

## **Robotic mirroring of movements in the lower limbs: signal delay of a consumer sensor**

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### **Abstract**

Mirroring human movements has a long tradition in the research of pain syndromes, sensory-motor interaction, ergonomics and illusions. On the one hand, the application of mirroring movements has reached digital games and changed the design of game controllers. On the other hand, those consumer electronics return to laboratories and rehabilitation departments and improve rehabilitation processes. Irrespective from the field of application, mirroring human movements may result in a physical or perceptual/visual effect or both. This describes the result of an action (e.g. single felt feedback) or a more complex visual and haptic information in natural or virtual environment. Virtual environments are using different robotic force feedback devices to simulate haptic information that is provided additionally to artificial visual information. A seamless integration between different afferent information is important for having no sensory disturbances and no impaired motor output in healthy subjects. Virtual environments are able to reduce the delay between the proprioceptive and visual information due to software issues. In naturalistic environments, the integration of software and hardware has a major impact on the occurrence of delays during the mirroring process. In this pilot study, we measured the global delay during the mirroring of movements of the lower limbs in different temporal conditions using a specific robotic implementation with a consumer RGB-D sensor. First results show that the delay between the human and robot movement was longer when the initial movement was faster. Results are discussed regarding the use of different sensors and potential fields of applications.

### **Keywords**

Robotic Device, Lower Limb Movement, Delay

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