School of Computing, Engineering, and the Built Environment
Edinburgh Napier University

PHD STUDENT PROJECT

Application instructions:
Detailed instructions are available at:
https://www.napier.ac.uk/research-and-innovation/doctoral-college/how-to-apply

Prospective candidates are encouraged to contact the Director of Studies (see details below) to discuss the project and their suitability for it.

Project details

Supervisory Team:

- DIRECTOR OF STUDY: Dr Iain McGregor (Email: i.mcgregor@napier.ac.uk)
- 2ND SUPERVISOR: tbc

Subject Group: Applied Informatics

Research Areas: Human Computer Interaction, Internet of Things

Project Title: Human Computer Interaction

Project description:

This project will explore the use of Audio Augmented Reality in hospitals. Out of necessity most devices in a hospital make a sound, whether intentionally or not. The requirement for easily cleaned surfaces, and open plan layouts can make for a highly stressful acoustic environment, that affects staff, patients and visitors alike. The need to have consistent medical alarms, combined with the close proximity of patients with related diagnoses requiring identical medical hardware, can make it very difficult to identify which has been triggered. Much time can be wasted by staff having to reassure both patients and their visitors that an alarm is not indicating a life-threatening situation but is only there to provide confirmation that everything is functioning correctly, or that routine monitoring is required. Auditory alerts could be transferred to a virtual medium, where they only become audible in the physical world if they are not attended to quickly enough. Staff can be equipped with open ear headsets to monitor all of the required technologies, spatially represented in the correct orientation. Reaction times are improved as complex reverberations will not impede accurate interpretation of the spatial location of the source. Expanded

auditory content can be represented to guide actions when closer to the sound source, which will help prevent errors in use, as well as ensuring privacy, and reduced noise pollution. Sonic representations of a patient's condition should be just as private as their medical notes. In some Intensive Care Units (ICUs) the average sound pressure level is always at least 5 dB above the World Health Organisation's recommendations, irrespective of the time of day, leading to patient sleep deprivation, which is known to impact recovery.

Within wards privacy curtains are far from private, whilst the visible actions become opaque, the auditory elements remain clear for all to hear. This is not only to preserve dignity, but also minimise stress for patients in the surrounding beds, who also have similar conditions of different severity, who may become distressed when overhearing aspects of a condition that might affect them in the near future. There are many solutions so that when a curtain is closed an acoustic curtain also kicks in. The simplest is that any speakers already built into the physical structure start to play white noise, or the phase inverted sounds already existing within the space in the immediate area surrounding the exterior of the curtain. If speakers are not already available, upward firing directional drivers can be utilised directionally mask the acoustic bleed. If a larger budget is available, and the curtains suitably dense, then highly directional ultrasonic units can be utilised to bounce sound off the screens. Private rooms often have to have their doors kept open so that staff can hear alarms, negating the benefits of medical isolation in transmissible diseases. Some patients report how horrible it is to hear a ticking clock in a hospital as it denotes time passing slowly, reminding them of their forced confinement and their lack of agency. An aspect that becomes an even greater issue the longer they remain.

The proposed research would explore the use of audio AR to dramatically improve patient privacy and noise exposure.

References:

[1] Ara, J., Karim, F. B., Alsubaie, M. S. A., Bhuiyan, Y. A., Bhuiyan, M. I., Bhyan, S. B., & Bhuiyan, H. (2021). Comprehensive analysis of augmented reality technology in modern healthcare system. International Journal of Advanced Computer Science and Applications, 12(6), 840-849.

[2] Camci, A., Abbott, P., & Rooney, D. (2020, December). Investigating Alarm Fatigue with AlarmVR: A Virtual ICU for Clinical Alarm Research. In Forum Acusticum (pp. 2973-2978).

[3] Escalada-Hernández, P., Ruiz, N. S., & San Martín-Rodríguez, L. (2019). Design and evaluation of a prototype of augmented reality applied to medical devices. International journal of medical informatics, 128, 87-92.

[4] Hughes Driscoll, C. A., Cleveland, M., Gurmu, S., Crimmins, S., & El-Metwally, D. (2020). Replacing overhead paging with smartphones to reduce hospital noise. Biomedical Instrumentation & Technology, 54(4), 251-257.

[5] de Lima Andrade, E., da Cunha e Silva, D. C., de Lima, E. A., de Oliveira, R. A., Zannin, P. H. T., & Martins, A. C. G. (2021). Environmental noise in hospitals: a systematic review. Environmental Science and Pollution Research, 28(16), 19629-19642.

[6] Kumar, S., Ng, R. Q., & Lee, H. P. (2020). Experimental investigations of acoustic curtains for hospital environment noise mitigations. arXiv preprint arXiv:2008.06690.

[7] Oleksy, A. J., & Schlesinger, J. J. (2019). What's all that noise—Improving the hospital soundscape. Journal of clinical monitoring and computing, 33(4), 557-562.

[8] Vieira, J., Santos, J. A., & Noriega, P. (2019, July). A review of design guidelines for clinical auditory alarms. In International Conference on Healthcare Ergonomics and Patient Safety (pp. 325-333). Springer, Cham.
[9] Werner, S., Klein, F., Neidhardt, A., Sloma, U., Schneiderwind, C., & Brandenburg, K. (2021). Creation of auditory augmented reality using a position-dynamic binaural synthesis system—Technical components, psychoacoustic needs, and perceptual evaluation. Applied Sciences, 11(3), 1150.
[10] Wüller, H., Behrens, J., Garthaus, M., Marquard, S., & Remmers, H. (2019).
[11] A scoping review of augmented reality in nursing. BMC nursing, 18(1), 1-11.

Candidate characteristics

Education:

A second class honour degree or equivalent qualification in Computing, UX or sound design

Subject knowledge:

Experience of fundamental Sound Design principles
Competent in Interactive audio programming C++, C#
Knowledge of User Experience (UX) research

Essential attributes:

- Good written and oral communication skills
- Strong motivation, with evidence of independent research skills relevant to the project
- Good time management

Desirable attributes:

- Familiarity with mixed reality technologies.