Monitoring and Detecting of Air Pollution using Wireless Sensors Network

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***Abstract*— In recent technological developments in the wireless communication technology have to the emergence of environmental pollution sensor and air pollution sensor network.it is monitoring system provides real time information about the level of air pollution particular region. Lacks of implementation of environmental regulation are contributing to the bad air quality of most of the Indian cities. Analytical measuring equipment is costly, time and power consuming, and can seldom be used for air quality reporting in real time. Wireless Sensor Networks are a new and very challenging research field for embedded system design automation, as their design must enforce stringent constraints in terms of power and the problem of air pollution is becoming a major concern for the health of pollution and all sector of our life and identify the approach in various application like leakage of gas industry and oil sector. I can also calculate the better power management and real time measuring and monitoring in an urban area to ultimately improve quality of life on earth. Air pollution in the urban environment is a major threat to human health. As the global population is becoming more concentrated in urbanized areas, new ideas and approaches are needed to help maintain clean air that is safe for everyone to breathe. I propose a indoor and outdoor air pollution monitoring system which uses ZigBee and ARIMA prediction model for monitoring air pollution. It predicts the carbon dioxide level in ubiquitous cities and system integrates wireless sensor board and also integrates with the dust, temperature and humidity and reducing power consumption. In this module is the small range, low power, low data rate wireless networking technology for many wireless application.**

Keywords—Zig Bee Model, ARIMA Prediction model, Wireless Sensor Network.

I. INTRODUCTION

The detectable presence of different chemicals in the air, together with their concentration, is a source of valuable information for many applications ranging from pollution monitoring to explosives and drug factories detection. In particular, several gases are considered responsible for respiratory illness in citizens, some of them (e.g. benzene) are known to induce cancers in case of prolonged exposure even at low concentrations [1]. Awkwardly, volatile organic compounds (e.g. formaldehyde) released as off-gas by furniture's adhesives or cleaning agents or by smoking in indoor environments reach concentrations levels that are order of magnitudes higher than in outdoor settings. The estimation of chemicals distribution is hence significantly relevant for citizens safety and consequently for the definition of integrated urban and mobility plans designed to face these problems.

Chemicals monitoring can be of paramount importance for security applications e.g. for the detection of explosives and drug factories in cities [2]. However, chemicals monitoring both in outdoor and indoor environment are affected by the peculiarity of chemicals propagation process. To be concise, diffusion and turbulence make a single point of measure ineffective, calling for distributed approaches to chemicals detection and concentration estimation. In many applications this, in turn, require the monitoring task to be fulfilled by a network of wireless (sometime mobile) modules, with the wireless term being related to either connectivity and/or power supply (Wireless Chemical Sensor Networks, WCSN). Different applications lead to different specific requirements but a number of challenges repeatedly recurs when engineer try to design real world operating WCSN systems. In facts, single module calibration and sensor stability, efficient power usage and cooperative reconstruction seems to be the most common challenges to face both in indoor and outdoor settings. In this paper will review these challenges together with the solution proposed by our group during our commitment in the wireless chemical sensing topic.

II. LITERATURE SURVEY

Due to recent technological advances, the construction are monitored are light, temperature, humidity, pressure, etc. a converter that transforms the sensed signal from an analog to a digital signal; A Processing Unit in the Microcontroller, process the signals sensed form sensor with help of embedded memory , operating system and associated circuitry. A Radio component that can communicate the sink node or zigbee router which collects the sensed pollution gas level from sensor node and forwards to pollution server which is in our campus. Powering these components is typically one or two small batteries. There are also wireless sensors utilized in applications that use a fixed value, wired power source and do not use batteries as a power source. In an external environment where the power source is batteries, wireless sensors are placed in an area of interest that is to be monitored, either in a random or known fashion.

The sensors self-organize themselves in a radio network using a routing algorithm, monitor the area for measure the gas levels in air , and transmit the data to a central node, sometimes called a pollution server or base station (interfaced with coordinator), or sink node(interfaced with router), that collects the data from all of the sensors. This node may be the same as the other detection nodes, or because of its increased requirements, may be a more sophisticated sensor node with increased power. The most advantage of wireless sensors is that they may be implemented in an environment for extended over a time period, continuously detecting the environment, without the need for human interaction or operation.

III. ZIGBEE STANDARD

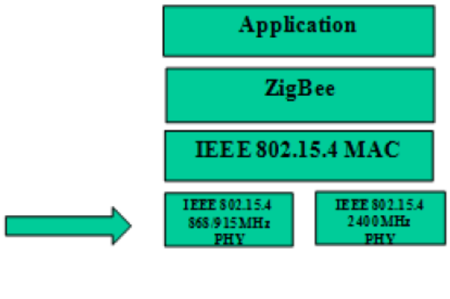
The ZigBee standard is the new short range, low power, low data rate wireless networking technology for many real time application. It is best specified the bottom three layers (Physical, Data Link, and Network), as well an Application material for small and low cost sensors became technically and economically feasible. Even though, Industrialization increase the degree of automation and at the same time it increases the air pollution by releasing the unwanted gases in environment especially in industrial areas. Inorder to implement the project, we selected four areas to deploy the application. To detect percentage of pollution ,we used the array of sensor to measure gas quantity in the physical environment in surrounding the sensor and convert them into an electrical signals for processing. Such a signal reveals some properties about interested gas molecule.

A huge number of these sensors nodes can be networked in many applications that require unattended operations creates a wireless sensor network. Wireless sensors are devices that range in size from a piece of glitter to a deck of cards. Integration of various components create the air pollution monitoring system.. They are functionally composed of: A Sensing unit that is designed and programmed to sense gas pollutants in air in Programming Interface (API) based on the 7-layer OSI model for layered communication systems.

Fig. 1. Application Layer of OSI Model

Programming Interface (API) based on the 7-layer OSI model for layered communication systems. Figure-1 shows the layered architecture adopted by the alliance industries. It should be noted that the ZigBee Alliance chose to use an already existing data link and physical layer specifications. These specifications are the published IEEE 802.15.4 standards for low rate personal area networks(PAN) as shown in Figure 1. Communication network is composed of many nodes, each of which can interact by transmit and receive data over communication channesl. The ZigBee network model supports star, tree and mesh topologies as shown in Figure

ZigBeecoordinator(ZC) is responsible for initiating and maintaining the devices on the network, and all other devices, known as end devices(ZE) including routers (ZR), directlycommunicate with the ZigBee coordinator. In mesh and tree topologies, the coordinator(ZC) is responsible for initiating the network with default values and for choosing certain key network parameters but the network may be extended through the use of routers. The configurations of coordinator and router using X-CTU interface shown in Figure 6. In tree networks, routers move data and control messages through the network using a hierarchical routing strategy.



Architecture diagram for Zig Bee and ARIMA prediction model fig 2

Below is a brief description of each component of **ARIMA** prediction model.

Reading Sensor generates a random value whose range is set based on the value of a “seriousness” variable.
Reading Transmitter gets the generated value from the reading sensor and transmits it through the communicator.
Power Controller: Each node will have a method called “turn on” that will start the node and we just call it. As for power-saving modes, this will depend on what the simulator will
provide to us.
Communicator: This is implemented by the simulator. Inter-Process communication is usuallydone using sockets; the simulator to provide us with sockets as well as methods such as “send” and “receive”.
Launcher informs the data collector to start collection based on the delivery mode set by the user.
Data collector gets a list of nodes from which it has to collect readings, then sends messages to inform them and finally receives the required values.
Aggregator implements the RCQ algorithm for data aggregation that we will discuss in the next section.
Data extractor uses SQL queries to extract data from database.
Data displayer: This extracts data as required by the user and displays them in a table aswell as evaluates the AQI for the selected area.
Trend analyser gets previous readings and determines relationship between them to be able to extrapolate future readings.

Nodes Deployment Viewer displays deployment of nodes in the WSN field and their AQI colours.
Connection Initiator: The java DriverManager allows for a method to open a database, providing it the name of the database, user name and password as parameters. So, this component just has to make a call to this method and store the return reference to theconnection.
Connection destructor: Connection object, in java.sql package, usually provides for a close method that closes the latter safely and frees associated memory.

The following table shows the various types of nodes that are present in WAPMS.

Type of Node	Energy Requirements	Location	Role
Source (sensor node)	Constrained	Random	Sensing and multihop routing
Cluster Head (collector)	Not-Constrained	Fixed	Collection and aggregation
Sink /Gateway	Not-Constrained	Fixed	Collection

These nodes will form a hierarchy that is shown in Fig 3.

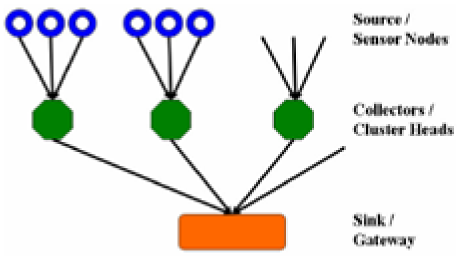


Fig. 3. Hierarchy of nodes

The strategy to deploy the WSN for our system is as follows:
First partition our region of interest into several smaller areas for better management of huge amount of data that will be collected from the system and for better coordination of the various components involved o Deploy one cluster head in each area; these will form cluster with the nodes in their respective areas, collect data from them, perform aggregation and send these back to the sink.Then, randomly deploy the sensor nodes in the different areas. These will sense the data, send them to the cluster head in their respective area through multihop routing o Multiple sinks that will collect aggregated from the cluster heads and transmit them to the gateway. Each sink will be allocated a set of cluster heads. The gateway will collect results from the sinks and relay them to the database and eventually to our application.

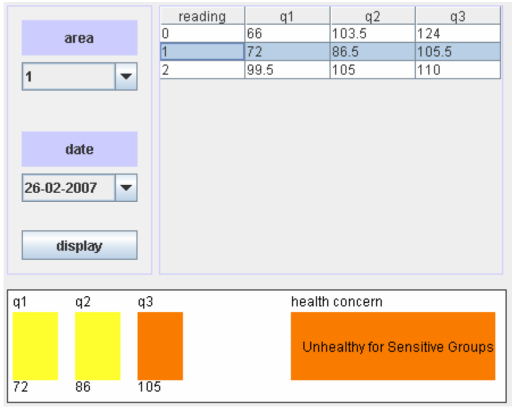


Fig. 4. Reading health concern in particular area

The system is simulated over a small region as a prototype and then it will be extended to the whole island. The town of Port Louis, the capital of the country, is chosen for the prototype implementation as it is an urban area and therefore, more exposed to air pollution than rural areas. The site is partitioned the site into 6 smaller areas as shown in figure 7. With this small number of areas, we will use a single sink and we further simplify the system by allowing the gateway to play the role of the latter. An Air Quality Index (AQI) is used in Zig Bee model. The AQI is an indicator of air quality, based on air pollutants that have adverse effects on human health and the environment. The pollutants are ozone, fine particulate matter, nitrogen dioxide, carbon monoxide, sulphur dioxide and total reduced sulphur compounds. Figure 8 and figure 9 illustrate the AQI range.

IV. CONCLUSION

As discussed in this paper, recent technological developments in the miniaturization of electronics and wireless communication technology have led to the emergence of Environmental Sensor Networks (ESN). These will greatly enhance monitoring of the natural environment and in some cases open up new techniques for taking measurements or allow previously impossible deployments of sensors. WAPMS is an example of such ESN. ZigBee and ARIMA prediction model S will be very beneficial for monitoring different high risk regions of the country. It will provide real-time information about the level of air pollution in these regions, as well as provide alerts in cases of drastic change in quality of air. This information can then be used by the authorities to take prompt actions such as evacuating people or sending emergency response team. WAPMS uses an Air Quality Index to categorise the various levels of air pollution. It also associates meaningful and very intuitive colours to the different categories, thus the state of air pollution can be communicated to the user very easily. The major motivation behind our study and the development of the system is to help the government to devise an indexing system to categorise air pollution in Mauritius. The system also uses the AQI to evaluate the level of health concern for a specific area. ZigBee and ARIMA prediction model uses a novel technique to do data aggregation in order to tackle the challenge of power consumption minimization in WSN. We have named this novel technique as Recursive Converging

Quartiles. It also uses quartiles to summarize a list of readings of any length to just three values. This highly reduces the amount of data to be transmitted to the sink, thus reducing the transmission energy required and at the same time representing the original values accurately. Another strength of ZigBee and ARIMA prediction model is the high quality of results it produces. The collected readings are saved in a database and these can be accessed individually in a table or summarized area wise in a line graph. The table uses the AQI to provide the results using the associated colors' and it also provided the level of health concern for a particular area. The line graph allows the user to view the trend of air pollution for several areas at a time ZigBee and ARIMA prediction model also displays a map of the town of Port Louis, showing the locations of the deployed sensors nodes and the readings collected by each one. Thus, ZigBee and ARIMA prediction model is very flexible, very easy and yet very powerful due to its ability to provide highly summarized results as well as fine-grain results at the level of sensors.

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