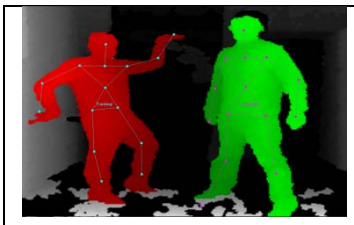
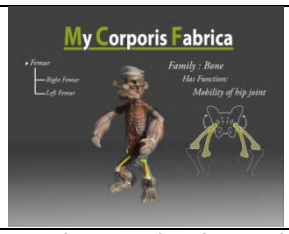
Objectives and motivations

Through the Persyval team we propose to develop the **« Living Book of Anatomy »** also called **LBA** to visualize the working/acting body using Augmented Reality techniques. The idea is to capture an user action (limb movement, speech sound or orofacial movement) and to display the muscles responsible for this action and their activation,by superimposing this information onto the user's body (Augmented Reality). This tool could be used to facilitate learning anatomy for medicine students and to provide an interactive way for general public to discover human anatomy in action. The assumption underlying this work is that experiencing the anatomical knowledge through body action, or embodiment, could make the acquisition of this knowledge easier. We aim at evaluating this hypothesis as well as the interactive designed techniques with medicine students A large collection of accessible data and applications describing anatomy or other medical knowledge are now available, based on advances in numerical sciences and more specifically to the spread of smart phones and tablets in general and more specifically in the clinical world. However, as far as we know, none of these new services and applications bridges the gap between the user's own body and medical knowledge. A core hypothesis of the LBA project is that the use of Augmented Reality could make the embodiment of knowledge easier by a closer connection between models, knowledge and reality.

Developing the LBA requires the resolution of several scientific or technical issues: (1) capturing the user's actions, (2) mapping the model to the user's body and conversely, (3) rendering anatomical and functional information onto the user's body (4) designing augmented reality interaction techniques for interaction with the physical (user's body) and digital information (anatomical/functional displayed information) on a mobile device. These issues can be addressed with different levels of complexity. First, a suitable knowledge base must be built, using Ontoly-Based Database Access, including medical knowledge of the description of anatomical structures and organs, together with their functions and behavior (including biomechanical models, medical images, etc.). Second, Interactive techniques should be developed to make the information handable by the user, with several levels of refinement and expertise. One challenge is also to make the LBA system able to render such information in real or interactive time. Third, the approach should be evaluated, which will require to understand the cognitive aspects and more specifically the link between knowledge and body-experience (see references here after).

			
Capturing moving bodies with a Carmine RGB-D camera	Ontology and animated models	Handheld Augmented Reality: Interaction techniques	Selecting anatomical entities through a SPARQL request on MyCF.

Work in progress:

- *Anatomy transfer*: The Imagine group of LJK is still working on anatomy transfer as presented to Siggraph Asia 2013. This is done in collaboration with TIMC by a co-supervised PhD (Armelle Bauer). MyCorporisFabrica (MyCF), a medical ontology, has been made available to a large audience via a web site. This work was submitted as a talk to Siggraph 2014. This year, the work will focus on the real-time capture of a user anatomy with a RGB-D camera (e.g. kinect), in order to be able to transfer a model anatomy to the user in real-time.
- *Augmented reality*: The goal is to design and to test interactive techniques in the context of the LBA. Several challenges beyond mobile touch-based interaction design challenges must be addressed. The design challenge lies in the fluid and harmonious fusion of the physical and digital worlds while breaking the constraints of physical world interaction. Two research axes will be studied: precise pointing techniques and techniques for relaxing the tight coupling between the on-screen content and the physical surroundings (i.e., user's body).

- *Ontology*: This work is directly related to MyCF. Developing the LBA requires being able to use the knowledge base on smart phones or tablets in a real-time context. The work of a masters student is dedicated to development on Android for retrieving information. MyCF will be also extended with knowledge about other complex anatomical regions. *Embodiment*: The LBA challenge is to develop a new tool that will allow students learning structural and functional anatomy using their body as a media. A first stage has been to collect most relevant literature. Our approach is connected to an embodied conception of cognition and the fact that cognitive abilities are shaped by tools-use and linked to experience through sensory-motor functions (Refs. 1)[1]. Hence, the active implication of sensory-motor function into conceptual learning in general may improve learning by contributing to spatial and conceptual memory and mental simulation (Refs. 2). Direct interaction with virtual representations of the body might also improve 3D perceptual skills (Refs. 2). The project is connected with previous work that investigated: (Refs. 3) the bi-directional interaction between visuo-spatial skills and medical practice, and (Refs. 4) how new technologies could improve learning of anatomy or surgery skills. The list of references provided at is illustrative.
- An invited talk is planned for April 2014 on mental imagery given by invited speakers from CRIS in Lyon.

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Partners' relevant publications:

- Vincent T, Nigay L, Kurata T. Precise pointing techniques for handheld Augmented Reality. *Conference Proceedings of INTERACT '13*, the 14th IFIP TC13 International Conference on Human-Computer Interaction, Springer LNCS (Lecture Notes in Computer Science), Vol. 8117, September 2-6, 2013, pp. 122-139. Best long research paper: "INTERACT 2013 Honorary Mention"
- Bauer A, Douchez V, Lemaire T, Ulliana F, Ali-Hamadi D, Benjamin Gilles B, Olivier Palombi O, Faure F. MyCorporisFabrica : Making Anatomy Easy. *Submitted talk to SIGGRAPH 2014*
- Palombi O, Ulliana F, Favier V, Léon JC, Rousset MC. My Corporis Fabrica: an ontology-based tool for reasoning and querying on complex anatomical models. Submitted to *theJournal of Biomedical Semantics*.

[1] The list of references can be found at https://persyval-lab.org/en/sites/lba/content/lba-illustrative-references-cognitives-sciences-aspects