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PROPOSAL OF AN INTERACTIVE AUDIO INSTALLATION MODULE FOR THE COLOMBIAN NATIONAL PARK

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The virtual reality area has great potential for generating three-dimensional spaces (audio-video), where an application of programming knowledge in video games is required. In this case, and as it develops in many countries, there are systems of 3D sound and 3D image, that manage to recreate different realities, especially for fun purposes. For this, various techniques of rendering three-dimensional spaces are used, as well as surround sound techniques, such as surround sound, wavefield synthesis, ambiophonics, ambisonics, and, in general, sound auralization techniques.

Keywords: Interactive audio module, virtual reality, surround sound techniques, 3D spaces

1. Overall description of the project

3D spatial audio techniques have encountered several applications either rendered through headphones, or loudspeakers. In this case, spatial audio is used to recreate a holophonic scene for advertisement purposes: an audio installation for Colombian National Park.

The National Natural Parks of Colombia is responsible for the administration and management of the Natural National Parks System and the coordination of the National System of Protected Areas [1], as described in its definition. In order to be able to fully carry out its functions, this entity has the task of constantly acquiring information about the biological and cultural biodiversity found in each of the approximately 58 parks located within the 6 different regions of the country (Amazon, Northeastern Andes, Western Andes, Caribbean, Orinoquía, and Pacific). Information on ecosystems, flora, fauna, communities, hydrography, environmental services, geographic location and, if the park is open to the public, can be found on the website of this organization [1].

The documentation center of National Natural Parks of Colombia, listed on the website of the organization, makes available to the general public a bibliographic collection with information about

protected areas [1]. There is also a section called The Children in National Parks that through interactive recreational activities provides information about National Parks including the species of fauna and flora that inhabit them. On the other hand, in the document National Communication Plan of National Parks of Colombia, found in the documentation center of the organization, there is a whole described strategy in order to *"strengthen the processes of social and institutional mobilization around objectives: Valuation and conservation of biological and cultural heritage through the development of community communication processes and public information at the local, regional and national levels of National Natural Park of Colombia"* [1].

Although there are procedures framed within a specific plan for the dissemination of the parks, it is observed by the officials of the same, a concern about the contact of the population in general with the National Natural Parks of Colombia, seeing the Parks as a tourist site, and also there is an awareness of the country's wealth in terms of biodiversity found in these places. It is also important to point out the opportunity that exists of awareness for the conservation of the natural and cultural heritage with which these natural spaces have to be disseminated.

Within the Plan of Communications of the National Natural Parks of Colombia are listed specific activities as events of dissemination and production of information material for the external communication of the information of the parks; you can then take advantage of these types of events and use them as a medium in which, through interactive installations and / or applications, attendees can learn about this organization and become aware of the benefits that we have in the country and why it is necessary to care for and protect the heritage of these parks.

Different devices and systems are continuously developed and improved, seeking to immerse human beings into different themes through friendly and intuitive alternatives that attract the public and indirectly provide information and knowledge. Interactivity is also enhanced with technology so that new components like Kinect [2], Wii Remote [3], among others, extend the possibilities for the creation of new applications not only in mobile devices or web but in different physical spaces that pretend to innovate and offer new alternatives of learning and entertainment to people in different environments. Body movements, voice commands, manipulation of elements, among others, became the new interactive application controls that offer to the user a more authentic and attractive experience.

Sound engineering, on the other hand, has the potential to create interactive systems that use sound as a key component for applications: voice commands, audios that identify specific elements or music that with the rhythm indicate specific actions. It gives the opportunity to the participation of professionals of Sound in projects through artistic and engineering approach.

According to all of the above, it is evident the opportunity for sound engineers for working together with the National Natural Parks of Colombia to propose a solution to the necessity for this organization to instruct the public about the conservation and dissemination of country's heritage in terms of biological and cultural biodiversity in protected areas. For this reason, the question arises: How to take advantage of physical spaces and environments through interactive applications that provide information and instruct the general public about the biological and cultural biodiversity in National Parks of Colombia?

2. Background

For the development of the project there are important concepts to consider, such as: Interactivity, interactive installation, motion detection devices, prototype design process and new technological

strategies for learning. Below is an explanation of the more relevant ideas summarizing some of the above concepts.

2.1 Interactivity

The term interactivity currently refers to a change in the way humans have changed their way of life: encompassing activities such as buying, learning, playing, among others, that are now directly related to interactivity. One of the most basic definitions given by Steuer in his book "Defining Virtual Reality" refers to the way in which users can participate in the modification of the format and the content of a specific environment in real time [4]; this means, in simpler terms, it is the way in which the user generates an action on a system and automatically receives a response on the part of the user. At this moment interactivity is mostly associated with human-machine interaction or even more precise: interaction of the human being with technology in general.

Likewise, in dealing with this concept, it is essential to speak of communication since in an interactive medium, it is always about the notification of a message; then it can be said that within the interactivity, the user has the ability to modify a message. For this reason, it is important to note the implementation of interactivity in different actions of society such as advertising, entertainment, and the one concerning this project: education.

The article "What is interactivity and is it always such a good Thing?" describe three dimensions of interactivity: active control, two-way communication and synchronization [5]. The active control is based on the possibility that the user has within an interactive system to decide what type of information he wants to take or otherwise ignore; in the case of the internet, all kinds of information are available to the user continuously but the user has the power to accept them by clicking on the subject of interest, or rejecting them and not knowing about them. This possibility then provides a wide variety of responses that vary according to the user.

A two-way interactive method is defined as a system that allows sending messages to both the receiver and the transmitter of the message, which gives the possibility of a feedback that can be used for breeding purposes, which is quite profitable by companies and institutions to know the response of the public or client as to their specific characteristics.

Finally, the synchronization refers to the speed of the response of the system once the user generates an input, thanks to the technological development of today, this answer is given instantaneously.

2.2 Installations or Interactive Art

The development of the arts has increasingly mutated into the creation of interactive experiences that engage the viewer as a basic element within the artistic work. That is why the emotions and thoughts that can be brought about through these experiences are the fundamental basis for the creation of this new art form.

For the creation of this type of interactivity, technological developments have been a great tool that has allowed a joint knowledge of science, technology and the arts to establish these new media that can be used in fields such as education, entertainment, among others. Video games, web applications, for mobile devices, are just a sample of the new forms of entertainment and education that are on the market today.

Artistic installations are specifically described as work that takes physical space as an essential part of creating a social interactivity as they seek to attract attention, attract the public and make it one more element of the system. With the help of current technological tools, interactivity is achieved through gestures, movements, sounds or other activities, and as Andrew Johnston mentioned, the

intention is to facilitate a creative dialogue between the user and the system providing a rich and stimulating environment for improvisation[6]; for that reason the answer is different with each participant.

Because an interactive installation is based on the experience that is provided to the viewer, it is of utmost importance the design of the same. The technological tools, the physical space and the users must be combined with the experience to be provided, which requires a thorough planning in terms of: What do you want to provoke in people, how to keep the person attentive to what is happening, what kind of actions are going to trigger the response of the system, and how will the system react to each of the entrances of the viewers?

3. State of the art

The term hypermedia refers to the creation of content that integrates different information media such as text, image, video, audio, in order to provide an interactive user experience. Nowadays, with the development of new technologies, the social impact of human interaction with other media has created a change in the way people perform certain activities: new alternatives of learning and entertainment have emerged as well as new artistic forms which bring the general public closer to different themes. The development of interactive installations or interactive art as it is currently called, basically consists of a facility that actively engages the audience in a way that the user has to interact in order for it to reach its main objective; if the hearing does not provide any action, the facility will not serve its purpose.

It is also important to take into account how the user's perception changes from being passive to being active, and also the different results according to each person, therefore the experience is unique and authentic. New focuses of interest have arisen through technological development, concepts such as mixed reality, augmented reality and augmented virtuality have allowed the exploration of artefacts that combine digital material with physical manipulation and visualization devices in a novel way [7]. This type of development seeks to create new alternatives for human interaction with technology. Countries, such as Germany, have developed these technologies [8, 9].

According to Christopher Cox and Daniel Warner in the book Audio Culture, the term sonorous art is described as an artistic work focused on sound that is generally produced as an installation for galleries and museums, which means the assembly in a physical space; reason for which the architectural space begins to play an important role [10]. The combination of sound study with the arts and ecology, among other disciplines, has allowed the development of sound works focused on the exploration of other fields. The following describes projects and works carried out around the world that involve the development of interactive sound installations oriented to different areas of study.

Projects such as "Multisensory Interactive Installation" by Daniela Voto of the University of Florence and the University of Granada, proposes a system in which, from the works of Kandinsky, the user can paint and at the same time compose music [11]. The concept of synesthesia is defined as the indirect activation of a sense from the direct activation of another sense; this explains how some people can "see a sound" so that listening to a specific sound automatically triggers the vision of a color or a form that has not been presented or directly related. Based on synesthesia, this installation relates visual elements of the painting to musical elements, where the exploration of the visual elements generates different musical pieces. This project proposes the implementation of the installation in other fields such as art, music, therapies and education, through the use of different sensorial channels.

"Ground Me! An Interactive Sound Art Installation", a project developed by Javier Jaimovich of the Sonic Arts Research Center at Queen's University in Belfast, creates interactivity from three important points: 1) A site-specific installation, 2) The conductivity of the skin and 3) The impedance

of the body [12]. These three characteristics take as a starting point the unique parameters of the place to transform it creatively, give it a different functionality to the one originally had and explore the space to achieve a different interaction with the users. Based on the concept of electricity, the audience enters the space of the installation and by making contact with copper poles hanging from the ceiling and the metal floor, previously recorded sounds of electricity are reproduced. By not having any instructions, the user intuitively finds different ways of interacting with other people and the system provokes different behaviours of the audience, especially when a sound symphony is discovered caused by the accumulation of participants that induce the reproduction of many sounds simultaneously. It is worth highlighting the potential of this project by involving not only one participant, but a group of people which allows a collaborative participation that attracts the participants.

At the national level, you can see the interactive experiences that are found in the Maloka interactive center that promotes initiatives of social appropriation of science, technology and information [13]. In its website, in its part of programs and projects, the interactive scenarios may be found: these scenarios are located in different parts of the country such as Medellín, La Guajira and Bogotá. Desqbre Guajira is a project carried out by Maloka in association with the Cerrejón foundation, which is located in the municipality of Albania and has 15 interactive modules that aims to raise awareness among tourists and inhabitants of La Guajira about culture, roots, myths and legends of the region. Although no specific information is found on each of the modules, the development and implementation of new innovative systems to publicize the heritage of a region of the country is indicated.

The Medellín Water Museum is a project developed by Maloka and the EPM Foundation that has interactive spaces and seeks to enrich the relationship between science, technology and society in people of all ages. With scenography, immersion spaces, models of natural phenomena, virtual simulations with different types of interfaces, animations, videos, among others, the water museum seeks to articulate scientific and ancestral knowledge around water. Through the integration of different tools, interdisciplinarity works for a common good.

As it has been shown, interactivity, exposed in a physical space that provides the public with the opportunity to provoke different responses according to the participant, allows and leaves open the possibility of using technological advances for awareness, learning and dissemination of all types of knowledge through unconventional media that can be engaging and entertaining for people of all ages. For this reason, this project aims to create interactive sound modules at the National Natural Parks of Colombia that may bring the audience to spaces that inform about the biological and cultural heritage that the country has.

4. Development

4.1 Goals

The main objective is to develop an interactive module for sound installation, using the Kinect, a touch screen and a carpet with sensors that allow the public to approach: Ancestral cultures in the National Natural Parks of Colombia, Water factories for citizens, some ecosystems and environmental services of the National Natural Parks of Colombia, and a species guide of the National Natural Parks of Colombia. For the above, it is necessary to achieve the following specific objectives: To determine specific thematic axes for the module of the installation with the respective approach of the interactivity to be programmed; to develop the prototype of the installation module; and assemble the installation module in a physical space.

5. Methodology

The development of the project represents a methodology that involves the development of software and for this reason it is proposed to follow the RAD (Rapid Application Development) model that is based on the creation of fast and effective prototypes for specific cases. To this end, the following specific activities are proposed:

5.1 Requirements Planning for the Module

This activity is based on the definition of the functions of the module of the installation; the thematic axes and the objectives that will be achieved with it, will be established. This activity requires the participation of National Natural Park of Colombia to guide the issues and provide relevant information; on the other hand, the research team will plan the installation module to be developed.

5.2 Design of the installation module

For this activity it is sought to specifically establish the requirements and characteristics of the installation module. At this stage, the research team is required to create an effective and intuitive design to achieve the proposed objectives for the installation module.

5.3 Construction of modular prototype

At this stage it is intended to develop the previously designed installation, where tests of functionality and effectiveness will be done. If necessary, it will re-design and improve the prototype to arrive at a final version.

5.4 Construction of the prototype of the articulated system

For this activity we propose the development of the system with the module of the installation.

5.5 Final implementation

In this stage the completion and presentation of the module of the installation is sought.

6. Conclusions

3D Audio, also known as spatial audio has encounter many applications during the last decades. Among them, basically are encountered the military applications, videogames, films and the health industry. In this project, the application is about a sound installation for advertisement purposes as well as for generating a collective consciousness about all the fauna and flora that is available in Colombia.

REFERENCES

1 Ministerio de Ambiente y Desarrollo Sostenible, República de Colombia, *Parques Nacionales Naturales de Colombia*, [Online.] available: http://www.parquesnacionales.gov.co/.

2 Microsoft, *Windows*.

3 Nintendo.

4 J. Steuer, *Defining Virtual Reality*, 84 (1992).

5 Y. Liu y L. J. Shrum, What Is Interactivity and Is It Always Such a Good Thing? Implications of Definition, Person, and Situation for the Influence of Interactivity on Advertising Effectiveness, *Journal of Advertising*, **31**, (4), 53-64, (2002).

6 L. Candy y S. Ferguson, *Interactive Experience in the Digital Age: Evaluating New Art Practice*, Springer Series on Cultural Computing, (2014).

7 J. Bowers, TONETABLE: A Multi-User, Mixed-Media, Interactive Installation, *Proceedings of the COST G-6 Conference on Digital Audio Effects (DAFX-01)*, Limerick, Ireland, (2001).

8 S. Gebhardt y e. al, ViSTA Widgets: a Framework for Designing 3D User Interfaces, *VRST '16 Proceedings of the 22nd ACM Conference on Virtual Reality Software and Technology*, Munich, (2016).

9 D. Zielasko y et al, Interactive 3D Force-Directed Edge Bundling, *Computer Graphics Forum*, **35**, (3), 1-10, (2016).

10 C. Cox y D. Warner, *Audio Culture: Readings in Modern Music*, A&C Black, 454, (2004).

11 D. Voto, M. Viñas Limonchi y U. D'Auria, Multisensory interactive installation, *Noema Lab*, February (2006).

12 J. Jaimovich, Ground Me! An Interactive Sound Art Installation, *Proceedings of the 2010 Conference on New Interfaces for Musical Expression (NIME 2010)*, Sidney, (2010).

13 Maloka, *Maloka*, [Online.] available: http://www.maloka.org/index.php/centro-de-investigacion.

14 http://www.kenfeingold.com/dinkla_history.html

15 Ungs TJ. Simulator induced syndrome: evidence for long-term aftereffects. *Aviat Space Environ Med*; **60**, 252, (1989).

16 Rizzo A, Pair J, McNerney PJ, et al. Development of a VR therapy application for Iraq war military personnel with PTSD. *Stud Health Technol Inform*, **352**, 111-407, (2005).

17 Rizzo A, Schultheis M, Kerns K, et al. Analysis of assets for virtual reality applications in neuropsychology. *Neuropsychol Rehabil*, **14**, 207, (2004).

18 Stewart JC, Yeh SC, Jung Y, et al. Intervention to enhance skilled arm and hand movements after stroke: a feasibility study using a new virtual reality system. *J Neuroeng Rehabil*, **4**:21, (2007)

19 Crosbie JH, Lennon S, McNeill MD, et al. Virtual reality in the rehabilitation of the upper limb after stroke: the user's perspective. *Cyberpsychol Behav*, **9**,137, (2006).

20 Dvorkin AY, Shahar M, Weiss PL. Reaching within video-capture virtual reality: using virtual reality as a motor control paradigm. *Cyberpsychol Behav*, **9**,133, (2006).

21 Sanchez RJ, Liu J, Rao S, et al. Automating arm movement training following severe stroke: functional exercises with quantitative feedback in a gravityreduced environment. *IEEE Trans Neural Syst Rehabil Eng*, **14**, 378, (2006).

22 Adamovich SV, Merians AS, Boian R, et al. A virtual reality based exercise system for hand rehabilitation post-stroke: transfer to function. *Conf Proc IEEE Eng Med Biol Soc*, **7,** 4936, (2004).

23 Boian R, Sharma A, Han C, et al. Virtual reality-based post-stroke hand rehabilitation. *Stud Health Technol Inform*, **85,** 64, (2002).

24 Broeren J, Rydmark M, Sunnerhagen KS. Virtual reality and haptics as a training device for movement rehabilitation after stroke: a single-case study. *Arch Phys Med Rehabil*, **85**,1247, (2004).

25 Baram Y, Miller A. Virtual reality cues for improvement of gait in patients with multiple sclerosis. *Neurology*, **66**,178, (2006).

26 Fung J, Malouin F, McFadyen BJ, et al. Locomotor rehabilitation in a complex virtual environment. *Conf Proc IEEE Eng Med Biol Soc*, **7**, 4859, (2004).

27 Riva G. Virtual reality in paraplegia: a VR-enhanced orthopaedic appliance for walking and rehabilitation. *Stud Health Technol Inform*; **58**, 209, (1998).

28 Holden MK. Virtual environments for motor rehabilitation: review. *Cyberpsychol Behav*, **8**, 187, (2005).

29 Lange B, Flynn SM, Rizzo AA. Game-based telerehabilitation. *Eur J Phys Rehabil Med*, **45**,143, (2009).

30 SharpBrains. The state of the brain fitness software market. San Francisco.