Петрозаводский государственный университет
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Petroskoin valtionyliopisto

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Towards a Personal at-home Lab for Motion Video Tracking in Patients with Parkinson's Disease

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"Why that?" Questions

1. Why Parkinson's disease (PD)?

2. Why Gait/Motion Analysis?

3. Why Video Tracking?

4. Why mHealth (at-home)?

Towards a Personal at-home ④ Lab for Motion Video ② ③ Tracking in Patients with Parkinson's Disease ①

Q1 - Why to study Parkinson's Disease (PD)?

Just alike *E. coli* in microbiology, or *A. thaliana* in genetics, or *Drosophila* fly, PD is currently regarded as a **human model pathology** due to unique features

Extremely diverse clinical picture:

- **Tremor**-dominant form
- **PIGD** (postural instability, gait disorders) form
- numerous **non-motor** symptoms (autonomic, sensory, **cognitive,** and affective disorders
- long (4-6 years) pre-clinical stage and chronic course
- PD is linked to ageing

- *Epidemiology:*

  ≈10M PD patients globally, and counting
- *Economy:*

  10-20K USD per PD patient annually (direct and indirect costs)

The ultimate problem of all <u>aged</u> and <u>disabled</u> people, including patients with <u>PD</u>

- **Unfriendly Environment**
- Constantly decreasing physiological functionality
- Loneliness, abandonment, non-inclusiveness (often)
- Lowered Cognitive and intellectual status
- Need to work (for some people)

- **Decreased quality of life:**
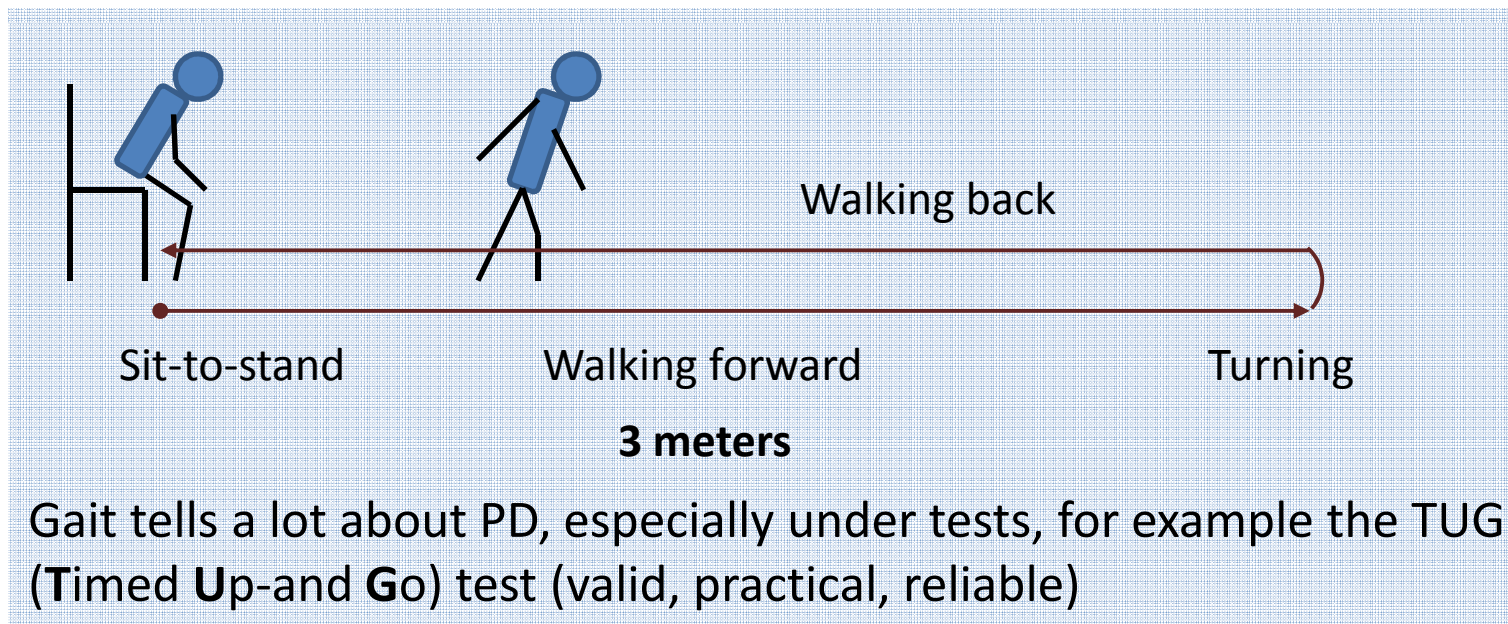Early retirement, loss of employment

- **Social Adaptation ↓**
- Self-service
- Security
- **Mobility (transportation)**
- Access to information
- Communication

Q2: What to track? – Gait provides the most information on motility and mobility

- Short steps
- Slow steps
- Impaired turning
- Freezing
- Shuffling gait
- Falling

- Cadence
- Foot clearance
- Gait speed
- Stride length
- Gait variability

Eskofier BM et al. Appl. Sci. 2017, 7, 986

Sit-to-stand   Walking forward   Turning

Walking back

3 meters

Gait tells a lot about PD, especially under tests, for example the TUG (**T**imed **U**p-and **G**o) test (valid, practical, reliable)

Q3: Why video? – It is regarded as the gold standard for gait parameters

Video-Based Motion Analysis   **Instrumented Walkway Systems**

Still… these two are *costly* and require specialized *movement laboratories*

87% of examinations for assessment of PD occurred <u>in a clinic or lab</u>

Sánchez-Ferro Á et al. New methods for the assessment of Parkinson's disease (2005 to 2015): A systematic review.
Mov Disord. 2016 Sep;31(9):1283-92. doi: 10.1002/mds.26723.

Q4: Why mHealth? - mHealth allows monitoring, assessment, managing

Wearable sensor systems

- Smart shoes
- Accelerometer
- Gyrosensor

Life Space

- GPS: global positioning system apps

Smartphone applications can be configured for system architectures

Summary: Pros and Cons

Features	Motion Video Capture System	Wearable sensors
Setting	Laboratory and clinical setting: influence of the setting (instructions, commands, agitation, fear etc)	At-home: more natural movements
Reliability	Precise, gold standard, valid	Provides relative information
Cost	Costly	Less expansive (cost of a smartphone or tablet) and apps
Practicality	Complex, time-consuming	Less complex, faster analysis
mHealth applicability	Less applicable	Easily configured for mHealth

The problem: no reliable video motion analysis system found for home setting

The "igniting" view and working hypothesis

Surveillance camera above the video motion capture camera

Video camera

The working hypothesis

Would it be possible to hybridize software of a customary video motion capture system with regular surveillance camera and/or a smart phone?

**Motion Video Capture + SmartPhone = Personal at-home Lab?**

Experimental settings

Devices (equipment)

- **Videoanaliz Biosoft 3D** complex (Neirosoft Ltd., Russia), used under IR supporting light
- **Xiaomi Mi** (Android platform) smartphone
- Surveillance camera **Wireless P2P Cellphone Camera S5030-MP2P**

Illumination conditions

- IR supporting light
- Night vision regime
- Regular illumination (daylight with electric light)
- Darkness (some daylight with curtains closed)
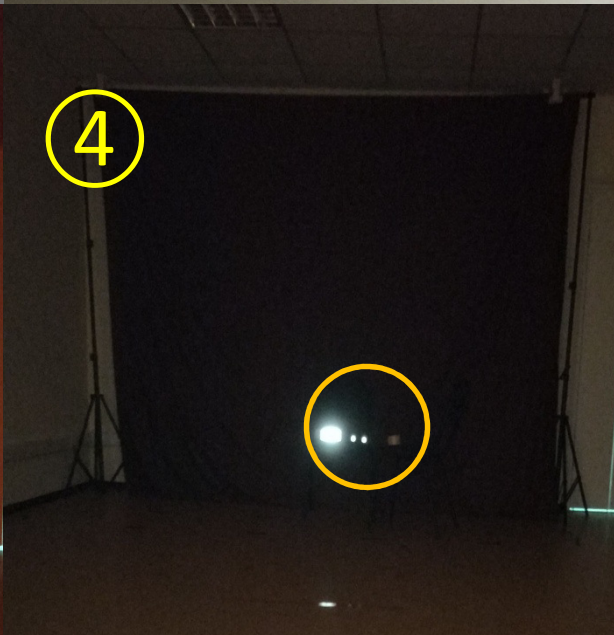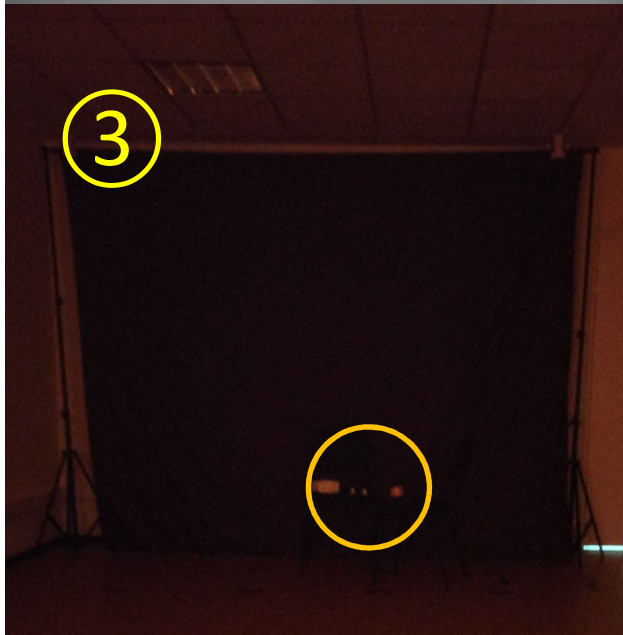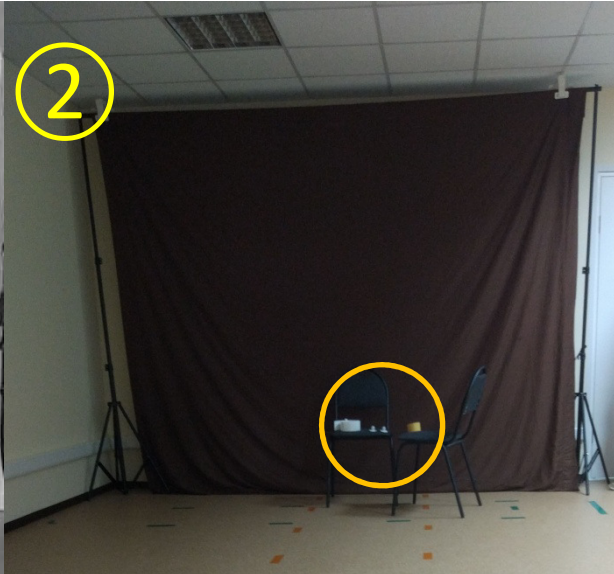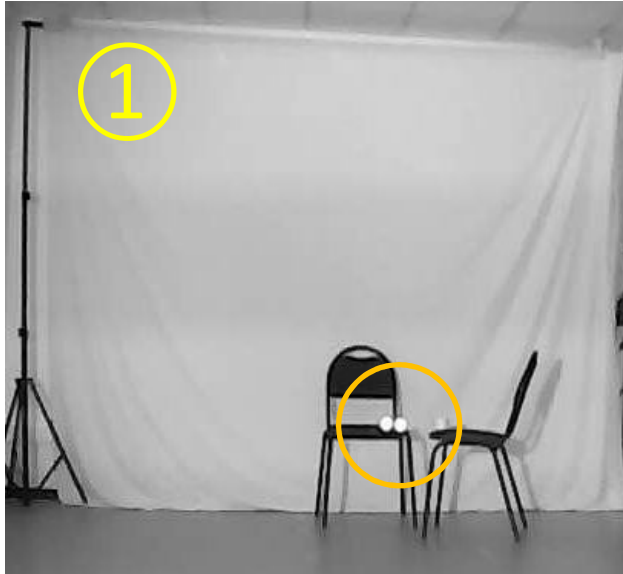
1 – screenshot taken by surveillance camera in the Infra Red regime ("night vision)
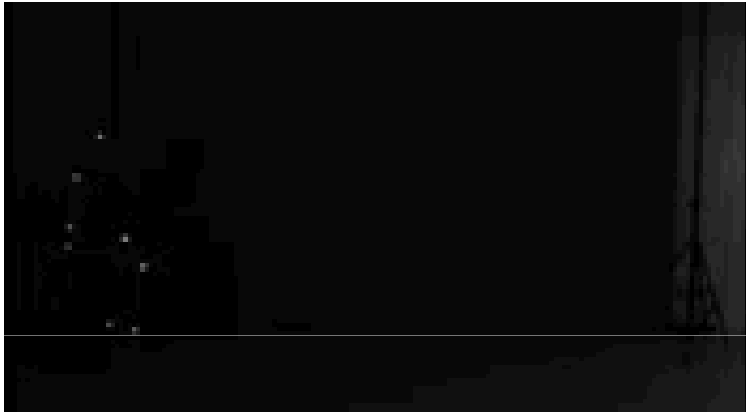
2 – and regular artificial illumination

3 – screenshot taken with help of smartphone illumination in near-darkness condition (without flash)

4 – screenshot taken with help of smartphone with flash illumination in near-darkness condition
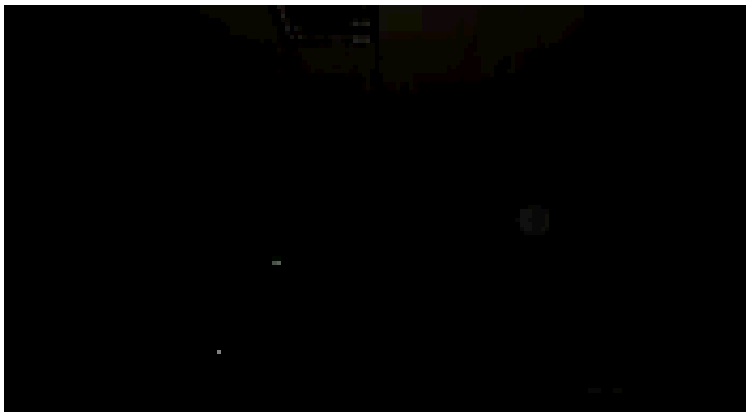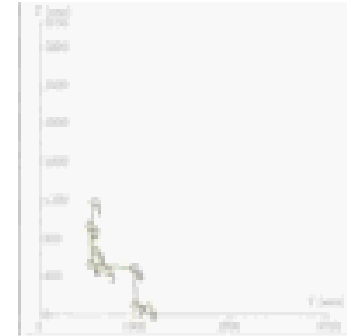
Reflective marker on head during walking under regular room illumination (smartphone)
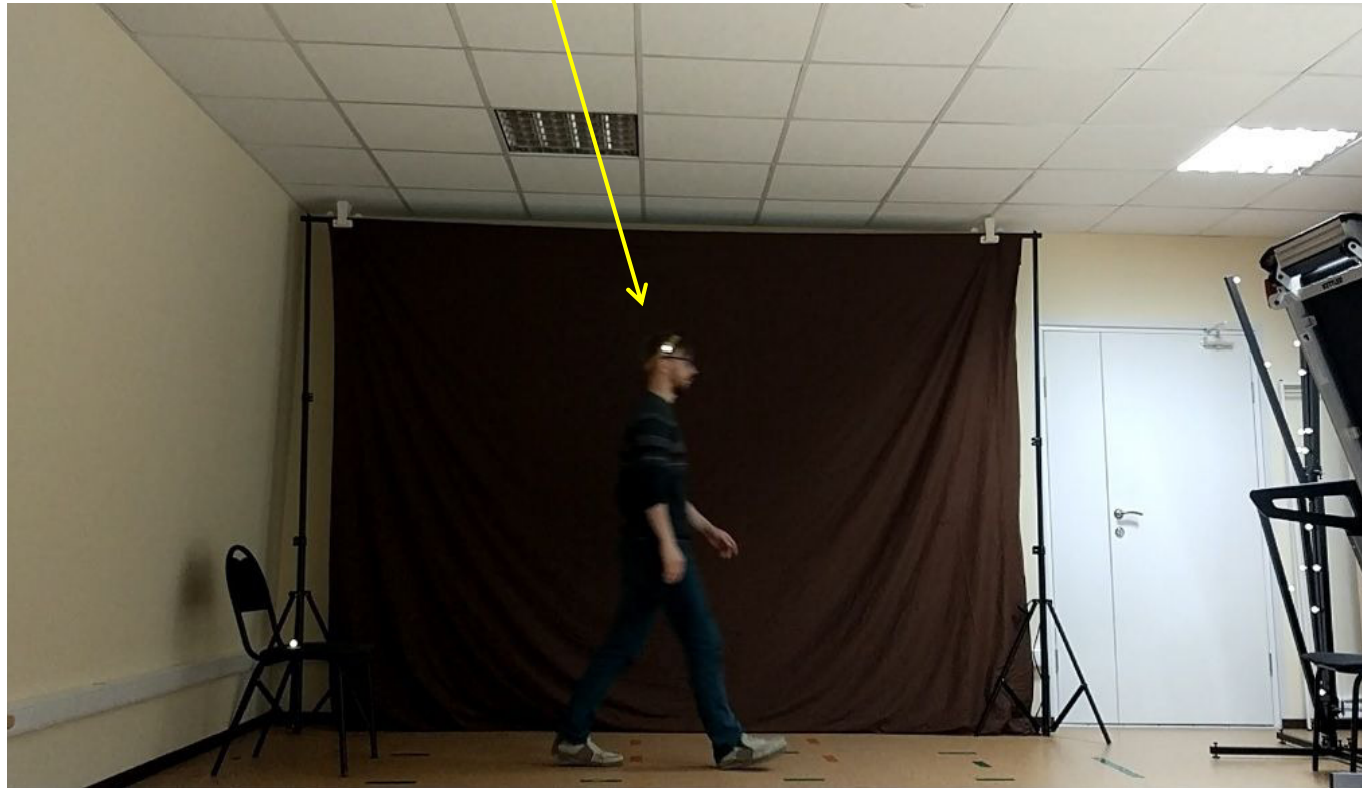
Results

Reflective markers recorded from PD patient in laboratory
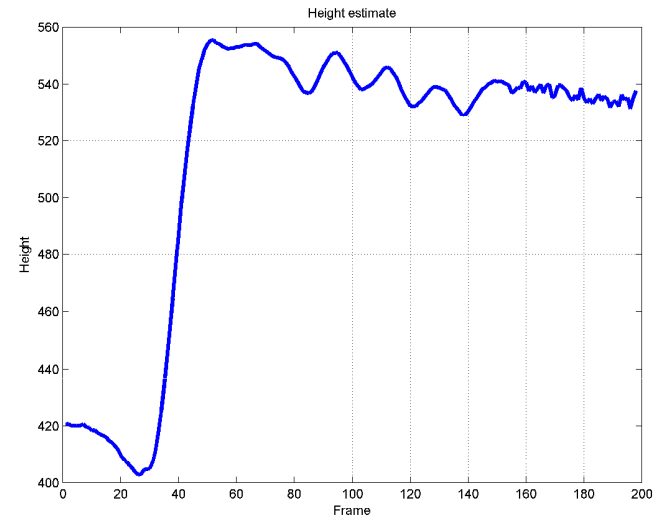

Reflective markers on head recorded by smartphone and loaded in the video motion capture system
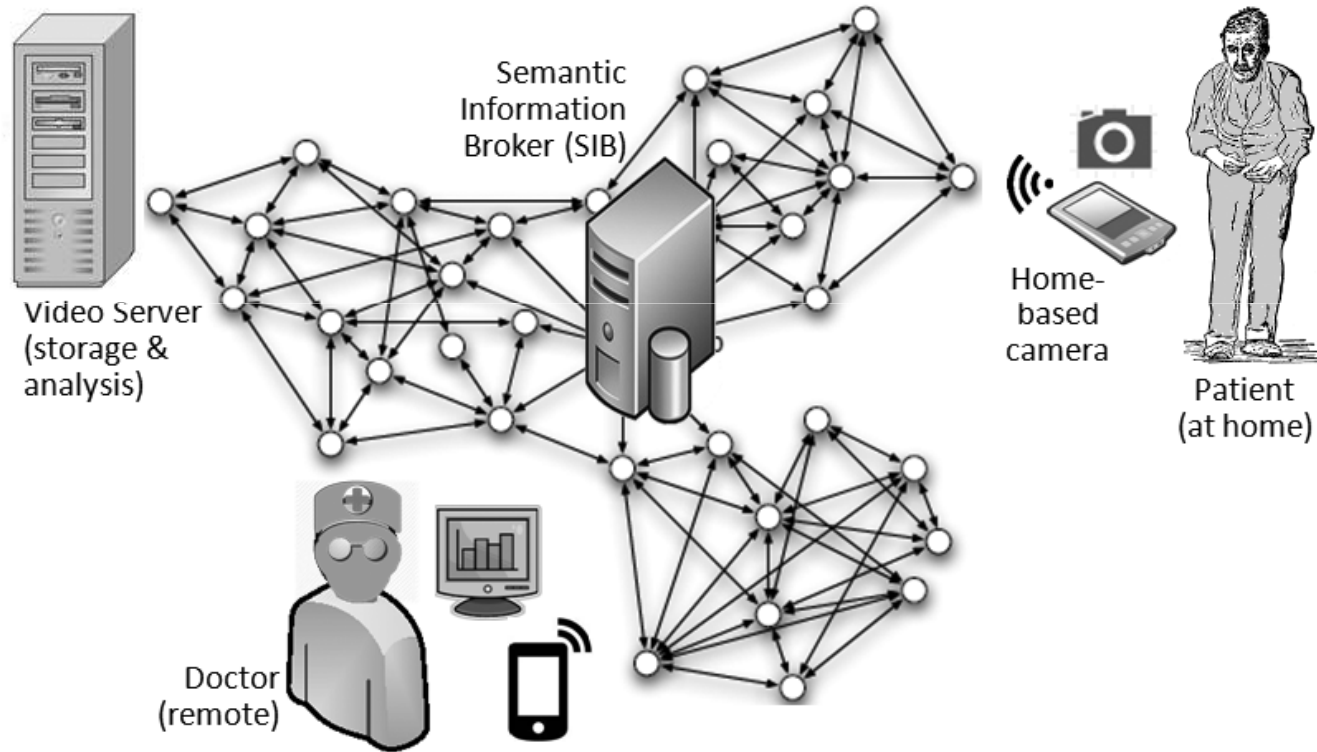
Regular video motion capture system   Smartphone

Further concept

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