The Immersive Lab:
An interactive audio-visual space for artistic exploration

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This article discusses the Immersive Lab, an artistic and technological research project of the Institute of Computer Music and Sound Technology at the Zurich University of the Arts. The installation is a media space that integrates panoramic video, surround audio with full touch interaction on its screens. The main characteristics of this project as well as the way of functioning and organisation of installation structure are exposed. Through examples of completed artistic works the possibilities provided by the Immersive Lab environment are highlighted, and the realisation of various ideas by a number of artists shows the potential and limitations of this idea.

> Yet immersion viewed from a human standpoint is achieved once our physiological, creative, intuitive, intellectual, and imaginative functions are engaged and transcend basic disruptions and distractions. This immersion is not the escape offered by cinema or by the CAVE environment for 3D computer graphics, but is a multifaceted and active human experience of connection and communication that involves both internal and external dimensions. (Kozel 2007: 145)

The Immersive Lab is an artistic and technological research project of the Institute of Computer Music and Sound Technology at the Zurich University of the Arts. It is a media space that integrates panoramic video, surround audio with full touch interaction on the entire screen surface. The Immersive Lab provides a platform for artistic works that are specifically tailored to the unique situation that this configuration offers. These works articulate the relationships between immersive audio and visual media and direct interaction. The lab functions both as a space for experimental learning and creation and as an audiovisual installation for the public, showing the finished pieces in a self-explanatory way inviting exploration.

Immersion

Immersion in its original sense means being submerged or enveloped, usually in water. In media arts and theory this term has been extended to mean envelopment by mediated contents, be they visual, sonic or sometimes even tactile. Older forms of mediated immersion can be frescoes set in architectural spaces (Almond 2011) and panoramic paintings (Grau 1995: 62). An important concept in the discourse about immersion is 'virtuality' (Nechvatal 1999), the idea that mediated contents generate an artificial envelopment. Here the embodied perspective (Varela et al 1991) informs the perception of the digital image itself, it becomes integrated into the body's process of perceiving it (Hansen 2004). Cinema has been for a long time the principal vector for immersive experiences for a large public (Rose 2012) and pushes further into that domain by the application of 3D and stereoscopic techniques (Zone 2007). Video games in general and the recent resurgence of virtual reality headsets have become another important way of experiencing virtuality in an actively engaged manner (Ihde 2002: 81).

In contrast, the Immersive Lab seeks a different blend between the virtual and the actual (Schechner 1997) by giving the audience a direct physical engagement with the media within the installation's space as well as providing the occasion for social and group interactions. In the entire project's scope, the communal aspect effects not just the visitors. Working in the Immersive Lab also presents the necessity for collaboration and sharing of experience, techniques and knowledge. Working in this way raises a number of questions:

- In which way can the notion of immersion inform artistic creation?
- To what extent can attention be shaped, in a situation that presents its contents and interaction in a surrounding format?
- Where are the boundaries between personal and collective observation?
- With which elements does a work have to be composed in order to take the multiple modalities into account?
- On what level does immediate tactile interaction transform the experience of engaging with digital art-forms?

- How can interactivity transform the relationship between abstract creation processes and sensorial experience?

Project concepts

The Immersive Lab installation as a platform is the fruit of several years of investigation, development and artistic creation. The term Immersion is used in a broader sense. Apart from spatial envelopment by image and sound, additional levels of immersion are generated for the visitors: they enter into a dedicated physical space, the direct tactile interaction on the panoramic surface enhances their personal engagement, and finally within the shared space arise group behaviors and social interactions. Such an extended form of immersion provides a multi-faceted experience.

The artistic works developed for this installation can be collaboratively created and combine visual and sonic material with generative and algorithmic methods. The focus of the installation is on artistic approaches of creating real-time pieces that react to visitor interaction and that take advantage of the panoramic nature of the installation.

Work in the Immersive Lab happens in different phases and activities, and addresses different people. In a teaching context, in general, any student can visit the lab in guided tours. Students majoring in electronic music or media arts, however, are invited to actively learn by exploring the inner workings of existing pieces. Artists and advanced students have the opportunity to become involved more intensely by creating entirely new pieces. For this, the ICST offers to share its experience, methods, and tools for development and realisation of ideas for this particular media space. Finally, in the exhibition context, general audiences are invited to experience the entire catalogue of works.

Different forms of engagement are possible within the installation. The audience can freely explore the works and experience different types of perceptions. Artists can experiment with the development of compositional strategies for working with different senses and artistic domains. Thus the installation exposes foundational aspects of immersion such as spatial and multi-sensory perception, which provide relevant topics for investigation.

Technical structure

The basic construction of the Immersive Lab consists of four sections made of free-standing metal frames that are covered with screens. Together these four panels form a cylinder of approximately 4 meters diameter, with a screen surface that spans 10.3 meters by 1.5 meters. By using four projectors to cover the cylindrical canvas an image is produced, which currently has a resolution of 5120 x 720 pixels (four times HD at 720p). Placed outside the structure at a certain distance behind the screens are four mirrors that divide by two the distance required for image projections as well as capturing tactile information. With this disposition, the minimum area required for setting up the installation structure is seven by seven meters, not counting the access and technical working areas (see Figure 1).

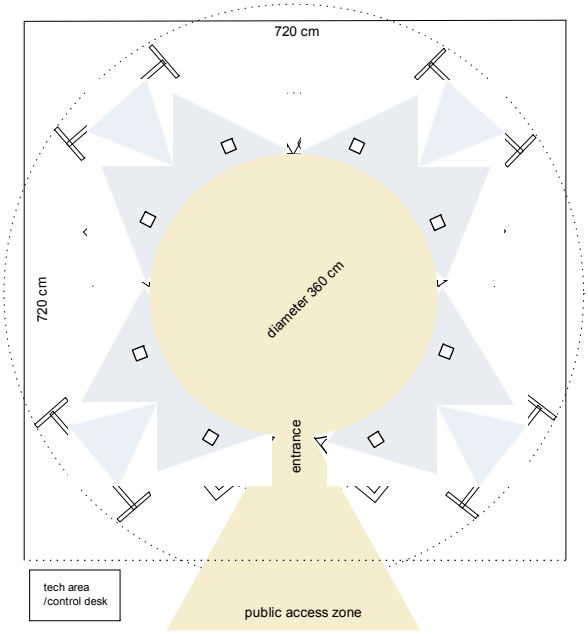

Figure 1. Floor-plan of the Immersive Lab

Touch interaction

Interaction with the installation occurs by directly touching the screens with the hands. The resulting points are measured by tracking software that is observing the screens from behind in infrared light. The complete system consists of infrared lighting on the edges of each canvas, cameras equipped with infrared filters that capture the visual field of each screen and software on dedicated small computers that process the signal from the cameras. The software applies standard OpenCV[1] computer vision algorithms and is capable of detecting a large number of points. Due to the delicate illumination situation within this circular arrangement, the detection reacts to fingertips but also elbows, shoulders, backs and other body-part that touch the canvas. The information obtained by the four sub-systems is processed locally and dispatched to a master application through OSC[2] to main computer. The touch information is transmitted via the TUIO[3] protocol (see Figure 2).

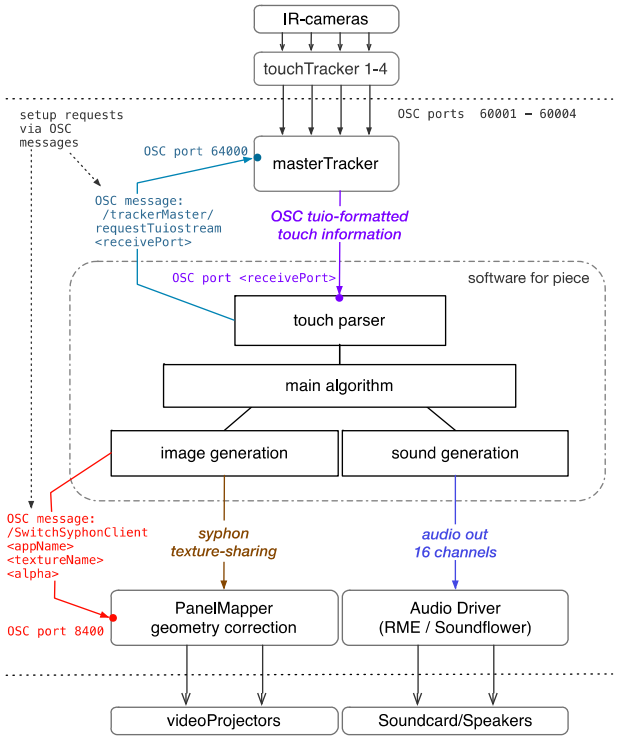

Figure 2. Software flowchart, connection and protocols

Image geometry correction

Distortion of the image presents an issue that needs to be solved when projecting from the outside onto a cylindrical screen. In the Immersive Lab system the counter-distortion for straightening out the image on the cylinder is done by a dedicated standalone application, which receives the output image from each piece's graphical software via a shared texture-bus on the graphics card called 'Syphon'[4]. In addition to geometry correction this application also offers the possibility of crossfading between images from two applications.

Audio system

The audio system consists of 16 speakers uniformly distributed on two levels as well as two subwoofers. The speakers are located behind each of the four screens and are arranged at the corners of the frames, thus avoiding the projection beam and forming two concentric circles (see Figure 3).

Platform and programming languages

Artists creating work for the Immersive Lab may use a variety of programming languages on the Mac OS platform. One of the main objectives of the project has been to enable working on many different types of programming languages. Until now commonly used software environments are MaxMSPJitter, Supercollider, Processing and OpenFrameworks. For participants the main challenge so far has been to find ways of interpreting the touch information received into meaningful interaction models for their audio-visual compositions.

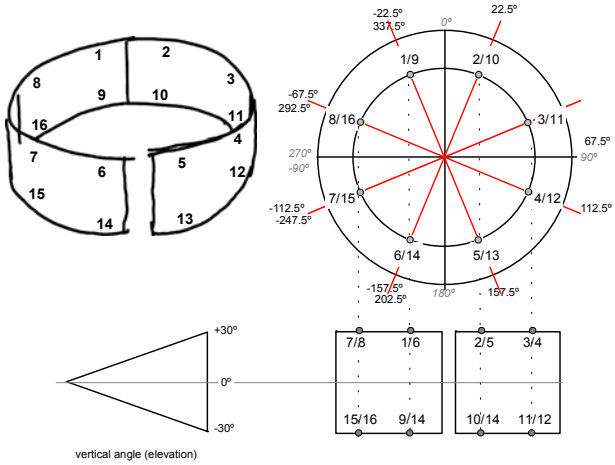

Figure 3. Speaker arrangements

Works

In the past three years the Immersive Lab project has seen the participation of a number of artists from the fields of music composition, media arts, creative coding and interaction design. The works are different in many of their aspects, which implies that the project offers opportunities for exploring ideas from different perspectives.

By following the interviews with the participating artists, it becomes possible to understand the diversity of ideas in the thematic, conceptual as well technical sense. The following four examples show the range of approaches present in the current collection of works.

Andre Sier, a media artist from Lisboa, Portugal describes his work 'Hyperborea' as

> an interactive immersive audio-visual environment forging the experience of travelling towards and inhabiting Hyperborea, inspired by ancient Greek myths, where in the land beyond the northern winds region, overseen by Borea's ruling and dynamics, through a long and perilous journey, far far away, lays Hyperborea ... This work provides audience the machine code infrastructure to walk this windy path to Hyperborea, through a game-like system architecture with 100 levels and haptic interaction, aural and visual spatialization. This vehicle opens its windows and offers audience the control. It's up to the audience to reach it, touch it, or to get lost along the way. The audience may engage on the path to Hyperborea individually, or collaboratively, ... Many have tried to taste its soil, feel its texture, rarely finding their destination. (Sier 2015)

Figure 4. Andre Sier – Hyperborea

Jan Schacher explains that

> in the piece 'Clocks and Clouds', the circular space is seen as a cyclical movement space that is filled with acoustic and visual pulse-trains of differing intervals and life spans, which are triggered by the user's touch. The combination and interaction by several users generates a complex web of overlaid visual and acoustical 'voices', which potentially merge in perception into groups or masses. … The main motivation for this piece is a curiosity about perception of temporal, spatial and sonic densities. The piece serves as an investigation into how our perception is capable of separating visual and acoustic streams and how sensory overloading has the effect of forming groups or combined objects or gestalts that exist in perception. Another topic of interest is the social interaction by several visitors, in particular in relation to such a reduced sonic and graphical space. The stark or abstract quality poses a challenge to perception. (Schacher 2015)

Figure 5. Jan C. Schacher – Clocks and Clouds

Terence McDermott describes his piece 'Star Chamber' as:

> an exercise in the sonification and visualisation of data. Chaotic data is generated by a simple mathematical algorithm, and it is represented as particles which emerge and die away in a virtual space. These same particles also have a sonic presence, to articulate the structures generated. It is a representation of an abstract mathematical space within a real space (the listening/viewing space), mediated through a virtual space. In this sense, the piece can be seen as a spatial collage, with disparate spaces layered upon each other. The idea of collage is further extended by juxtaposing the representational (data visualisation) with the expressive (human voice). Here, the piece attempts to enter another space, the so-called psychological space. Representation of abstract structures is usually arbitrary, and based on principles of convenience and clarity. The mode of representation itself does not contain any expressive meaning. This piece attempts to play around with the idea of meaning and representation, by deconstructing the voice, through its particularization, separating out its symbolic meaning from the sounds themselves, taking us back in time, to a preverbal state. The title refers to a medieval court of law where, if individuals were seen to behave immorally, but not technically breaking any law, they could be summoned by the Council of the Star Chamber to defend their actions and reflect on their past deeds. (McDermott 2015)

Figure 6. Terence McDermott – Star Chamber

Ted Davis remarks that his work 'FORMBIT'

> revolves around interactively positioned nodes, forming the 2D basis for 3D explorations. Through rotation and transposition, each structure becomes a 3D extrusion of itself, immersing the visitors as it orbits at oscillating speeds around them. This creates a feedback loop for the visitors as they design within the Immersive Lab's multi-touch surrounding and react upon the generative output. With each new structure replacing the older of two FORMBITs at any given time, an array of Moiré effects can be experienced through the lines' subtle offsets and overlaps. Rather than reacting to audio, this work investigates generating audio from the visuals. This is accomplished by measuring the luminosity of light passing each of the 16 audio channels' physical zones, which are mapped across a virtual synthesizer's frequency and amplitude. Additionally, the speed of rotation and distance of orbiting forms are passed to the synth, modulating and phasing these frequencies in an intensity that reenforces the visuals being projected. Ideally the minimal aesthetics and interaction of this work provides the visitor with a clear understanding of

their own interactions within the Immersive Lab and an engulfing cinematic experience when standing back to enjoy how their FORMBITs evolve over time. (Davis 2015)

Figure 7. Ted Davis – FORMBIT

Discussion

With these quotes from the pieces' program notes it should become evident that the works are thematically and technically diverse and represent different approaches. The artists use as inspiration myths, science, situations from real life, and technology. A variety of techniques is used to generate audio-visual processes, and different methods engender specific interactive worlds. Each of these works opens up a specific perspective onto the field of interaction and immersivity.

Some of the artists use the Immersive lab space to present scientific work through visualisation and sonification. Here the role of observation rather than the interaction becomes more dominant. Other artists such as Ted Davis successfully combine the role of interaction and observation. In his work "FORMBIT", by drawing dots on the screen, the audience provides the raw information that will be used to create dynamic 3D forms, thus compelling visitors to motionless observation and balancing out interaction and observation.

The foundation of many of the works within the Immersive Lab are generative processes. Thanks to them the installation space can be active even in the absence of an interacting audience. Although this might give the impression that interaction is insignificant, at the first touch with the screen the importance of interaction becomes immediately evident. The artistic freedom in defining interaction through algorithms can be considered as one of the specific strong points of this installation and encourages further artistic developments.

Future work

In the immediate future the Immersive Lab project expands its reach by engaging with students and artists from different countries and the new forms and ideas they bring. This process might mean changes to the installation structure. The most common suggestions are related to using additional devices, either temporarily or permanently integrated within installation's structure. One of the ideas is to introduce of a depth-sensing camera such as a Kinect. In this way the interactive zone could be expanded from a 2D to a 3D space.

Experiments are planned with 'Audicor'[5], a portable acoustic cardiograph. This would represent a first attempt at extending the project to include experiments with physiological data of the visitors.

A further task will be the creation of a database of different information. During the development of their pieces participants create code solutions for various programming environments. Collecting them as examples in a common repository will reduce the time required for future participants to solve technical but also conceptual issues such as touch interpretation. This would give participants more time for their artistic work.

Recently a first version of an Immersive Lab software simulator was completed that allows participants to experiment and develop works on their own computers outside the actual installation structure. The simulator cannot completely replace the Immersive Lab infrastructure, mainly because of the nature of real-time interaction with multiple hands by an audience. Only the actual conditions in the installation can provide the full immersive and interactive experience. However, through further development and refinement of the simulator software, the time needed for experimentation within the real infrastructure may be reduced and simplify project organization.

Figure 8. The Immersive Lab shown from the top

Conclusion

Works created within the Immersive Lab project represent a blend of art and science inside an interactive immersive environment. In this way the possibilities of technology, the human response to the digital world and the forms that connect those two worlds can be

investigated and experienced. One of the biggest advantages of this project is that it enables artistic experimentation and learning in a hands-on, fully matured media installation. This implies exploring different ideas and thematic areas through audio-visual and interactive work and, most importantly, through collaboration between and among the artists and the audience.

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The project website: http://immersivelab.zhdk.ch

The institute's website http://www.icst.net

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