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
Overview

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Interactive Visualization of Muscle Activity During Limb Movements: Towards Enhanced Anatomy Learning
Learning Anatomy: 3D Visualization

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Medicine [InnerBODY, 2013]

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

Fovea MOOC[anatomie3d.univ-lyon1.fr/]
“Our Motor System Influences our Cognition”

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

Eroding the Boundaries of Cognition: Implications of Embodiment
Anderson ML, Richardson MJ, Chemero A

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

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

Digital Mirror [University of Paris-South, 2014]
Related Work: Anatomy in Motion

Medical Simulator [LapSim, 2012]

(1) Biomechanical Analysis of Typical Upper Limb Movements Based on Kinect-LifeMOD
Ming Zeng, Changwei Chen, Qinghao Meng, Honglin Ren, Shugen Ma

(1) [Ming Zeng & all, 2014]
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Key Contribution

Capture user Motion

Visualize Muscles & Muscle Activation

Improve Learning Process

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User-Specific 3D Anatomical Model

Augmented Reality: Interaction

Capture and Identification

Validation of the Embodiment Theory

Anatomy Knowledge Database

LBA
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**Pipeline**

1. **User Tracking**
2. **User Calibration**
3. **Motion & Muscle Activation**
4. **Visual Feedback**

- Muscle Activation Experimental Data
Pipeline

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User Tracking → User Calibration → Motion & Muscle Activation → Visual Feedback

Muscle Activation
Experimental Data
User Tracking

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Pipeline

User Tracking → User Calibration → Motion & Muscle Activation → Visual Feedback

Muscle Activation
Experimental Data
Right Leg: Flexion/Extension cycle in no-load conditions

Healthy subject:
- 48 years old
- 186 cm
- 77 kg
Intersegmental angles were calculated at ankle, knee and hip joints.
Interactive Visualization of Muscle Activity During Limb Movements: Towards Enhanced Anatomy Learning
Motion and Muscular Validation

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

Flexion

Extension
Visualization of Activation

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Pipeline

User Tracking → User Calibration → Motion & Muscle Activation → Visual Feedback

Muscle Activation Experimental Data
Results

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Conclusion & Future Work
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:

- **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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