

Research Article

# Wireless Sensor Network based Resource Tracking System for the Safety of Workers Exposed to Physical Agents while constructing or demolishing any Building

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## Abstract

The Approach of proposed System is to protect the workers in the construction sites and the nearby residents from various Hazardous conditions such as Ultraviolet rays, Dust, noise causing risk to develop cancer, lung diseases and various other health issues. In this paper we combine various Wireless sensor nodes which detect the parameters such as emission of dust, rays etc. and send the information to Data sink. This approach enables wireless Sensor Network for real time monitoring for various critical conditions.

**Keywords:** Ultraviolet Rays, Datasink Sensor, Nodes, Localization, ZigBee, RSSI, Gateway etc.

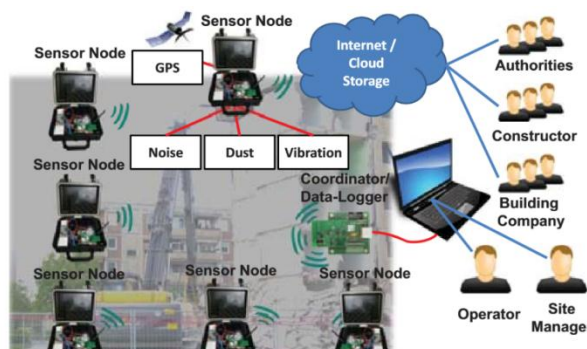
## 1. Introduction

Wireless Sensor Networks have extensively found applications in various environmental purposes such as maintaining water quality, regulating water and air pollution etc. Construction of any building and its demolition always leads to emission of dust, noise and vibrations which not only disturbs and harms the health of the workers working within site but also the nearby residents. Here the effort is entirely focussed on developing and installing a framework which successfully monitors and visualizes the gas emission, noise from the construction sites in real-time environment and monitors the safety condition of the workers employed in the site.

In this paper a mobile wireless sensor network (MWSN) is introduced for the purpose of worker's safety. Public authorities and Standard Committee sets the limit for the emission of dust, noise and other harmful agents based on the previous examination of endangerments for worker's and resident's health as well as environment. When the emission exceeds the set limit, the mobile sensor nodes sends this information to the operator which then reacts upon this information and takes the action quickly. For tracking the workers within the site ZigBee based WSN network and RSSI methods are widely used. This is done by implementing one of the following localization principles namely Angle of Arrival (AOA), RSSI, Time of Arrival (TOA), Time Difference of Arrival (TDOA). Once

these principles are analysed, wireless positioning is done followed by assessment of technologies such as ZigBee, Ultra-Wideband, Bluetooth. The feasibility of these technology and methodology are evaluated for tracking workers at the building and demolition sites. For finding the location of tracking node two different methods can be used at construction site for determining node positioning

- 1) By finding distance between the nodes (lateration)
- 2) By finding angle between the nodes (angulation)



**Figure 1** Real-Time wireless sensor network for monitoring harmful emissions at building and demolition site

## 2. MSWN and hardware architecture

A Number of mobile or Self-organizing Sensor nodes are kept at the building or demolition site. Mostly

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these nodes are fixed on the metal rod for easy installation on the ground of the site using screws. The nodes can also be installed at the deep depth of the ground for vibration measurement if any. The nodes placed on-site have two parts, one above the ground for monitoring dust and noise emission and another placed within the ground mounted on same rod called acceleration sensor for monitoring vibrations caused by tools used for construction and demolition of building.



**Figure 2** Installation of Sensor nodes on-site using metal rods and screws

For the workers' safety point of view working in an Indoor environment, mobile nodes are embedded on their garments which accompany them whole day. Sensors detect the physical activities within the site, process it and then send it to Gateway. These Sensor nodes in worker's garments working in closed or indoor environment are connected via ZigBee. For large environment ad-hoc network is utilized.

The data related to workers from all the sensors are received by Gateway which then transmits it to a remote unit via standard Internet connection 3G, Wi-Fi etc.

### 3. Sensor node architecture

Wireless Sensor Nodes have found wide applications in various Physical and Environmental applications. The main components of sensor nodes are:

- i) Sensors which detects the physical activities
- ii) Microcontroller
- iii) Antenna
- iv) External memory
- v) Power source
- vi) Energy harvester

### 4. ZigBee used for resource tracking

ZigBee is a standard which is recognized globally for its use in Wireless Network technology. It can access the remote unit, monitor it and can also be used for its control applications.

The technologies offered by ZigBee are cheaper than any other wireless Networks such as Wi-Fi, Bluetooth etc. Since power consumption of ZigBee is very less because of which also it is used in construction sites as it gives the sensor a longer battery life.

For resource tracking and monitoring in construction sites, ZigBee based Wireless sensor network are applied with Ultrasound and TOA for localization purpose.

When the ZigBee based wireless network is used on-site its nodes are divided in to two parts-static nodes and mobile nodes.

Static nodes are scattered at the site and constitute a adhoc network for monitoring emission of dust, noise and vibrations. Mobile nodes are attached resources to be tracked such as labour, tools etc.

### 5. Received signal strength indicator (RSSI)

The localization principles such as TOA, TDOA etc. are used at the sites but the accuracy of these principles suffer because of shadowing or blockage caused due to surrounding settings or construction materials, equipment at the site. This is overcome by using RSSI principle at the construction or demolition sites. RSSI with the aid of signal propagation models estimated the distance between the two ZigBee nodes. It then determines the range in relation to three different nodes to calculate the location of tracking node by use of triangulation algorithm.

### 6. Physical sensors

Exact measurement of dust is nearly impossible as it keeps on varying at construction sites and depends on factors such as rain, wind, humidity etc. Dust Sensor gives the indication of dust concentration in environment and hence useful for improving air quality at construction sites.

Vibration sensors such as accelerometer are use at the construction sites. They are installed within the ground with the help of metal lances and screws.

### 7. Energy harvester

Sensor Nodes are not auto rechargeable. So all the components in WSN are chosen such that they consume less power.

When used continuously the battery discharges and also it becomes very difficult to provide power supply to recharge batteries of sensors at construction sites.as a result Energy harvester is used in the WSN that converts energy available from the environment such as solar light, wind Energy, Acoustic Noise, thermal energy etc. to electrical energy. This Electrical energy is then used by battery for its recharging thus making network more reliable and avoids nodes failure.

## Conclusion and future work

This Paper suggests designing a Wireless Sensor Network for continuous monitoring and controlling of harmful emissions of dust, noise from construction and demolition sites thus providing safety to the workers and nearby residents at the site. It gives the detailed overview of hardware architecture of Wireless Network used at construction site.

For the future implementation a limit can be set for the emission of dust, noise, vibrations at the site based on the previous experiences and accordingly a series of experiments on real construction and destruction sites can be performed. If the emission exceeds the set limit, check and analyse the working of WSN, Sensor Nodes and the action taken by authorities.

With the development and improvement of ZigBee based wireless sensor network and localization principle, the proposed system can be used to track the resources such as labour, material, tools at the construction sites and the exact position of node of interests

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