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VIDZEMES AUGSTSKOLA

Design Research for User-friendly Guidance of Complex Whole-body Rehabilitation for Lower Extremity Amputees by Means of Extended Reality and Advanced Wearables Data Processing

Linda Lancere, SSII pētniece, 18.06.2019.

Valsts izglītības attīstības aģentūra
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Challenges

- 1 million annual limb amputations globally
- Mumber of amputees vs number of physiotherapists
- High individualisation necessary
- Cardiovascular and respiratory systems are compromised
  - Hypoglycemia, Hyperglycemia - diabetes
  - Stroke, Heart attack, Tachicardia, Stenocardia, Arterial hypertension
  - Pneumonia, COPD, Bronchectases, Bronchial asthma
- At home - injuries, pain, how should I do it?!

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Solution

Wearables

Real time
- Movement precision
- Breathing
- Heart rate
- Blood pressure
- ECG
- Oxygen saturation

+

Medical know-how

Individualisation
Deep breathing training
Deep core muscle training

+

AR + AI

Clear instructions
Data pinterpretation
Neural networks
Progress reports, reminders

Faster recovery
Returning to work
Sustained rehabilitation
Everyday, sports activity performance

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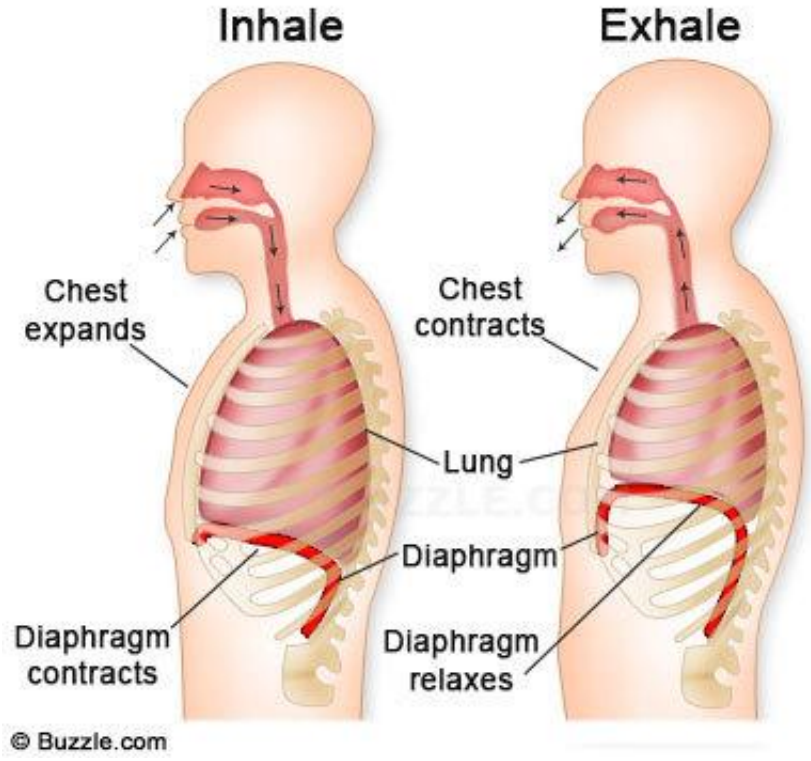


Spiral Line


Arm Line


Superficial Front Line


Deep Front Line


Lateral Line


Superficial Back Line

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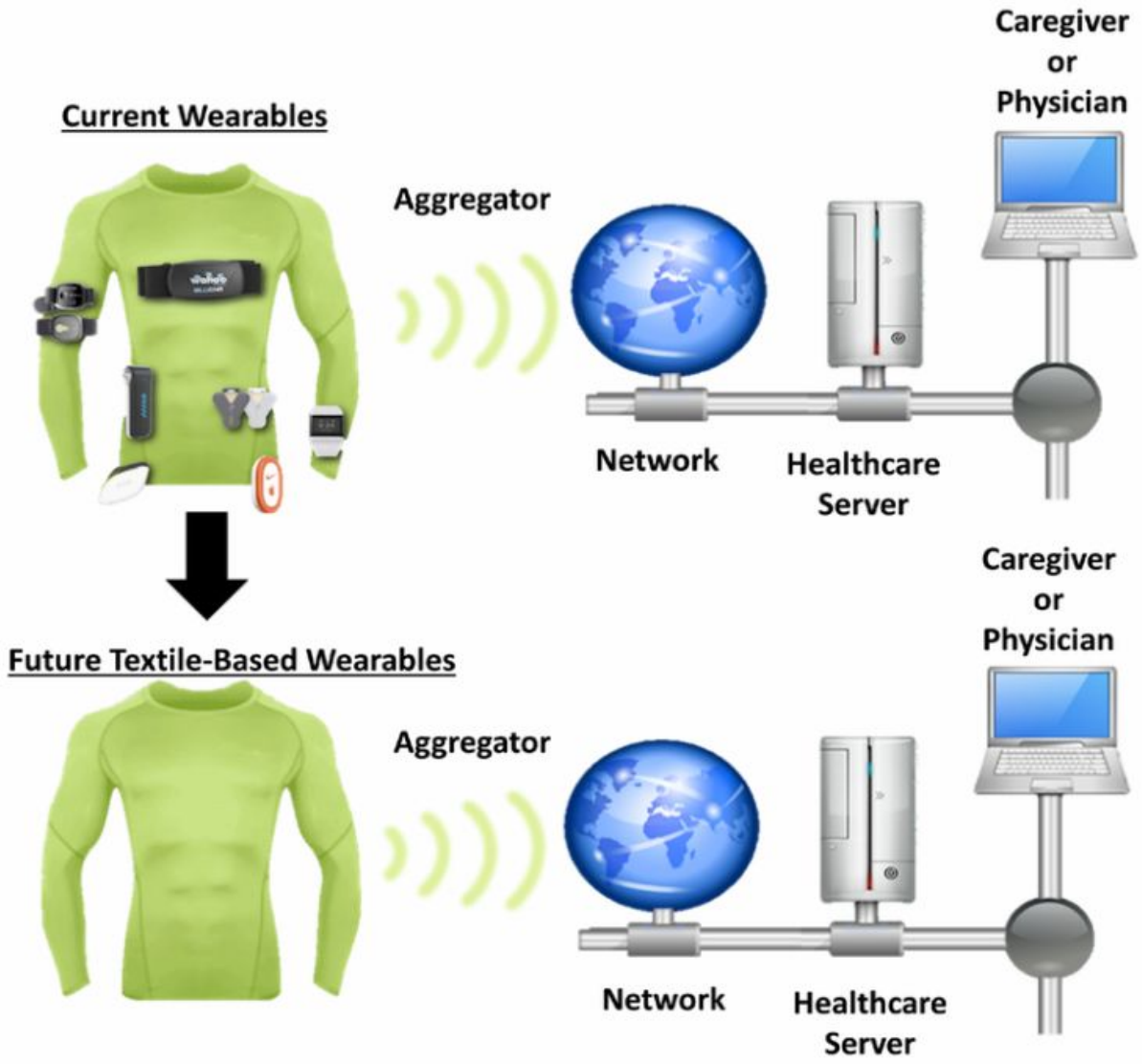
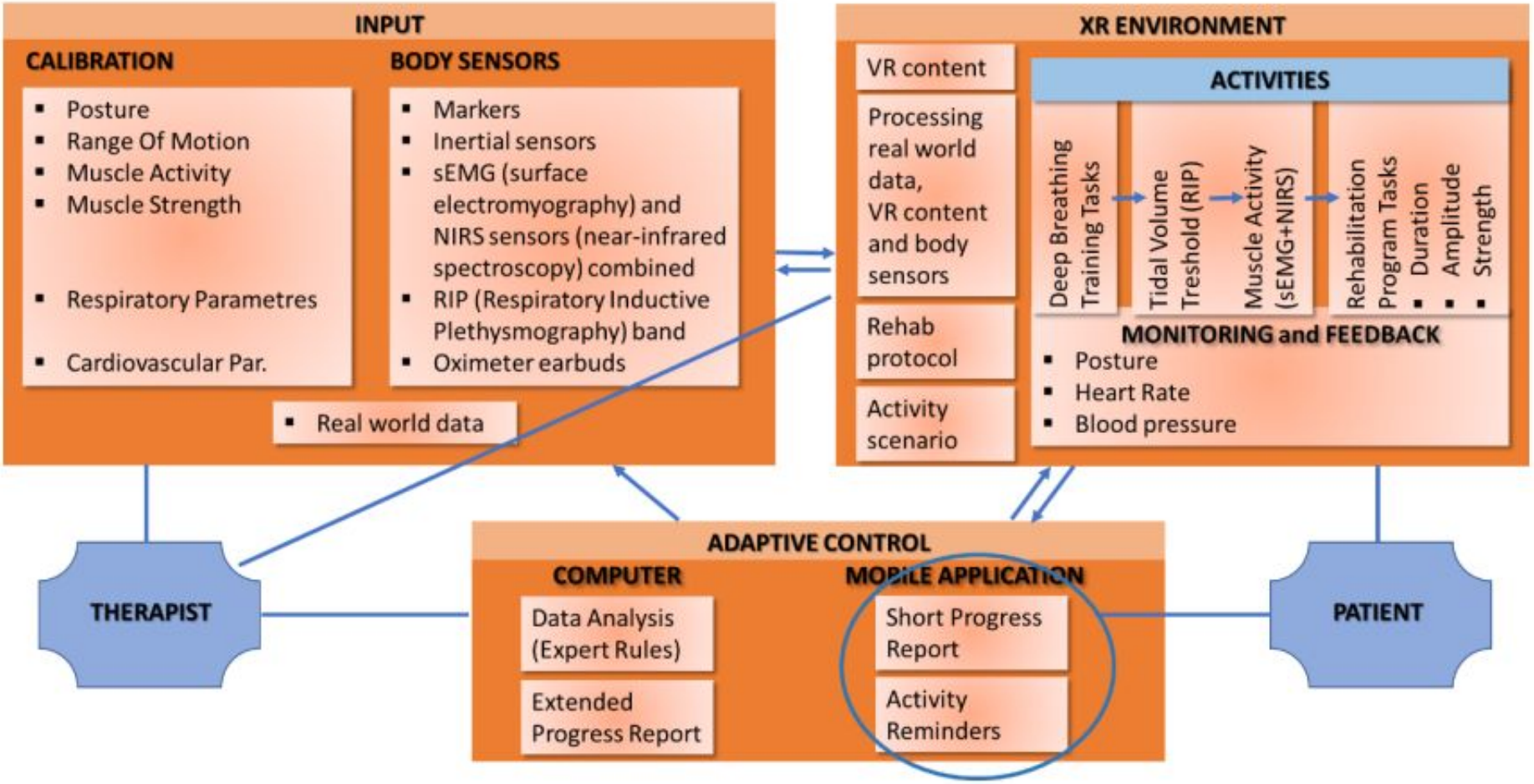


Raj Bhakta, relationship between the textile based wearable device and the data infrastructure for our internet-of-things application // Courtesy of Raj Bhakta


INPUT
CALIBRATION
Posture
Range Of Motion
Muscle Activity
Muscle Strength
Respiratory Parametres
Cardiovascular Par.
BODY SENSORS
Markers
Inertial sensors
sEMG (surface electromyography) and NIRS sensors (near-infrared spectroscopy) combined
RIP (Respiratory Inductive Plethysmography) band
Oximeter earbuds
Real world data
XR ENVIRONMENT
VR content
Processing real world data, VR content and body sensors
Rehab protocol
Activity scenario
ACTIVITIES
Deep Breathing Training Tasks
Tidal Volume Treshold (RIP)
Muscle Activity (sEMG+NIRS)
Rehabilitation Program Tasks
Duration
Amplitude
Strength
MONITORING and FEEDBACK
Posture
Heart Rate
Blood pressure
THERAPIST
ADAPTIVE CONTROL
COMPUTER
Data Analysis (Expert Rules)
Extended Progress Report
MOBILE APPLICATION
Short Progress Report
Activity Reminders
PATIENT

Stages

- Rehabilitation methodology development
  - Study design
  - Limitations
- XR solutions and the creation of a mobile application
  - Technical limitations
- Testing and prototyping

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Stages II

WP2.1. State-of-the-art analysis of rehabilitation, XR and wearables existing methods.

WP2.2. In-depth interviews with physiotherapists and amputees.

WP2.3.Rehabilitation methodology development.

WP2.4.Technology, wearables testing - procurement procedure in process

WP4.1.Patient trial evaluation protocol development.

WP4.2.Patient search, formalities, ethics.

WP.4.3.Patient trials. Testing XR solution with lower extremity amputees.

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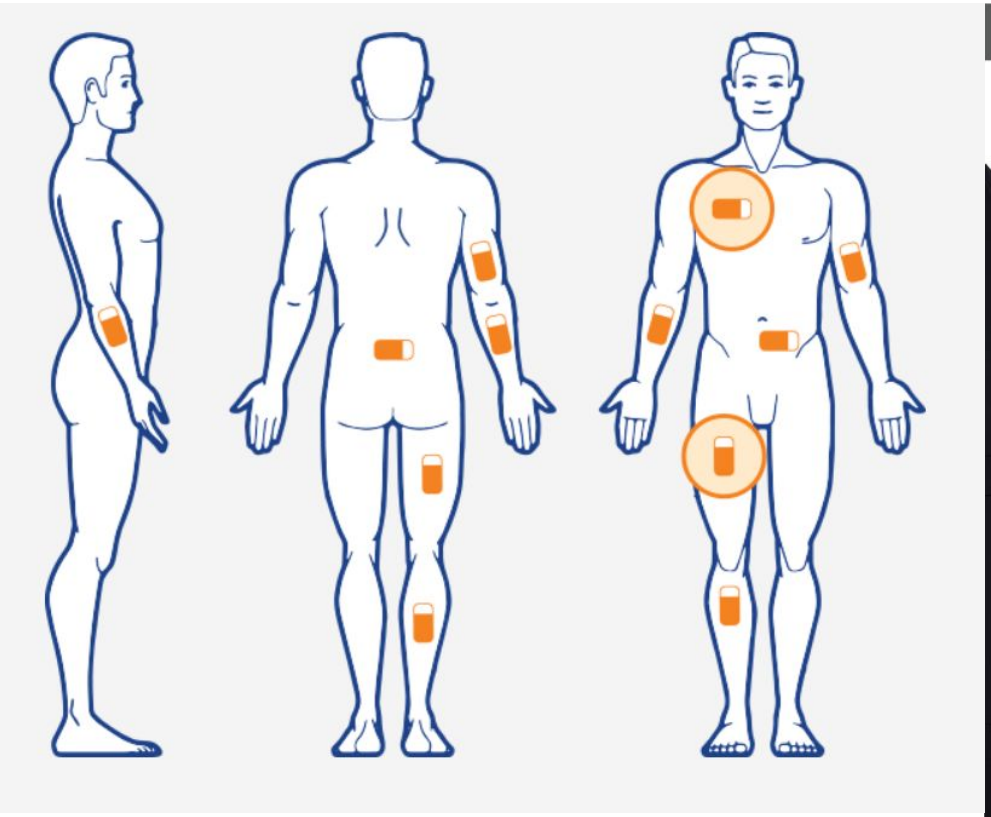

Hexoskin **Classic Kit** - MEN'S

- **BLOOD PRESSURE**
- **OXYMETRY**
- **GLUCOSE MEASUREMENTS**

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Rehabilitation program

- Patient questionnaire - RAKUS stacionārs Gaiļezers
- Rehabilitation program preliminary testing
  - limited positions defined
  - range of motion limitations
  - cognitive disfunctions
- Rehabilitation
  - Evaluation - posture, ROI, muscle strength, Amputee Mobility Predictor, Fiziskās slodzes tests, ABC scale, Ampierinātibas tests
  - Exercise program - healthy subjects, amputees with prosthesis, amputees in subacute stage - duration, intensity, repetitions
  - Secondary condition limitations

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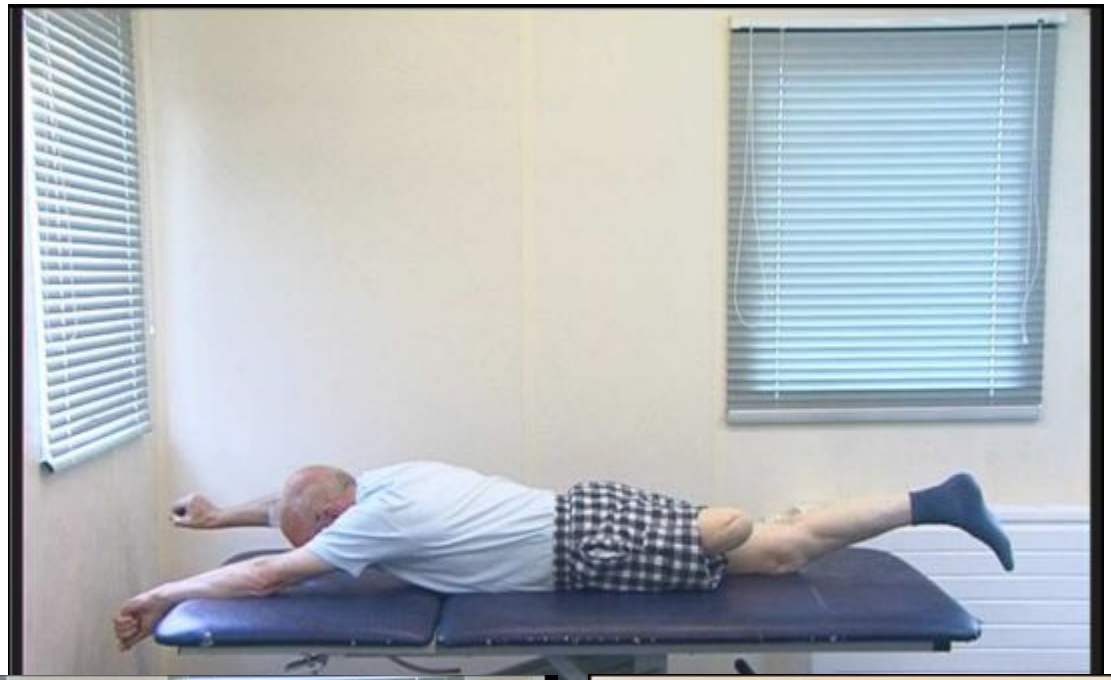

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Breathing		Hook lying position, hands immediately below the anterior costal cartilage, four fingers in medial direction, thumbs in posterior direction, relaxed						
		Relaxed neck and shoulders	Inhale through nose slowly and deeply only by swelling abdomen	No movement in shoulders and upper chest		Count till 4 to 6	na	
		Relaxed neck and shoulders	Hold breath for 3 seconds	No movement in shoulders and upper chest				
		Relaxed neck and shoulders	Exhale through pursed lips (like whistling)	No movement in shoulders and upper chest		Count till 6 to 9		
		Repeat 8 to 10 times 3 to 5 times every day, before and during the exercises						
ABDOMINALS	Activation	Lie on your back.Bend your knee in 90 deg so the foot of unaffected leg is resting flat on the floor. Affected leg is resting on the floor relaxed. Place your hands in the small of your back.	Inhale	-		-		
		Keep your neck, shoulders, gluteus, quadriceps relaxed.	Exhale	Pull in abdominal muscles. Slowly tighten the pelvic floor muscles. Push your lower back into your hands.		Hold for 20sec	na	**Tranversus abdominis**
			Inhale	Relax				
		Repeat 8-12 times, 3 intervals						
	Partial sit-up	Lie on your back.Bend your knee in 90 deg so the foot of unaffected leg is resting flat on the floor. Rest your hands on your tighs. Afftected leg resting on a towel.	Inhale				Towel	
		Keep your neck, shoulders, gluteus, quadriceps relaxed.	Exhale	Slowly curl up until your head and should blades are off the floor. Look up to the ceiling as you do the exercise.	max 30 deg			Rectus Abdominis
			Inhale	Slowly curl back to the initial state.				
		Repeat 8-12 times, 3 intervals						
	Diagonal sit-ups	Lie on your back.Bend your knee in 90 deg so the foot of unaffected leg is resting flat on the floor. Rest your hands on your tighs. Afftected leg resting on a towel. Stretch right hand upwards in 90deg restinh on the floor.	Inhale				Towel, bottle or dumbbell	
		Keep your neck, shoulders, gluteus, quadriceps relaxed. Do not use the arm stretched out on the floor for stabilization.	Exhale	Slowly lift the back of the left straigt hand and push past the right leg. Follow the hand movement with the head and allow head to come up off the floor.	max 30 deg			Rectus Abdominis, External Oblique, Contralateral Internal oblique
			Inhale	Slowly return back to initial state.				
		Repeat each side 8-12 times, 3 intervals						

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PALDIES!

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