



Hochschule für
Technik und Wirtschaft
Dresden
University of Applied Sciences



POTENTIALS OF A LOW-COST MOTION ANALYSIS SYSTEM FOR EXERGAMES IN REHABILITATION AND SPORTS MEDICINE

University of Applied Sciences Dresden, Dipl.-Inf. (FH) Loreen Pogrzeba
University of Applied Sciences Dresden, Prof. Dr. Markus Wacker
University of Technology and Mining Freiberg, Prof. Dr.-Ing. Bernhard Jung
Faculties of Mathematics and Computer Science

1

Funded by the European Union
and the Free State of Saxony.



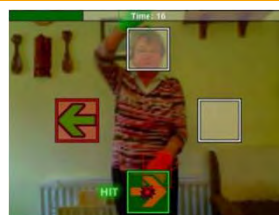
26.10.2012

1. Exergames in Rehabilitation



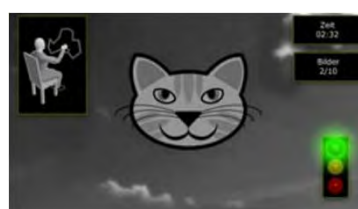
„WuppDi!“, University Bremen

Assad et al. 2011



University Ulster

Burke et al. 2009



„SmartSenior“

John et al. 2012



„Whishy-Washy“, Eyetoy

Rand et al. 2004

2

26.10.2012

2. Motivation

- Motion analysis can be an effective method to diagnose and document the therapeutic progress of patients
- If used, often does not fulfill requirements of therapists Annema et al. 2010

→ Motion analysis system (MAS) which:

- is truly helpful for therapists
- could be combined with various exergames

3

26.10.2012

Potentials of a Low-Cost Motion Analysis System for Exergames in Rehabilitation and Sports Medicine

3. PARTICIPANTS AND PARTNERS

4

26.10.2012



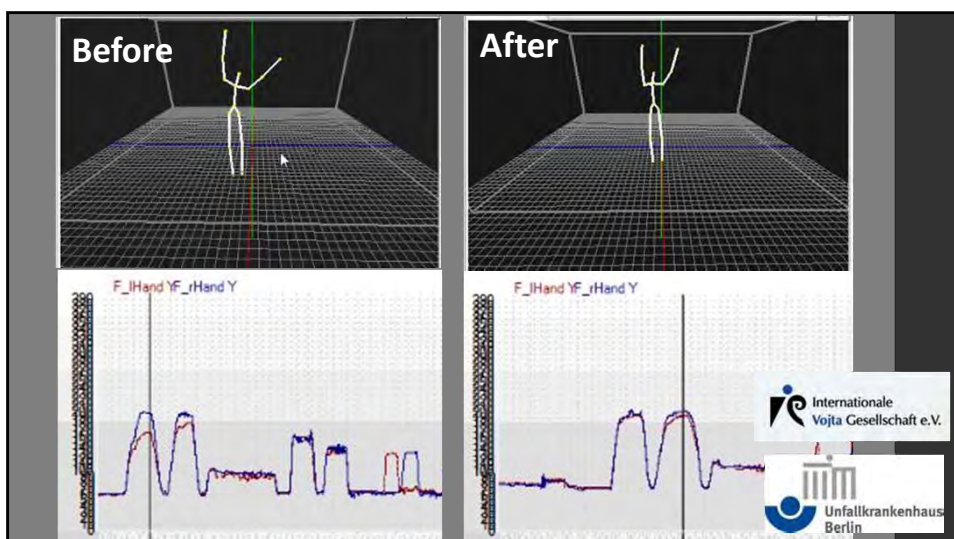
3.1. Rehabilitation: Swedish Music Therapy

5

Recording of entire sessions of about 25 min. in length

→ Collaboration with Swedish therapists of function-oriented music therapy (FMT)

26.10.2012



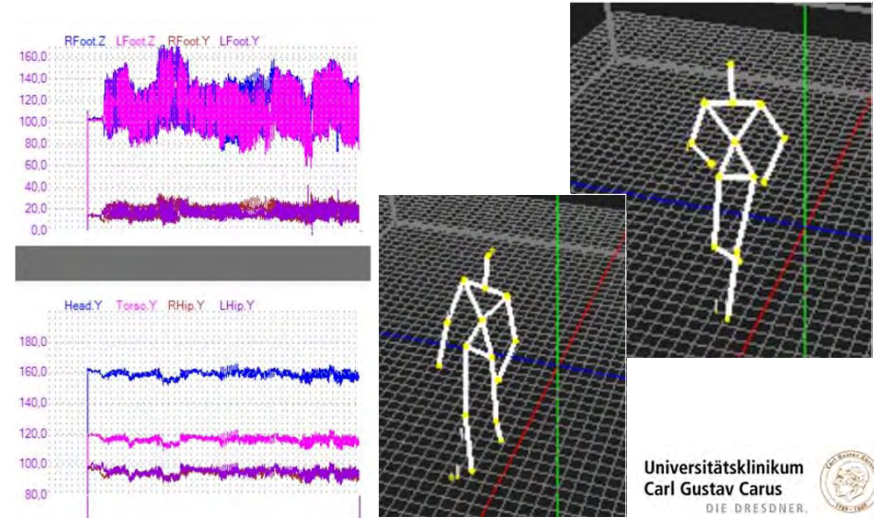
3.2. Rehabilitation: Vojta Therapy

6

Recording of control motion before and after treatment

→ Collaboration with therapists of International Vojta Society

26.10.2012



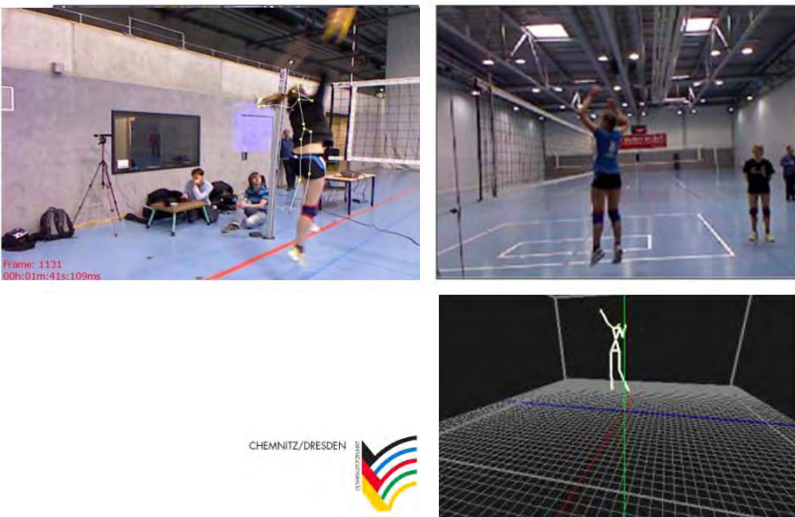
The image displays gait analysis data and a 3D skeletal model. On the left, there are two line graphs. The top graph shows vertical displacement for the right and left feet (RFoot.Z, LFoot.Z, RFoot.Y, LFoot.Y) with a y-axis from 0.0 to 160.0. The bottom graph shows vertical displacement for the head, torso, and hips (Head.Y, Torso.Y, RHip.Y, LHip.Y) with a y-axis from 80.0 to 180.0. On the right, a 3D skeletal model of a person is shown on a grid floor, with yellow markers at joint positions. The logo for Universitätsklinikum Carl Gustav Carus DIE DRESDNER is visible in the bottom right corner.

3.3. Sports Medicine: Gait Analysis

→ Collaboration with University Hospital Carl Gustav Carus Dresden at the clinic and polyclinic for orthopedy

26.10.2012

7




The image shows a jump height analysis setup and a 3D skeletal model. On the left, a photograph shows a person performing a jump in a gymnasium, with a camera on a tripod and a person sitting on the floor. A timestamp reads "Frame: 1131 00h:01m:41s:109ms". On the right, a 3D skeletal model of a person is shown on a grid floor, with yellow markers at joint positions. The logo for CHEMNITZ/DRESDEN is visible in the bottom left corner.

3.4. Sports Medicine: Jump Height

→ Collaboration with training theorists of the Olympic Training Center Dresden/Chemnitz

26.10.2012

8



- **Hardware:**
 - Short preparation time
 - Not distracting
 - Input technology for patients with various special needs
 - Portable and robust
 - Low-priced
- **Software:**
 - User-friendly interface
 - control over choice/form of displayed data, store/load-functionality Annema et al. 2010

- **Hardware:**
 - Short preparation time
 - Contact-free technology (no suits, no marker)
 - No calibration pose

9

3.5. Needs of Therapists and Patients

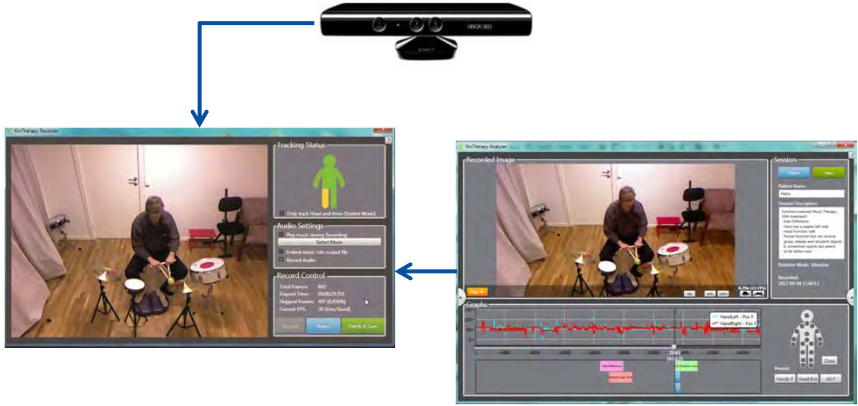
26.10.2012

Potentials of a Low-Cost Motion Analysis System for Exergames in Rehabilitation and Sports Medicine

4. SETUP

10

26.10.2012




4.1. Components of our MAS

Hardware: Microsoft Kinect Sensor

Software: In-house developed software modules

26.10.2012

11

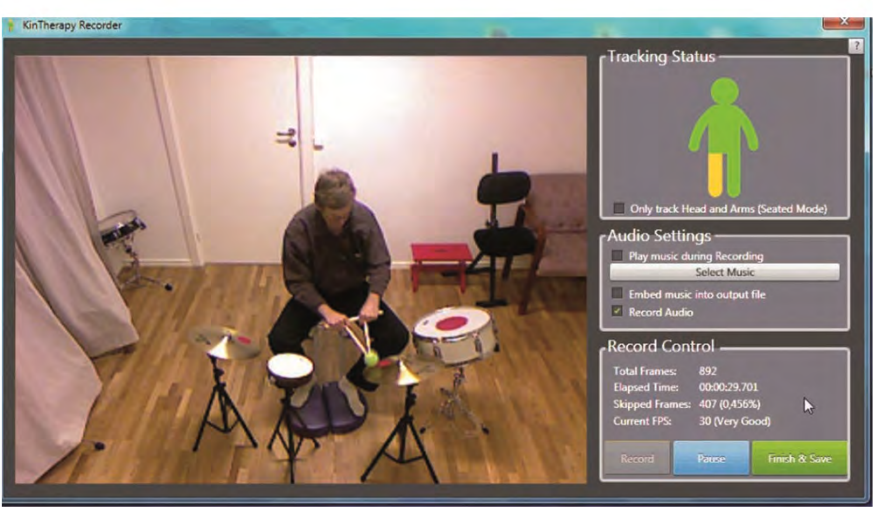


4.2. Setup

Fixed position of Kinect at FMT treatment room

26.10.2012

12

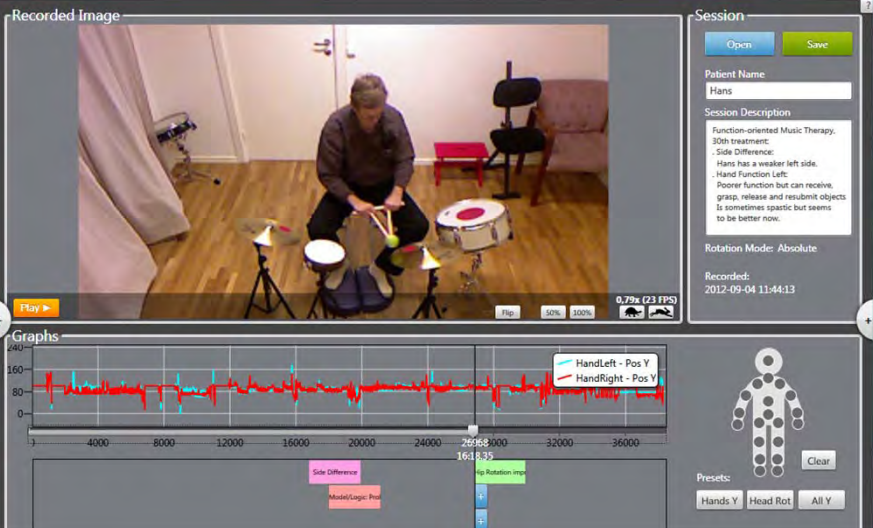


4.3. Demonstration: Recorder

Realtime recording of video image, sound and skeletal data while patient is performing the exercises

26.10.2012

13



4.4. Demonstration: Analyzer

Replaying or scrolling through the video and motion streams with time sliders, adding comments, displaying motion trajectories and changing the displayed motion graphs

26.10.2012

14

Potentials of a Low-Cost Motion Analysis System for Exergames in Rehabilitation and Sports Medicine

5. RESULTS AND DISCUSSION

15

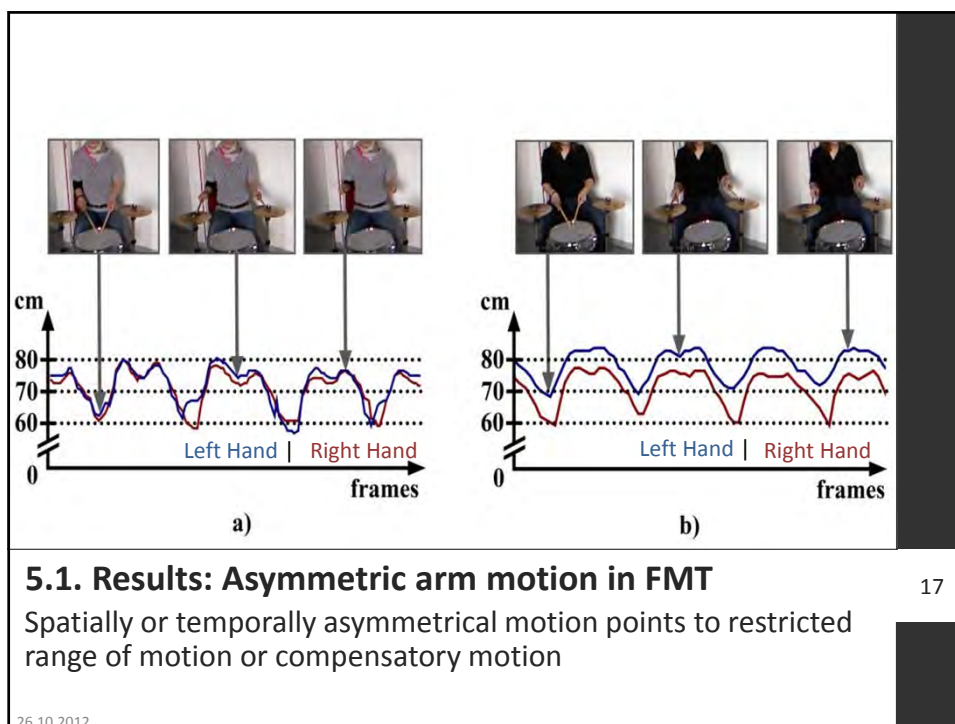
26.10.2012

5.1. Results

- Recording speed, accuracy, and stability were completely satisfactory for tested applications
- Easy detection of irregular or asymmetric motion
- Our MAS enabled therapists for the 1st time to:
 - Capture the motion of their patients
 - Objectively evaluate the therapeutic progress

16

26.10.2012



17

5.2. Discussion

- Limitations of our MAS:
 - Not suited for outdoor activities
 - Max. sample rate of 30 fps
 - Limited field of view (masking problems)
 - No information about muscular strength or activity
 - Not as precise as markerbased/markerless MAS
- MAS is well suited for analysis of stationary motion → non-stationary sports require longer testing period


18

6. Prospects


- Long-term studies
- Automatic detection of motion patterns
 - Identify relevant patterns which were not (yet) recognized by therapists
- Independent use of MAS by all partners
 - Continuous improvement
 - Kinect 2.0 with better functionalities


19

26.10.2012

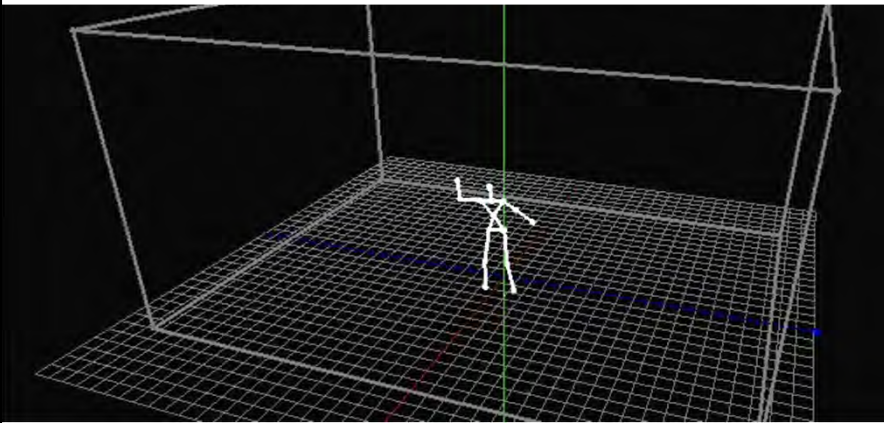


Hochschule für
Technik und Wirtschaft
Dresden
University of Applied Sciences





BERGAKADEMIE
TECHNISCHE
UNIVERSITÄT
FREIBERG



Questions?

Dipl.-Inf. (FH) Loreen Pogrzeba | pogrzeba@htw-dresden.de | www.drematrix.de
 Prof. Dr. Markus Wacker | wacker@informatik.htw-dresden.de | www.drematrix.de
 Prof. Dr.-Ing. habil. Bernhard Jung | jung@informatik.tu-freiberg.de | <http://www.informatik.tu-freiberg.de>

20

References

- Assad, O., Hermann, R., Lilla, D., Mellies, B., Meyer, R., Shevach, L., Siegel, S., Springer, M., Tiemkeo, S., Voges, J., Wieferich, J., Herrlich, M., Krause, M. and Malaka, R. (2011). WuppDi! - Supporting Physiotherapy of Parkinson's Disease Patients via Motion-based Gaming. In: Proc. Mensch und Computer 2011 (Entertainment Interfaces), pp. 469-478
- Burke, J.W., McNeill, M.D.J., Charles, D.K., Morrow, P.J., Crosbie, J.H. and McDonough, S.M. (2009). Optimising Engagement for Stroke Rehabilitation using Serious Games. J. In: The Visual Computer 25(12), pp. 1085-1099
- John, M., Klose, S., Kock, G., Jendreck, M., Feichtinger, R., Hennig, B., Reithinger, N., Kiselev, J., Gövercin, M., Steinhagen-Thiessen, E., Kausch, S., Polak, M. and Irmscher, B. (2012). SmartSenior's Interactive Trainer - Development of an Interactive System for a Home-Based Fall-Prevention Training for Elderly People. In: Proc. Ambient Assisted Living – Advanced Technologies and Societal Change, pp. 305–316
- Rand, D., Kizony, R. and Weiss, P.L. (2004). Virtual reality rehabilitation for all: Vivid GX versus Sony PlayStation II EyeToy. In: Proc. 5th Intl. Conf. on Disability, VR & Assoc. Tech. 2004, pp. 87–94
- Annema, J.-H., Verstraete, M., Abeele, V.V., Desmet, S., and Geerts, D. (2010). Videogames in Therapy: A Therapist's Perspective. In: Proc. of the 3rd Intl. Conf. on Fun and Games, pp. 94–98