Real-Time Noise Monitoring and Analysis for Abatement of Noise Pollution

Abstract

Noise, an environmental pollutant generated as a byproduct of human activities, is linked to hearing loss, reduced work productivity, and personal physiological and psychological damage. Exposure to noise in various combinations of intensity and duration causes hearing loss ranging from slight impairment to total deafness[1], workplace injuries due to the difficulties in hearing warning signals[2], and adverse physiological and psychological effects including degradation in communication, recreation, and effective work participation[1]. Noise is an especially critical issue in large urban settings where highways and freeways, aviation operations, and other stationary and non-stationary noise sources are proximal to and embedded within densely populated residential and commercial regions[3]. The research objective is to develop a portable real-time noise monitoring prototype using the low-cost TI MSP432 microcontroller to monitor noise pollution levels in and around high-density residential areas in close proximity to noise pollution sources. Real-time data analysis and monitoring conducted will test the hypothesis that these residential areas experience significantly higher levels of noise pollution which will then be used to develop novel noise abatement strategies. Results from the study will be prepared for submission into leading academic journals such as the Journal of Environmental Sciences, and disseminated through media and trade publications.

Objectives and Importance

Traditionally, noise monitoring can be accomplished in two ways: using a Sound Level Meter (SLM) or a dosimeter. The SLM may not adequately capture the variations or fluctuations in sound intensity. The dosimeter is similar, except that it can record and provide an average reading over the study duration. Modern noise monitoring systems do not require trained personnel. However, they do require a person trained in noise data monitoring and analysis. Noise monitoring data (i.e., the magnitude and duration of excessive noise levels) will be recorded over the summer and will serve as a benchmark for developing an effective noise abatement strategy. Community Noise Equivalent Level (CNEL) will be established for a variety of single-source noise events to better protect the community from unpleasant Sound Pressure Levels (SPLs). The proposed research activities are geared towards providing students with real-world experiences through direct application of material they have learned in classroom activities. To that end, the project seeks a close collaboration with the California State University, Fullerton Auxiliary Services Corporation (CSUF-ASC). It should be noted that CSUF-ASC provides affordable housing to its faculty and staff members and the housing is only a few meters away from an Orange County Transit Authority operated train station. This site will be used as a site to study noise pollution and to develop the abatement strategies. OSHA recommends a three-pronged strategy for noise abatement: noise reduction, relocating source(s), and installing noise-reducing barriers. Depending on the noise levels recorded at the site, an economically feasible and long-term sustainable noise abatement protocol will be established. Any novel research will be disseminated in domestic and international conferences and journals.

Levels of Contribution

The main contribution of this independent study will be the development of a portable real-time noise monitoring prototype. This device will be used to monitor noise pollution levels, in and around high-

[1] W. Gan et al. "Exposure to Occupational Noise and Cardiovascular Disease in the United States: The National Health and Nutrition Examination Survey (1999-2004)," Occup. Environ. Med., 2010

[2] Occupational Safety and Health Administration (OSHA)

[3] As an example, California Government Code § 65302(f) explicitly addresses urban noise abatement

density residential areas that are in close proximity to noise pollution sources, in real-time. If successful, the materials will be disseminated at relevant conferences and/or journals. This work can then be used by students interested in the areas of DSP and real-time audio processing.

Outcomes

At the end of the semester, students should have an understanding of:

- Programming in Matlab, assembly, and C/C++
- Real-Time Audio Signal Processing
- Embedded system

Assessment of Activities and Deliverables

The activities described above will be assessed on a continual basis through progress reports and weekly meetings. The direction of the activities will be refined based on this information. As shown in the schedule below, the student will periodically provide progress reports and their current code, and the instructor will evaluate the student's progress based on this.

Tentative Schedule

Week	Topics	Assignment
1	Literature Review	Literature Review Report
2	Initial System Design	Progress Report and Code
3	Design Implementation	Progress Report and Code
4	Design Verification	Progress Report and Code
5	On-Site Testing	Progress Report and Code
6	Validation of Data	Progress Report and Code
7	Development Noise Abetment Strategies	Progress Report
8	Presentation and Final Report Preparation	Final Report and Final Code

Grading

Plus and minus grading will be used when determining final grades. Final grades are computed by first finding the average score in each category described in the table below on the right. All scores are normalized to a scale of 0 to 100 before being averaged. The average score for each category is then used to compute the weighted average according to the weights in the second table below.

Letter Grade	*% of Total Points*
A+	96% & Above
A	93% – 95.99%
A-	88% – 92.99%
B+	85% – 87.99%
B	82% – 84.99%
B-	78% – 81.99%
C+	75% – 77.99%
C	72% – 74.99%
C-	68% – 71.99%
D+	65% – 67.99%
D	62% – 64.99%
D-	58% – 61.99%
F	Less than 58%

Category	*% of Final Grade*

Reports	30%
Code	30%
Presentation	20%
Final Report	20%