BIOENGINEERING AND MEDICAL-SURGICAL SCIENCES

UNITO - Immersive audiovisual laboratory for hearing-impaired listeners

Funded By	UNIVERSITA' DEGLI STUDI DI TORINO [P.iva/CF:02099550010]

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Context of the research activity	Auditory research has actively sought methods to implement ecological tests to assess hearing-impairment degree and test and perform the fitting of hearing devices. The need to make laboratory tests replicating the competitive acoustical conditions of ordinary life situations has led to exploit virtual reality to integrate immersive audiovisual scenarios. Multiple-loudspeaker arrays for the spatial auralization of virtual complex acoustic environments have been set up coupled with display systems showing the related visual environments to recall the audiovisual interplay proper of real-life conversations. Speech intelligibility tests are carried out in these laboratories where the listener is in the center of the array of loudspeakers, able to rotate his/her body and move the head, with or without visual stimuli. Datasets have been collected, consisting of either audiovisual scenes simulations or only-audio recordings of realistic ordinary environments. However, databases leveraging "ground-truth" measurements for both the acoustical and visual scenes need to be deeply enlarged, as well as the investigation of the listening effort with specific sensors for detecting the physiological outcomes to speech comprehension stress. Test protocols to be implemented in clinics for assessing the hearing ability should involve accurately designed real-world communication scenarios, so that the degree of real-life hearing impairment can be correctly evaluated. In particular, realistic scenes with the interaction between two people engaged in a conversation should be recreated and the speech comprehension, listening effort and cognitive outcomes should be evaluated.

	The research activity aims to implement tools to automatically investigate the hearing ability and the cognitive response of hearing-impaired subjects within the new spatial audio lab of the University of Torino, by setting psychological and physiological tests, together with speech intelligibility tests, whose outcomes are strictly related to hearing impairment. In order to recreate real-time interactive conversations between the subject under test and virtual talkers inside real-life-like auditory scenarios, where the truth-to-

Objectives	life hearing and cognitive impairments can be measured, machine learning techniques will be applied.. In particular, machine learning techniques will be applied for signal processing of real-time speech of two speakers (i.e., the real listener and the virtual speaker) and for developing a realistic dialog between them. To this aim specific metrics will be developed to objectively quantify and evaluate the speech comprehension and cognitive abilities of the listener within these interactive scenes. [1] HAPPAA Project, https://uol.de/en/sfb-1330-hearing-acoustics [2] VR/AR and hearing research: current examples and future challenges, L. Picinali et al, Forum Acusticum 2023 https://www.doi.org/10.61782/fa.2023.0322 [3] Angela Guastamacchia, Fabrizio Riente, Louena Shtrepi, Giuseppina Emma Puglisi, Franco Pellerey, Arianna Astolfi, Speech intelligibility in reverberation based on audio-visual scenes recordings reproduced in a 3D virtual environment, Building and Environment, Volume 258, 2024, 111554, ISSN 0360-1323, https://doi.org/10.1016/j.buildenv.2024.111554.

Skills and competencies for the development of the activity	Some of the following skills and competencies are expected: o Background in applied acoustics and signal processing; o Knowledge of 3D modeling and DAW tools as Blender, 3ds max, Reaper, Bidule, MAX o Knowledge of programming languages as C / C ++, Matlab, JavaScript, Python. o Background on machine learning algorithms.