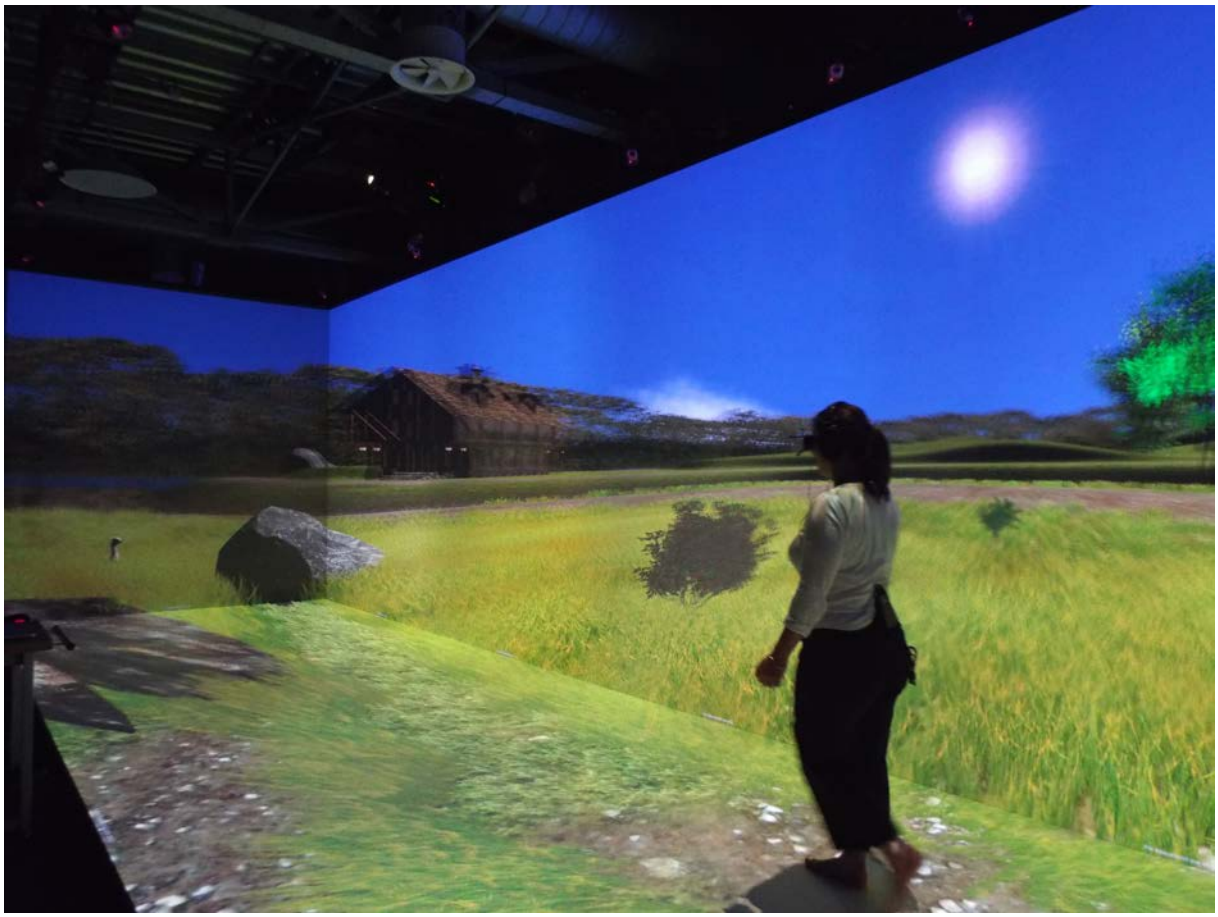

Surrounded by contacts : spatialization of multiple contact sounds in immersive space

Motivation and objectives: The main objective of this research is to test the importance of spatialized audio in a VR walking experience, in a large space. Specifically, we will build an interactive audio-visual environment where the user walks around in presence of sounding objects.
We will test the interaction with the environment in different conditions: one where the sound is rendered with binaural techniques, one where the binaural field is affected by a roto-translation, and another one in which the sound is rendered with stereo technique.
We will then test the degree of immersion that the user can achieve in the different conditions and also the main différences that he can identify between those different kinds of auditory feedbacks.

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Methods: A number of subjects/volunteers were asked to participate in an user experience evaluation. Their task was to walk inside a natural environment built with Unity3D, following a precise path. The environment contained some 'punctual' audio objects (e.g. a frog, a goose, a bird..) placed among the path. A specific MaxMSP software was designed to perform a realtime rendering of different audio techniques receiving the relative coordinates of the sounding objects -referred to the position of the user- from Unity3D, via UDP protocol.

Each 'walk' was performed twice, with two different Audio Scenarios to be compared. We did provide them three kind of different Auditory Scenarios/Stimuli:

- "good" Binaural : a binaural rendering realized using non-individual HRTF (Head Related Transfer Function)
- "bad" Binaural : the same kind of technique of the "good" binaural was used, but providing an auditory input that did not correspond to the visual input. In this case the auditory world was rotated by 90 degrees and shifted by 5 meters, so the auditory position and the perspective of the sounding objects was not coherent with the visual ones.
- "good" Stereo : a rich stereo panning was also provided to be compared, this stereo panning was a rich stereo image coming from an Ambisonic downmix, richer than a standard 'poor' stereo panning.

Recordings & Results: All recordings were performed using Immersia facilities including a high resolution stereoscopic immersion room including a wall and a floor, 3D glasses tracked with a 360° tracking system with 16 ART infrared cameras (IRISA Rennes, France) and binaural headphones.
A questionnaire was used as subjective evaluation. Two kinds of questions & scales were used for each couple of walks/stimuli:

- A Likert-type 7 points scale was used on two questions, to ask the 'general appreciation' and the 'coherence of auditory feedback' for each of the two scenarios to be compared of each pair of walks
- A direct choice '1 or 2' was used on two questions, to ask to select the best scenario in terms of 'Immersion' and 'Auditory Rendering'

Some general 'open' quesions were then used at the end of questionnaire to retrieve more feedback from the users.

Conclusions: The first results are showing, as assumed, that a *rich* auditory rendering is more appreciated in terms of Immersion. In particular, all the subjects did clearly express a strong preference for the "good" auditory rendering techniques. A more deep analysis of the results is needed to clarify how much a good Binaural Rendering made with non-individual HRTF can be preferred to a rich Stereo rendering. Firsts results are showing that Binaural Rendering is preferred, but for the moment the difference is less than expected. A possible explanation is to be found in the kind of Stereo Rendering choosen, richer than a standard one (but still not capable to provide a 360° image of the sound field, and not capable to render sources positioned to the "back" of the user, for instance).
Interesting challenges came up during the setup of the experiment, calling for further investigation and motivating us to open a new possible scenario of study, identitying an open and promising field of research. The Auditory Rendering Software Tool developed for this project is very flexible and we already take into account to carry on other works by the next months in the research area of spatialized auditory feedback in VR.

Publications (ongoing):
Submission forecast to IEEE Virtual Reality 2014 (March 29th-April 2nd, 2014, Minneapolis, MN, USA)

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