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# 3D Tune-In: 3D-Games for TUNing and lEarnINg About Hearing Aids

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**Abstract.** The EU-funded (Horizon 2020 Grant Agreement No 644051) 3D Tune-In project employs a novel approach using 3D sound, visuals and gamification techniques to support people with hearing aids to understand their many features and how to calibrate them in different real world situations (e.g. at a concert, in a restaurant, on a street, at a train station, in a classroom). 3D Tune-In brings together the relevant stakeholders from traditional gaming industries (Reactify, UK; Vianet, Italy; XTeam, Italy; Nerlaska, Spain); academic institutions (Imperial College London, UK; De Montfort University, UK; the University of Nottingham, UK; University of Malaga, Spain); a large European hearing aid manufacturer (GN Hearing, Italy); and hearing Associations (Extra Care, UK; Hearing Link, UK; Action Deafness, UK; Accesibilidad y Personas Sordas, Spain and Ente Nazionale Sordi, Italy) to create 3D virtual interactive environments and videogames which will greatly improve the quality of life and level of social inclusion of individuals with hearing impairment.

**Keywords.** 3D sound, visualisation, virtual environments, digital games, gamification.

## 1. Introduction

3D Tune-In (*3D-games for TUNing and lEarnINg about hearing aids*) is a three-year European project funded under the Horizon 2020 ICT work programme. Coordinated by the recently established Dyson School of Design Engineering of Imperial College, UK, it has nine university and industry partners from Italy, Spain and the UK, and began on 1 May, 2015.

In this paper a brief introduction to the project is carried out. More information about 3D Tune-In can be found in the project website (http://3d-tune-in.eu/) and in [2].

## 2. Background

Over 90 million people in Europe currently suffer from hearing loss, and due to an ageing population this number is likely to continue to increase. While hearing aid technologies have dramatically advanced in the last 25 years, people's perception and use of these devices have changed very little. Hearing aids are now sensibly smaller, but incorporate several functions that

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go far beyond the simple amplification and equalization operation performed by the analogue devices (see Figure 1).

Nevertheless, this technological advancement is not always accessible or accessed by the hearing impaired population. The majority of individuals with hearing aids use the device as if it was a standard analogue hearing aid, i.e. only for its amplification and equalisation features, and new algorithms are under-used or not exploited to their full potential. Hearing impairment in older adults can lead to frustration, low esteem, withdrawal and social inclusion [6]. Furthermore, in children hearing loss affects speech and language development that impacts on academic achievement and future vocational choices [8].

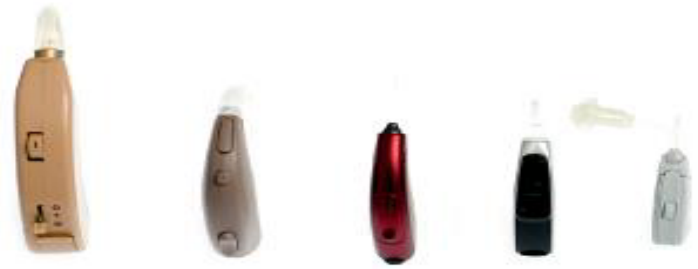

**Figure 1.** *Miniaturization from an analogue hearing aid (on the left) to a modern digital one (on the right)*[2]

Traditional gaming technologies have been successfully employed in non-leisure scenarios for learning and skill acquisition, empowerment and social inclusion [1]. In these scenarios, mechanisms such as game dynamics to ensure an adequate level of competition among the players, an effective reward system and a captivating storyline have proven to be effective elements to engage and motivate users [5]. The challenge is to facilitate the successful exploitation of existing, overlooked or neglected functionalities of hearing devices to optimize their potential thus greatly improving people's quality of life, and their interactions with other people and their surrounding environment.

## 3. The 3D Tune-In project

The 3D Tune-In project will create an innovative toolkit based on 3D sound, visuals and gamification techniques tailored to different target audiences (e.g. older users and children). The consortium consists of relevant stakeholders from traditional gaming industries (Reactify, UK; Vianet, Italy; XTeam, Italy; Nerlaska, Spain); academic institutions (Imperial College London, De Montfort University and the University of Nottingham, UK; University of Malaga, Spain); a large European hearing aid manufacturer (GN Hearing; Italy); and hearing Associations (Extra Care, UK; Hearing Link, UK; Action Deafness, UK; Accesibilidad y Personas Sordas, Spain; and Ente Nazionale Sordi, Italy).

Using a participatory approach we are creating virtual auditory and visual scenes that will:

- Enable end users to explore, review and customize hearing aid devices for different scenarios (e.g. at a concert, in a restaurant, on a street, at a train station, in a classroom, see Figure 2)

[2] Image from www.hearinglink.org, last accessed 06/2015

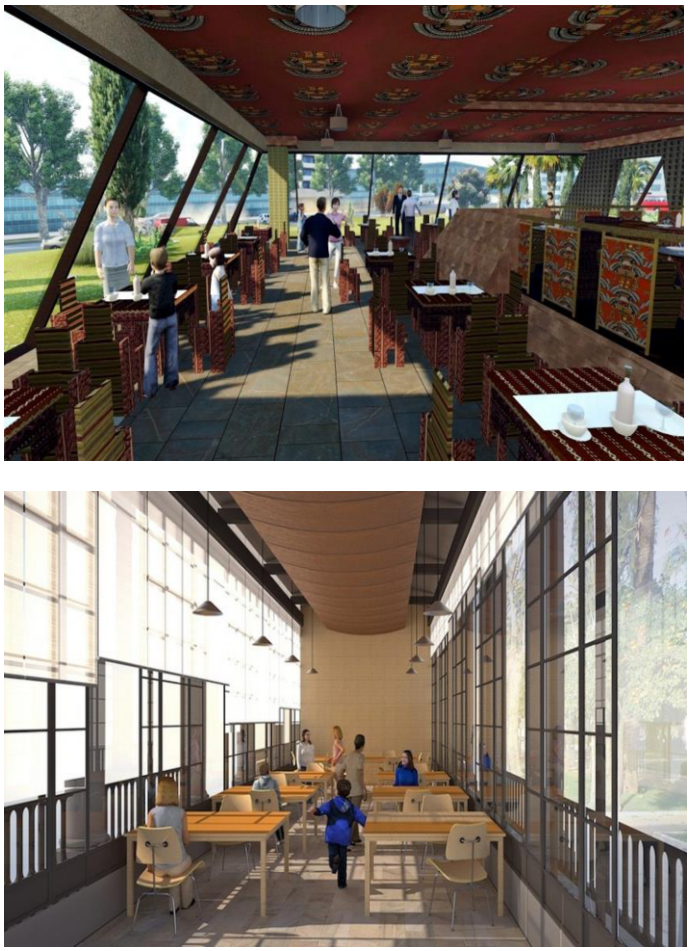

**Figure 2.** *Possible scenarios for 3D-Tune-In depicting indoor and outdoor environments*

- Enable individuals with no hearing impairment to understand how hearing loss can compromise everyday activities, and how a hearing aid can improve this situation
- Enable Small-Medium-Enterprises (SMEs) in digital gaming to explore new non-leisure applications in the area of hearing loss and hearing aid technology with support from the scientific community
- Enable hearing aid providers to evaluate and demonstrate the various functionalities of their products using 3D technologies to improve their services and increase sales

The expected outcome includes:

- Technology transfer between traditional SME game developers and broader research and industrial communities in 3D sound and virtual reality
- 3D Tune-In Toolkit for development of further hearing aid-related technologies
- 3D Tune-In applications, each coordinated by one the project's industrial partner while addressing a specific activity or target group (e.g. elderly population, children, etc.)
- Guidelines on the effectiveness of 3D and digital games on hearing loss and hearing aid technologies.

## 4. The 3D Tune-In Toolkit

The 3D Tune-In Toolkit, developed in the first 18 months of the project, includes the following functionalities:

- 3D audio engine, for both loudspeaker and headphones (binaural) rendering. This will include a novel HRTF-based (Head Related Transfer Function [4]) binaural audio algorithm, with HRTF selection, adaptation and individualisation functionalities, as well as an Ambisonic-based binaural reverberator. The loudspeaker-based version of the 3D audio engine will be based on the Ambisonic technique [5], and will include a convolution-based multichannel reverberator. This will allow developers to integrate within their applications high-quality 3D audio for both loudspeaker and headphones rendering.
- Hearing loss simulator. This will include frequency filters (e.g. parametric and graphic equalisers), dynamic range compressor/expander, non-linear distortion and degradation of the temporal and spatial resolution.
- Hearing aid simulator. This will include functions such as selective amplification, directional processing, dynamic range compression/expansion and non-linear distortion.
- Full integration with gaming development environments (e.g. Unity) and with currently available video and haptic rendering engines.

The 3D Tune-In toolkit will be made available open-source through the project website before May 2018. During the WISHWell'16 it will be able for the audience to interact with some of the demos/prototypes developed within the first part of the project. Other demos/prototypes will be available through the 3D Tune-In website (http://3d-tune-in.eu/)

## 5. The 3D Tune-In applications

Five applications are being developed within 3D Tune-In, each application coordinated by one the project's industrial partners, while addressing a specific activity or main target group:

- **Musiclarity** (Musical listening for hearing aid users). Musiclarity is an interactive music rehabilitation application developed by Reactify, dedicated to improving the experience of listening to music for hearing aid users.

- **Hearing Aid Tuner** (For the elderly with hearing aids ). Hearing Aid Tuner aims at enabling people with hearing loss to understand the basic parameters that influence the quality of sound in different contextual situations.

- **Dartanan** (For children with hearing aids). The fundamental aim of Dartanan is to teach children with hearing loss how to calibrate their hearing aid in specific scenarios.

- **Fallen Angel** (Educational games). Fallen Angel aims at educating people without hearing impairments about hearing loss, to raise awareness and empathy for people who experience difficulties.

- **AudGam PRO** (Hearing aid demonstrator). AudGam PRO will allow GN Hearing to demonstrate, through a series of video games, specific functionalities of their hearing aids, and to support end users to understand the impact of such technologies in their everyday life.

## 6. Preliminary results

The project kick-off took place at Imperial College London on 11-12 May, 2015 [7]. The activities of the first work-package (stakeholder requirements, system concept and specifications) started immediately. Thanks to the partnered hearing associations, it has been possible to involve hearing-impaired individuals, hearing-aid users, audiologists and hearing-aid technicians in the participatory design stage. The outcomes of this process have allowed the 3D Tune-In SME partners and GN Hearing to further develop their initial application ideas and scenarios. The related output has been formalised and is continuously updated (see also http://3d-tune-in.eu/applications). Subsequently, the team at the University of Malaga, in close collaboration with Imperial College London, led activities towards specifications of the 3D Tune-In Toolkit, which included the in-depth requirements, specification and guidelines for design, development and implementation. The alpha-version of the 3D Tune-In Toolkit will be completed in August 2016, and part of it will be released open-source in May 2017.

In terms of the 3D Tune-In applications, activities are now progressing towards the final design and initial development of the applications, in view of a prototype release in November 2016. At the same time, the team lead by the University of Nottingham is currently moving forward towards the development of the evaluation and validation protocol, and the organisation of the evaluations of the first prototypes.

## 7. Conclusions

3D Tune-In provides a great opportunity, not only to make a real difference to many people's lives now and in the future, but also opens up new markets to the virtual reality community. For more information please contact the 3D Tune-In coordinator Dr Lorenzo Picinali (l.picinali@imperial.ac.uk), or visit: www.3d-tune-in.eu.

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