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Future Sensors and Utilization of Sensors in Chemical Industries with Control of Environmental Hazards

K. Nirmal Kumar[1]
M.E (Pervasive Computing Technologies)
Center for Convergence of Technologies (CCT)
Anna University of Technology
Tiruchirappalli, India
e-mail: nirmalkumar.paruthi@gmail.com

V.R. Sarma Dhulipala[2]
Assistant Professor, Department of Physics
Member, Center for Convergence of Technologies (CCT)
Anna University of Technology
Tiruchirappalli, India
e-mail: dvrsarma@gmail.com

R.Prabakaran[2]
Assistant Professor, Department of EEE
Member, Center for Convergence of Technologies (CCT)
Anna University of Technology
Tiruchirappalli, India
e-mail: hiprabakaran@gmail.com

P.Ranjith[3]
M.E (Pervasive Computing Technologies)
Center for Convergence of Technologies (CCT)
Anna University of Technology
Tiruchirappalli, India
e-mail: ranjithpct09@gmail.com

***Abstract*—Sensors are the essential devices to industrial applications, particularly for chemical industries where varieties of sensors are being used for different applications. In present era, only few sensors are used for chemical applications such as ground water monitoring, chemical identifiers and so on. In this paper, we have detailed about how to improve the utilization of sensors in the chemical industries and also proposed some new ideas to researchers to make sensors for chemical industries, according to their need and machinery systems of organic industries. This paper concentrates on minimizing the hazards of chemical wastages, by implementing efficient monitoring sensors in and around the chemical industrial environment. This paper also recommends the unavoidable requirement of sensor motes in the world of chemical industries. The main objective of this paper is to provide infrastructural ideas to the researchers, regarding sensor monitoring and merging of sensors from various area of applications to chemical industry applications and the results are proving that the emerging trend brings effective control over the variables.**

Keywords: Wireless Sensor Network, Zigbee, Chemical Applications

I. INTRODUCTION

A sensor is an electronic device used to measure a physical quantity and convert it into an electrical signal which can be read by an observer or by an instrument. Recent advances in Micro Electro mechanical Systems (MEMS) technology have enabled the development of low-cost, low power, multifunctional sensor nodes. Wireless sensor network (WSN) is an autonomous network of a number of sensor nodes, very small in size and communicate in short distances. WSN operate unattended, adaptive to the environment [1]. Hence, widely used in applications for military, environment and health monitoring, for home and other commercial areas. Sensors are now widely used in the chemical fields and chemical industries for identifying the chemicals and monitoring of petrol tanks in petro chemical industries and all. Zigbee is a new standard; intended for low cost devices in automation, home controls and computer peripherals. It enables the broad-based deployment of wireless networks with low cost, low power solutions.

A. Sensor Node

Usually sensor node have four unit.That are;1)power unit,2)processing unit,3)sensing unit , and 4)transceiver unit.

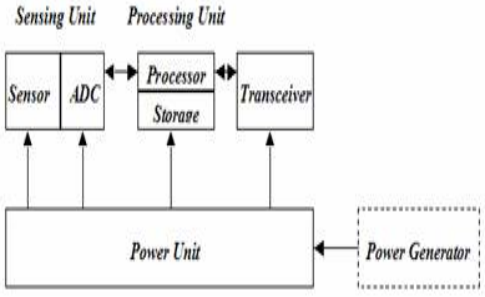

Figure:1 sensor node architecture[2]

Initially power unit generates the power. Processing unit have the microcontroller,which is the fully responsible to get sesned data and transmit over the another network. The controller performs tasks, processes data and controls the functionality of other components in the sensor node. Sensing unit has the sensors and analog to digital converter (ADC) to convert analog sensed signal to digital signal.

The functionality of both transmitter and receiver are combined into a single device known as transceivers. zigbee transceivers are used for transmission purpose.

B. Wireless Sensor Network Architecture

Mainly wireless sensor network consists of a base station or gateway which can communicate with a number of wireless sensors through a radio link. Sensor node is responsible for collecting the data from the environment. Usually in chemical industries; the wireless sensor network is used for monitoring the petrol tanks, oil and gas tanks etc. Sensor node collects the data and transmits to the gateway directly. From that gateway, the collected signal is forwarded to the external industrial Ethernet network.

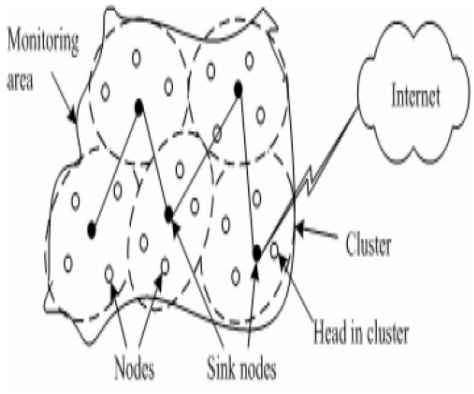

Figure 2: Wireless sensor network architecture [1]

II. EXSISTING APPLICATION OF SENSORS IN CHEMICAL FIELD INDUSTRY

A. Oil and Gas Industry

As oil and gas are characterized as highly hazardous, their transportation through pipelines warrants proactive continuous monitoring. Unfortunately, there has been limited continuous monitoring of this critical infrastructure, which causes financial losses to the industry. Moreover, pipelines can unexpectedly fail for many reasons including, corrosions, cracking, process upsets, and external environment. Wireless Sensor Network is not limited but utilized by Oil & Gas Industry for monitoring various features such as; i)Pipeline Integrity monitoring, ii)Tank Level Monitoring, iii)Equipment Condition Based Monitoring(CBM),iv)Pipeline Pressure Relief Value Monitoring(PRV).v)Refineries Pressure Relief Value Monitoring(PRV) vi) Wellhead Automation & Monitoring etc [3].

Condition monitoring is often carried out periodically ranging from months to year interval, but system may fail between these intervals. Different kinds of sensors such as acoustic, vibration and temperature sensors can detect wall thinning or thickness through temperature of noise measurements, leakages by analyzing real-time flow, and pressure measurements etc [5].

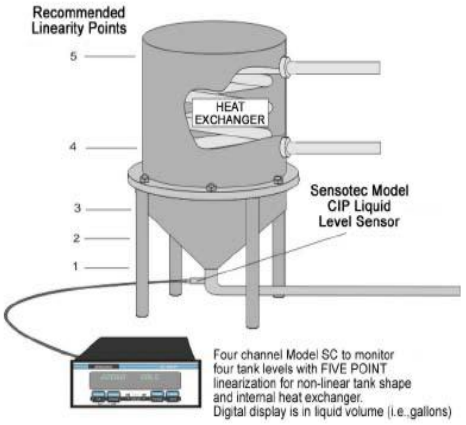

Figure 3:Real time oil field monitoring with level sensor[4]

III. ZIGBEE WIRELESS SENSOR NETWORK

A. Topologies of Zigbee Wireless Sensor Network

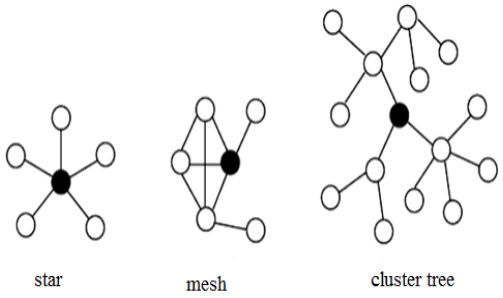

Figure 4: Topologies

Zigbee is famous for its mesh topology. By forming mesh network, it can be used for more applications such as crop field monitoring, early warning technology of the mine safety, home applications and all. But in chemical field industries, the utilization of sensors and sensor network is very low. At present in chemical fields, sensors are used to identify the chemicals, pressure sensors are used for measure the different pressures from different corners of the pipelines, and so on. So the utilization of sensors in chemical field is very low. This paper, proposes architecture for remote monitoring of chemical wastages by using Zigbee wireless sensor network. In the proposed system, mesh topology methodology is used to monitor the wastages.

B. Zigbee Protocol Stack

Zigbee wireless networking protocol layers are shown in the above (Figure 5). The Zigbee standard gives only the networking, application, and security layers of the protocol

and adopts IEEE 802.15.4 PHY and MAC layers as part of the Zigbee networking protocol.

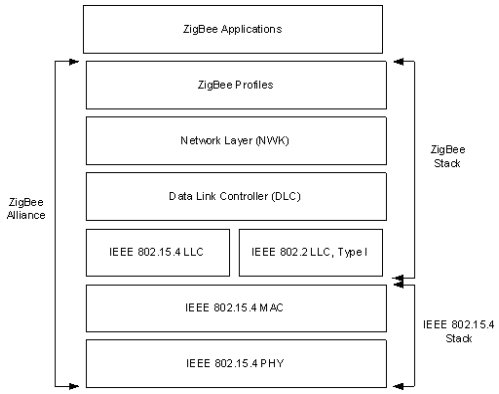

Figure 5: Zigbee protocol stack [6]

Therefore, any Zigbee-compliant device conforms to IEEE 802.15.4 as well. Implementing the full Zigbee protocol ensures interoperability with other vendors wireless solutions and additional reliability due to the mesh networking capability supported in Zigbee [7].

IV. PROPOSED SYSTEM

A. Zigbee Wireless Sensor Network for Monitoring the Chemical Wastages

In chemical industries, wastages are dumped in a particular location or dump site. Continued presence of chemical waste in large quantities at a particular spot can cause hazardous reactions. It can cause environmental hazards like soil erosion, water pollution, air pollution etc. Usually, chemical industries employ pipelining system for dumping the wastages to land. Environmental hazards can be prevented if a maintenance system is engaged to monitor the chemical waste disposal in industries. We propose a monitoring system using Zigbee wireless sensor network. In our proposed system, we suggest the use of several dumpsites rather than a particular site. When chemical waste dumped in a particular site reaches the limit of maximum safely storable capacity, the system raises an alarm to indicate the need to change the dump site. The chemical waste stored in the dump site is recycled while; the other dump site is being used.

V. PROPOSED SYSTEM ARCHITECTURE

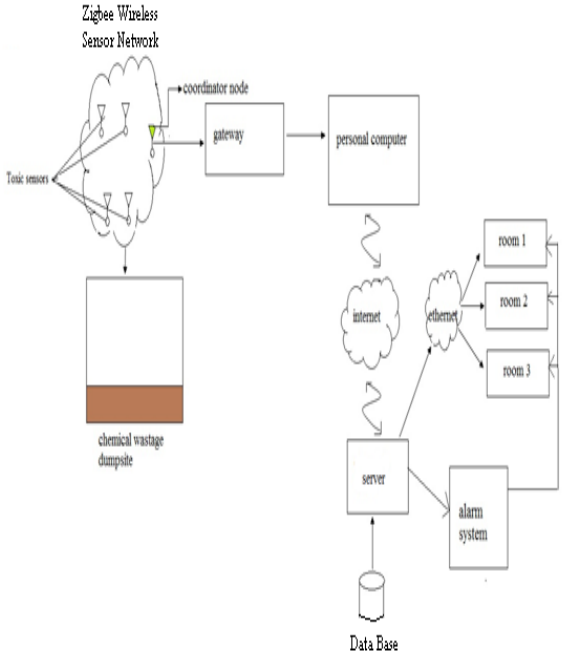

Figure 6: Real time monitoring of chemical wastages by using Zigbee wireless sensor network to control environmental hazards:

A. Initial Setup of the System

- Make pipeline control system in rooms to control the flow of wastages from different places of industries
- Provide data base to the server.
- Store the minimum and maximum threshold level of different toxic liquids and gases the server
- Make Ethernet connection from server to all control rooms.
- Make alarm system which is connected to the server

The proposed monitoring system consists of five main components;1)The Zigbee wireless sensor network, 2)A Personal Computer, 3)Chemical Server, 4)An alarm system, and 5)Ethernet connection to the different rooms which have controls for the disposal of chemical wastage.

B. Process Details

The toxic sensors in the Zigbee wireless sensor network, senses the data on the chemical waste being disposed; by continuous monitoring of the dumpsite. The sensed data include details on the toxic liquid or gas being disposed, the disposed amount etc. These details are sent to the Personal computer via a Gateway. A Gateway is the device which can be used to connect two networks of different protocols. In a communication network; a gateway is a network node equipped for interfacing with another network that uses different protocols and data formats. The chemical server is

connected to a database which contains the minimum and maximum threshold value of the different toxic substances. The alarm is raised to alert the different rooms that controls waste disposal, when the toxic material being disposed nears the maximum threshold value. The alarm system is triggered by the chemical server, and the alarm signal is sent through the ethernet connections to the different waste disposal control rooms.

VI. CHEMICAL SENSORS AND FUTURE SENSORS FOR CHEMICAL INDUSTRIES

A. Chemical Sensor

Chemical sensors mainly classified into four groups.

That are; 1) Spectrometry and Chromatography, 2) Electrochemical sensors, 3) Mass sensors and 4) Optical sensors.

This classification of the sensor is depending on the principal physics and operating mechanism of the sensor. Chromatography relies on separation of complex mixtures percolation through a selectively adsorbing medium, with subsequent detection of compounds of interest. Electro chemical sensors detect signals changes (resistance) because of an electrical current being passed through electrodes that interact with chemicals. Mass sensor works when disturbance occurs and changes to the mass of the surface of the sensor during interaction with chemicals. Optical sensors detect changes in visible light or other electromagnetic waves during interactions with chemicals [8].

Chemical sensors are used to measure a wide range of elements and molecules for organic, inorganic and biochemical molecules in all environmental media (atmosphere, soils, sediments, groundwater, and fresh and marine waters).particularly chemical sensors are used for to detect toxins and determining the presence and amount of nitrogen and phosphorus mixed in the air and liquid [8].

VII. FUTURE SENSORS

A. Wireless industrial pressure sensors

Wireless industrial Pressure sensor is the one new to the industries. Transducer is used in monitoring pressure in industry and determines the bottom-hole pressure in oil industry. wireless devices has several advantages such as multipoint sensing ,enhanced signal to noise ratio, less wiring, reduced size of sensors ,ease to work with circuit integration. Transducers are based on piezoresistance. Pressure can be detected using current flow in the material. Transducers are provided with batteries [9]. Applications of these sensors are in petroleum industry, waste water treatment, paper and pulp industries, metal industries, chemical industries, and food beverage industries

Figure 7: wireless industrial pressure sensor [9]

B. Nano sensors

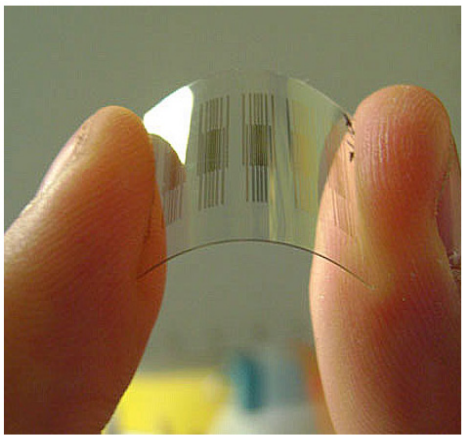

Figure 8: hyper-sensitive nano tube sensors [10]

Nano sensors are the new sensors in the chemical field world. The beauty of those sensors is that, they are much more sensitive than the present sensors in the world. For chemical industries we have to measure the chemicals very deeply and correct. For that purpose the nano sensors will change the chemical field industries next decade. The below one is the hyper-sensitive nano tube sensors for detect toxins in the water of the chemical industries.

VIII. ADAPTING NEW SENSORS AND UTILIZATION OF SENSORS FROM OTHER TECHNOLOGIES TO CHEMICAL INDUSTRIES

A. Nanotechnology

Nano technology is the upcoming technology. The sensors made by that technology are much more sensitive and accurate. For chemical industries nano sensors are very useful for to sense chemicals and all**.**

B. *Nano Sensors*

While some environmental sensors measure physical parameters (air pressure, solar radiation, temperature) that do not require direct contact of the transducer element with the environment, a substantial number are used for chemical detection. When chemicals interact directly with the sensor surface, "nanotechnology" is always involved because biomolecules and other species of interest are at the nanometer size scale. Nanotechnology is already built in and essential to sensor function. However, there are many recent examples where new forms of nano structured materials increase the response speed or detection limits of chemical sensors and where nano machined mechanical elements can translate a chemical signal into an electronic one. For the purposes of this article, "nanotechnology" encompasses structured materials having dimensions on the sub-100 nm scale. This includes self-assembled nano materials, such as gold nano particles and carbon nano tubes, and fabricated objects like silicon nano cantilevers [11].

IX. CONCLUSION

In this paper, we have discussed different applications of sensors in present day world in chemical industries. We have proposed architecture and tested it partially using simulator. The partial phase results of our model have shown good set of results. The model verification is under test phase. In future we are planning for a thorough test and simulation and addition of extra modules for security purposes.

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