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Wireless Sensor Network for Harmful Radiation Monitoring System and Web Enablement using OGC Interface.

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ABSTRACT

The proposed work explains about the design and execution of radiation monitoring network using sensors. GM Tube is the sensor used in this work for radiation detection. The second part of this work describes how they are web enabled using Open Geo-Spatial Consortium (OGC) interface for Sensor Web Enablement (SWE). The recorded values from different environments under different radiation units as microSievert levels are made available for the authenticated users through the SWE services. The hardware design has an alarm which is set at a threshold of 0.8 microSievert, so that once the recorded values reaches the threshold, an alert sound is made by the instrument and indicated in the database also. This alert is sent to the authority concerned using Sensor Observation Service (SOS). This will be useful in places surrounding nuclear power plants where the radiation levels have to be continually monitored. An analysis of the values taken using the same hardware set-up in four different places and on four different occasions around the radiation prone zone has also been made. According to the data analysis the threshold will vary slightly.

Keywords: Sensors, Sink, Radiation, GM Tube, SWE, Wireless Network, etc.,

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INTRODUCTION

Wireless Sensor Network (WSN) is the core of this presented work. These sensors are distributed spatially and work in organized manner for monitoring and recording conditions and share data continuously with the data centre. The activity of a sensor can also be managed using these networks.

These WSN are used mainly in places where human intervention causes harm to health. The idea of deploying a WSN for harmful radiation detection emerged as a result of safety measure for the people living near nuclear power plants. The development of WSN has led to its usage in many ways. In this project it is used for sensing radiations. A network of interconnected nodes is placed in the area of monitoring. A sensor monitors the amount of radiation in that particular area continuously and gives readings in a specific time interval. These values are recorded and made available for public use. This is mainly done to remove the confusion surrounding the people nearby power plants.

As days pass by the nuclear power plants are inevitable as the power generated by them is huge. But people are opposing it considering it to be more dangerous. So this project is to clarify the doubts regarding the amount of radiation level caused by the nuclear power plants as there is plenty of rumours among people about this. We provide a live interface for the people using the data collected by sensors which can be accessed by them to know the radiation levels. By this the people can also know the radiation levels around them and prepare themselves for any kind of nuclear disasters that could happen.

RELATED WORKS

Some of the related works are discussed in this section. In the work of Tuna et.al., [1], an autonomous wireless sensor network deployment system using mobile robots has been explained. This paper presents a novel approach of using autonomous mobile robots to deploy a Wireless Sensor Network (WSN) for human existence detection in case of disasters. This system has important advantages over a human-assisted system. However, the realization of these envisaged gains depends on communication and coordination capabilities of the system. This work addresses the advantages of using multiple robots for WSN deployment in terms of cooperative exploration. It has the benefit of simultaneously deploying wireless sensor nodes during the exploration of an unknown deployment zone. It uses WSN-based communication as an alternative communication method during exploration. The main drawback of this proposed system is the communication and coordination capabilities of the system.

In case of radiological accidents, before sending a human team to the site it would be better to have real time information about the situation that rescue teams can find. In this paper [2], an opportunistic network over the nuclear plant of Ascó, in Tarragona, Spain has been explained which provides network connectivity and resource utilization to the rescue teams supposing a highly partitioned ad-hoc network.

The system consists of distributed sensors in charge of collecting radiological data and ground vehicles that are sent to the nuclear plant at the moment of the accident to sense environmental and radiological information. Sensed data would be delivered to a control center using an Unmanned Aerial Vehicle (UAV) as a carrier. Based on this information, we propose a transmission protocol with data control. Control centre can modify the UAV flight plan in order to get the highest quantity of data from sensors and ground vehicles and at the same time maximizing the ground sensed data.

A self-sustainable wireless sensor node for the monitoring radiation in contaminated and poorly accessible areas is presented. The node designed here [3] works with an unmanned aerial vehicle used for two essential mission steps: air-deploying the wireless sensor nodes at suitable locations and acquiring data logs via ultra-low power, short range radio communication in fly-by mode, after a wake-up routine.

The node is equipped with a low-power nuclear radiation sensor and it was designed and implemented with self-sustainability in mind as it will be deployed in hazardous, inaccessible areas. To this end, the proposed node uses a combination of complementary techniques: a low-power microcontroller with non-volatile memory, energy harvesting [4], adaptive power management [5] and duty cycling, and a Nano-watt wake-up radio. Experimental results show the power consumption efficiency of the solution. This confirms the solution's self-sustainability and illustrates the impact of different sampling rates and that of the wake-up radio.

SENSOR NODE DESIGN

A board for microcontroller ATmega1281, 8MHz frequency, 4KB EEPROM, a small FLASH memory, a SD card and a clock are used to design the mote. The base board (Fig.1) weighs around 20gms [6]. The zigbee radio is integrated with the base board and is used for communication in a separate board. The 'Geiger Muller' (GM) Tube is interfaced with the base board and is used for the detection of ionizing radiation.

Figure1. Sensor Board

GM Tube

GM TUBE is an ionization detector. It consists of a hollow cylinder which is filled with a gas at low pressure. An electrode is present in the centre of the GM tube (Fig.2). It has a thin mica window at one end.

Figure 2. GM Tube

It contains a voltage supply across the tube and the electrode. By using the Townsend avalanche phenomenon it produces an easily detectable electronic pulse due to radiation. This is used to detect gamma radiation, x-rays, alpha and beta particles. Using this radiation levels can be measured in Sieverts.

Waspmote Description

The data collected by the sensors are transmitted through the zigbee radio and received using another zigbee radio in the receiver side and output is produced. The programming part for output is done using WASPMOTE.

After finishing the programming phase, the sensor board starts detecting the radiation even in an enclosed safe place.

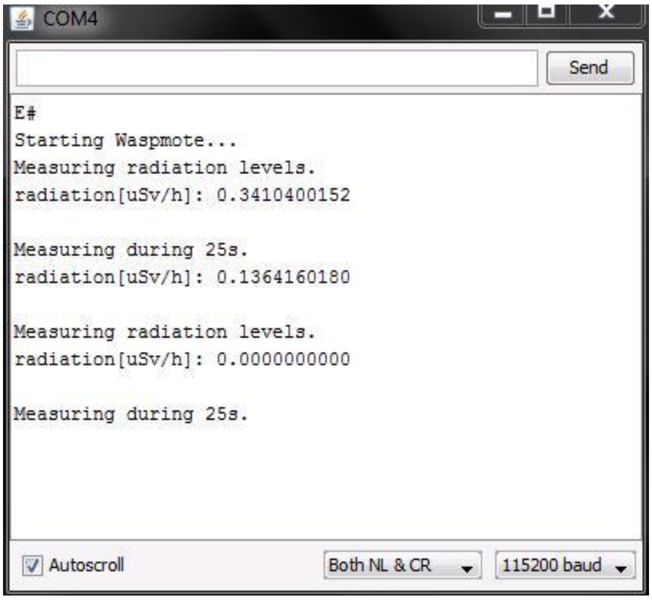

Figure.3. Immediate recording of natural radiation

The output obtained as a result of newly programmed sensor board in this work using Waspmote IDE is shown in the fig.3. That figure shows the dynamic recording of natural radiations received by the GM tube when a normal human being came into contact with it.

The above details give the description about deployment of the sensor mote in an enclosed environment and its reception unit in the server side.

FIELD STUDY AND ANALYSIS

A field study has been done in the surrounding areas of (IGCAR), Kalpakam in India. Like the above given description, some set of motes are deployed at four different radius around the plant and the values received are analysed.

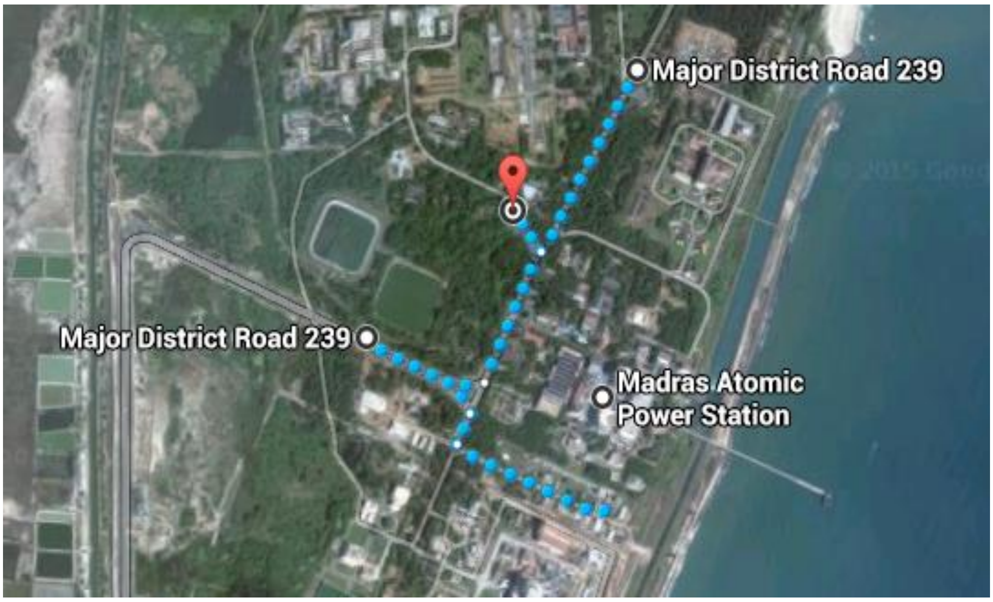

Figure 4. Test bed sensors placed around the MAPS (in 1km, 2km and 3 km radius), Kalpakam

Kokilamedu is the village surrounding IGCAR – Madras Atomic Power station (Ar-41 Gaseous activity). The nodes were initially placed in Kokilamedu Major District Road 239 (which is a restricted place) falling within a radius of 1 km from the Power station. The values were recorded and then the same testing was done in a radius of 2 km and 3 km from the power station (fig.4).

The recorded values are tabulated down in Table 1.

Table 1. Radiation Values (in uSv/hr) recorded in kokilamedu on a single day

Sensor Motes → Radius ↓	M -1	M-2	M-3	M-4
1km Radius	0.166	0.167	0.167	0.163
2 km Radius	0.134	0.135	0.129	0.129
3 km Radius	0.121	0.122	0.125	0.119

The radiation exposure values recorded in microsievert per hour has to be typed, converted to dose and adjusted with factors (millisieverts per year) to estimate any health impact. If the detected value is greater than or equal to 1.0 uSv/hr, then it is dangerous. So 0.8 is set as the threshold value, because for our country even with natural background radiation, more than 0.8 uSv/hr is abnormal. So when the observed values exceed 0.8 uSv/hr, an alert message will be created by our server application where these data are stored and maintained.

All the data provided above (for sample) are recorded by using our mote in the specified locations on a same day. Like that the data is stored daywise. The dat analysis is done based on the recorded average background dose. The slight changes in the observed data recorded on a same day is due to the wind speed and wind direction. They are the gamma radiation effects in the surrounding areas of Madras Atomic Power station in IGCAR, Kalpakam. From the observation it is clear, that for a period of six months the values never exceeded 0.8 uSv/hr and also Alpha and Beta particles were never observed.

WEB ENABLEMENT

Our Detection system, aims for the systematic development of a web application which can be used for accessing nuclear radiation detecting sensors' data. The system will utilize the ad hoc wireless sensor networks and spatial data infrastructure technologies to produce a interoperable and per formant web app. Methods of data access, communication and visualization are to be implemented using OGC norms & SWE specifications.

Motes will be installed in some fixed known locations on a safer locus around the radioactive area. They will transmit pre-synchronized time data for location identification. They are well shielded and can be reused. They have wireless capabilities and transmit data using wireless networking.

The design of the user interface is being done using Google maps API .The geolocations of the sensors were tagged on to the map. SOS service has been implemented to get the observations and measurements (O&M) . O&M output documents can be requested by a web-based authorised client using the GetObservation operation with options to filter all available observations by time, location, observed phenomenon or sensor.

For easier understanding of the O&M, the O&M is made into an animated graphical chart. The animated graphical chart is being implemented using JQUERY library and JavaScript .The SOS and graphical representation of O&M made it easier to share and access sensors and their data.

SWE enables interoperability and is well designed towards the upper application layer, the interaction between the Sensor Web and the underlying sensor network layer will be sufficiently described. The system bridges the gap between the two distinct layers and is essential for enabling future sensor plug & play within the Sensor Web. This system will be extended to the other nuclear power plant located areas of South India and further extended nationwide.

CONCLUSION

The proposed work uses a sensor –GM Tube which works based on MOSFET (Metal Oxide Semiconductor) radiation detection to identify the level of radioactivity. These units shall transmit the data to the neighboring motes using zigbee radio. A detailed record set of the observed values are maintained using the SOS of SWE at the back end. Using this any authenticated user can check the radiation level in a particular area surrounding the power plants, where the motes are deployed.

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