Investigating An Urban Noise Nuisance – *The Ranchlands' Hum*

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I. INTRODUCTION

The 'Hum' is a popular name for a series of sporadic low-frequency noises reported worldwide. They have adverse health-effects such as anxiety and depression and can cause vibro-acoustic diseases [1]. Recent reports have been made for a Hum noise nuisance in the Ranchlands community, Calgary, Canada. Smith et al. [2] performed a preliminary analysis of anonymized Hum recordings with the aid of Patching Associates Ltd. As shown in Fig. 1, there appears to be a variety of Hums rather than a specific Hum. However, the limited availability of industrial recording equipment meant that only infrequent recordings from individual houses could be acquired, making full characterization of the community noise nuisances difficult.

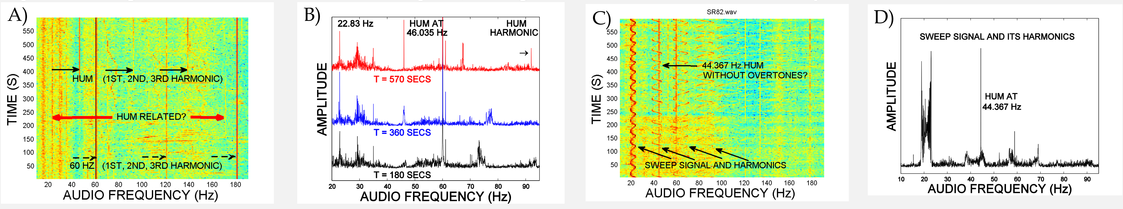


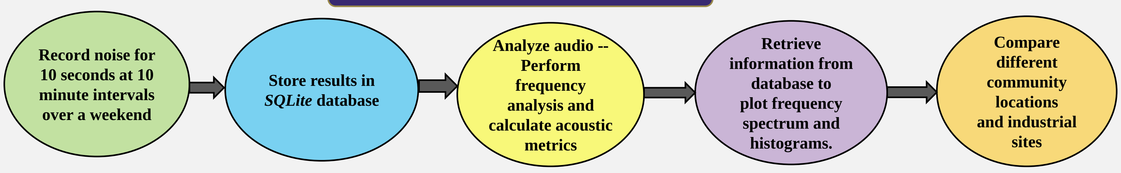
Figure 1: The noise environment in the Ranchlands' Community is varied.
(A) One household's spectrogram showed evidence of a 46.035 Hz Hum with multiple harmonics that (B) started with noise like characteristics (180s), briefly broadening into a wider spectral band signal (300s) before becoming a sharp intense Hum signal with multiple harmonics (570s). (C) A spectrogram from another house-hold showed (D) a steady 44.37 Hz hum signal with no overtones together with a second signal with multiple overtones sweeping between approximately 19 Hz and 22 Hz with a period of 40s. Courtesy Circuit Cellar magazine [3].

Gaspard et al. [4] developed an open source cell phone application with sufficient ability to (A) to record / playback the Hum to convince sceptics that the Hum physically exists rather than is caused by physical or medical issues; and (B) allows the user to compare frequency characteristics of two Hum recordings, e.g. between their house and a neighbour. We have extended the application to provide the ability for a more detailed, and long term analysis.

II. OBJECTIVE

- Capability to gather noise data over a period of time so that a systematic and comprehensive analysis can be performed .
- Tracking of changing signal content using 1) a Night-time high SNR noise metric, **Percentage Worse Case frequencies,** which provides the number of hum instances with a power X% of the loudest hum recorded over a weekend or selected time period; and 2) a Day-time low SNR noise metric, **Ratio Background Noise frequencies,** which provides the number of hum instances significantly larger than the background urban noise level [2].
- Comparison of acoustic metrics of multiple Hum instances recorded with the same cell phone at different times. This allows the householder to track how the noise characteristics change with time. Smith et al. [2] provided preliminary evidence of a possible seasonal component to the noise,
- Ability to use multiple "low-cost" collectors, and provide the ability to compare Hums in many locations simultaneously to determine if Hums are similar. Locations for simultaneous recordings should include potential sites for the low-frequency noise generation.

III. METHODOLOGY



IV. RESULTS AND DISCUSSION

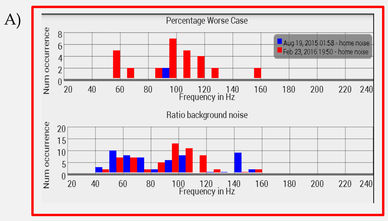


Figure 2A. Two sample sound recordings from an author's private dwelling show different characteristics when analyzed using the metrics suggested in [2]; Percentage Worse Case (high SNR Hum instances) and Ratio background noise (low SNR Hum instances).

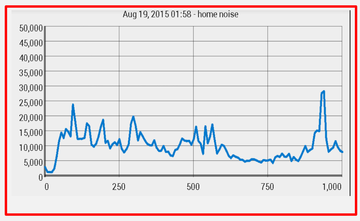


Figure 2B. Frequency spectrum of one of the recordings showing some peaks at lower frequencies. Self-recalibration to account for the poor low-frequency cell-phone microphone response would be a preferred solution to purchasing expensive, wide-band, external microphones.

V. FUTURE WORK

- Automated self-calibration to compensate for known low-frequency bandwidth limitations of a standard cell phone microphone.
- Setting up a secure cloud database where users can upload their private cell-phone recordings to facilitate more extensive comparative research.
- Community-wide study involving a phased array of sparsely located cell-phone sensors which can be used as direction indicators for the Hum source.
- Calibration to display sound levels in "industrial standard manner" to handle industrial sources, e.g. an individual noisy turbine in a wind farm.
- Use home theatre system to generate anti-Hum signal (180 degrees out of phase) to cancel out the Hum and create ***"a zone of quietness"*** in bedrooms as there is a suggestion that some Hums are related to structural resonances activated by movement of concrete basement pads.

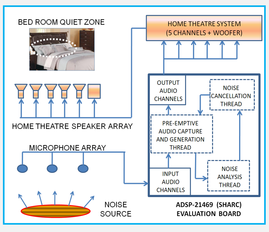


Figure 3: Schematic of SSSH! – SHARC-based Sound Suppression system for the Home [5]. A microphone array picks up a noise source. The audio information is fed into an 'inexpensive' Analog Devices SHARC evaluation board designed to handle consumer home theatre demonstrations. Information about the noise source is determined: e.g. direction, type of sound, etc. An appropriate series of anti-noise signals are calculated and then amplified by the home theatre system feeding a series of speakers to generate a *Quiet Zone* over a small area, such as the head of a bed.

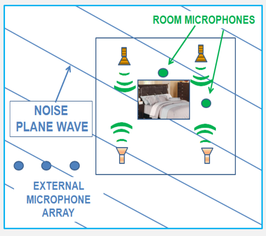


Figure 4. A key issue to overcome in producing an in-house noise cancellation system is that the external 'distant' noise source will probably have far-field characteristics (quasi-plane wave) while the loudspeakers producing the anti-sound signals will have near-field characteristics (quasi-spherical waves) and generate multiple virtual speakers through wall reflection. A further complication, especially for low frequency noise cancellation, is that the noise source and speakers could independently set up room resonances. Hearing aids with custom active noise algorithms might overcome this problem [5]

REFERENCES

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