CONTROL OF LEG MUSCLES

Comparison of the gait pattern between an amputee and a non-amputee

Seminar „Motions in Man and Machine“
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THE IDEA

Combination of „**Muscle Modeling“** (Syn Schmitt)
„**Biomechantronic Systems“** (Urs Schneider)
„**Intelligent Autonome Systems“** (Jan Peters)

→ Integrative approach

„Is it possible to assimilate the gait of an amputee to the original pattern of locomotion?“

„Is this possible by self-improvement by intelligent automatic systems?“

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THE CONCEPT

1. Data collection of the gait pattern of an amputee
2. Data collection of the gait pattern of a non-amputee
3. Comparison of the patterns → Differences?
4. Integration of the knowledge in the roboter

SETUP

3D motion capturing
- 9x IR-cameras
- Up to 500 Fps
- Outdoor-recording possible

Quelle: qualisys.com

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SETUP

Force plates

- 2 x AMTI AccuGait
- Measurement of forces and moments

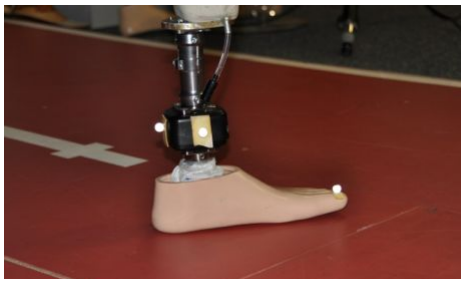
Quelle: amti.biz

SETUP

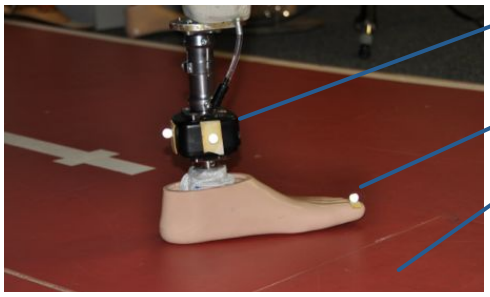
Load cell

- Integrable in prostheses
- Measurement directly on the socket

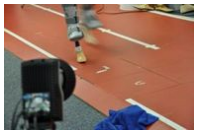
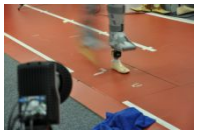
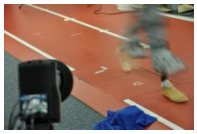
Quelle: college-park.com/ipecs



GAIT ANALYSIS



- Load cell
- 3D Motion capturing
- Force plates


PREPARATION

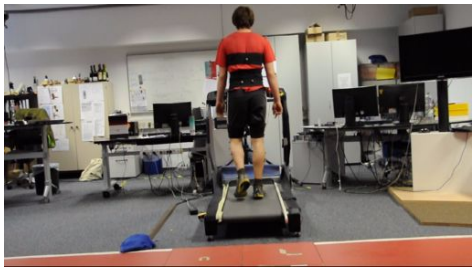

38 markers

DATA COLLECTION

Comfortable walking
Speedy walking
Treadmill walking (comfortable speed)
Treadmill walking (modest speed)
Treadmill walking (4% incline)
Treadmill walking (15% incline)
Treadmill walking (2% decline)

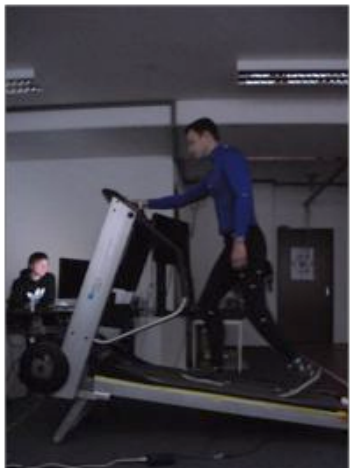
TREADMILL WALKING

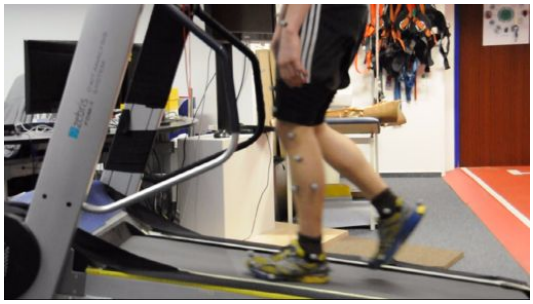
Modest walking: 5,0 km/h



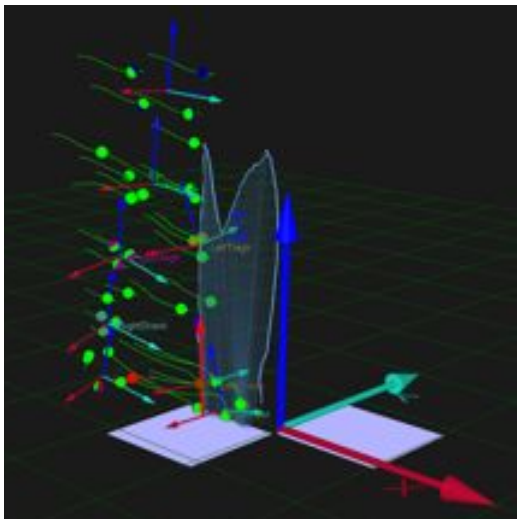
TREADMILL WITH INCLINE

15% incline
3,1 km/h





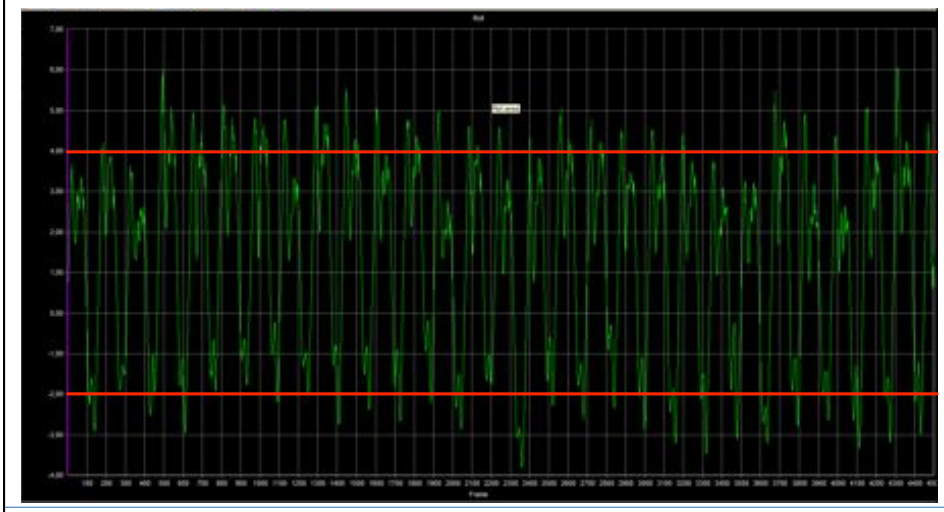
DATA ANALYSIS



Results
Qualysis

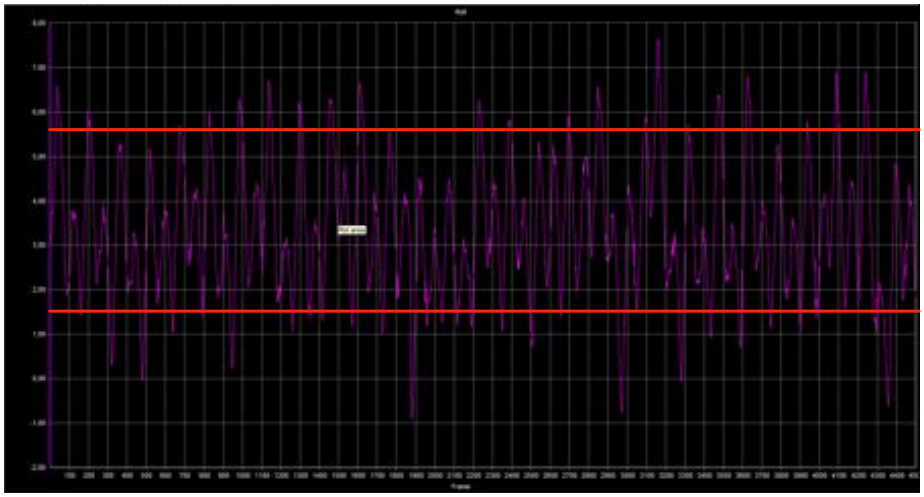
DATA ANALYSIS

Hip rotation, amputee



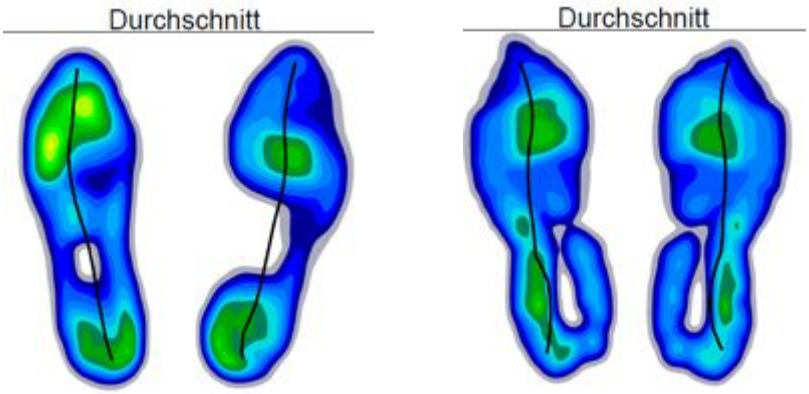
DATA ANALYSIS

Hip rotation, non-amputee



DATA ANALYSIS

Comfortable walking: 3,1 km/h

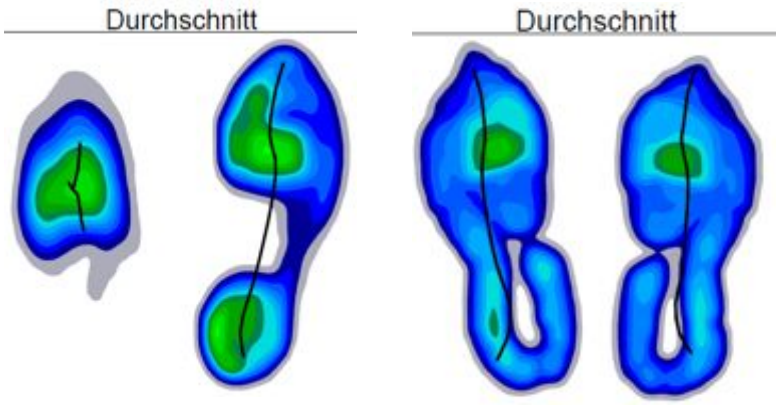


Amputee
(instability in stand phase)

non-amputee

DATA ANALYSIS

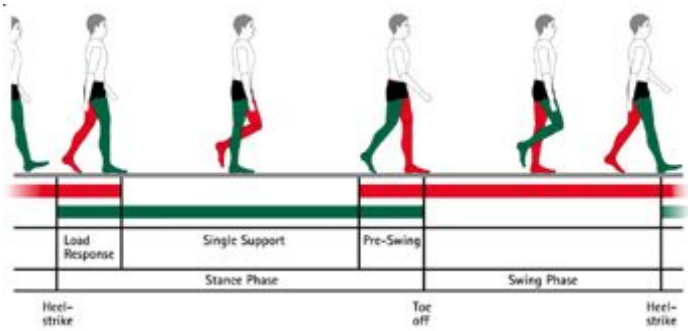
Strong incline on treadmill



amputee

non-amputee

DATA ANALYSIS



Standphase (Stance phase), %	Amp	Links	62.7+/-0.9
		Rechts	70.0+/-1.6
Standphase (Stance phase), %	Non-amp	Links	67.5+/-1.5
		Rechts	66.7+/-1.3

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DATA ANALYSIS

Fußrotation, grad	Amp	Links	11.2+/-4.3
		Rechts	12.9+/-1.5
Fußrotation, grad	Non-amp	Links	14.3+/-1.7
		Rechts	8.6+/-1.9
Schrittlänge (Step length), cm	Amp	Links	67+/-3
		Rechts	50+/-5
Schrittlänge (Step length), cm	Non-amp	Links	65+/-2
		Rechts	63+/-3

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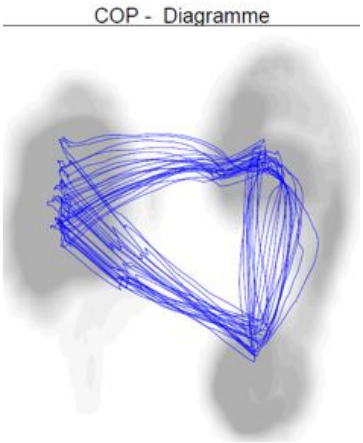
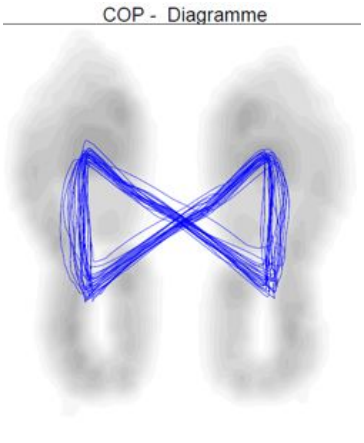
DATA ANALYSIS

Strong incline on treadmill



amputee



non-amputee

SUMMARY

Apparent differences in gait parameters of amputees
(swing phase, stand phase, center of pressure, hip rotation)

→ Asymmetries in the lower extremities influences the upper body

Problems on daily activities (stairs, inclines, declines)

Need of research (technological innovations)
→ Intelligent autonome systems

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DIGRESSION: STRUCTURAL ADAPTATION

Search for possible explanations for the differences of the foot angle

→ Individual analysis: Biographic background

DIGRESSION: STRUCTURAL ADAPTATION

Competitive sport
Decathlon training: 6d/w

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Competitive sport

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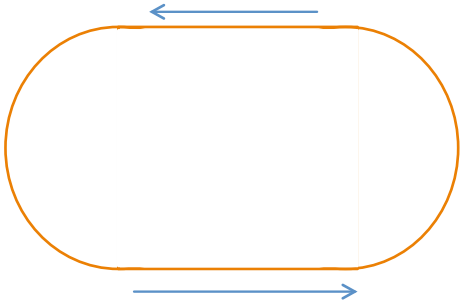
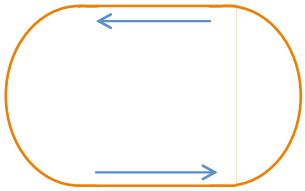




Outdoor
400m-track

Indoor track
200m-track
curve incline

DIGRESSION: STRUCTURAL ADAPTATION

Literature analysis

In running athletes, the power of the eversion muscles were higher on the outer foot
inversion muscles were higher for the inner foot

(De Garie, Pearsall & De Serres, 2004)

Increased muscle strength ~ Muscle shortening
→ Morphological adaptation → Greater ankle angles

Higher injury rates at indoor tracks (Beukeboom et al., 2002)

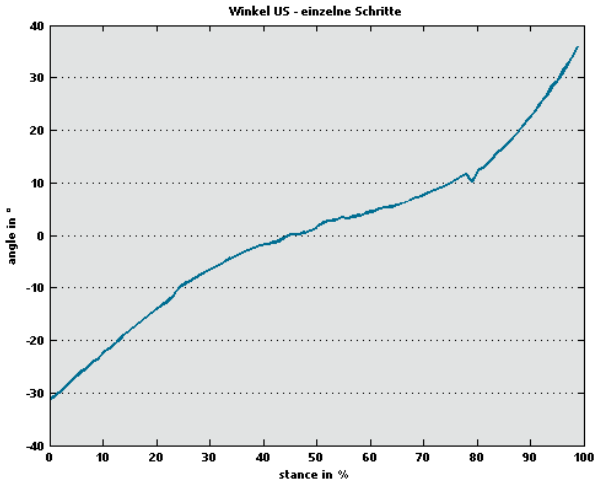
ROBOTICS

→ Converting the algorythms (MadLab) to integrate information into the robotic system

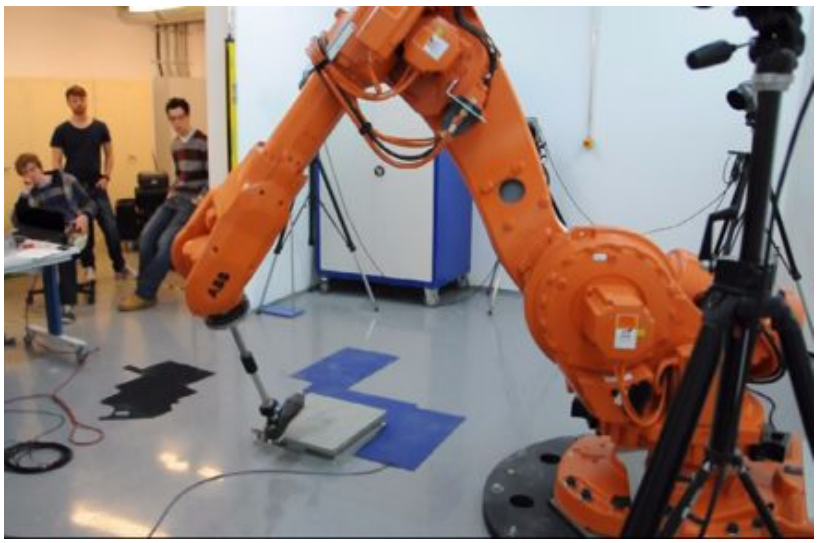
→ Approach of the height, angles to the force plate

→ Increase of velocity

ROBOTICS



ROBOTICS



POSSIBLE PROSPECTS

→ Research possibilities concerning amputees

→ Assimliation of extremity movements (e.g. leg, arm)

Example: Dart throw (Elbow flexion)
Simulation of a throwing movement (with goal on board; Syn Schmitt)
Analysis of an successfull arm movement
Transformation on a roboter
Movement optimation by IAS (Jan Peters)

→ integrative approach of this seminar

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