

Project Initiation

Interaction Mechanism

Interaction Elements

Global Aim	to develop an active video game for gait rehabilitation for children with motor disabilities and particularly cerebral palsy	Aim of this phase	To select the interaction system and to capture the therapy into this system.	Aim of this phase	To design the interaction elements that force patients to perform the therapy correctly
Operational objectives <i>describe the needs in general</i>	To be safe; to provide efficient gait training; to improve walking speed; to motivate the patient; to be fun.	Device selection	Device: Microsoft Hololens AR headset version 1 was selected because its technical characteristics matched all identified specifications. Tools : - Unity software (version 2019.4.8f1) -Microsoft Visual Studio 2019 - Mixed Reality Toolkit for Unity (MRTK version 4.2.3)	Feedback reflexion	We have proposed a model of feedback in Augmented Reality (AR) for Motor Rehabilitation (article not published yet). Indeed, AR feedback can be displayed to the user through different characteristics. This theoretical work was necessary before designing feedback and testing specific characteristics of the model. The final aim was to optimize the augmented information provided to the patient. To carry out this work, we extended and adapted the biofeedback model described by Macintosh et al., and the qualitative model from Martinez et al., to the AR context. Our descriptive model of feedback in AR application helped us design an AR application, called Best-Of ARROW. We have tested with this app, the impact of different virtual feedback characteristics on walking speed of children with CP. The results of this first study will be published soon (article under review). This help us to better design the feedback used in ARROW-CP AVG.
Restrictions <i>detail economical, technical, operational, legal restrictions</i>	The development of the game must correspond to the duration of a 3-year thesis; grants are limited and predefined; the agreement of the ethics committee and written consents from participants are required before any test on humans ; all technical solution could be explored.	Gait parameters detection development and evaluation	Algorithm development: HoloStep measuring the real-time gait parameters with the AR headset system ⁴³ Evaluation : - The accuracy of the AR headset's sensors was sufficiently high to evaluate the position of the user without time drift in the global environment ⁴² - HoloStep was reliable for measuring and calculating walking speed, cadence, step length and global distance travelled in comparison to a reference motion analysis tracking system ⁴³	Game selection & Universe	The choice of the game universe (Samurai world) and reward panel were unanimously validated by experts and end users. All packages used to design the game were available in the Unity Asset Store: Polygon Samurai low poly 3D Art by Synty, Tiny Dragon by Suriyun, the GUI Kit - The Stone, and the Particle FX. Voice of game characters from volunteers were recorded in a professional radio studio (HandiFM – France 107.3 FM).
Stakeholders <i>identify customers, special needs and required functionality ; define experts and representatives end users</i>	Customers : Children with cerebral palsy, 10-18 years old, GMFCS I-III, with cognitive skills to understand and follow simple instructions == END USERS Physiotherapists, occupational therapists, physiotherapist assistants, rehabilitation therapists == EXPERTS Special needs and required functionalities : The active video game must include the principles of motor learning, which are task-specific practice, variable practice, high practice intensity, progressive difficulty, augmented feedback, and adaptability to user abilities. The active video game should allow the inclusion of motivational elements to increase engagement. Children must be free to move in the global environment, without restriction of movement. Children must be able to use their usual walking aids (crutches or posterior walker). Therapists should have access to the previous and global performance of their patient through the game The solution should be "ready to use" easily both for children and therapists	Therapy Selection	The team's members agreed on making walking speed the main variable input of the serious game. Meaningful reason is that intensive gait training focused on walking speed has shown their clinical efficacy. ^{12,39} The therapy to transfer into the serious game should include walking sprints.		