

Architecture: Noise Pollution Monitor through Wireless Sensor Network

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Abstract: The area of wireless sensor network is wide & there are various kinds of sensor devices are used in mobile applications. Sensors monitor the environmental activities like air pollution, noise level, water level, greenhouse monitoring, agriculture monitor etc which grows & generates greater interest & becomes a challenge for finding out the graph or curves for the large amount of data sets. In this paper, we propose architecture how to monitor a noise pollution through wireless sensor network. Wireless sensor network with mobile phones monitor systems with high energy efficiency, high tolerance, more security & ease of implementation because multiple sensor nodes collect high volume of data. Monitor a noise pollution helps to make life better & it effects naturally. Wireless sensor network makes monitoring process easy, precise & effective. Recently work has been done how to sense a noise pollution through a wireless sensor nodes or mobile phones, how to monitor the environmental activities level.

Keywords: noise pollution, WSN, sensing, mobile phones, tasking server.

1. INTRODUCTION

Noise pollution is a big challenge in today's scenario. Using mobile phones it provides low cost solution to measure the noise level everyday & it helps to collect the data of all the places & user can easily trace the noise level of noisy places like railway station, roads, dense places etc. As the negativity of environmental pollution, affects the health of people & the quality of their life. The pollutants level is increasing day by day, due to which human's life becomes haphazard. If the high level of noise is exposed, it is very harmful for human health. It may causes a serious illness, several researches [1] suggests an alternate approach i.e using microphone of mobiles which are inexpensive sensors.

Noise defines "The unwanted or unbearable or harmful outdoor sound which is created by human activities through either by loud-speaking, by vehicles (road traffic) or from industry activities.

The noise pollution level can be measured by different methods. To prepare a noise map, a noise indicator is used as:

$$L_{eq,T} = 10 \log_{10} \left(\frac{1}{T} \int_0^T \frac{P(t)^2}{P_0^2} dt \right)$$

L_{eq} stands the equivalent continuous sound pressure level, $p(t)$ represents rms (root mean square) sound pressure by acoustic wave, p_0 is a standard value refer to the audible acoustic signal (i.e., $20 \mu Pa$). The period T , over which the L_{eq} indicator is computed, trace for few years or months. The L_{eq} indicator, measured in decibel (dB), captures the sound level of a constant noise source over the time interval T that has the same acoustic energy as the actual varying sound over the same interval [20].

A complicated situation is established of a noise policy which can't be handled by an institution alone but it requires a general public participation also. As, mobile phone uses sensors through which one can detect & analyse the noise pollution. Mobile phones have sensors & are connected to a network, using mobile as sensors have several disadvantage & mobile phones also provide a proper coverage when sensors are deploy & maintain. Lastly, when it interacts with user, they used to enhance the functionality of applications. Users target is to sense the object which required. At present, gathering information by using mobile phones in wireless sensor network is the common factor. The main access in Wireless sensor network can be done by mobile phones. By using mobile phones, data capturing is easy & it provides all facilities available in web based rather than system based applications. We can carry mobile & use those applications & gather information easily.

2. Wireless sensor n/w:

A wireless sensor n/w is a wirelessn/w which consists of physically connected devices which are using sensors to monitor sound, pressure, environment, temperature, etc at different locations. The concept of wireless sensor comes from **sensors + mobile + radio signals=generation of hundred of application [2]**. Wireless sensor node is built of “nodes”- from one to a several hundreds or thousands of. Even nodes are connected to one sensor. A particular sensor node has 5 basic components as follows:

1. Sensing capability.
2. Memory where data is stored.
3. Processor which is used to process data & brings a desired result.
4. Transceiver(through transmits & receives data) with internal(inbuilt) or external(connect) antenna.
5. Battery which gives power to the mobile.
6. Microcontroller- it is an electronic device to interface with sensors or work as energy source.

Sensor node size may vary from a grain of dust to a box size & there size is similarly variable, range from dollars to a few pennies, it depends on their complexity. Size &cost constraints vary for the various constraints as:

1. easy to use & implement
2. network topology should be dynamic
3. scalability
4. Communication bandwidth can be narrow & easily change.
5. Sensor nodes are self-organised, need not to preinstall.
6. Easily cope up with node failures.

When sensors are built into the structures, environment, etc it provides efficient information which provides benefit to the society(conservation of natural resources,emergency responses,and catastrophic failures & save life of humans, etc). Wireless sensor are networked into various topologies, consumes less power, capable of data acquisition, more reliable, accurate, no maintenance cost, smart, software programming & low cost to purchase.

As the devices increases, its installation cost decreases, wireless sensor has ability to change the environment dynamically. Extracting the knowledge from data mining techniques such as clustering plays an important role in Wireless sensor network. As wireless sensor have ability to generate or captures a large amount of data through which a useful information can be find out, when various techniques of data mining applied. Even when wireless sensor network are deployed, it easily monitor & detect the real activities of environment also. It collects data like humidity, speed, acceleration, temperature, noise etc from

surroundings. As wireless sensor network collects information regarding various parameters needed by environment like aircraft, noise, air, fleet monitoring, shipboard, utilities. It's easy to install & maintain. Sensors have various constraints as capacity of CPU, storage space, battery & communication bandwidth.

3. Architecture of wireless sensor n/w:

Preparing a wireless sensor network is a key issue, because it consists of no. of sensor node, which monitors and passes the data towards main location.

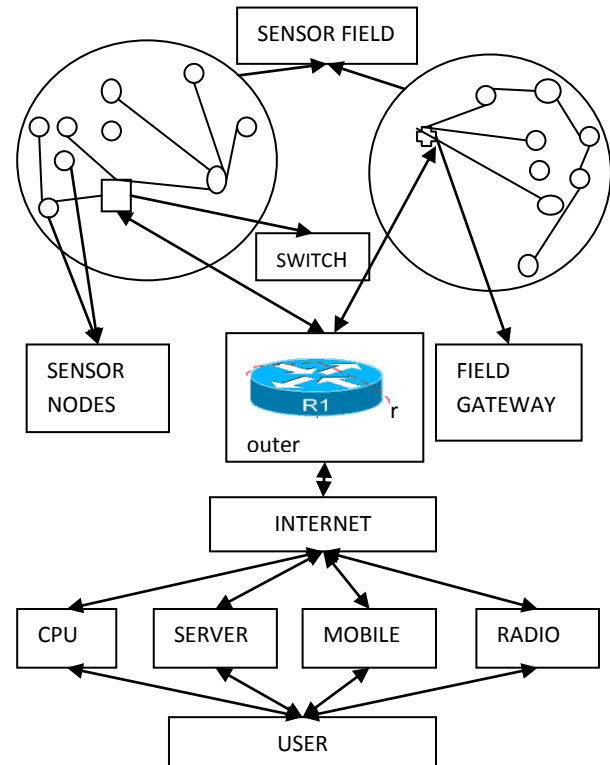


Fig.1 architecture for wireless sensor n/w

Architecture has basic functionalities as adaptability, communication & autonomy. Adaptability operates through capturing the environmental (as air, noise, etc) changes through sensors; the curves that it depicts may increase or decrease in order to reduce power consumption. Communication completely depends on the way of collecting data about the environment. As how the user runs their applications. Autonomy means sensors are mined into unwanted & unreachable areas where also the users require the minimum efforts to sense the data from their base station.

4. Potential Applications:

1. **Air pollution monitoring:** They monitor the appropriate concentration of various gases in cities. The sensors are deployed over a region which controls the quantity of gases (like CO₂, CH₄ etc) generated by vehicles (trucks, cars, bikes etc). Monitoring the concentration helps to make human life better.
2. **Water level monitoring:** Through wireless sensor network, we use to measure the level & pressure of water, because if it measures at a regular interval & it harms the area, the appropriate action is to be taken.
3. **Military application:** The military/army members deployed a sensor in a dense or enemy region & use to sense the enemy attacks.
4. **Health monitoring [3]:** As the sensors are embedded into the machines, which diagnose a disease of a patient & then the doctors prescribed the treatment on the diagnosed report. Machines & their structures are being checked at the regular interval, their parts are to be repaired or replaced according to the working conditions. As the use of wireless, the installation cost of long cable is prohibitive [6]. A sensor allows assets to be tested & if they cause any problem, it reduces maintenance cost & chances of failure reduce.
5. **Area monitoring:** As wireless sensors are deployed in a region & phenomenon is being monitored (heat, pressure), then that event is transferred to the base station, so that appropriate action is to be taken.
6. **Civil monitoring:** civil engineers monitor the basic structure of bridges as high speed trains crossed over the bridge. The wireless sensors checks for the presence of train at low power sampling at low rate & they also check periodically so that any failure doesn't occur.

5. Noise pollution monitoring through mobile phones

5.1 Literature Survey

In past years, the European commission pay more attention towards the problem of noise pollution [18][19]. The European community implements a reliable management system & noise monitoring research on several issues. They outline how sensor n/w satisfies the need of a researcher with cheap & marketable solutions. Previously, they use different platforms: the Tmote&tmote sky invent from

Moteiv& that equipped with either the SBT80 multi modality board available from EasySen or either with noise level meter. But, it doesn't provide satisfactory results. As sensor n/w is a wide topic & used in various applications. Basically, wireless sensor network focused on two areas: networking issues as routing, capacity, delay etc & various application strategies [5]. Management of sensor database is complicated, so various techniques (Query processing, clustering etc) has been acquired & also manages data. In past years, the European commission has continuously pay attention towards the problem of environmental noise, large no. of projects [6][7][9] demonstrates. To implement, a reliable noise monitoring system & its management system requires a research on several issues, like refinement of noise propagation models, development of standard infrastructure. The European community issues a directive that requires all agglomerations within the European Union with more than 25000 humans [8] to provide accurate levels of noise through mapping. With the help of noise maps, it provides data on year basis & these graphs are drawn on the basis of rough data, because rough estimations can be estimated on the perceived noise level. There are many effects of noise on humans as well as animals. It affects the human health & behavioural nature. Sometimes unwanted sound damage physiological & psychological health. It causes annoyance, aggression, hypertension, hearing loss, self-disturbance, tinnitus. In animals also, sometimes the risk of death occur in changing the delicate balance in prey.

5.2 Properties for assessing noise pollution through mobile phones: -

There are various challenges & possibilities to use mobile phones in various applications. Misra et al [9], presents how the microphone is used for audio/video applications. Mainly the authors devoted time for the ease of programming of mobiles [10] [12]. There are various properties for capturing a noise level as:

5.2.1 Context Awareness –

Context awareness means it collects the information according to the need of users & triggers data collection. Basically, noise levels are measure only when requires. The complete decision depends upon the user whether it requires or not. The user uses microphone, Bluetooth, internet or other device to collect & represent data. Context Recognition ideally involves local sensors, which able to classify the status of user [13].

5.2.2 Energy Awareness [14][15] –

The battery of mobile phones is used to measure the level of noise, so we need to preserve the battery of it. We should keep as low as possible usage, because battery discharges depends upon how the user run its application. Energy awareness depends upon the available battery, to measure the level of noise.

5.2.3 Unobtrusiveness–

Unobtrusive usage of resources in mobile phones includes access to hardwareResources (batteries, computation, communication,). The user use to set privacy settings. Whenever the user requires, it performs any action to participate or to collect information in the sensing task.

5.2.4 Correctness [16]–

Correctness means the measured value should be estimated accurately & then we logged with the values it. Mobile phones have feature low filters or dynamic input levels, which have possibility to measure the actual loudness of the signal. It is expected that common phones won't give such accuracy, but important to ascertain, if the envisioned applications to work reliable & accurate.

5.3General Implementation strategy:-

The implementation or collecting OS sensor data requires a new data mining techniques for the discovery of knowledge. There are two strategies as sensor data pre-processing & sensor data clustering, which helps not even to monitor a noise level but also the other environmental activities like area monitoring, detect forest fire data, fleet monitoring etc& then this framework is used to the development & placement of sensor networks.

5.3.1 Sensor data pre-processing-

Data pre-processing means to clean up the data by removing irregular data or by putting missing values. It also means to summarize & to aggregate data. Through clean up method, it helps to prepare data for analyse. So, the following steps are involved in data pre-processing are as:

- a) Detect irregular values in the sensor data.
- b) Apply pre-processing techniques.
- c) Collect the clean data.
- d) Prepare to analyse data.

5.3.2 Sensor data clustering-

Data clustering involves organising& arrangement of a set of objects or cluster. The object have similarities are put together in one cluster & other dissimilar objects in another cluster. Generally, we use k-means clustering algorithm to make clusters in wireless sensor network. We can say that clustering is a basic method for future data analyse in data mining techniques.

6. ProposedArchitecture for monitor Noise pollution

As the mobiles phones can run their applications either by CPU connectivity, Bluetooth device on, or directly attach with internet. The mobile memory stores the output & that data is used to predict the noise level at particular position. When signals reach wireless sensor networks, it produces data, and then returns to the user system. It may give accurate & correct result. This architecture may help in many research problems & may develop a new strategy to gain knowledge, design to evaluate, optimize n/w.

Mobile phones consist of various entities while monitoring noise pollution through wireless sensor networks as:

1.Data Repository	Where it stores the complete data in the mobile phones.
2. Proxy	This disconnects operation of sensor when it collects their required data.
3.Tasking server[17]	According to the user's need, the applications are enabled to program the sensor n/w.

- 1. Sensors: This examines the environmental activities.
- 2. Network infrastructure: It is a combination of:
- 3. User: a human that sense the data through their phones.
- 4. BTS(base transceiver station): initially when user sends request to the base station then it transmits to the controller.
- 5. Controller: electronic device which controls & interface with sensors.

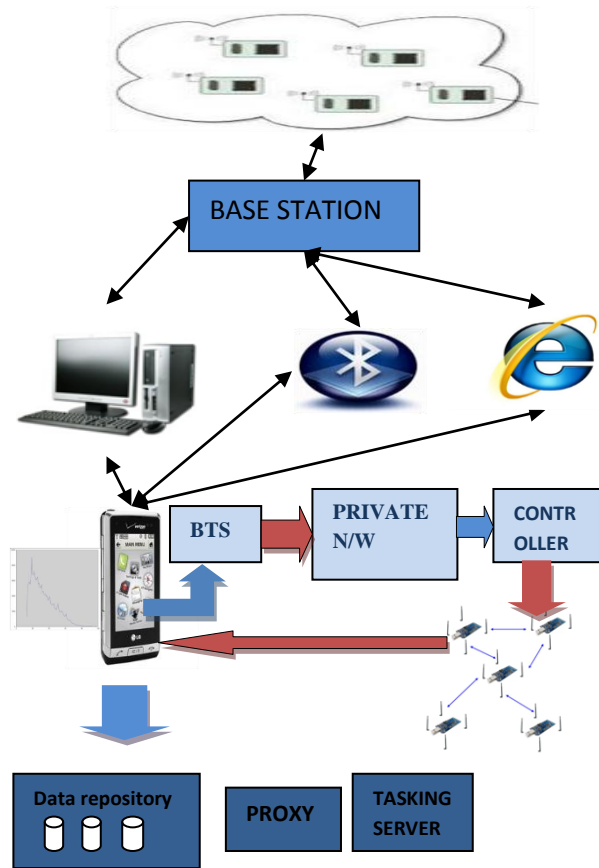


Fig 2:Architecture:NOISE POLLUTION MONITORING

7. Discussion

1. **Scalability:** Scalability means when architecture runs through wireless sensor n/w, allow responses to bring changes in the topologies with a minimum no. of updated messages being transmitted. As thousands or hundreds of sensors observe particular applications & influence the real world. It is more durable.
2. **Self-organisation:** There is no need to preinstall any network when we deploy any application in a mobile phones. We simply download an application & whenever we run an application it can collaboratively adjust itself, perform well, distribute algorithms & automatically & rapidly form an independent network. It works as an equal network.
3. **Tracing:** As the application runs on mobile phones, through sensors data is collected & user runs according to their requirement.

4. **Performance:** when the sensor nodes interact properly, it gives a accuracy & better performance.
5. **Task Orientation[4]:** As this architecture is Dynamic, it provides many services at that time. Basically, it is task oriented. Our architecture initially collects data from the specified positions & than it provides the possibility of sensor performance.
6. **Dynamic:** It is not necessary that all the sensors are active at a particular time, so sensors can be added or removed from the network according to the user need, so that's why it works dynamic & self adjustment.
7. **Multi Hop communication:** The sensor node can communicate directly with their neighbours, but if one node needs to communicate with other, which is beyond radio's frequency or coverage area. It has a multihop node which works as an intermediate node to transmit data. Multihop node work as a information router or gateway.
8. **Capability to compute:** As their size & cost is limited, so power consumption, memory & program space, is also very limited.

Conclusion & future work

As earlier, mobile phone applications are enabling applications that were not practical. As new standards-based sensor n/w are released due to which a wide spectrum deployment of sensor in mobile phones. Due to which many technical problems are solved as power demands, sensor development, scalability of n/w. finally, in this paper we propose an architecture which may emphasize our difficulties to evaluate the noise pollution, this architecture helps to exchange information through wireless sensor n/w & optimize sensor n/w from the real world & try to resolve many haphazard problems. In future, we can gather information more easily, with less improper data, save power consumption & also try to reduce noise at high level noisy places.

References:

[1]. C. Aguiton and D. Cardon. The Strength of Weak Cooperation: An Attempt to Understand the Meaning of Web 2.0. Communications & Strategies, 65:51 {65, First Quarter 2007.

- [2]. Arms, S.W., Townsend, C.P., Hamel, M.J.; "Validation of Remotely Powered and Interrogated Sensing Networks for Composite Cure Monitoring," paper presented at the 8th International Conference on Composites Engineering (ICCE/8), Tenerife, Spain, August 7–11, 2001.
- [3]. Townsend, C.P., and Arms, S.W., Hamel, M.J.; "Remotely Powered, Multichannel, Microprocessor- Based Telemetry systems for Smart Implantable Devices and Smart Structures," SPIE's 6th Annual Int'l Conference on Smart Structures and Materials, Newport Beach, CA, Mar 1–5 1999.
- [4]. F. Akyildiz, W. Su, Y.Sankrasubramaniam, and E. Cayirci. A Survey on Sensor Networks, IEEE Communications Magazine, 40(8):102-114, Aug. 2002.
- [5] E.M.Knorr and R.T.Ng. Algorithms for Mining Distance-based Outliers in Large Datasets. VLDB 1998.
- [6] European Commission, "Green Paper on Future Noise Policy," <http://ec.europa.eu/environment/noise/greenpap.htm>, COM (96) 540 final, November 1996.
- [7] S. Santini, B. Ostermaier, and A. Vitaletti, "First Experiences Using Wireless Sensor Networks for Noise Pollution Monitoring," in Proceedings of the 3rd ACM Workshop on Real-World Wireless Sensor Networks (REALWSN'08), Glasgow, United Kingdom, April 2008.
- [8] "Directive 2002/49/EC of the European Parliament and of the Council of 25 June 2002 relating to the Assessment and Management of Environmental Noise," Official Journal of the European Communities, July 2002.
- [9] Coordination for European Research for Advanced Transport Noise Mitigation (CALM) - A Coordination Action funded by the 6th Framework Programme of the European Community, "BlueBook - Research on Environmental Noise, " Available online at <http://www.calm-network.com/bluebook/content/index.htm> (Accessed on January 13th, 2009), April 2006.
- [10] E. Miluzzo, N. D. Lane, K. Fodor, R. Peterson, H. Lu, M. Musolesi, S. B. Eisenman, X. Zheng, and A. T. Campbell, "Sensing Meets Mobile Social Networks: the Design, Implementation and Evaluation of the CenceMe Application," in Proceedings of the 6th ACM Conference on Embedded Networked Sensor Systems (SenSys 2008). New York, NY, USA: ACM, 2008, pp. 337–350.
- [11] A. Misra, G. Essl, and M. Rohs, "Microphone as Sensor in Mobile Phone Performance," in Proceedings of the 8th International Conference on New Interfaces for Musical Expression (NIME 2008), Genova, Italy, June 5-7 2008.
- [12] K. Leichtenstern, A. D. Luca, and E. Rukzio, "Analysis of Built-In Mobile Phone Sensors for Supporting Interactions With the Real World," Whitepaper, University of Munich, February 2006.
- [13] K. V. Laerhoven, A. Schmidt, and H. Werner Gellersen, "Multi-Sensor Context Aware Clothing," in Proceedings of the Sixth International Symposium on Wearable Computers, 2002. IEEE Press, 2002, pp. 49–56.
- [14] D. A. Bies and C. H. Hansen, Engineering Noise Control: Theory and Practice., 3rd ed. London and New York: Spon Press (Taylor & Francis Group), 2003.
- [15] International Organization for Standardization, "Acoustics - Description, Measurement and Assessment of Environmental Noise - Part 1: Basic Quantities and Assessment Procedures," 2007.
- [16] A. T. Campbell, S. B. Eisenman, N. D. Lane, E. Miluzzo, and R. A. Peterson, "People-Centric Urban Sensing," in Proceedings of the 2nd Annual International Wireless Internet Conference (WICON'06), Boston, MA, United States, August.
- [17] Aman Kansal, Michel Goraczko, and Feng Zhao Microsoft Research "Building a Sensor Network of Mobile Phones " IPSN'07, April 25-27, 2007, Cambridge, Massachusetts, USA. ACM 978-1-59593-638-7/07/0004.
- [18] European Commission, "Green Paper on Future Noise Policy," <http://ec.europa.eu/environment/noise/greenpap.htm>, COM (96) 540 final, November 1996.
- [19] "Directive 2002/49/EC of the European Parliament and of the Council of 25 June 2002 relating to the Assessment and Management of Environmental Noise," Official Journal of the European Communities, July 2002.
- [20] Directive 2002/49/EC of the European Parliament and of the Council of 25 June 2002 relating to the Assessment and Management of Environmental Noise. Official Journal of the European Communities, July 2002.