Masking and Attenuating Noise Within Hospital Settings: Sleep Good Hood System

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Statement of Purpose: Hospital rooms, especially intensive care unit (ICU) and emergency room (ER), have high-stress environment that contains adverse stimuli such as bright lights and high levels of noise. These contribute to the high prevalence of sleep deprivation among in-patients, negatively impacting their body and natural circadian rhythms [1]. Sleep deprivation can impair patients' immune system which can leave hospital patients even more susceptible to infections, disease, and may affect patients' ability to heal which lengthen their stay [2]. To address this clinical issue, we designed a novel localized environment prototype, with the goal to aid patients in retaining a regular sleep cycle. The device is a hood-like structure, the Sleep Good Hood System, that masks and attenuate noise both passively and actively while attenuating blue light to allow patients to rest comfortably without impeding necessary hospital workflow. Noise attenuation is achieved by using open-cell sound absorbing foam to passively attenuate ambient noise and using active noise cancellation (ANC) system while sound masking is done using computer generated and volume modulated colored noise [3].

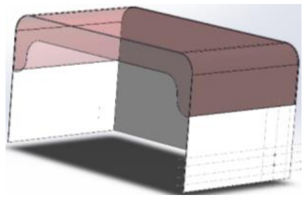

Fig 1. *CAD model of prototype*

Methods: For fabrication of an initial prototype, two types of cast acrylic were used: a red translucent acrylic and an opaque white acrylic. The acrylic sheets were laser cut, thermoformed and reinforced with aluminum brackets, and open cell sound absorbing foam was applied to the inside of the prototype. Sound masking algorithms have been developed on Python to run in real-time on a Raspberry Pi where colored sound is processed and outputted through a set of speakers, allowing volume to be modulated.

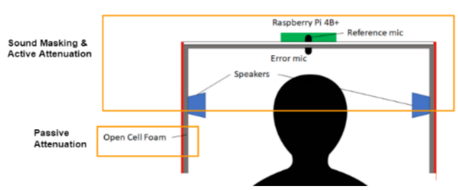

Fig 2. *High level overview of prototype*

Results: A first-generation prototype was fabricated from our CAD design (Fig.1) (Fig.2). For passive attenuation (Fig.3), ambient sound pressure levels were reduced (orange) by approximately 4 A-weighted decibels. A simple sound masking system was simulated where colored noise at a constant level reduced the peak magnitudes of overall sound pressure levels (Fig.4), and adaptive sound masking algorithms were incorporated (Fig.5) to demonstrate rolling window average attenuation (red) of a sound recording (blue) from an ICU.

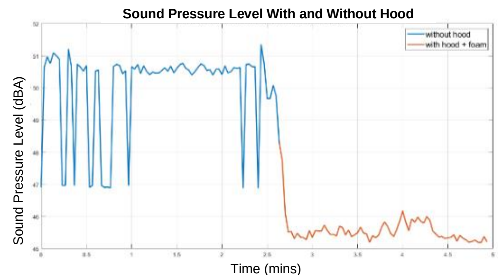

Fig 3. *Passive noise attenuation with open cell*

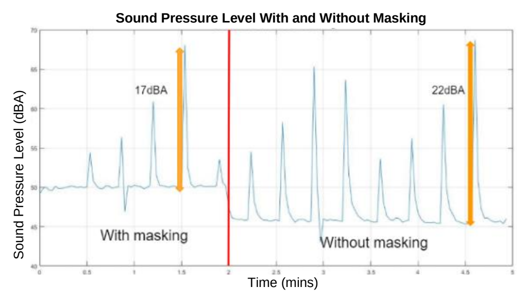

Fig 4. *Simple sound masking system*

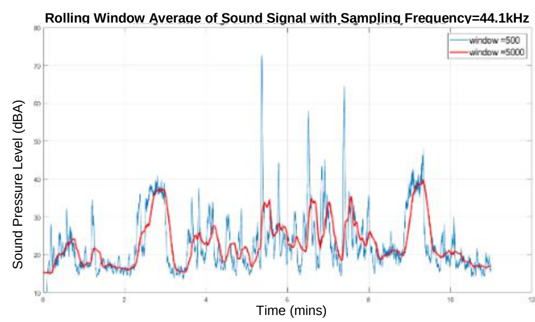

Fig 5. *Rolling window average attenuation*

Conclusions: A first-generation prototype was fabricated, and initial noise attenuation testing demonstrated successful proof-of-concept. The adaptive sound masking algorithm will be used for the next generation prototype, where an ANC algorithm will be incorporated. Future studies will also include using hospital source noises to further develop sound masking and ANC systems, finite element analysis, and mechanical testing. Additionally, precise positioning of speakers will be able to obtain complete and effective destructive interference.

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References: [1] Al Mutair, A., DSAHMJ, 2019, vol.1, pp.30-35. [2] Kamdar, B., JIC, 2011, vol.27, pp.97-111. [3] Gallacher, S., ICMx, 2017, vol.5, article 47.