Nuisance Monitoring System

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Abstract— Noise pollution is a common problem in urban environments that has been shown to affect people's health and children's cognition caused by vehicular traffic, Festival celebration, loudspeakers etc. In the last decade, several studies have been conducted to assess this noise, by measuring the equivalent noise pressure level to acquire an accurate sound map using wireless networks with acoustic sensors. Environmental noise monitoring systems continuously measure sound levels without assigning these measurements to different noise sources in the acoustic scenes, therefore incapable of identifying the main noise source. The goal is to evaluate the hardware limitations of a low-cost wireless acoustic sensor network. The sensor is based on an inexpensive credit-card sized single-board computer with a microphone and associated electronics and wireless connectivity. The measurement results and source information are send from the sensors scattered around the measurement site to a storage service and a noise portal is used to visualize the data to users. A conveniently study has been done on this concept in which an acoustic pattern classification algorithm is working in a wireless sensor network is used to automatically assign the measured sound level to different noise sources. This noise monitoring system can reduce the amount of required human effort for validation of the sound level data when the target noise source is known.

Key words: Arduino, Sound Sensor, Iot, Environmental Noise Monitoring, Acoustic Pattern Classification, Wireless Sensor Network, Psycho Acoustic, Low-Cost, Real Deployment, Low Power System

I. Introduction

Environmental noise, defined as unwanted or harmful outdoor sound created by human activities, can be generated by traffic, industry, construction, and recreation activities. One challenge in environmental noise monitoring is how to make sufficiently comprehensive measurements both in time domain and spatially. The changes in weather conditions have a significant effect on monitored noise levels and in order to obtain most of the variations the noise has to be monitored for extended periods of time. Also, a single point noise measurement is rarely representative for a whole neighbourhood and several sensor locations are needed.

II. Literature survey

This method is about monitoring concept by an acoustic pattern classification algorithm. Sensing the environment with the sensor and sending data to cloud services so that a noise portal can analyse the measurements. This system is incapable of identifying the main source of the noise. The system includes a Raspberry Pi. Additional functionality added by an audio codec (a 24-bit multi-bit sigma delta AD converter), a smart power management board with an uninterruptible power supply feature, and mobile connectivity. The microphones with two models: one covering the audible range dynamics from 14 dB to 119 dB, and another from 20 dB to 140 dB (A-weighted). Solar power was also selected for totally wireless sensors. A solar panel frame is for the electronics and batteries which were built inside. There is a web based interface which gives you the visuals in the readable format. The sound pressure level (SPL) measurements can be filtered based on the sound source classification results to show measurements for assigned to particular sound source. The calendar heat-maps are used to visualise the average SPL values over certain time span (one day, one hour) with a colour of a calendar cell. Feature extraction transforms an audio signal into reduced representation. Mel-frequency cepstral coefficients (MFCCs) are used in the proposed system. MFCCs have been proposed and widely used in speech recognition. Two classifiers are also used one is GMM (Gaussian Mixture Model) and another one is ANN (Artificial Neural Networks).

A case study has been made at a rock crushing plant. As result there were many type of noises like of machines in plant, traffic noises and wind noises all have different spectra. In future, all the data from a large number of various networked sources, already available or from the autonomous smart sensors, will be centralised to a cloud service, where the data is accessible to a various groups of people: public, authorities, and to the dedicated users. It is concluded here that the that environmental noise monitoring could be more enhanced by separating between the target and interfering noise sources and implementing this approach to the sensor level. A cloud service and a noise portal were introduced. The sensors transmitted the results to the cloud service and the portal was for visualisation of the results, statistical analysis, and data archiving. [1]

The similar values of equivalent noise pressure level (called Leq) people can feel the noise differently according to its frequency characteristics. According to the analysis the suitability of using the psychoacoustic metrics given by the Zwicker's model with considering Leq .Tmote-Invent nodes and Raspberry Pi platforms are used as a types of commercial and off-the-shelf sensor nodes. Tmote-Invent nodes are not that much efficient because of their limited memory and calibration issues. Here in this system they also used wireless sensor network for sensing capabilities. And in each node have its own power supply and memory. The nodes communicate using multi-hop routing protocols and at least one node (Called sink) acts as a gateway for external connection. This model measures the Nuisance (N) based on other parameters which are: Loudness (L), Sharpness (S), Roughness (R) and Fluctuation Strength (F). Zwicker's Psychoacoustic Model is based on anatomy of human hearing. When complex sounds are being considered the frequency spectrum of the psycho-acoustic metrics is made in terms of Critical Bands (CB) that refers to the frequency bandwidth of the auditory filter created by the cochlea, the sense organ of hearing within the inner ear. The human hearing combines the sound stimuli which are situated in close proximity of each other in terms of frequency into particular CB. When serializing these CBs, a frequency scale is created, called the CB rate scale and measured in the unit Bark. The conclusion is that the hardwares have their limitations. And also the Zwicker's Psychoacoustic Model helps in providing more information than the measurements based on the Leq. [2]

Noise of tyres and engines is the main contribution to noise pollution in traffic. Automotive manufactures invest a lot of effort and money in that. So for making it less complicated then trial and error method they proposed a system with a purpose to develop simple source models for engine noise using a mock-up panel of loudspeakers set up following the substituted monopole technique. Now-a-days there is a testing that is Jury testing is done for testing the sounds of vehicle. The idea is that a group of people evaluate the sound quality from different parts of the vehicle such as the engine, the tyres and the doors, amongst others. So for making an ease is that noise predictions models are used which are quite simple. In this model the main aim is to describe the extension of airborne source quantification methods to determine the number of equivalent source descriptors needed for the model and also the quantification of those descriptors. The descriptors have acceptable accuracy of sound synthesis. This type models have low post-processing time. Using an ASQ model, sound sources can be identified with a level of accuracy acceptable for the purposes of sound synthesis, at a low computational cost. Using an ASQ model, sound sources can be identified with a level of accuracy acceptable for the purposes of sound synthesis, at a low computational cost. Airborne

Source Quantification (ASQ) is referred as procedure which allow the flow of vibro-acoustic energy to be traced from source. This model has the limitations with respect to the frequency and also a dependence on the receiver's position. Monopoles are the dominant factor in the accuracy here. And for result representation we can use Zwicker's loudness and sharpness. [3]

Environmental sound analysis is a challenging task for machine learning because of the too much other noises in nature of the signal, and the small amount of labelled data that is typically available. The effort for deep learning on detection and classification of acoustic scenes is challenging. While performing with the some features like MFCC, Binaural MFCC etc. And on these features the model applied are Gaussian Mixture Model (GMM), Deep Neural Network (DNN), Recurrent Neural Network (RNN), Convolutional Deep Neural Network (CNN) and i-vector. Training the classifiers independently first to maximize model diversity, and fuse these models for the best performance. Because of the random and unpredictable environment behaviour. [4]

Indoor noise level is a significant factor for occupant's health, comfort, and psychological well-being in residential buildings. For analysing these levels in terms of A-weighted equivalent Leq and maximum sound pressure levels LAFmax. The categories in which the noises are divided they are air-borne noise, structure-borne noise etc. Here they just considered two factors that are mentioned above and according to that the different noises are annoying with respect to both the factors. The noises of footsteps, dropping a simple object, crying of a baby etc. are some of the events which makes lots of disturbance to the neighbour. [5]

Automatic analysis and recognition of impulsive sounds, such as child whining, screams, gunfire, explosives noise or door and window slams is quite a challenging measure. With the help of algorithms based on median filter and for recognition Gaussian Mixture Models (GMM) and Hidden Markov Models (HMM) can be used. Analysis of sound can be done by comparing with different sound models trained from the database. The database has various sounds feeded already like of child whining, gunfire, and human screaming. The median filter is used to analysing the energy variations in the input signal. For impulsive sound recognition the spectrum of the signal is calculated for every successive time frame of 512 samples. For each frame, the energy of N spectral bands is then derived, covering the frequency range from 0 to 20 kHz in a uniform manner. And now the pattern recognition can be done by our two models that are HMM, GMM. This method provides adjustable and very sensitive noticeable scheme for impulsive signals, where the impulses can be noticed under quite unfavourable background noise conditions, with a signal-to-noise ratio (SNR) becoming as low as –10 db. Recognition rate can be increased even under more noise degradation conditions. Other \ robust recognition techniques, like Perceptron Neural Networks, will be considered. Hybrid solutions helps to increase robustness and reduce the overall system complexity load. [6]

Smart phones are the becoming more common tools and everyone is using smart phones for every purpose in daily life for every task. So for more enhancing it can be established in a feasible Sound source localization algorithm for current top end smart phones, and to recommend hardware improvements for future smart phones, to pave way for the use of smart phones as advanced auditory sensory devices capable of acting as avatars for intelligent remote systems to learn about different acoustic scenes with help of human users. So for that a framework can be built where smart phone can be crowd sourced sensors understanding the human senses to interface Artificial Intelligence (A.I) systems with Big Data through crowd sourced supervised learning. By this sound source localisation, counting, separation and classification can be done. [7]

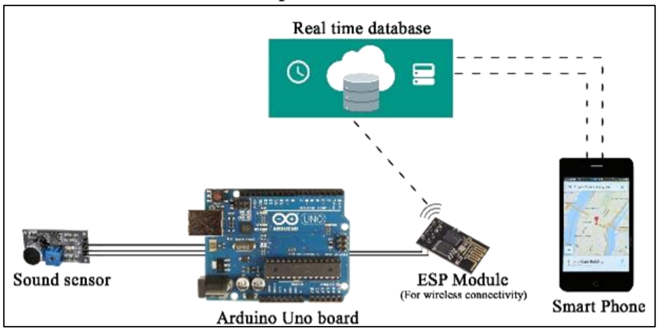
The noise generated during drilling is only from rock drilling or from the drilling unit itself identifying this is difficult. It is important to fabricate a new drilling set-up which is a silent unit in itself. Such unit when used for drilling purpose will clearly indicate the change in sound level produced with different rock properties. A Weighted equivalent sound level produced during drilling process increases nonlinearly as the mechanical properties like SRN, Density, and Tensile strength of the igneous rock increases. Drilling sound of the machine can be minimised so that identifying rock does not make any difficult for the efficient drilling. [8]

III. BASIC ARCHITECTURE

There are many systems by which you can monitor a whole area by sitting just at your desk. This system is also a good monitoring system, in this system we monitor using noise levels of the environment. In this system we used sound sensor as our data collector which sense noise levels as they are higher than some standards feeded in the system. The location can be easily identified of the nuisance prone area as the level get higher and a notification to the handling device that at location X there is Y level of noise is occurring. There is also a smart device on which you can view the level of noise and its position on maps, and a storage for data storing and analysis of data can be done.

IV. PROPOSED SYSTEM

In this proposed system shown in Figure 1 sound sensor will sense the sound in the environment and pass on all data to database is Arduino Uno board and then data is analysed if the sound levels are more than the standards set in system then the notification is sent to the control authority. The position of the sound source can be detected and position can be seen in a smart mobile phone.



V. CONCLUSION

As far we studied about the problem we concluded that the cost for environment monitoring system can be reduced to very low cost and efficiently utilised. We also concluded that environmental acoustic sounds are should be non-disturbing.

REFERENCES

[1] Panu Maijala, Zhao Shuyang, Toni Heittola, Tuomas Virtanen, "Environmental noise monitoring using source classification in sensors," P. Maijala et al. Applied Acoustics 129(2018) 258-267, 2017.
[2] Jaume Segura-Garcia, Santiago Felici-Castell, Juan J. Perez-Solano, Maximo Cobos, Senior Member, IEEE, and Juan M. Navarro, "Low-Cost Alternatives for Urban Noise Nuisance Monitoring Using Wireless Sensor Networks," P. Maijala et al. IEEE SENSORS JOURNAL 2015.
[3] M. D. Redel-Macas, A.J.Cubero-Atienza, D. Berckmans, Leuven, Belgium, "Design and experimental validation of a sound source model for engine of vehicles," IEEE JOURNAL 2014.
[4] Juncheng Li, Wei Dai, Florian Metze, Shuhui Qu, and Samarjit Das, "A Comparison of deep learning methods for environmental sound detection," 978-1-5090-4117-6/17/31.00 2017 IEEE.
[5] Sang Hee Park, Pyoung Lee, Byung Kwon Lee Acoustics Research Unit, "Levels and sources of neighbour noise in heavyweight residentials in Korea," S.H. Park et al. / Applied Acoustics 120.
[6] Alain Dufaux, Laurent, Michael, and Fausto, "Automatic sound detection and recognition for noisy environment," Swiss National Science Foundation under Grant FN 20-53843.98.
[7] Pius Kavuma, Dr. Simon Winberg, "Sound Source Localisation on Android Smartphones," 978-1-4799-7498-6/15/31.00 2015 IEEE.
[8] Masood, "Estimation of Sound Level Produced During Drilling of Igneous Rock Samples Using a Portable Drill Set-up," Procedia Earth and Planetary Science 11(2015)469482.

