Nuisance Monitoring

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Abstract - *There are many types of noises in the environment. That nuisance causes lot of disturbance and have their hazardous effects on life that is part of that environment. So these noises are needed to be monitored and controlled. Nuisance can be monitored with a system that can detect the sound. Sound level is a quantity measurement for sound waves that how much loud they are. The sound sensor attached to a micro-controller like Arduino Uno for just getting the sound level of the noise. Micro-controllers are small systems that can perform small task because they have very less memory and limited resources. This can continuously measure the sound level as the micro-controller performs task continuously till the new task or program is not assigned. We have proposed a system which can monitor noise and display output, which consist of sound level and location coordinates of that sound source which can be accessed on smart phone's map services.*

Keywords **- Environmental Noise Monitoring, Wireless Sensor Network, Low-Cost, Real Deployment, Intelligent Control Ubiquitous Scene Analysis, Low Power System.**

1. INTRODUCTION

The environment in which we are living is full of different noises. Noise is nothing but sound that are unwanted and loud in nature. Noises can be created in environment by many reasons. Noises can be by traffic, loud music, accidents, pubs, marriage halls, parties, industries, construction, and recreation activities. These are very harmful to humans. They can create serious problems like human hearing problems, heart attacks, distractions and many other health issues. That is why we need to monitor the noise in the environment. These noises can be minimized by continuous monitoring and taking action against it.

Monitoring these noises is complex task because of many reasons like weather conditions, energy consumption, cost and human resources. So a system should be designed that should monitor noise with capabilities of low power consumption, less expensive and requires very less human validation. This type of system can be designed with the help of wireless sensor network which can monitor noise levels of the environment and can identify the location of the source. The system should be easily implementable on a city level. In this paper, we present Nuisance monitoring system, a low-cost, wireless and power-efficient Arduino based system. In this system various sensors and modules are connected to Arduino micro-controller which make this system possible to fulfil the requirements.

2. LITRATURE SURVEY

Noise monitoring system which has capabilities to identify main source of noise with a pattern classification algorithm which can identify source noise even in interruption of other noises. System also has internet connectivity for cloud service which is used to store the data and information. The cloud service is used for data visualisation and validation. System consist various component to fulfil the requirements these are a smart sensor is used which has a microphone for measurements and a single board computer for wireless transmission that is called Raspberry PI. This sensor has advantage of placing to area which have lower quality wireless uplinks. Additionally an audio codec is used for uninterrupted power supply, 3G/4G modem for connectivity to internet, solar panel for free power supply, and batteries for power storing. System uses MFCC as a feature extractor, GMM and ANN as classifiers with Expectation minimisation algorithm. The system has two classes of noise one is target class and other is background class. Target class are the noises which are need to be monitored. Background class are the noises which are interfering noises with target noises. The system works in two stages one is training and other is monitoring. In training stage the feature extractor and classifiers are used to manually annotate the target noises. In monitoring stage system detects the target noises in interrupting environment. The system is a bit expensive because of solar panel and other components like Raspberry PI, 3G/4G modem. The system also need to be trained first to get target noise this can be very tedious and lengthy task because of manual annotations. [1]

Assessing the noise by sound pressure level to acquire the sound map using wireless sensor network with acoustic sensors. The advantages of the wireless sensor networks are each node have their own resources and they communicate with each other. But at these same pressure levels human can feel the different experiences according to the frequency characteristics. So for that there is a requirement of human's feelings in subjective measures. This can be performed on two types of platforms one is Raspberry PI and other one is Tmote-Invent nodes. The psychoacoustic matrices given by Zwicker's model are also considered in the system. Zwicker's model is based on anatomy of human hearing. When typical sounds are considered psychoacoustic matrices are made in terms of Critical bands and that is frequency bandwidth of cochlea. This model measures the Nuisance (N) based on other parameters which are: Loudness (L), Sharpness (S), Roughness (R) and Fluctuation Strength (F).

The TmI platform supports sound recording and have an integrated suite of sensors with a power consumption of 3 V. This type of platforms have resources issues like of computational memory RAM and physical memory is less.

This type of systems also have poor audio processing and transmitting. In these type of platforms duty cycles is also less due to less listening capabilities. On the contrary the Raspberry platforms have no issues of RAM and internal memory we can also insert SD card for more storage. The Wi-Fi is also more upgraded then the TmI note platforms. The main issue with this type of platforms that they are operated by Linux/Ubuntu systems mainly. So it is quite clear that Raspberry PI is more efficient than TmI platforms. [2]

One of the major reasons of the noise pollution is exterior noise emission of the vehicles. So it is very important that automotive manufacturers to look on that. It takes lot of money and effort to improve vibro-acoustics performance of their vehicle. With trial and error method without any prior knowledge it is very difficult and time consuming. Sound models implementation is more efficient and faster than trial and error method. Developing a simple sound source model for engine noise using a mock-up panel of loudspeakers set up following the substituted monopole technique. For developing this one of the first priority factor is identification model. An identification mainly based on acoustic pressure descriptors derived out from conventional microphones. Identification makes this quite easier. There three techniques for detection and identification one is sound intensity technique, second is NAH that is acoustic holography techniques. The sound intensity techniques have drawback when the wind effects comes in the scene and the measurements are also can be only performed at very closed distance. NAH is based on numerical treatment of acoustic pressure levels detected by sensor and also allow us to retro-propagate the waves from the detection surface to the source surface, they gives us advantage at low frequencies and also assessment of source strength. But this techniques have also major drawbacks that it take lot of computational time. On the contrary the ASQ techniques that is airborne source quantification, it quantifies the sources and the airborne path from source to receiver. It also has high computational efficiencies. Therefore it is mainly applied in sound synthesis models. Transfer path analysis is used as an ASQ method which giver airborne path to the source. [3]

Noise detection is a challenging because of noisy natures of signals. Also very less amount of data is available in that context that is labelled. This is a factor which requires a deep learning on detection and classifications. For that experiments on six sets of features are performed, including standard Mel-frequency cepstral coefficients (MFCC), Binaural MFCC, log Mel-spectrum and two different largescale temporal pooling features extracted using OpenSMILE. On these features, we apply five models: Gaussian Mixture Model (GMM), Deep Neural Network (DNN), Recurrent Neural Network (RNN), Convolutional Deep Neural Network (CNN) and i-vector. Training the classifiers independently to maximize the model diversity and fuse these models for the best performance. We use the GMMs for acoustic scene recognition. Each clip is represented as a collection of acoustic features extracted from sound segments, for each class label, a GMM is trained on this collection of acoustic features using only audio clips from that class. DNN are applied for speech recognition, audio analysis and it also gives more efficient performance than GMM. The CNNs are also good in achieving efficiency than DNNs. The classifiers and the models are efficient than any other methods. [4]

All the studies has been conducted on the outer noises as they are more affecting than the internal noises in the buildings. The noises from the residential apartments are measured on the basis of two levels one is A-weighted equivalent, maximum sound pressure level. The noise was recorded using a half-inch free field microphone (B&K Type 4189). The microphone is connected to the noise monitoring system (DUO, 01 dB) which has the calibrated recording feature as all-in-one device. The noise levels are recorded whenever the noise level exceeded 30 dBA (LAeq) at a sample rate of 51.2 kHz. As you can say threshold of the system is 30 dBA. The recordings were then transferred to a laptop computer. Before the data collection, the entire measurement system was calibrated using an acoustic calibrator (B&K Type 4280). The pressure levels of a noise source is higher inside the house while it create less impact on outer environment. [5]

Sound detection and recognition is one of the efficient techniques this can contribute great in security and surveillance applications. This can validate and also can trigger alarms. In this system the microphone is attached to the online surveillance system. Whenever there are discontinuous or anomalies in the input signal, the process of identification is started. A time frequency analysis is then performed, and that detected sound is compared with different sound models trained from database. In database there are many types of sound are present and many of them are manually recorded. System has one non-linear median filter which analyses the energy variations. The method gives a tunable and very sensitive detection scheme for impulsive signals, where pulse can be detected even in very harsh background noises. In this system the classifiers are of two type one is GMM (Gaussian Mixture Model) and HMM (Hidden Markov Mode). [6]

Animals have 360 degree awareness with the of sound source localisation of their environment. Humans also require that but it is restricted to 180 degrees, because humans mostly use visual senses more than sound senses. As all of us know smartphones are extremely popular in this era, and phones has microphones and recorders in them. So it can be used as a sound source localizer and it can be act as avatar for intelligent remote systems. Here Big Data is used it is a large volume of a data continuously produced by various fields in fast rates. Big data is used because of it gives the advantage of training AI systems although several machine learning algorithms and large training data sets are also required. The system can perform various tasks one of them is Sound Source Localization. It is the ability that gives a distance from say listeners head to the source of the sound. It can be done with the help of Android phone, because android is open source platform so applications for the purpose can be made. [7]

Using the advanced sensor technology the system can be designed which gives warning of airborne sound that comes from aircrafts and flights. This can help a lot it can identify the friendly aircrafts and can detect enemy crafts. This is also done by a traditional method which is tape type system, but there are many demerits of that system such as slow response, bulky, dismantle and maintenance is not easy. The main hardware include the micro-controller P87C52X2FN and the voice chip ISD4003. Micro-controller is single-chip 8-Bit Microcontrollers designed by CMOS process, and are derivatives of the 80C51 microcontroller family. The instruction set is compatible with the 80C51 instruction set. This system also includes voice store and processor, digital logic information and priority level logic decision unit, automatically record and broadcast switching circuit, serial communication interface, export controlling. This system is small, less consumption of power, easy to maintain, less expensive, it has higher performance cost rate than the tape type voice information system, the more important thing is that be able to improve and maintain supportability fast. It adopts the micro-controller and voice chip to realize functions, make use of micro-controller to realize, record and playback the voice information stored in the chip of the voice, can realize difference in different responses to different input signals, i.e. input a route of sensors and it can also broadcast with its corresponding voice information, in order to realize the voice reports an emergency and asks for help or increased vigilance function. Chip ISD4003 is integrated pre-amplifier for speech processing, it also can gain control circuit, internal clock and exporting the amplifier, also automatically finish the memory of the voice signal and broadcast, communication interface and reset automatically circuit automatic detection and trouble to use for system diagnose, and can connect with new automatic checkout equipment conveniently. [8]

In drilling application the sound produced by drilling machines produce high noise level sound, that is also depends upon the rock properties. So a concept in which a drilling machine is fabricated which is silent enough to execute task. The sound detection in this system is considering A-Weighted equivalent sound level produced during drilling process increases nonlinearly as the mechanical properties like UCS, SRN, Density, Tensile strength and abrasivity of the igneous rock increases. This type of sound identification can also help in determining which type explosive is used for the particular type of rock properties and also the pattern of blast holes. [9]

1. PROPOSED SYSTEM

In this system we used Internet of Things, in IoT there is a wireless sensor network which is quite efficient and scalable. This system does not require continuous human validation. Noise monitoring is a new concept which is demand of future because there are many ways by which our health is compromising. By this system we can monitor noise levels and can take possible actions for the same. In this system we are using Arduino Uno as micro-controller which can hold many sensors and many modules like GSM, GPS, and ESP-8266. These all have different functions which they perform and make our system possible to give efficient results.

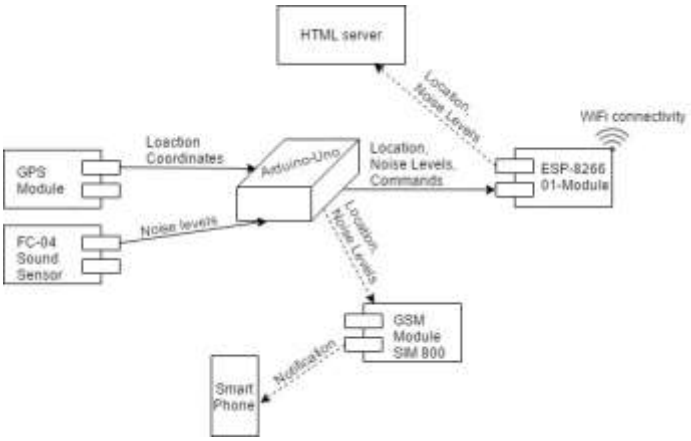

Figure 1- Architecture

2. IMPLEMENTATION

4.1. Introduction

We proposed a system that detects sound level and also detects location of the source at first stage. At second stage the data is sent to an address which directs us on HTML page for visualisation. At third stage the data is analysed by system, it is checked if noise level is higher than the threshold or not. At fourth stage the system notify user that noise level is higher and also tells the location of the source. This section provides a more in depth look at the system architecture and it also elaborates on every single component of the system. This section explains the enabling technologies they are used to glue the system components together, along with the motivations why these technologies are suitable for the system. The system is composed of a micro-controller, WiFi module, GPS module, GSM module. Figure [1] illustrates the architecture of the system and shows the main communication technologies used for information and event flow between the system major components.

4.2. Micro controller

Arduino Uno is a micro-controller we used in the system for handling the sensors and modules. The task of this component is to collaborate with other components and give output what is the requirement of the system. This component has many inputs and outputs ports which makes the implementation easy. The various ports that are used are one input port for FC-04, one input for the GPS module, one output port for GSM module, one input port and one output port for ESP-8266. This component has not memory for storing data.

4.3. Sound sensor : FC-04

This component is used for sound detection it has only one output that is digital output. This component takes 5V power supply which is given by micro-controller. This component is used to get the noise levels in the system.

4.4. GPS Module

This component has one antenna and one receiver, antenna gets the location in GPRMC format and gives it to receiver which is connected to micro-controller it pass on the data to micro-controller. It takes 9V power supply which is given by DC adapter. This component is used to get the location of the noise source.

4.5. ESP module

This component has the capability of connecting to internet. It is 3.3V power operating device, the power of this component is derived from micro-controller. That is also a problem the micro-controller operates on 5V power supply so to solve this problem we used AMS converter which converts 5V supply to 3.3V supply. This component has the capability of creating a server through access point. It connects to internet and creates a HTML server where we display results for user visualisation. It takes data input from micro-controller and display it to the HTML page.

4.6. GSM module

This component is SIM 800 model of GSM module it has one SIM slot that is GSM type which has a bandwidth of 2G spectrum. It takes power supply of 9-12V for operating which is given by same DC adapter used by GPS module. This component is used for sending notification to user. It is connected to micro-controller, takes input from micro-controller and send that data to user as a text sms.

5. FLOWCHART

In this system it consists one micro-controller (Arduino Uno), a WiFi module (ESP 8266-01), GSM module (SIM 800), GPS module and lastly one sound sensor (FC-04). In this system first sound sensor FC-04 will sense the data then the data is sent to Arduino Uno board. GPS module also start getting signals from its antenna and then GPS receiver will get data from antenna and pass on to the board. Then ESP module start its connectivity from internet and when it is connected the Arduino board sends data to ESP module and then ESP module starts its server where a HTML page is designed. On that page all data that has come from Arduino go to that page with an address which you can get this while configuring ESP module. On that HTML page you can view the noise levels and the location of that source of the noise. While the noise levels are continuously analysed by Arduino, if the noise levels got higher than the threshold (a value set in the system which is barrier if that value is crossed the system will perform a task) then the Arduino sends all data and a warning notification to the user that noise level is too high at this location. After that user can monitor all data on that HTML Page and can take actions according to that.

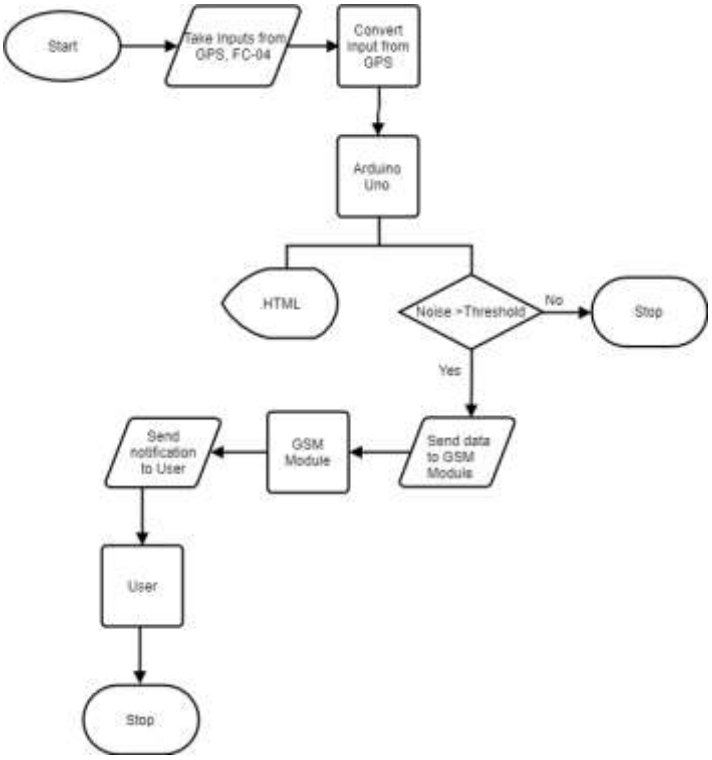

Figure 2- Flowchart

6. RESULT

The noise levels are monitored continuously in the environment, there is approx. 5 minutes gap in every value because of the system takes time to perform given task. The table given below is the table view of the noise levels:-

Date	Time	Noise Level
2018-03-28	06:23:42	36
2018-03-28	06:42:35	37
2018-03-28	06:47:67	38
2018-03-28	06:51:35	0
2018-03-28	06:56:15	37
2018-03-28	07:02:46	98
2018-04-21	01:29:78	36
2018-04-21	01:34:59	37
2018-04-21	01:39:16	38
2018-04-21	01:44:01	40
2018-04-21	01:49:57	62
2018-04-21	01:51:29	61
2018-04-21	01:29:78	36

Table 1- Noise levels on daily basis

Graph 1- Noise levels

CONCLUSION

We studied that environmental noise monitoring could be enhanced by separating between the target and interfering noise sources and implementing this approach to the sensor level. Also, an autonomous and a low-cost sensor implementation with a connection to online service was introduced. A credit-card-sized single-board computer, Arduino, was found to be powerful enough for automatic noise monitoring. A sensor was demonstrated to allow measurements in locations.

FUTURE SCOPE

In our future work, we will consider about system is enhanced then it can be used in other field also like military, irrigation, water supply, automobiles. We will also look out for the possibilities of adding external features which are affecting noise levels and after separating that affects what will be the noise levels.

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