VisioTherapy

AI-powered remote physical therapy

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About me

- 2013: Ph.D. at FI MUNI (Large-Scale Multi-Modal Image Search)
- 2013-2021: postdoc at DISA lab, FI MUNI
  - Image retrieval and annotation
  - Human motion retrieval
- Since 2022: R&D in VisionCraft + little research at FI

- **Summer 2023: joined forces with DISA lab within TACR grant**
  - **Objective: develop VisioTherapy software for remote monitoring of rehabiliation exercising**

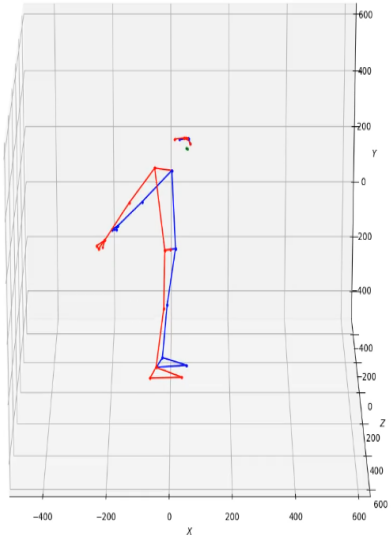
About VisionCraft

- Startup from Brno, founded in 2018
- At first, focus on Intelligent Transportation Systems
  - Object detection and tracking using NNs
  - Edge computing, privacy-safe
- Since 2022, another area of interest: applications of human motion analysis for healthcare

Human motion analysis for dummies

Video taken by standard camera/webcam/ smartphone

motion data **extraction**



3D model of human skeleton

motion data **analysis**

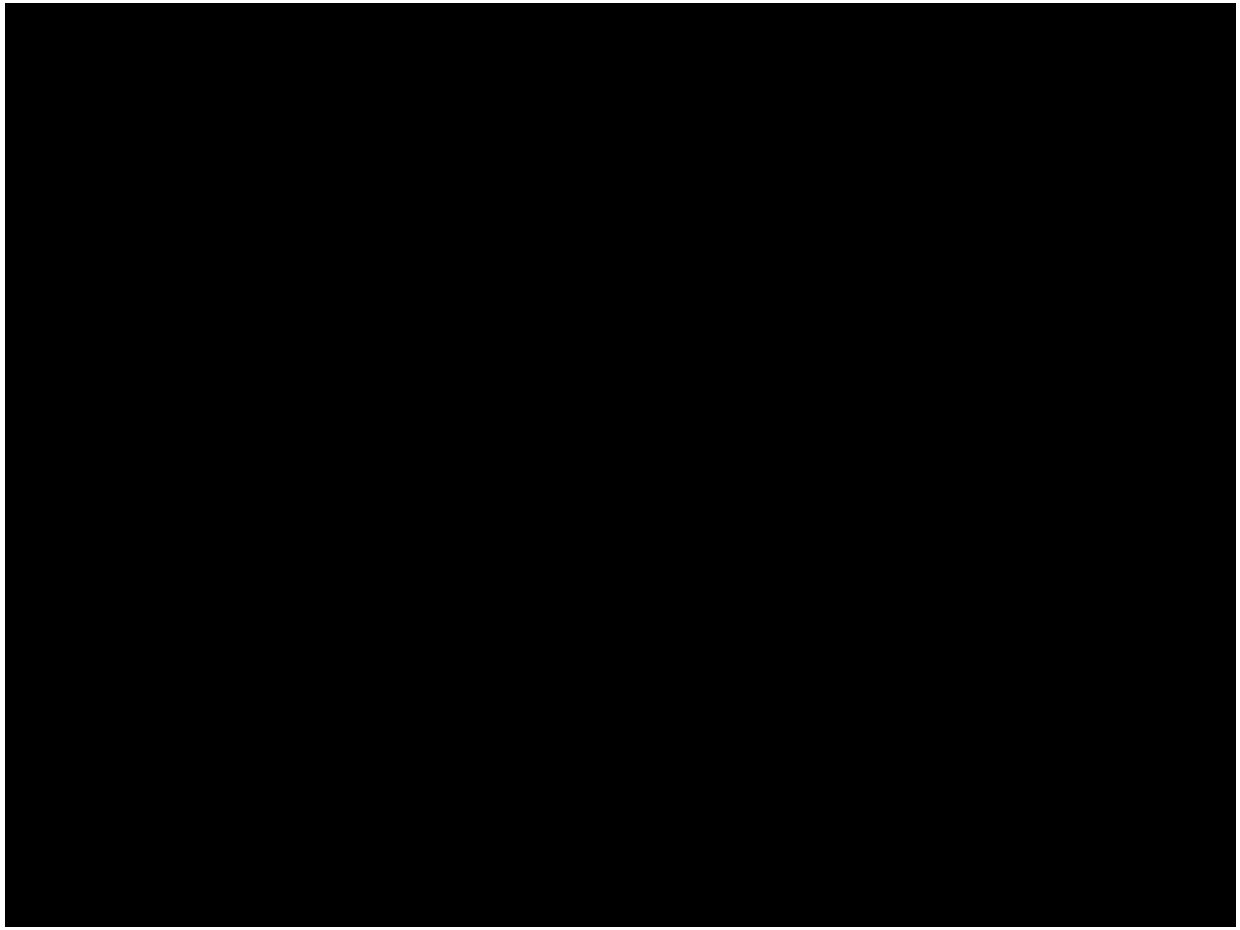
What is the man doing?

Is his movement similar to some example?

Is he dangerous?

…

Why physical therapy?



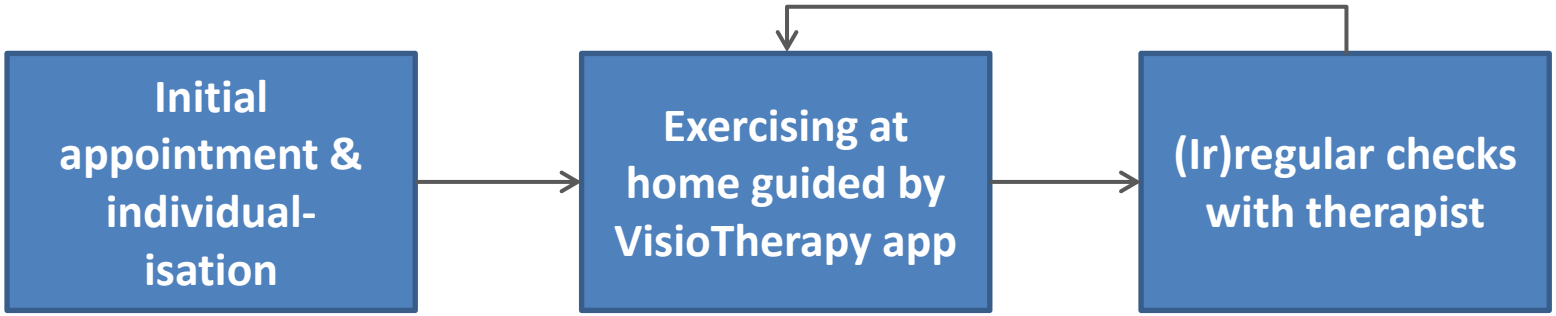
Why physical therapy? (II)

- Home exercising issues
  - 50-70% of patients do not adhere to home exercise plans
  - Patients often exercise incorrectly or do not even remember the exercise
- Poor accessibility
  - Waiting times about 9-15 weeks to see a physical therapist is US and UK
  - In USA, it is estimated that 50 000 therapists will be missing by 2050
- Enormous demand
  - A third of people globally are currently living with a health condition that would benefit from rehabilitation
  - The number is expected to grow in future

VisioTherapy concept

- Basic idea: Assist patients during home exercising
  - Guide them during exercising
  - Detect errors, provide feedback
  - Provide motivation, measure progress
  - Report to therapists

- Patient's journey:

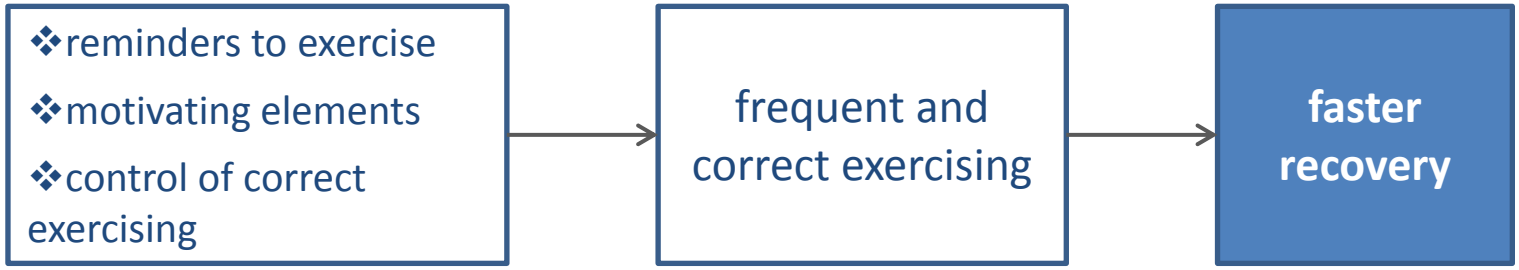


VisioTherapy concept: UI

+ acoustic feedback (sound signals or synthetic voice)

VisioTherapy concept: Benefits

- **For patients**



- **For therapists**

VisioTherapy concept: What makes us special

- **Wide availability**: runs on smartphone, no special hardware needed
- **Absolute privacy**: edge computing, no video shared anywhere
- **Fast and precise feedback**: real-time motion analysis, high-precision motion detection
- **Personalized solution**: takes into account the individual needs and abilities of each patient
- **Therapist in the loop**: therapist remains in charge, guarantees the medical quality of the rehabilitation

VisioTherapy: first steps

- Autumn 2022: first experiments and consultations with therapists
  - Very rough prototype presented at WebSummit conference, positive feedback
- January 2023: submission of TACR TREND grant proposal
  - Scope: in cooperation with FI, develop more precise algorithms for skeleton detection and motion analysis, create working desktop application
- May 2023: submission of TACR SIGMA grant proposal
  - Scope: develop of mobile application, gamification, business strategy
- **Summer 2023: received both grants, can build a reasonable team and start serious work on VisioTherapy!!**
  - Developers and business people: VisionCraft
  - Physiotherapy expert: Mgr. Lukáš Katzer
  - Research team: Honza Sedmidubský, Mima Jánošová, Andrej Černek, Dávid Rusnák (DP)



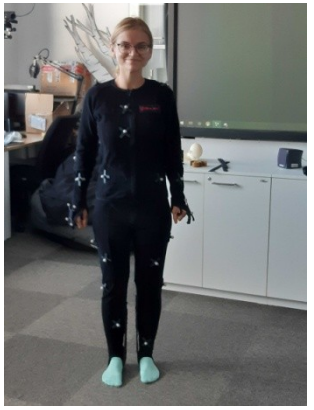

VisioTherapy: from idea to product

- Extraction of high-quality motion data from video
- Precise and fast evaluation of exercise correctness
- Analysis of patient’s progress, problematic parts, …
- Gamification elements
- Design and implementation of desktop and mobile app

Extraction of high-quality motion data from video

- On one hand, there are many NNs that perform human pose extraction from ordinary video
- On the other hand, the results are often far from perfect

- What can we do to extract high-quality motion data?
  - Search for NN models suitable for rehabilitation exercises
  - Create dataset of rehabilitation exercises with GT of precise motion data
    - HCI lab at FI
  - Fine-tune existing NN models using our data
  - Preprocess video before applying NNs
  - Apply cleaning algorithms to extracted motion data



Motion analysis

- Basic functionality
  - Checking static constraints on patient's position
  - Measurement of joint movement angles
- Advanced processing of motion data
  - Definition of suitable similarity model
  - Online detection of erroneous exercising
  - Offline comparison of motion sequences using both positive and negative examples
  - Exercise repetition counting
  - Detection and explanation of differences between model and actual exercise
  - Patient progress monitoring
  - Data mining over exercising data of patient groups

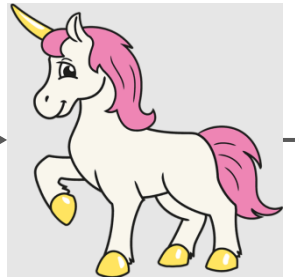
Gamification

- Many apps use gamification
  - Language learning
  - Fitness training
  - …
- However, not all gamification principles are suitable for physiotherapy
  - The more the better is not true here!
  - We need to consult with therapists to come up with suitable motivation elements
- Could be a nice bachelor/diploma theses… anybody interested?

Design and implementation of VisioTherapy app

- Both desktop and mobile interfaces
  - Mobile for patients
  - Mobile and desktop for therapists
- Challenge: Feedback on exercise correctness
  - During exercising, after exercising
  - Visual and audio
  - This could also be a very nice bachelor/diploma thesis!
- Implementation
  - Edge computing – emphasis on efficiency
  - Only derived data (MoCap + statistics) sent to server

Timeline



7/2023
Very rough prototype
Basic motion analysis

7/2024
Full prototype for desktop
Enhanced quality of motion data
Evaluation of exercise correctness
Exercise repetition counting

Ready to test with first users

7/2025
Working mobile app
High-quality motion data
Full scope of motion analysis

The End… Questions? Comments?