Interactive Visualization of Muscle Activity During Limb Movements : Towards Enhanced Anatomy Learning

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Overview

Related Work
- Learning Anatomy
- Related Work

LBA Architecture
- LBA Project
- Kinect & User-Specific 3D Avatar
- Muscle Activity data
- Model & Results

Conclusion & Future Work

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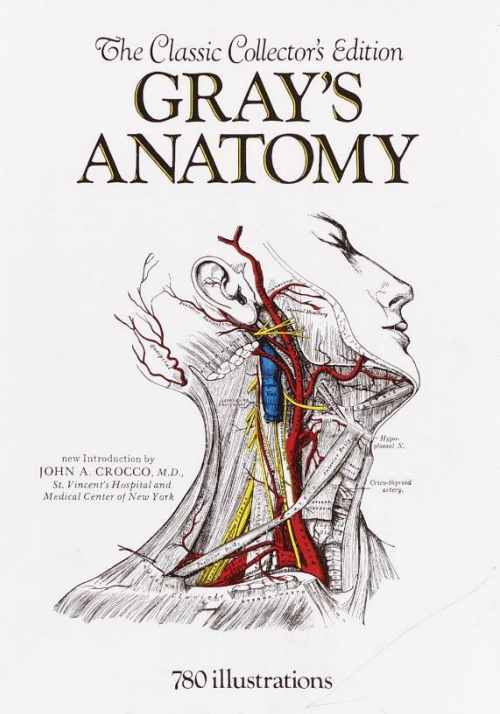
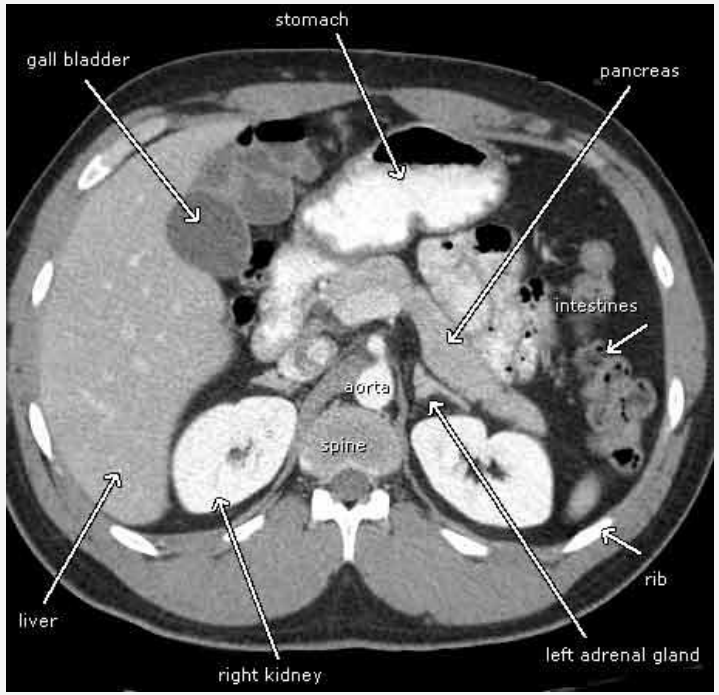
Learning Anatomy : Classic Methods



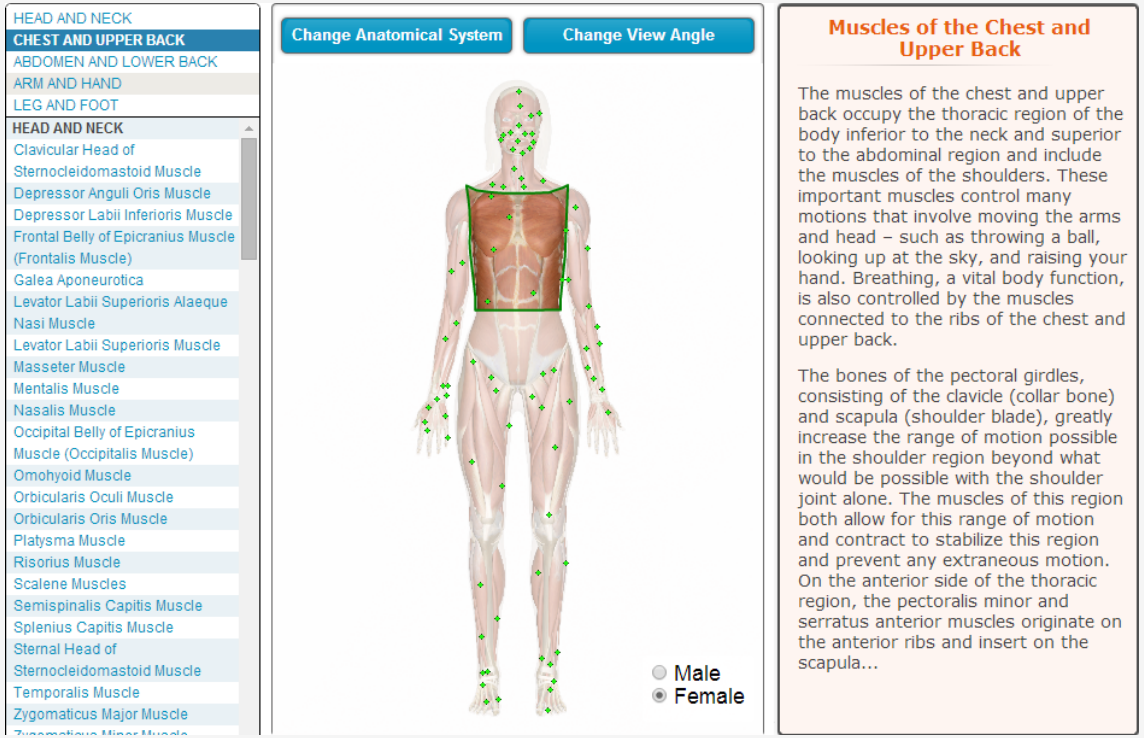
Gray's Anatomy



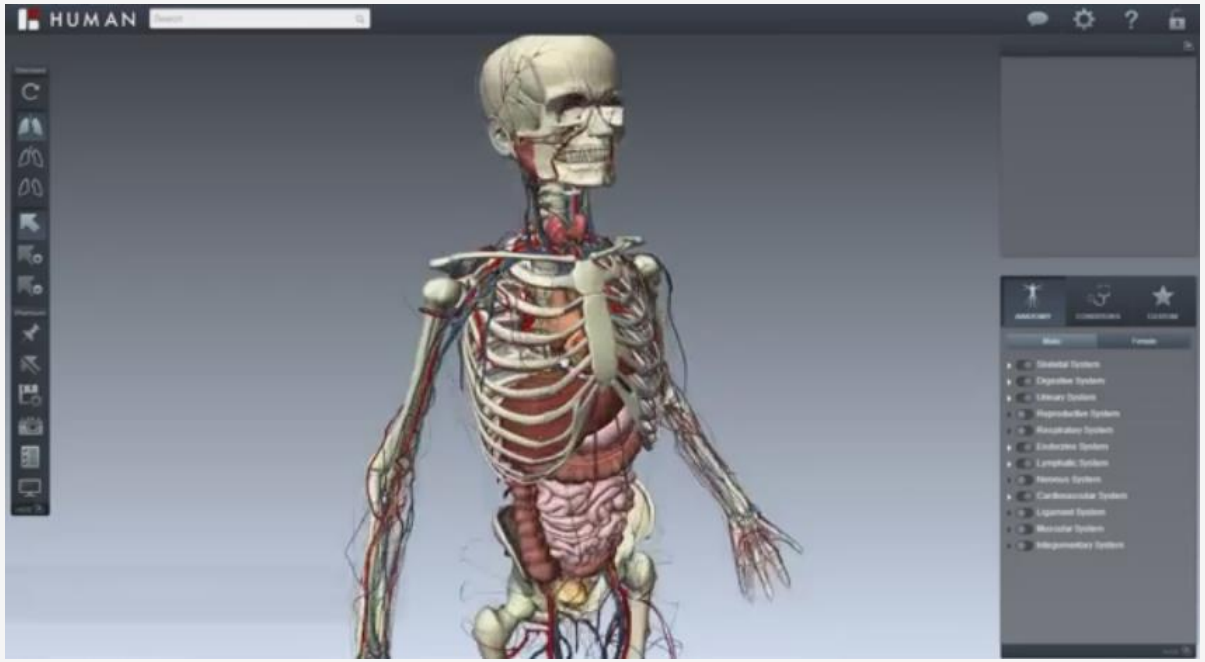
CAT Scan (CT)

Anatomical Model

Learning Anatomy : 3D Visualization

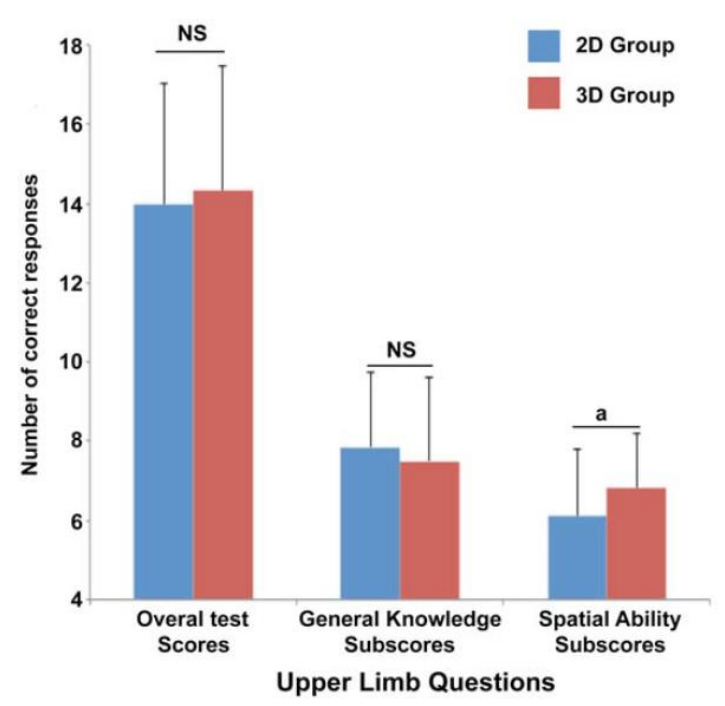


Medicine [*InnerBODY, 2013*]



BioDigital Human [*https://www.biodigitalhuman.com/*]

Learning Anatomy : Animation



(1) [Nady Hoyek & all, 2014]

Fovea MOOC[anatomie3d.univ-lyon1.fr/]

(1) Effectiveness of Three-Dimensional Digital Animation in Teaching Human Anatomy in an Authentic Classroom Context
Nady Hoyek, Christian Collet, Franck Di Rienzo, Mickael De Almeida, Aymeric Guillot
Anatomical Science Education, 2014 mar 27

Embodiment Theory

*"Our Motor System **Influences** our **Cognition**"*

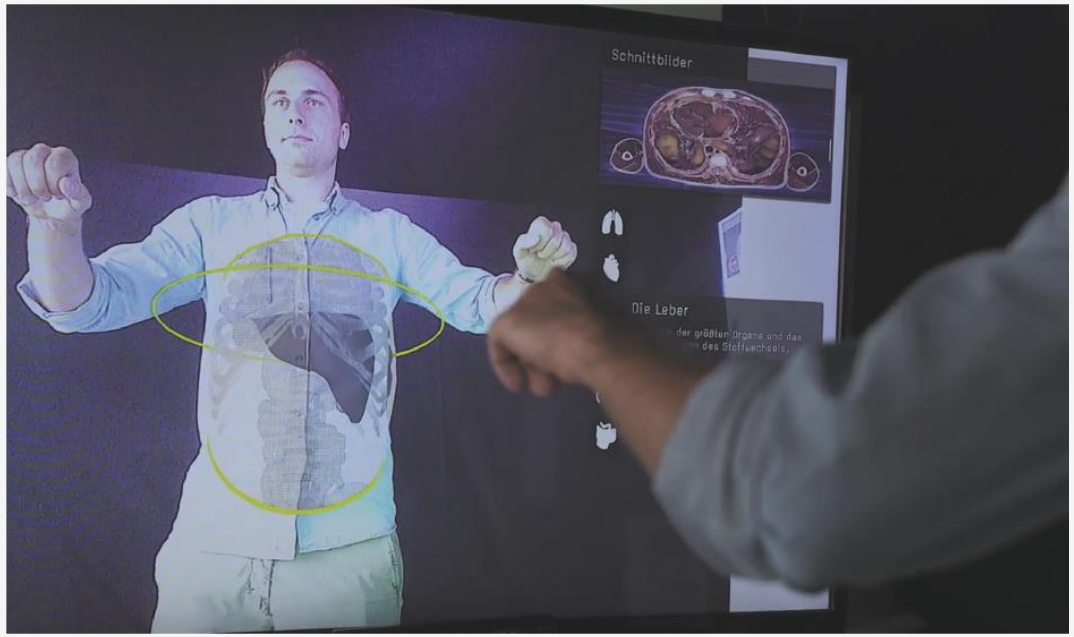
Embodied Cognition and Virtual Reality in Learning to Visualize Anatomy
Susan Jang, John B. Black, Robert W. Jyung
Proc. CogSci, 2010

Eroding the Boundaries of Cognition: Implications of Embodiment
Anderson ML, Richardson MJ, Chemero A
Topics in cognitive science, 4(4): 717–730, 2012

Being there: Putting brain, body, and world together again
Clark, A..
MIT press, 1998

Embodied cognition is not what you think it is
Wilson AD, Golonka S
Frontiers in psychology, *4.*, 2013

Related Work : Augmented Reality

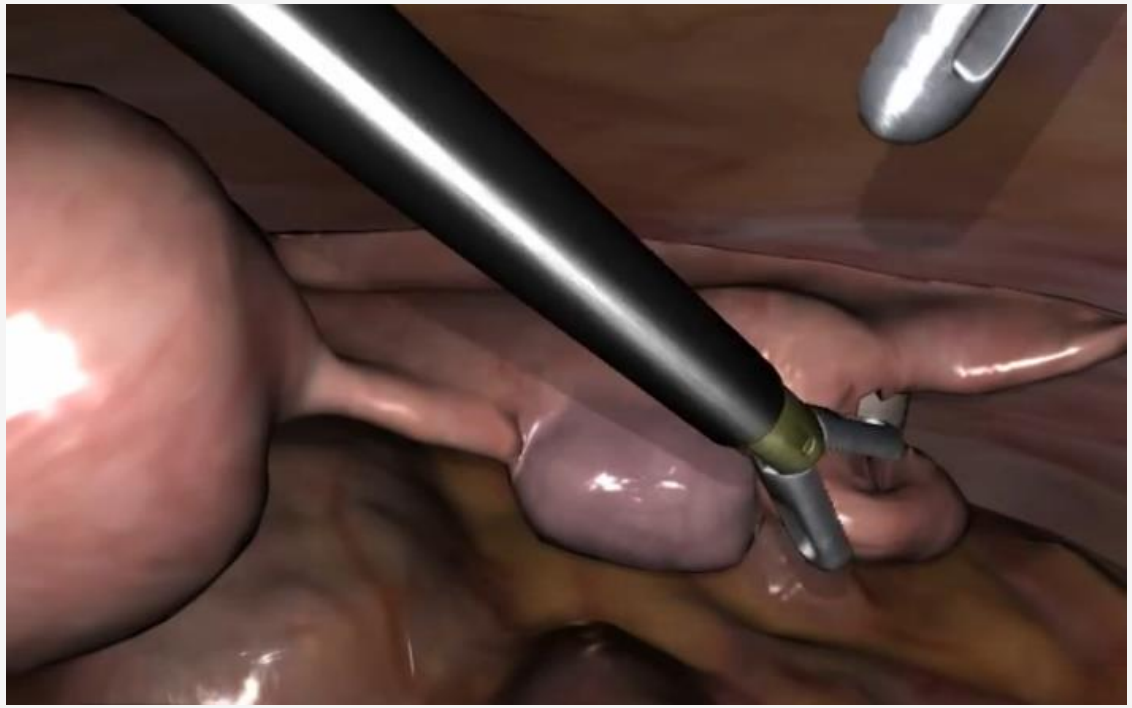


(1) Magic Mirror [Ma Meng & all, 2013]

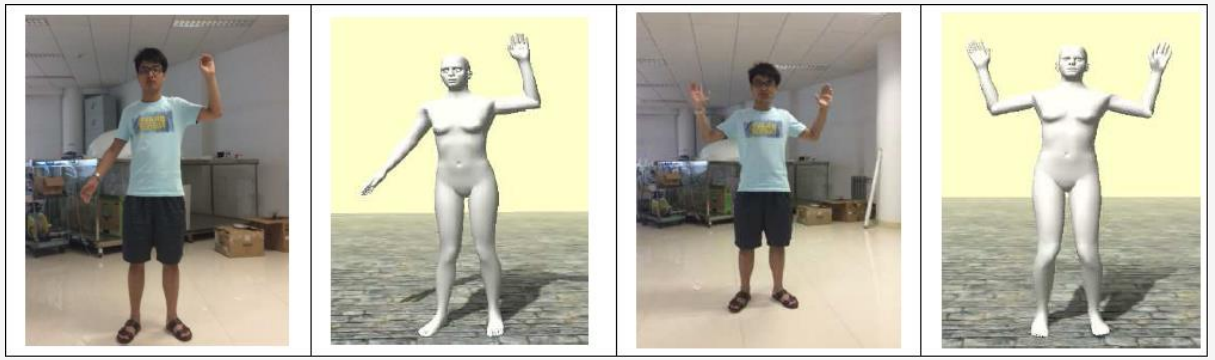
Digital Mirror [University of Paris-South, 2014]

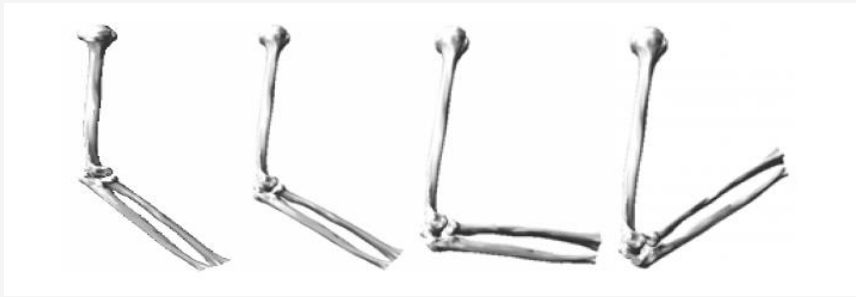
(1) Kinect for Interactive AR Anatomy Learning
Ma Meng, Pascal Fallavollita, Tobias Blum, Ulrich Eck, Christian Sandor, Simon Weidert, Jens Waschke, Nassir Navab1
IEEE Virtual Reality, 2012

Related Work : Anatomy in Motion



Medical Simulator[LapSim, 2012]





(1) [Ming Zeng & all, 2014]

(1) Biomechanical Analysis of Typical Upper Limb Movements Based on Kinect-LifeMOD
Ming Zeng, Changwei Chen, Qinghao Meng, Honglin Ren, Shugen Ma
Applied Mechanics and Materials, Vols, 599-601 (2014) pp 534-538

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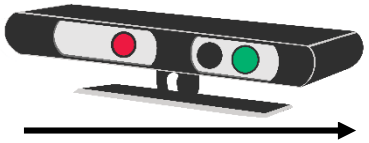
Key Contribution

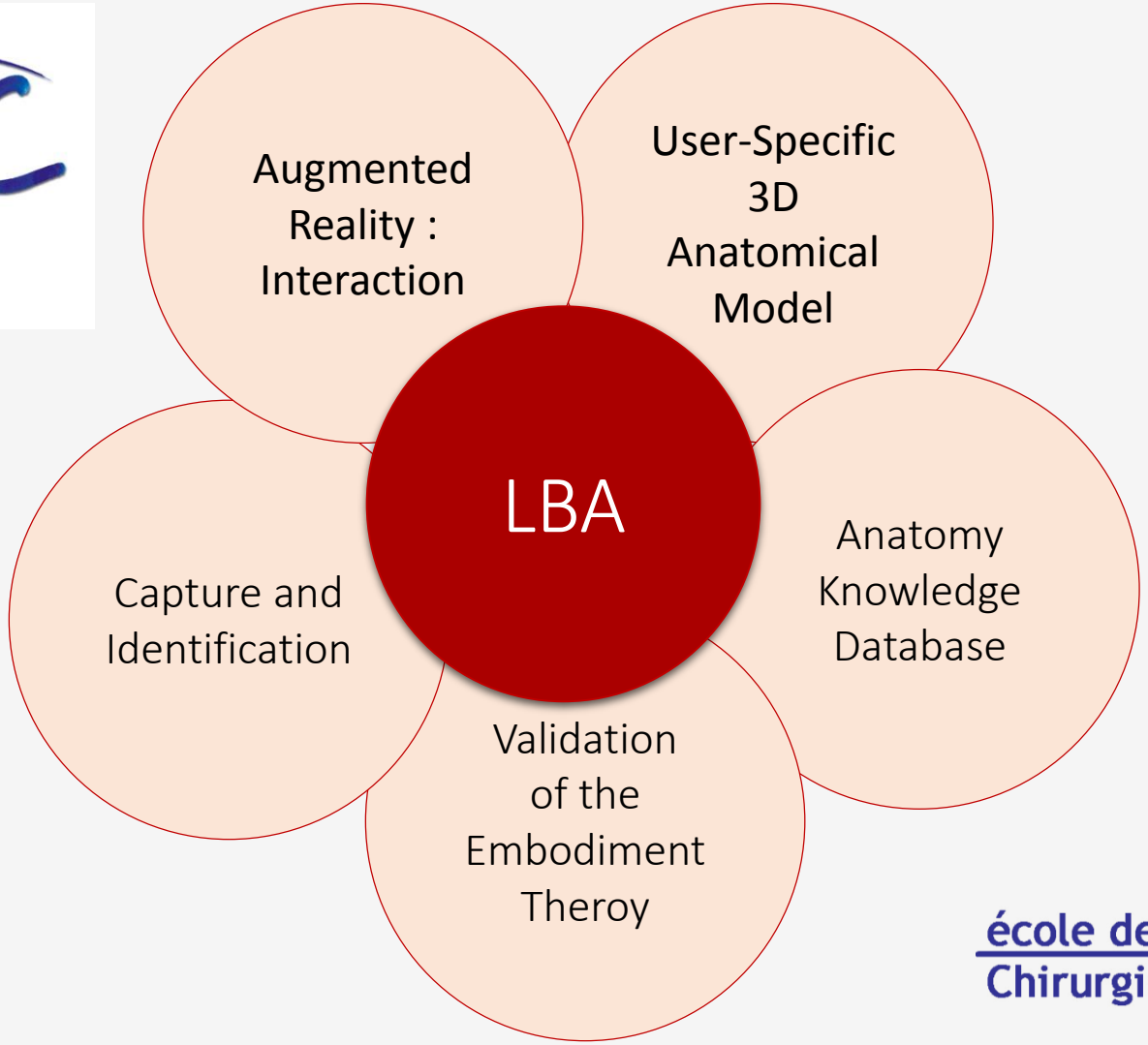


Capture user Motion

Visualize Muscles
&
Muscle Activation

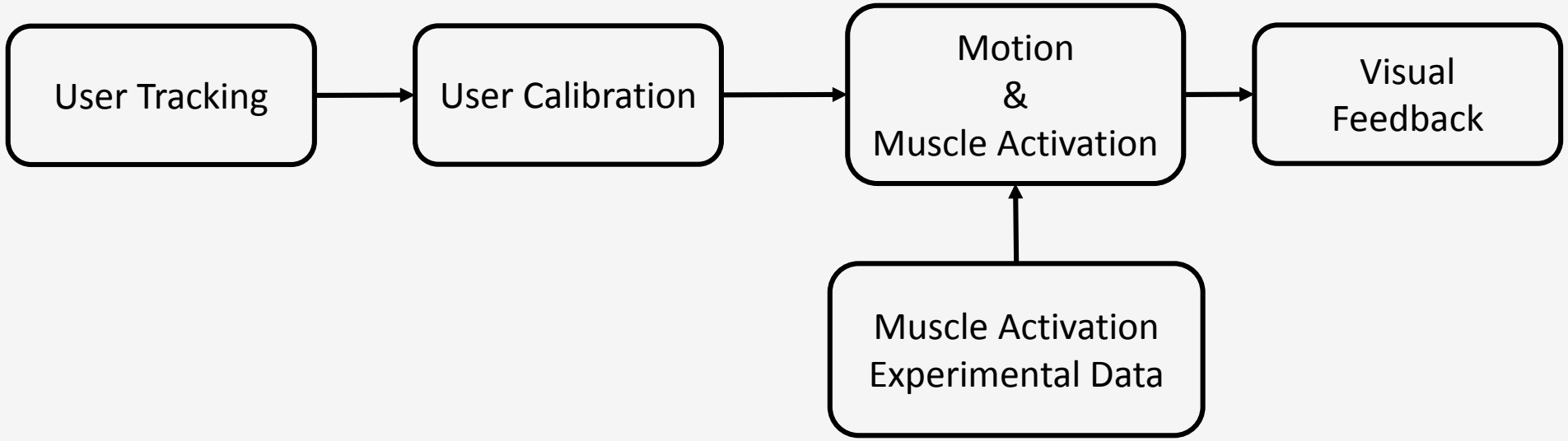
Improve Learning Process

Collaboration Work

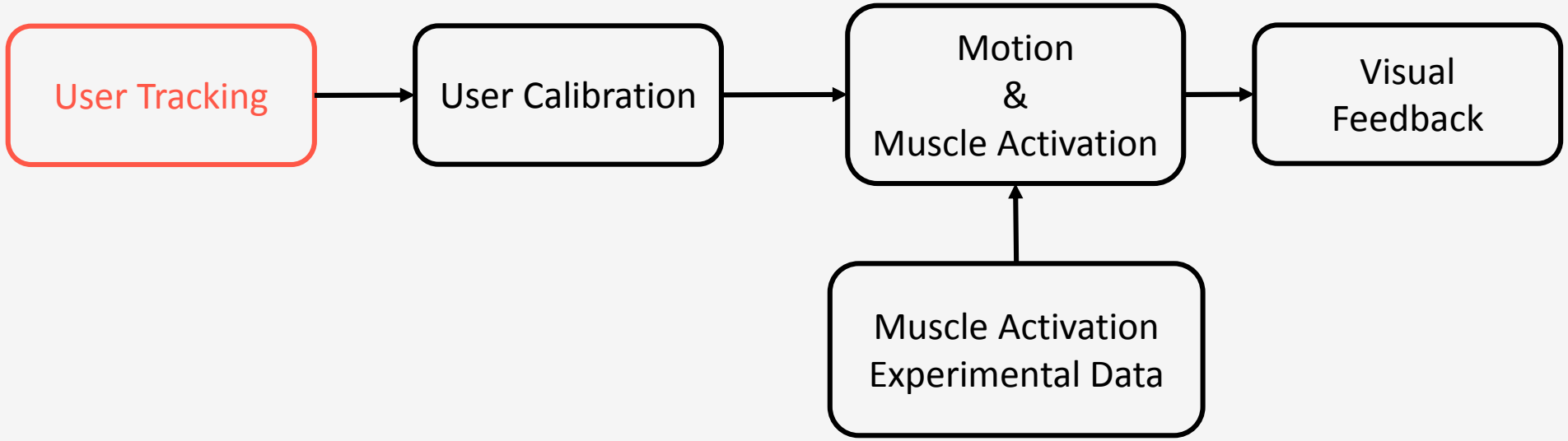


gipsa-lab

Pipeline


User Tracking
User Calibration
Motion
&
Muscle Activation
Visual
Feedback
Muscle Activation
Experimental Data

Pipeline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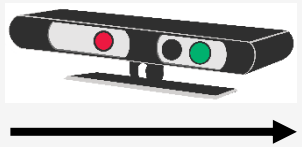
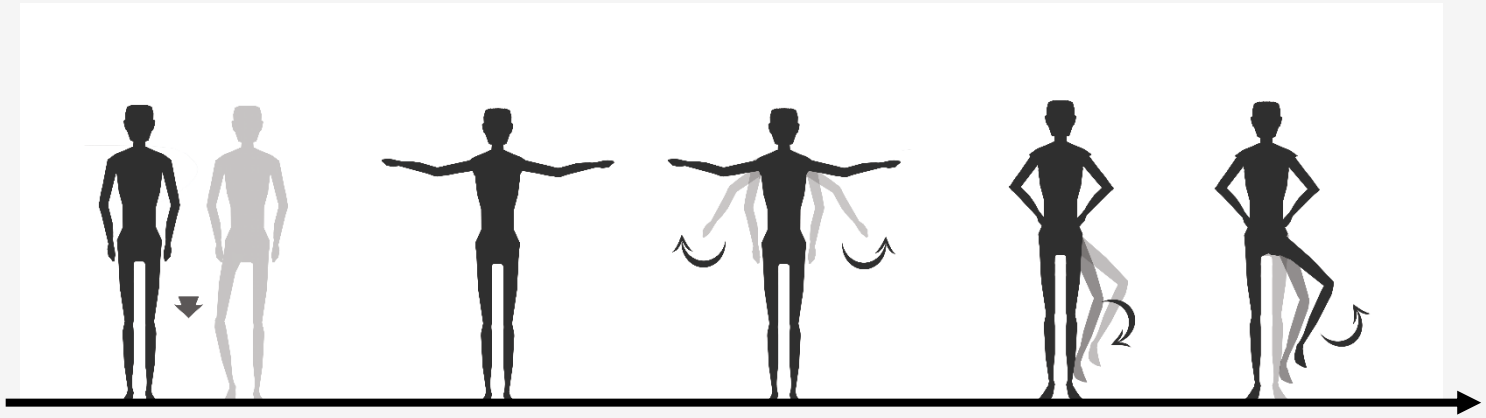
User Tracking

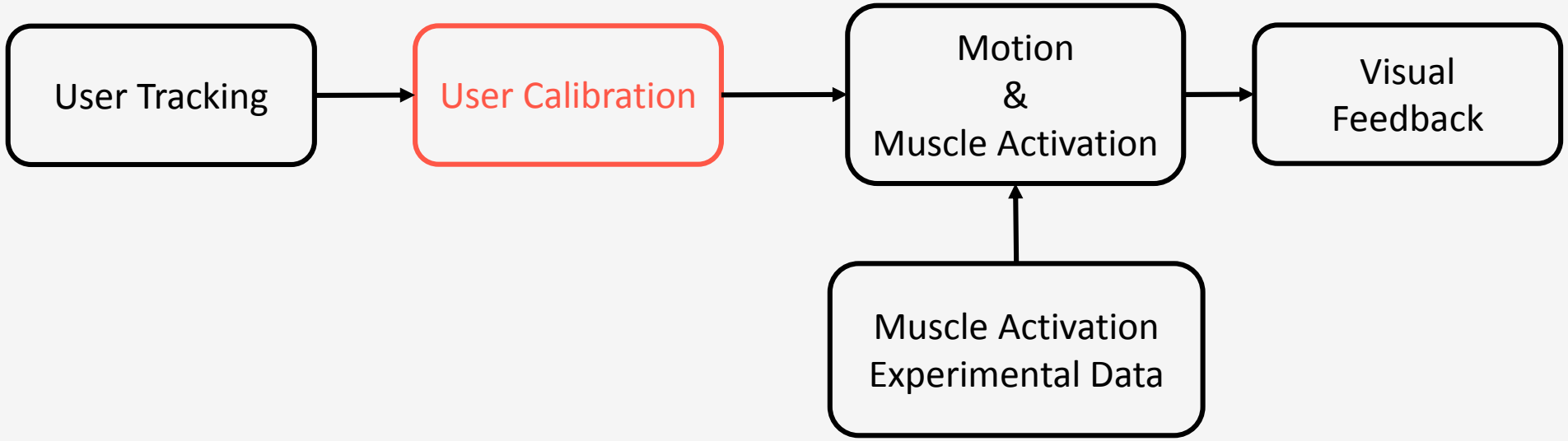


OpenNI™

+ Filtering



Pipeline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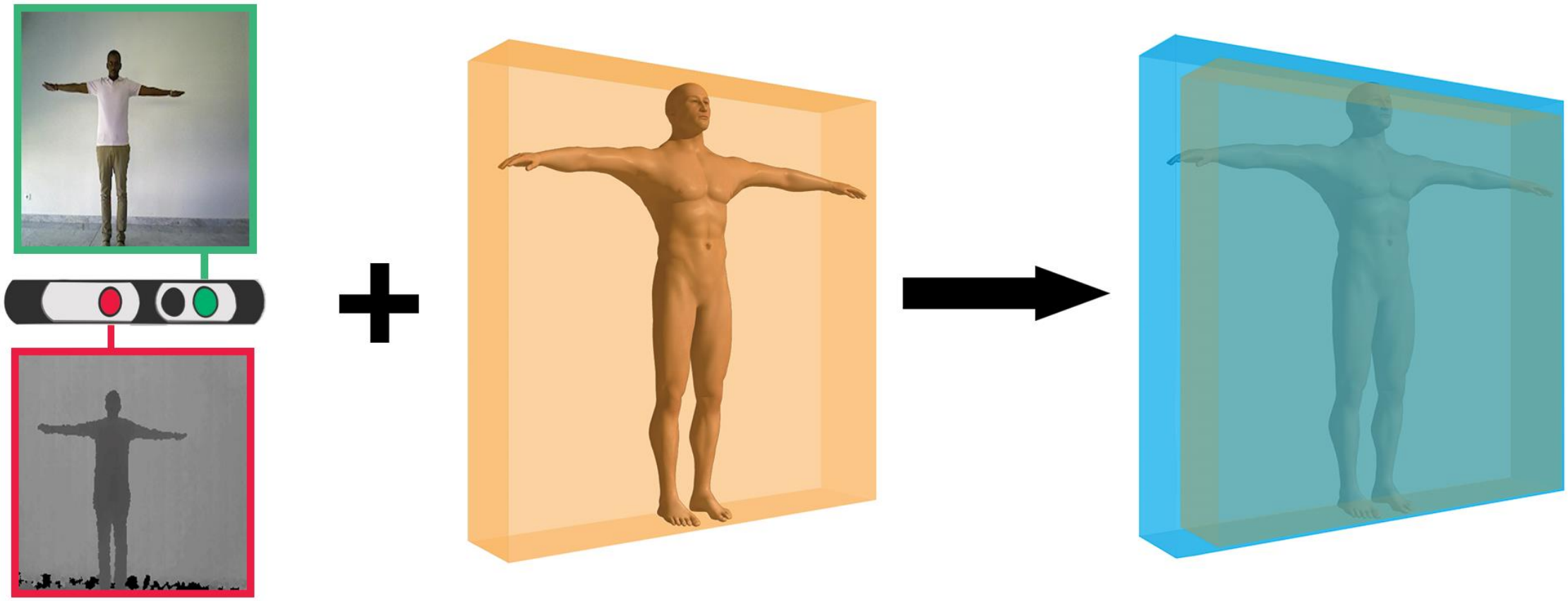
User calibration

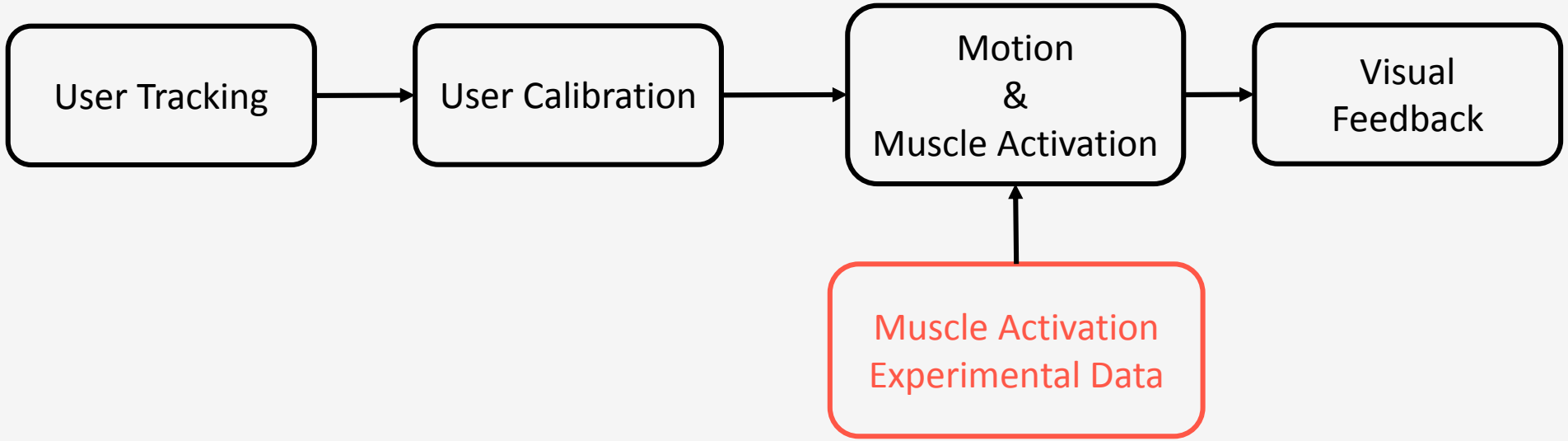


Title….

Computing Bounding Box

User -specific Avatar
height :1.59 m
Reference Avatar
height :1.91 m

Pipeline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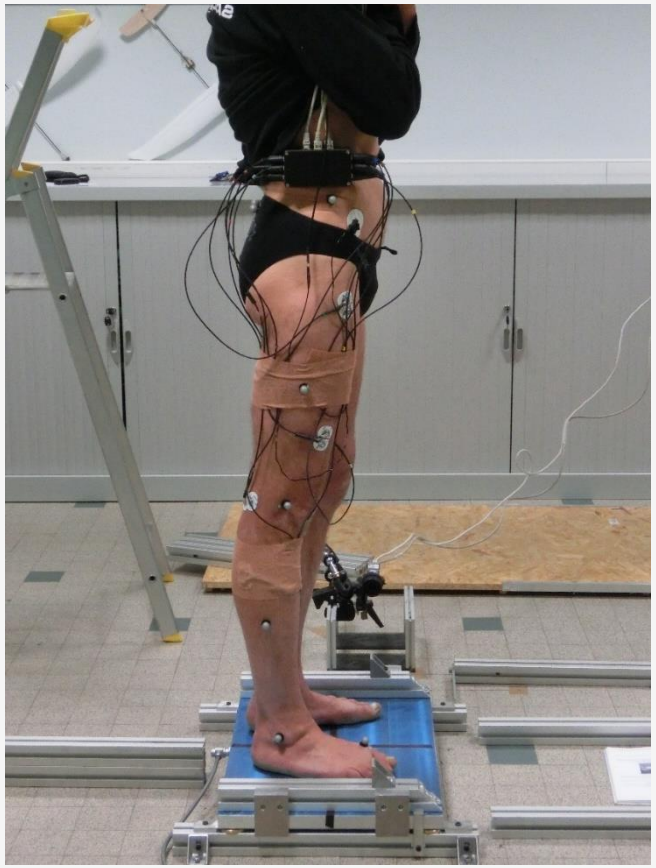
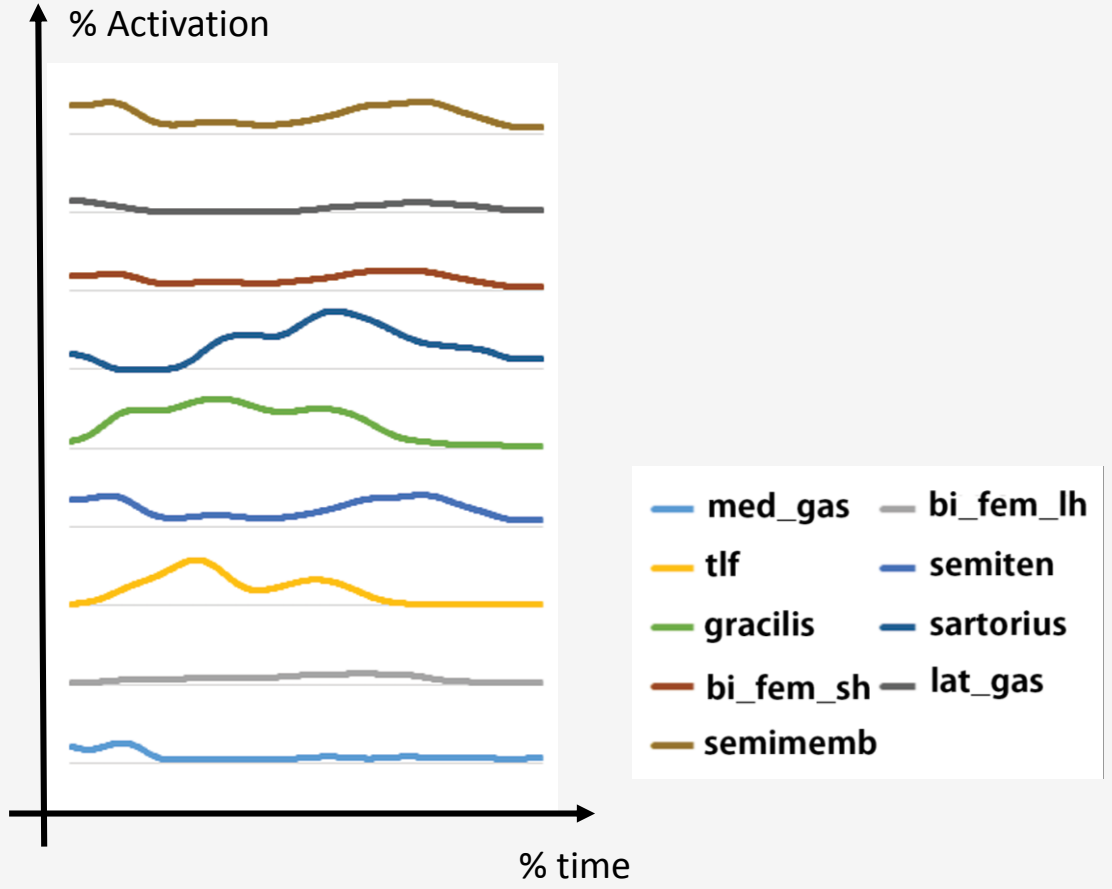
Experiment (EMG)

Right Leg : Flexion/Extension cycle in no-load conditions

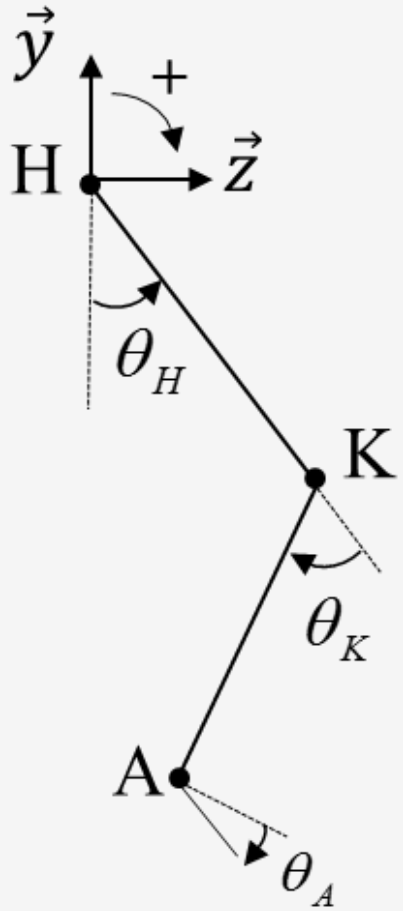


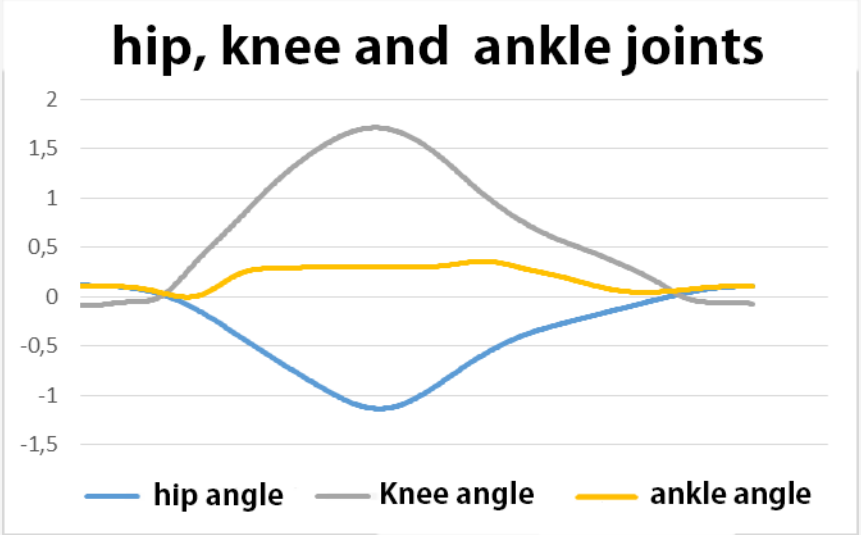
Healthy subject :

- 48 years old
- 186 cm
- 77 kg



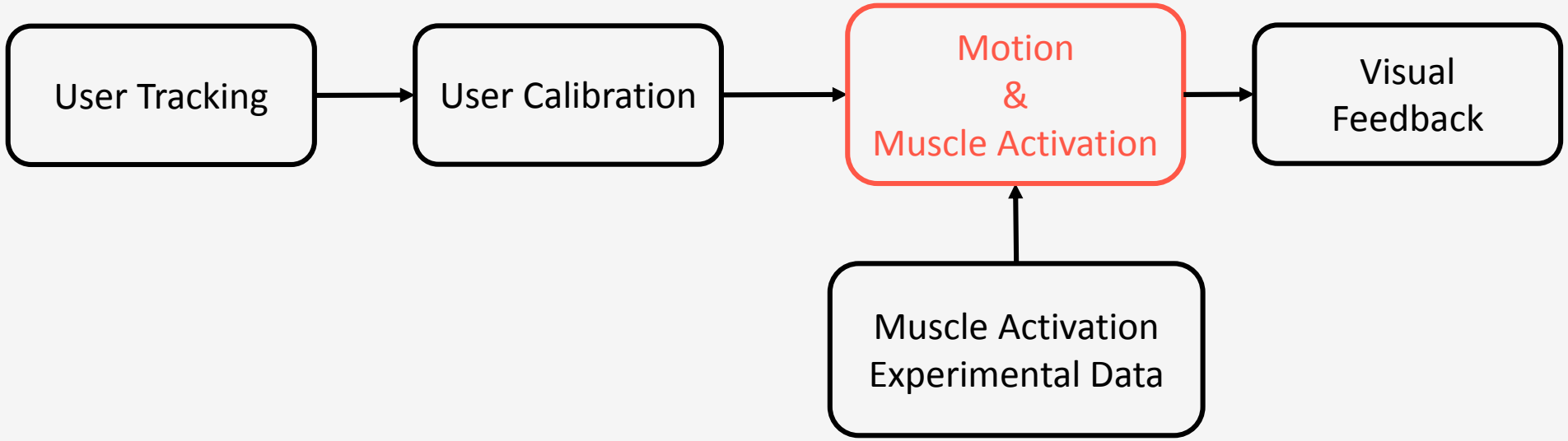
Output of Experiment





Intersegmental angles were calculated at ankle, knee and hip joints

Pipeline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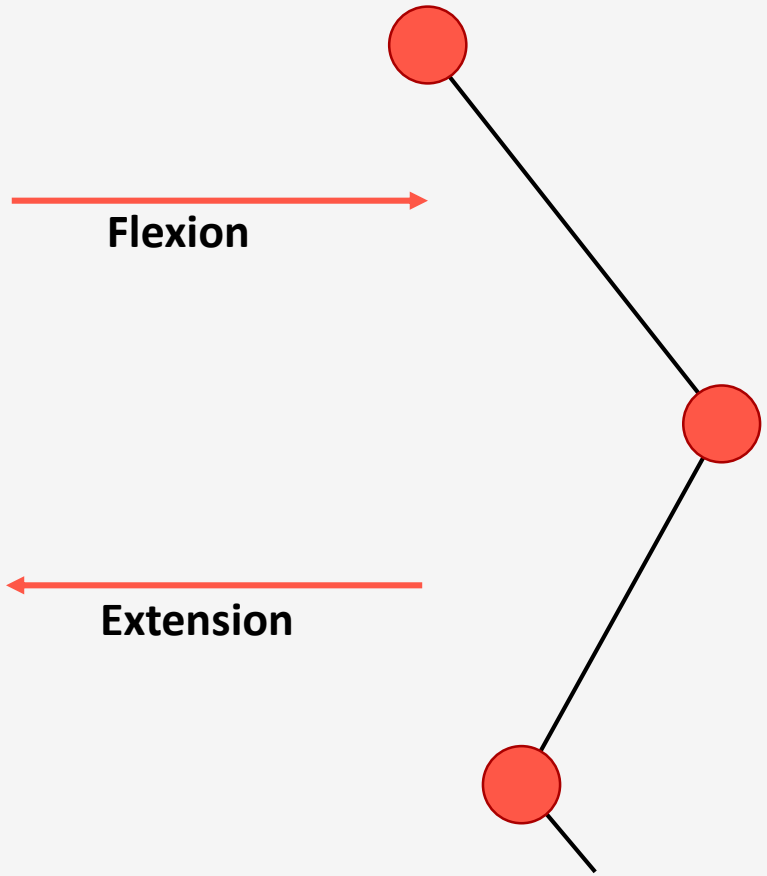
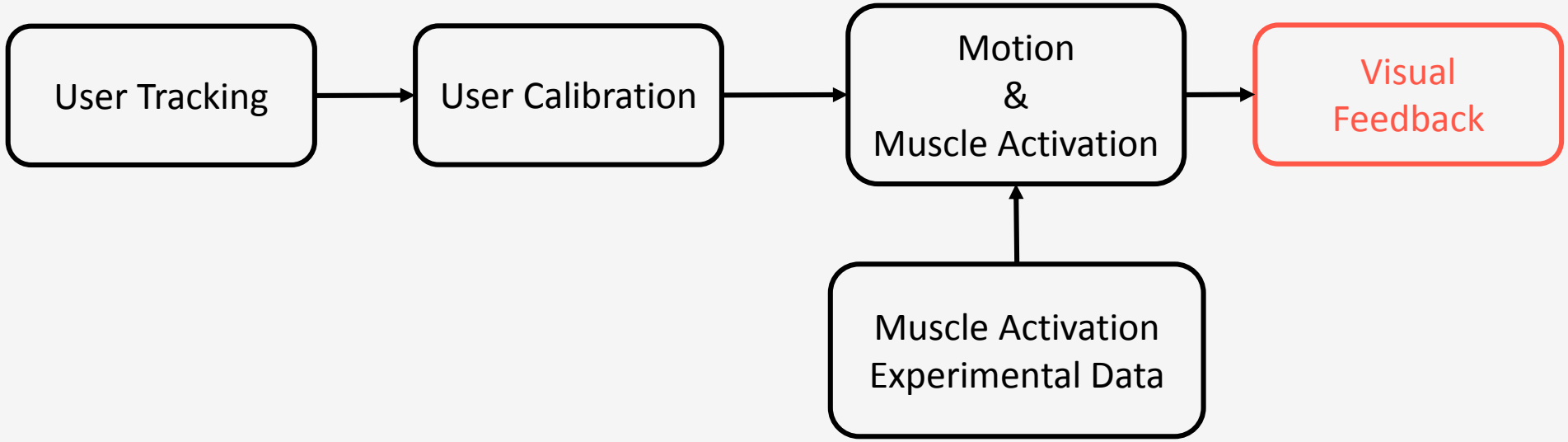
Motion and Muscular Validation



Visualization of Activation

Pipeline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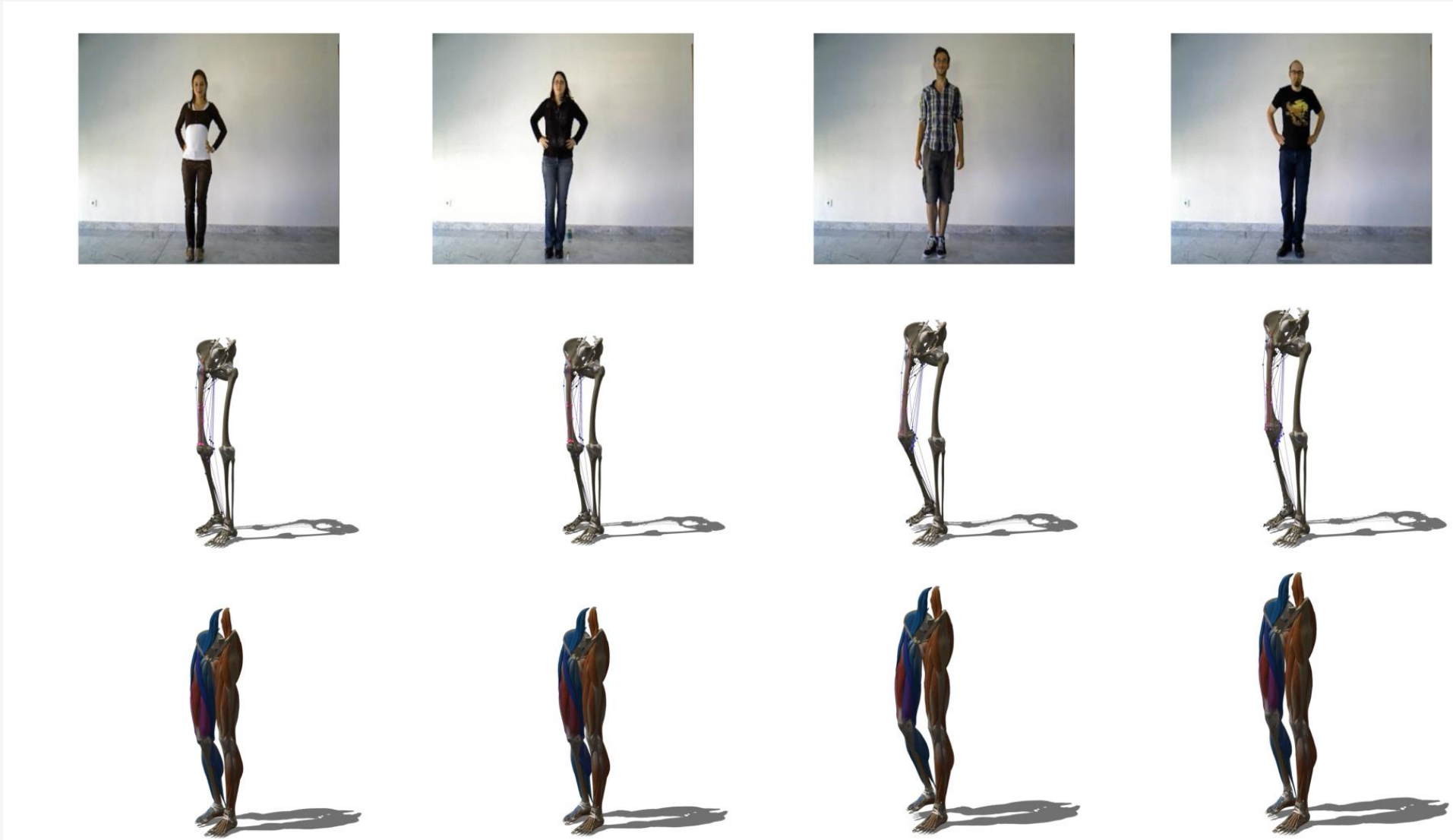
Experimental Data

Results

Results



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Anatomy Lesson

Purpose : Ease the **Learning Process** of the lower limb **musculoskeletal system**.

Muscular Activity is essentially studied by :

- Physiotherapy Students
- Medical Students

Same knowledge but different **level of details**

Requirements : Osteology and Arthrology of lower limb

Lesson :

1- Explain the lower limb movement
2- During motion : show bones *name, joint*
3- During motion : show a muscle *name, morphology, function, insertion, and innervation*
4- During motion : show region of muscles *name, function and distribution*

5- Same movement with different Velocities

Conclusion

Conclusion :

- **Validate** the theory of **Embodiment**
- Innovative Aplication : **Visualization** of Human Body **Kinetics**
- Displaying Muscle Activation

With accurate anatomically-based models and realistic motion **learning anatomy** will be **eased**

Future Work :

- **AR Visual Feedback**
- **Improve** the **avatar personalization** to reinforce embodiment
- **Visualize** information on other limbs motions
- **Automatically detect** the user motion and deliver knowledge accordingly

Thank you for your attention!

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PERSYVAL-Lab ANR Inria INVENTEURS DU MONDE NUMÉRIQUE SJK TIMC gipsa-lab UNIVERSITE JOSEPH FOURIER SCIENCES.TECHNOLOGIE.SANTÉ école de Chirurgie LADAF