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Noise Hazards and Monitoring Using IOT Case Study

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Abstract - In factory floors noise pollution is a major problem. The employees who work there are well aware of this problem. Due to indispensable need for money many choose jobs that are proven to take several years off one's lifespan (occupational hazard). Occupational hazard that cause severe damage worth mentioning are the consequences of failed engineering ethics. Noise pollution is not just responsible for hearing problems. It's also responsible for several other problems in the human body. It is often overlooked as no physical damage is caused. Noise monitoring is an important necessity in every factory floor. This paper is a complete case study of the noise hazards and the gaps in the monitoring practices. This paper also talks about the implementation of our proposed noise monitoring system using IOT which bridges the gaps efficiently.

Keywords - Occupational hazard, Personal Protective Devices (PPD), Hearing Protection Devices (HPD), Occupational safety and Health Administration (OSHA), Pulse tone audiometers, Pure tone audiometers, Warble tone audiometers, Recommended Exposure Limit(REL), Dosimeter.

Noise hazard - a comprehensive elucidation - An occupational hazard is a risk accepted as a consequence of an occupation which is mostly unskilled than skilled. There is literally no occupation without a hazard. The only thing that matters is the degree to which it affects. Hazards range from simple stress or body pain to fatal consequences.

Manufacturing is proven to be the most hazardous work environment. There are several possible hazards there. Many hazards like falls, electrocution, being struck by heavy equipment or machinery, improperly installed machine guarding, employee lockout or tagout etc happen. The consequences of the above mentioned hazards are physical garnering the required attention. As the adverse effects of noise are not visible to the eye it is often overlooked. The occupational hazard that garner the least attention are noise hazards. The workers are in for a serious noise problem if they experience ringing in their ears or if they have to shout to a worker beside them. Loud noise causes headache. The nerve endings in the ear might get seriously affected. Loss of hearing renders one incapable of hearing high frequencies and also comprehends speech. These workers are prone even to irreversible damage. Excessive noise interferes with speech resulting in a drop in productivity. It causes emotional and behavioural stress. It increases the risk of high blood pressure and heart failure. It is proven to cause constriction of blood vessels and dilation of pupils. Occupational noise should not exceed 85 dBA per 8 hours of exposure.

Regulations - The count of the total number of workers being introduced to potentially deafening sound per year is Twenty-two million in US according to OSHA (Occupational safety and Health Administration). In US there are penalties for not protecting one's workers from dangerous levels of workplace noise for which a record claims to have witnessed a maximum expenditure of $1.5 million. In US there are compensation amounts provided for hearing loss in workers. An estimated amount of $242 million is spent on compensation per year.

OSHA provides us not just with the accepted standards but also with details on the noise exposure computation (as one universally accepted standard is expected to compare, test, verify etc) and the methods for determining the adequacy of the hearing protector attenuation. It also provides the requirements and calibration etc of the pulsed toned audiometers commonly in use. The three classes of audiometers are Pulse tone, Pure tone and Warble tone audiometers. It's for measuring the hearing ability of the people to be audio screened. These are portable testers. It also gives us advice on the noise monitoring processes around. The Recommended Exposure Limit (REL) commonly accepted is 85 dBA.

In India the noise regulations are as follows

Area code	Category	Limit (Day)	Limit (Night)
A	Industrial Zone	75	70
B	Commercial Zone	65	55
C	Residential Zone	55	45
D	Silent Zone	50	45

a.The noise regulations in India

***Noise monitoring or protective practices around* -** The above mentioned problems can be countered by a few solutions. The standard solution that comes to one's mind is wearing Personal Protective Equipment (PPE). Personal Protective Equipments are of several types including respiratory protection, eye protection, hearing protection, hand protection (includes not just gloves but barrier creams also), leg protection, head protection, skin protection and even harness for heights etc. The basic PPE for hearing are ear muffs and plugs. These PPEs for noise are also referred to as Hearing Protection Devices (HPD).

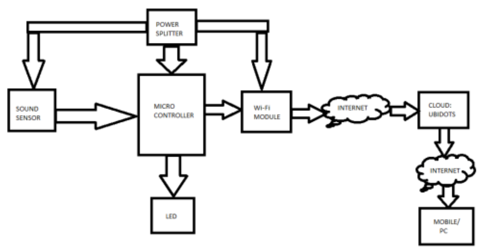
An inexpensive way to control noise exposure is isolation. This is approached in two ways namely isolating the machine or the source by building a barrier or limiting the time the worker gets exposed to it. This includes working with low noise tools and maintaining the tools and machinery under us. Even hearing conservation programs exist.The most commonly accepted practices are scheduling yearly hearing exams for the workers, monitoring noise levels and deploy proper protection if needed.

Our prime focus being noise monitoring, we looked into existing noise monitoring units. The most common noise monitoring unit is handheld. It is taken around while the factory is being checked for its noise levels. In many places even this simple check is not deployed at all.

***The gaps in handheld noise monitoring units* -** There are two types of noise monitoring currently. The one that uses sound level meters and the one using Dosimeter. In both these types checks are scheduled for a year or so. In the first type the sound is monitored in different places across the factory floor not just once, but for a number of times in a day. When measurements are taken just once, error occurs. The sound level meters are used in factory floors where there is not much movement across the floor. A sound map is created for that area. This method is known as ‘area noise monitoring’. The later is a personal sound monitoring or personal exposure monitoring. This is done via a Dosimeter which is attached to the shoulder of the worker. It tracks and plots the exposure per sensing unit, per day. By this the total noise one person gets exposed to can be measured. The existing noise monitoring devices are too costly. This forces small companies to only rent the monitoring devices rather than buying it. The standard noise monitoring systems costs around $500 - $1000 for sound level meters and $750 - $1500 for dosimeters. The solution we proposed is much cheaper and also bridges much more gaps in the existing solution.

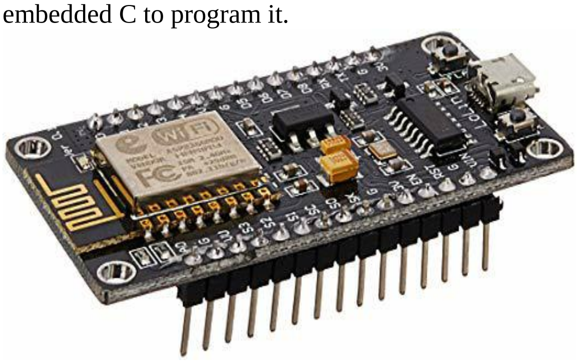
There are several gaps in these types. This monitoring check is done once a year or once in a few months. In a few places the monitoring check is done when new machines are introduced. This holds a drawback because a lot of machineries that vibrate the most are to be monitored continuously. When we monitor the behavioral patterns of motors etc, continuous monitoring is required as there might be unnoticeable spikes along the way which might cause serious damage to the workers. The pattern is not entirely predictable. Even these pose a threat to the welfare of the workers. Not every machinery is purchased at the same time. A yearly monitoring practice might not be suitable for every machinery on the floor. Some machines might cause issue even months before the inspection. This puts the health of several workers under stake until the stipulated checkup reveals the mishap. Even when the noise is closer to the permissible limit, the workers hear the noise. A gradual step up might go unnoticed by the human ear. This makes scheduling the checkups futile. The above mentioned gaps supports the need for our proposed project.

***Our study and project* -** The employer being concerned about the employees safety is no brand connect or something that can be used to market the service or solution. It's a basic requirement of every company or organization.



b. The block diagram of a node in our proposed implementation

This is implemented using Arduino NodeMcu, Industrial sound sensor, Wi-Fi module, 12 V adapter, Power Splitter, Light Indicator etc. The software used are Arduino IDE, IOT Cloud (UBIDOTS). We use embedded C to program it.

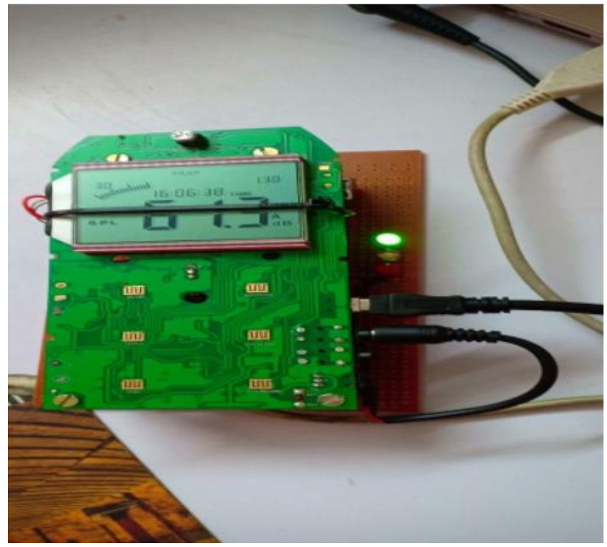


c. NodeMcu

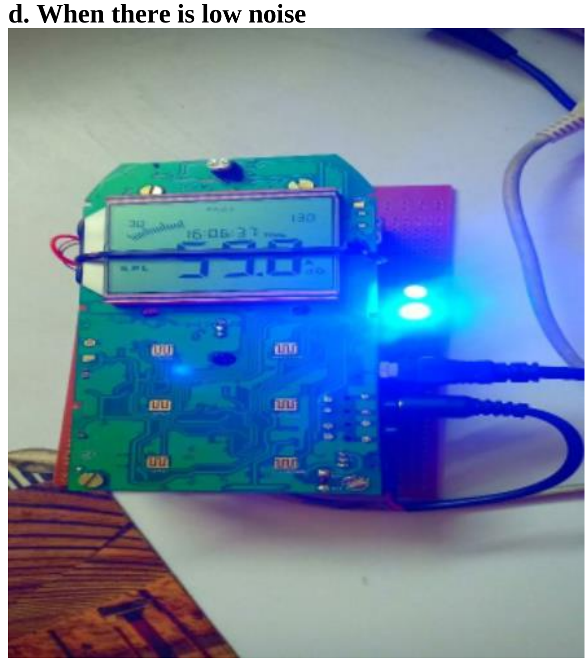
The NodeMcu is used by us to simply create a noise level sensing node. The other components are attached to it as per the block diagram. The instantaneous values are measured.

The industrial sound sensor is a analog device. It takes inputs from the physical world which is in the analog form. This is like a transducer too as it converts the sound samples (particle-less mechanical wave which is nothing but the physical vibrations in air) collected at various instances into a measurable electrical form. This is interfaced with the Analog pin (A∘).

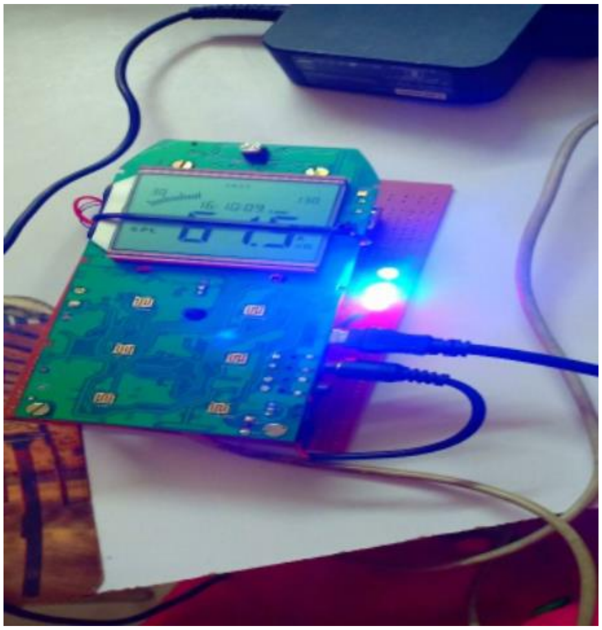
The coding is done in embedded C which facilitates it to check the level instantaneously and alert the workers at proximity by blowing up the light indicator. Plus this gives a cloud supported alert to the people in charge. It is cheaper and much more flexible. The result of the implementation is as follows.



d. When there is low noise



e. When there is medium noise



f. When there is loud noise.

Future projections - Our work can be further developed for use in libraries, hospitals, work-spaces, rooms of elderly people, apartment premises etc. Even for factories some fine tuning could be done and the development boards (Node Mcu) can be replaced by a manufacturing prototype. An user interface can be created to enhance the flexibility we provide to the monitoring personnels. If this is taken up by the government officials who are responsible to inspect noise control reports per deployment can be automatically generated by adding features to our work. Noise cancellation too will be taken up by us in the future deploying smart noise cancellation units (The smartness refers to the way in which each node will be able to calculate the cancellation to be done in a spontaneous manner. This also implies networked calculations as the noise from one machine might fall in the range of more than one sensor) as possible. By simply changing the sensor in use this framework can be used to monitor anything that off the shelves sensor supports.

Conclusion **-** Thus this study taught us a lot about noise as an occupational hazard. This paper also stresses on the gaps felt by small business or workspace owners. This solution is aimed at creating a difference to at least a few workers or workspaces. This system is to be implemented and verified in a few months.

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