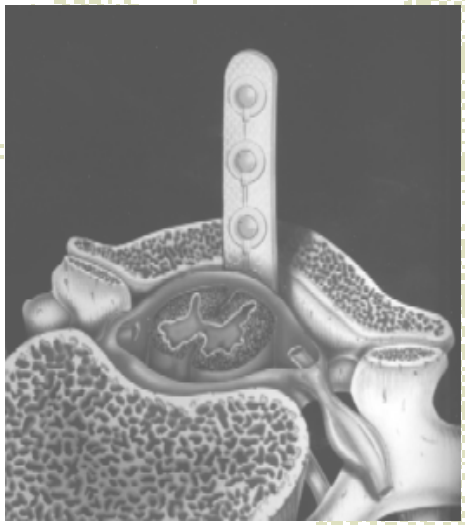
Parkinson patient

Brain stimulation with Parkinson

Dr. Lenders, MST
Medtronic

Influencing behaviour control system

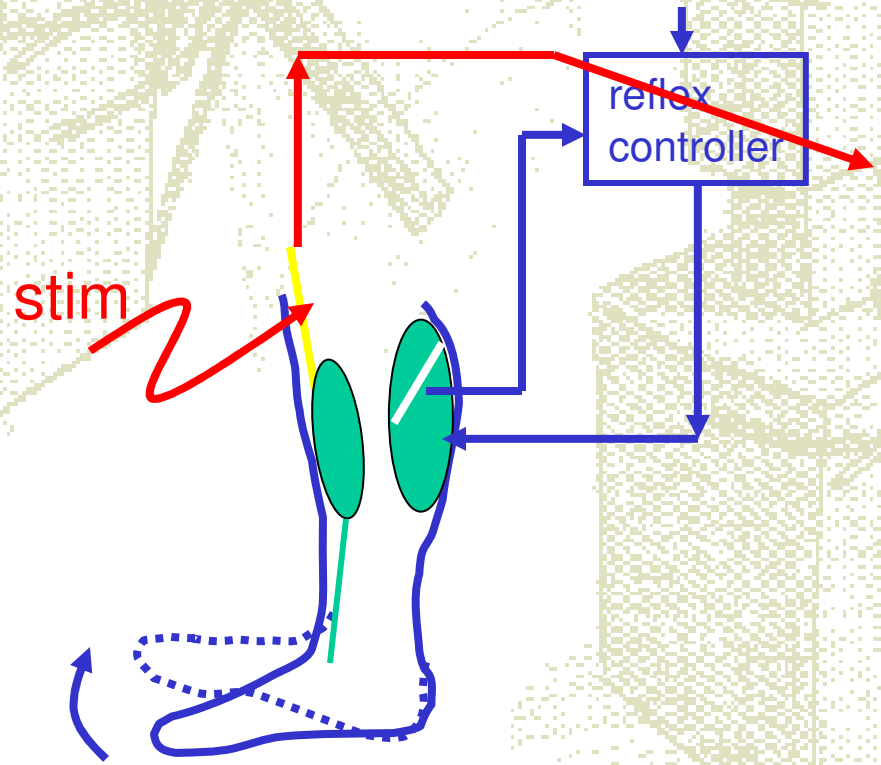
Influencing sensation
Spinal cord stimulation
against pain



Dr. Holsheimer, UT

Influencing behaviour control system

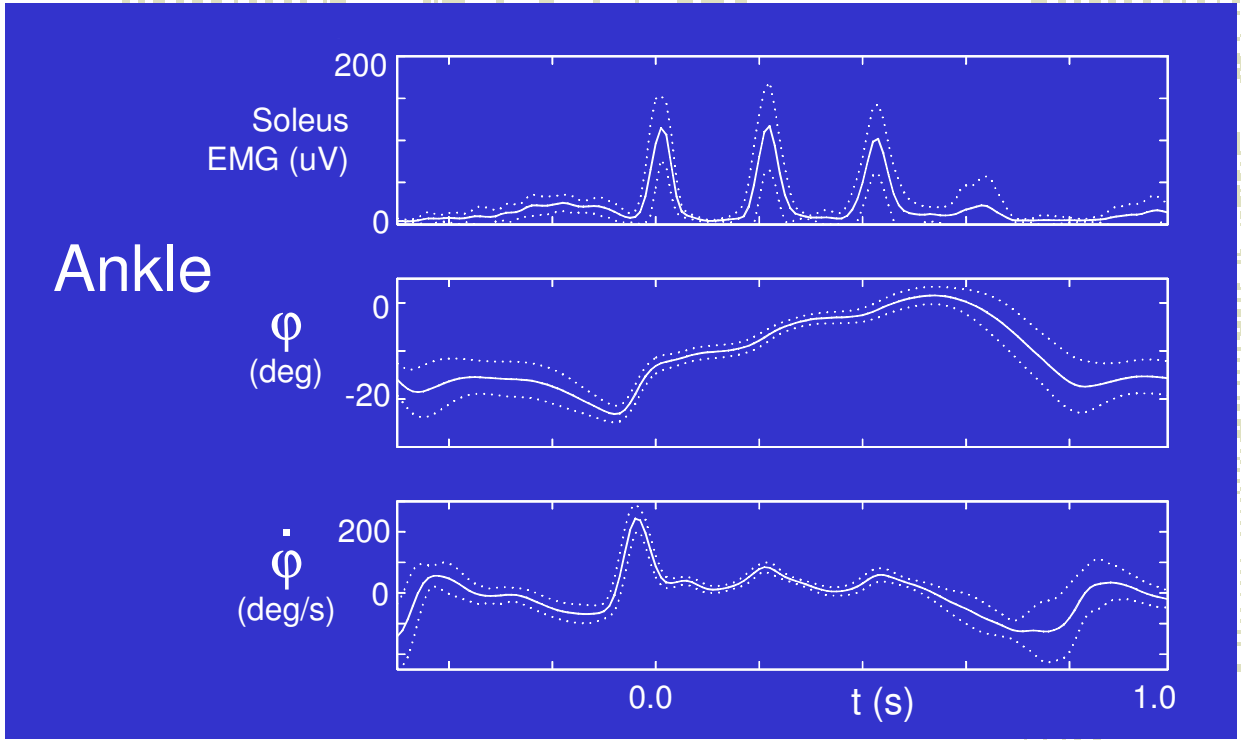
attenuation
hypersensitive reflexes
by reciprocal inhibition



Spasticity calf muscle

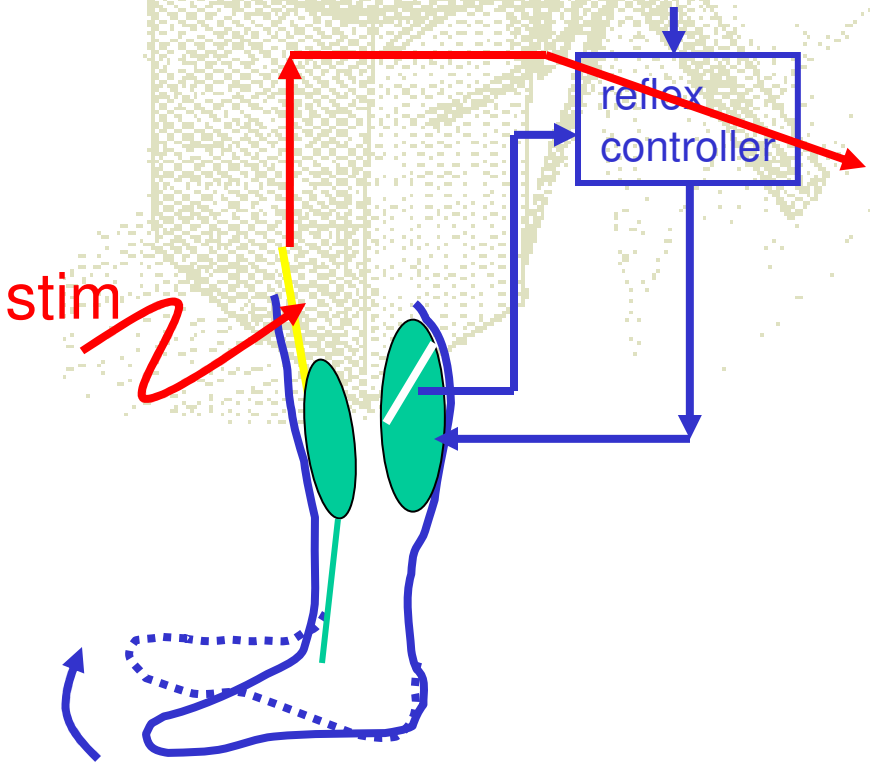
The problem

CVA
patient



Influencing behaviour control system

attenuation
hypersensitive reflexes
by reciprocal inhibition



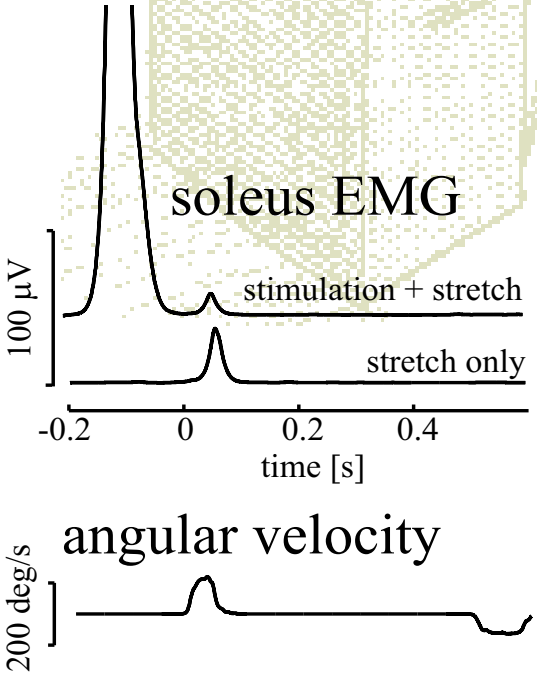
Shank front

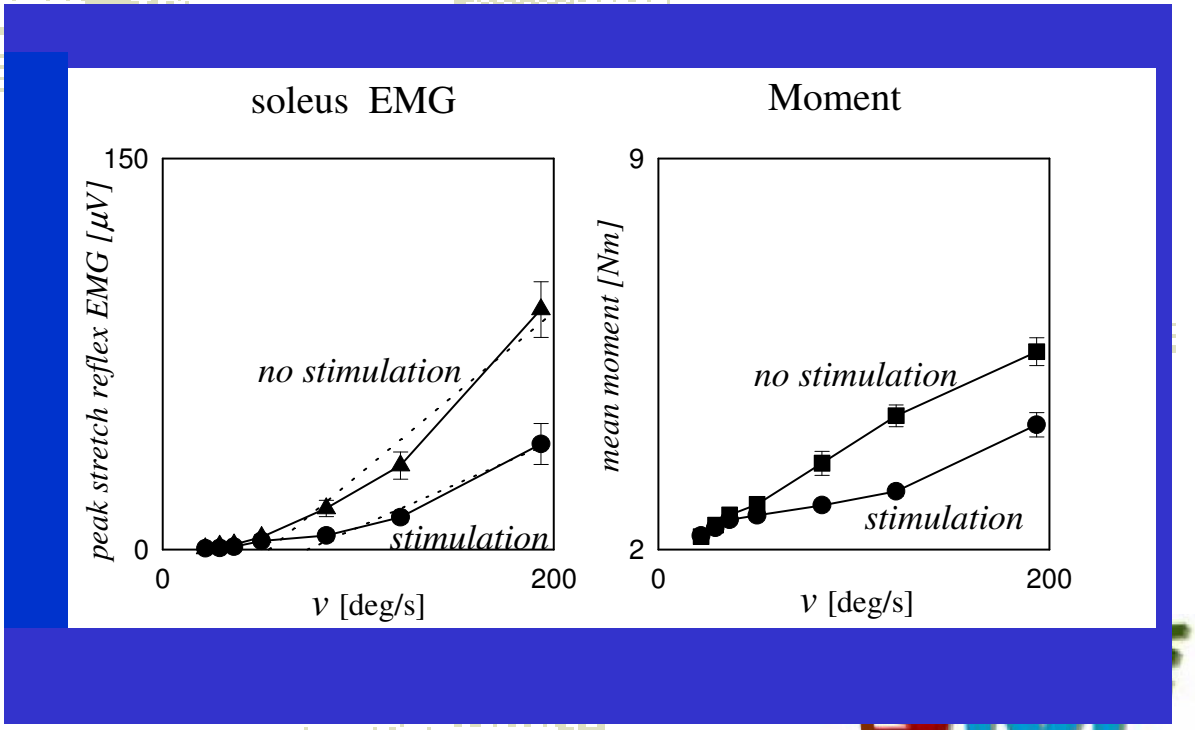
Shank back

Influencing behaviour control system

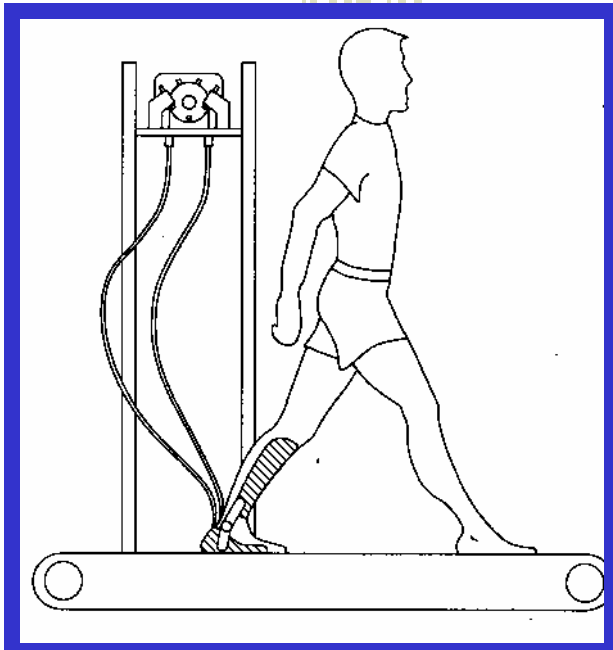
Attenuation hypersensitive reflexes by reciprocal inhibition

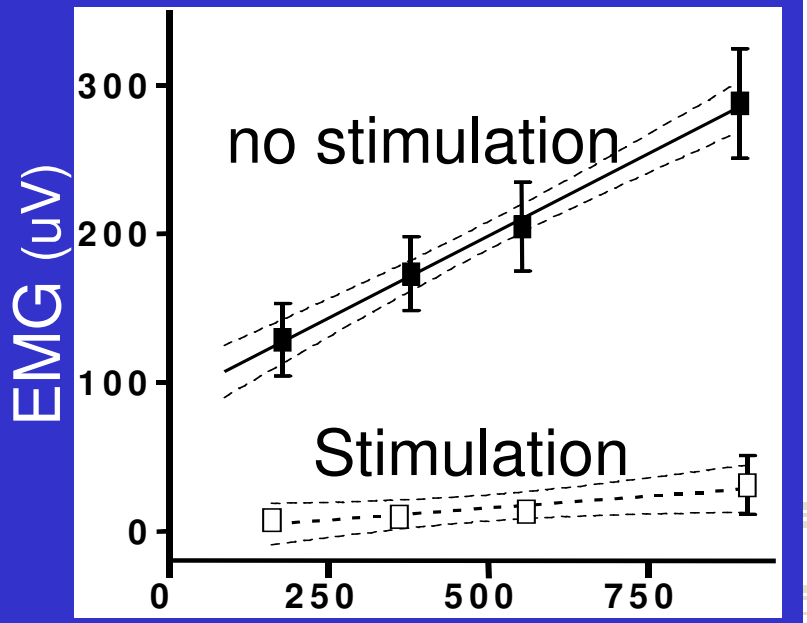
results





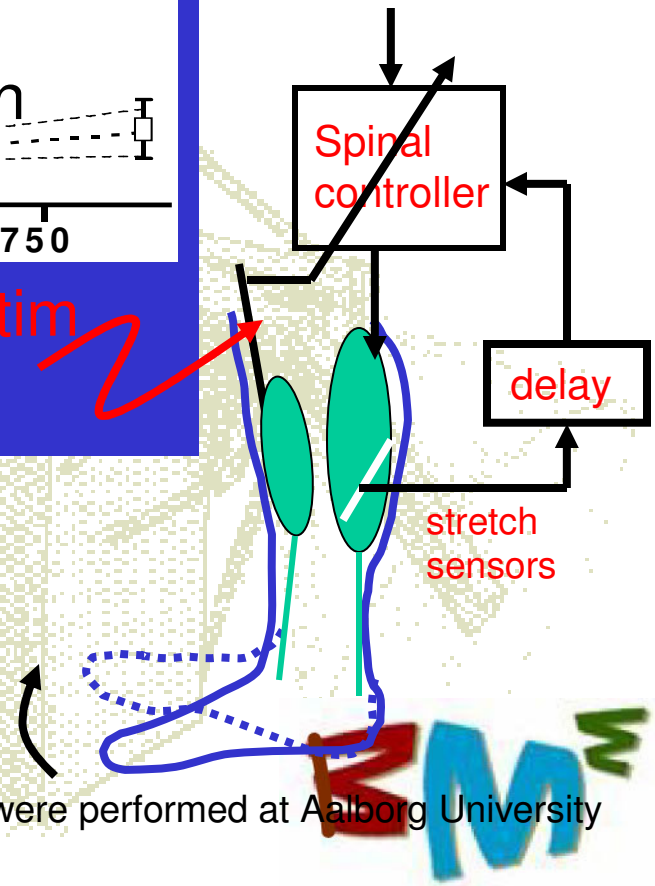
During walking





(Voormolen et al, 2000)

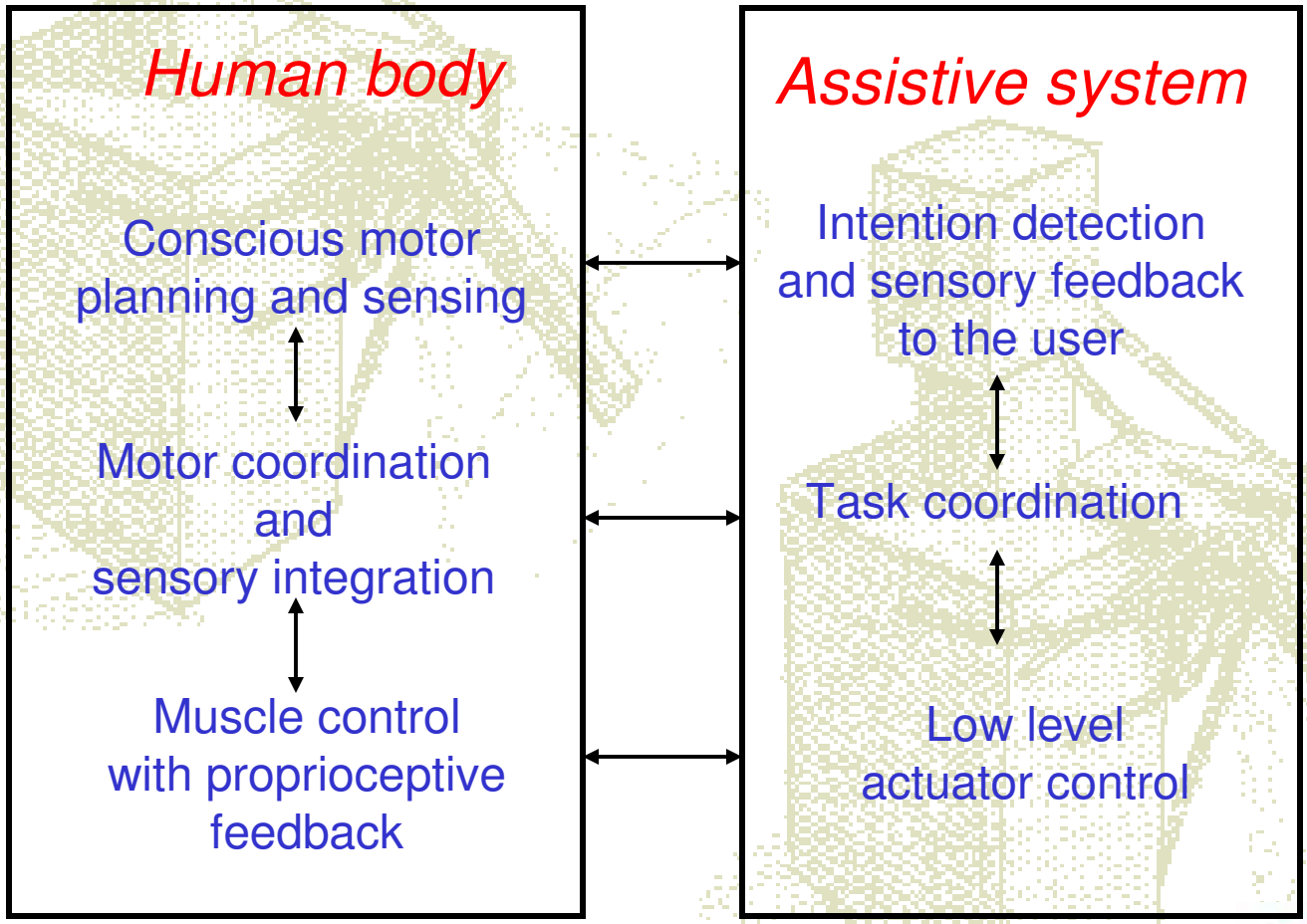
Stimulation and stretch during initial swing phase of gait



Experiments were performed at Aalborg University

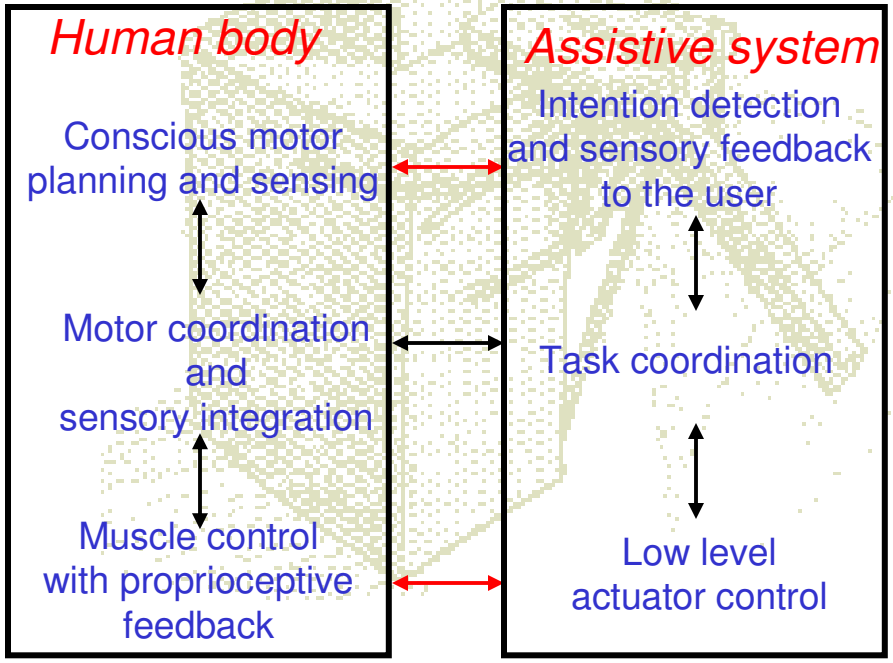
artificial motor control

Hierarchical control



artificial motor control

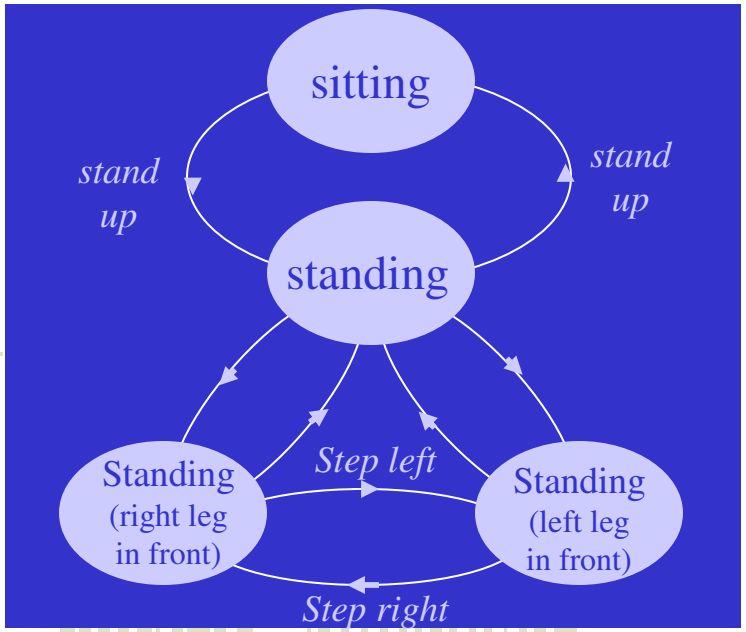
user interaction



	Continuous control	*Discrete time control*
High level	continuous operator control	intention detection
Low level	Impedance control	Artificial reflex

	Continuous control	*Discrete time control*
High level	continuous operator control	intention detection
Low level	Impedance control	Artificial reflex

Finite state control

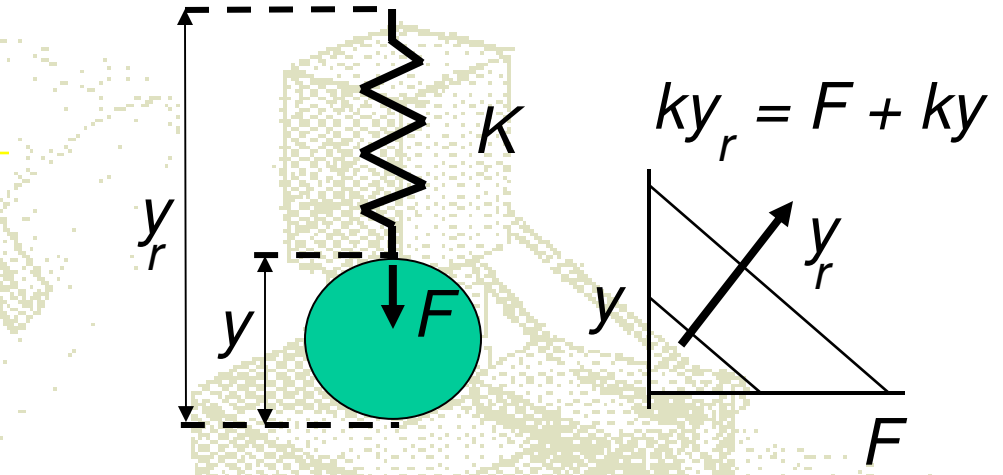


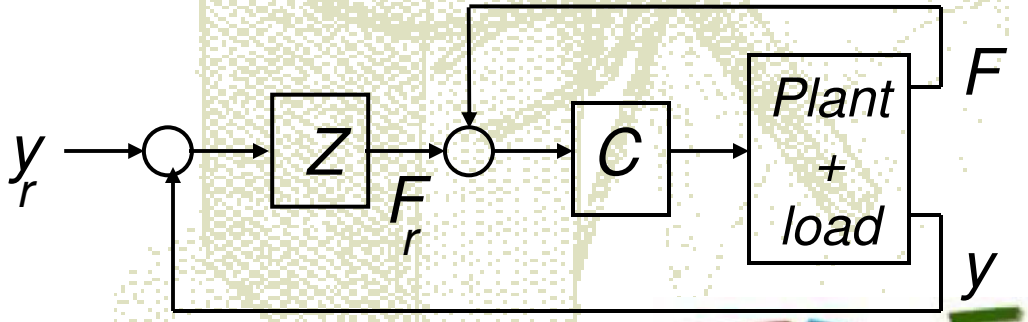
artificial motor control

	Continuous control	*Discrete time control*
High level	continuous operator control	intention detection
Low level	Impedance control	Artificial reflex

Principle

Control a relation between position and force

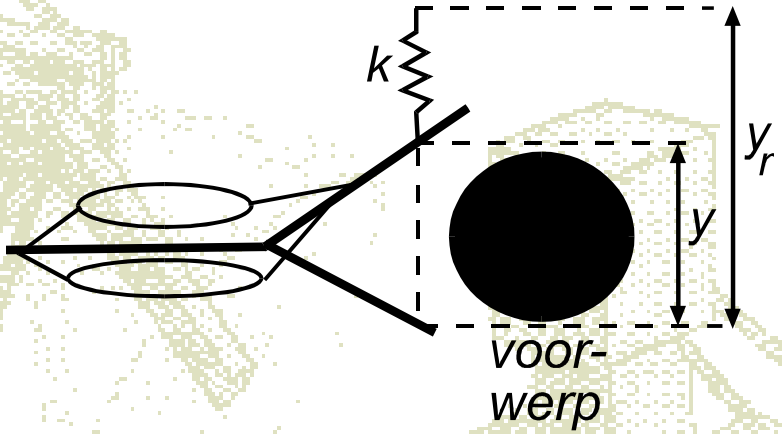


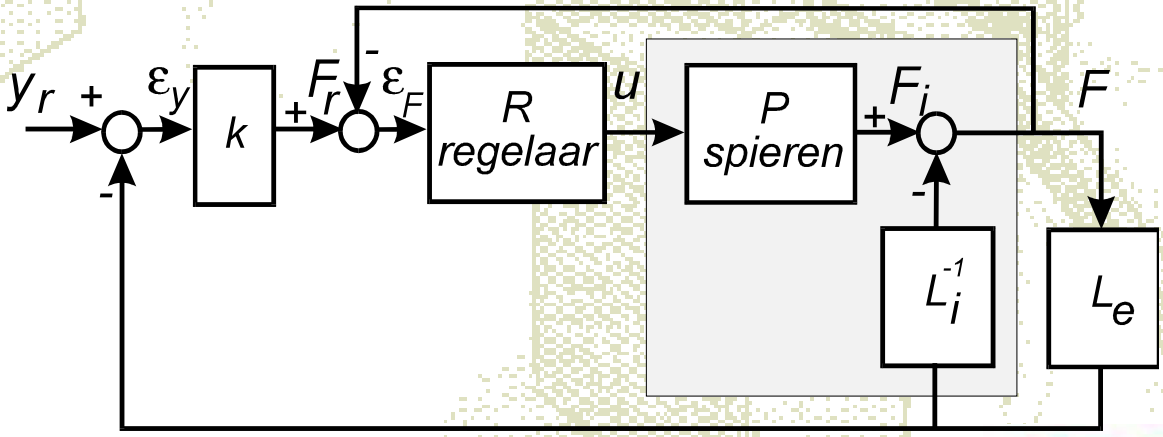


artificial motor control

Physiological Impedance control
of the human body

Control of
FES assisted
hand grasp

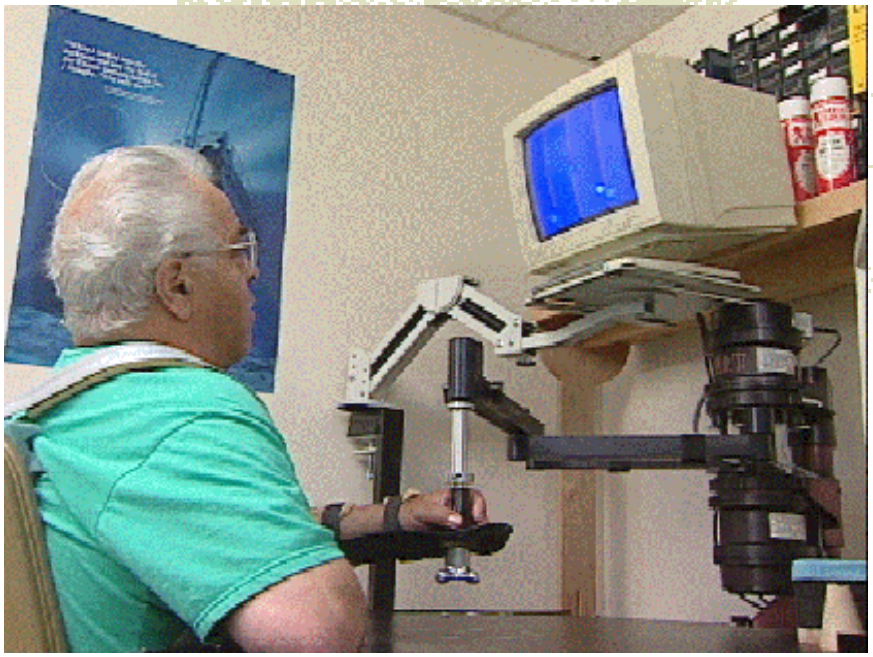




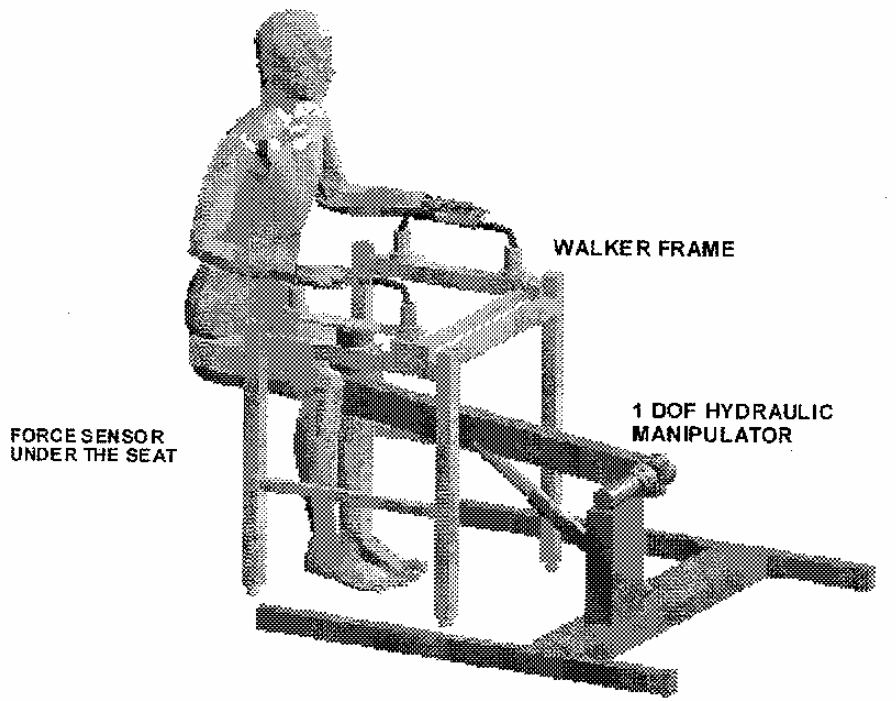
Crago et al., CWRU

artificial motor control

artificial Impedance control
of assistive system



MIT, Hogan, Krebs



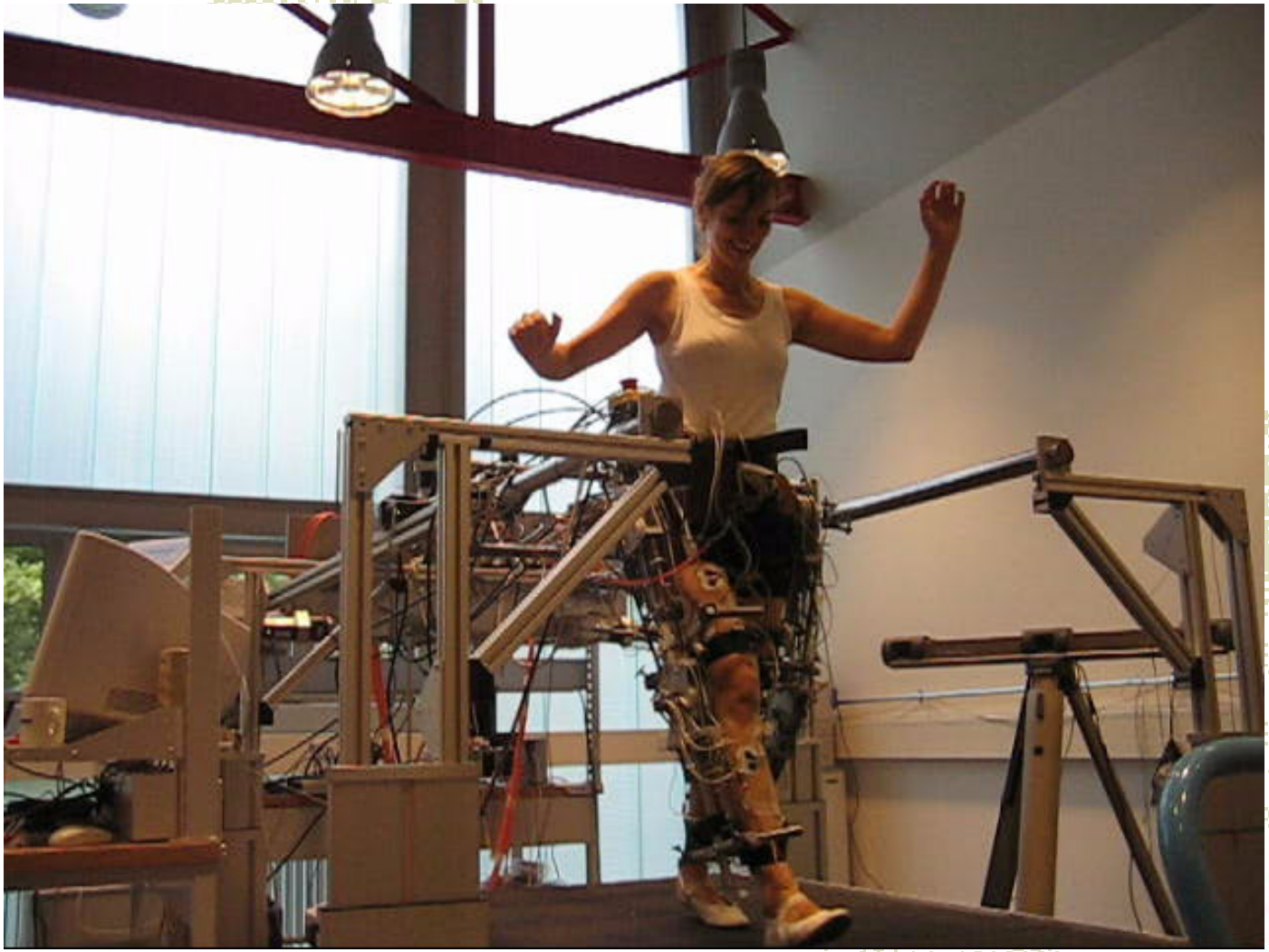
Impedance controlled system
for standing-up training
(Kamnik & Bajd, Ljubljana)

Physical Therapy

Lokomat system

LOPES

LOPES



BLEEX

HAL5

HAL5