Automated System for Air Pollution Detection and Control

[1]Viky V. Bagde, [2]Dr. Suresh D. Shirbahadurkar
[1,2]ENTC (VLSI and Embedded System), Dr. D.Y. Patil COE, Ambi, Pune, Maharashtra, India

Abstract
Air pollution is one of the environmental issues that have been often discussed. The fast-growing population and urbanization that result in the population concentrated in certain areas. Heavy transportation may lead to poor air quality and also it should inhaling pollutants for a long time also causes damages in human health. A traditional air quality monitoring is the method to build air quality monitoring stations, but this method is expensive and provides low resolution sensing data. As Pollution monitoring and traffic surveillance technologies continue to grow worldwide, suggesting the most suitable path to the user according to customized needs is becoming increasing important. This paper proposes a real-time system in which we detect Pollution and imbalanced traffic Loads at traffic lights and propose a path which is suitable to the user using Android APP and also propose Real-Time Directed Diffusion (RTDD),a real-time communication protocol for directed diffusion. RTDD significantly enhances the directed diffusion protocol, allowing time-critical flows to delivery more packets on time.

Keywords
Pollution Monitoring, Traffic Discipline, Direct Diffusion Protocol, Wireless Sensor Network, ZigBee/RF Communication.

I. Introduction

With fast development of the industries and urbanization process in the worldwide scale, environmental pollution problems become more universal now a day. At present environment contains different types of pollution as air pollution, water pollution and soil pollution on worldwide level. Air pollution is the presence of doped or pollutant substances in the air that interfere with human health or welfare, or produce other harmful effects on environment. The World Health Organization states that 2.4 million people died each year because of air pollution. Generally, pure air and human health just looks as hand in hand. Air pollution is harmful for human health. It causes many problems and difficulty in breathing, wheezing, coughing and many respiratory problems.

Currently there are two methods to monitor air pollution. First one is non-automatic and other is automatic. The advantages of non automatic sampling method are monitoring devices which is simple and also inexpensive but it monitors the parameters for certain period. It does not provide the real time monitoring. While the automatic sampling method provides the real time monitoring of harmful gas substances in the air. The non automatic sampling method uses the sensors to monitor the parameters, and send the data to central control centre. At present, for monitoring air pollution in wireless network the system includes the GSM, GPRS, etc. But these wireless nodes installation and maintenance are costly. That's why wireless sensor network have been rapidly developed. To support time-critical property of physical environments, sensor network protocols must provide real-time communication mechanisms. The goal of real-time communication is to make a proper communication and also minimize the number of packets. This is typically accomplished by prioritizing packets by their deadlines so that more urgent messages are sent first. Less urgent packets are essentially delayed so that more urgent packets can reach their destinations on time. The main issues for real-time communication over sensor networks are that the nature of sensor networks as multi-hoping.

II. Related Work

Many air pollution systems in various areas were reported in literatures. In 2011, Dan Stefan Tudose, Traian Alexandru Patrascu, Andrei Voinescu, Razvan Tataroiu, Nicolae Tapus etal. Proposed an environmental air pollution monitoring system that measures CO_2, NO_2, CO, HC & NH_4 concentration using mobile sensors in urban environment. The acquired information about air pollution in surroundings is then stored on central online repository system periodically. It uses a wireless GSM modem connection for transferring data to a central computer [1].

In 2012, Amnesh Goel, Sukanya Ray, Prateek Agrawal, Nidhi Chandra et .proposed a wireless sensor network to monitor air pollution levels of various pollutants due to environment changes. This system proposes a method which mainly focuses on longer sustain time period of sensor network by effectively managing energy in sensor network, effectively processing of information between various sensor nodes [2].

In 2011, Wenhu Wang, Yifeng Yuan, Zhihao Ling etal. [3], in order to comply with requirements of oil and gas industry, an air quality monitoring system was proposed based on Zigbee wireless sensing technology. It uses Zigbee wireless network to send results to the monitoring center so that, if some abnormal situations happens, a quick warning will be generated to remind staff to take effective measures to prevent major accidents and protect human lives in industry. Volatile organic compounds the World Health Organization (WHO) states that 2.4 million people die every year of a result of air pollution so, continuous monitoring of air pollution is necessity to day [6]. Directed diffusion [7-8] is a sensor network routing protocol based on the publish-subscribe communication model. Its development was guided by the principle of data-centric routing. This is in contrast to traditional address-centric protocols (e.g. IP, DSR [9], or AODV [10]) which route based on host information. Diffusion also emphasizes in-network processing and localized interactions in order to promote energy efficiency and scalability. The goal of directed diffusion is to perform multipoint-to-multipoint communication using named data. All routing is based on named data which takes the form of attribute-value tuples as opposed to host information for address-centric protocols. Diffusion is also characterized by its emphasis on localized routing. Each node stores routing information only about its immediate (i.e., 1-hop) neighbours; no global information is required. In addition to RAP, there have been several other real-time protocols for sensor networks proposed. SPEED [11] is a real-time protocol for sensor networks that employs feedback control and stateless algorithms to support soft real-time communication. The protocol's design emphasizes load balancing, localized behaviour, and minimized dependence on the MAC layer. SPEED uses a location-based routing protocol to forward packets to nodes which have maintained a required relay speed. MMSPEED [12] is an extension of SPEED which provides support for different levels of timeliness and reliability. Timeliness is achieved using the required delivery speed algorithm defined in SPEED and reliability is maintained by probabilistic multipath forwarding. DEED, a soft real-time communication protocol for sensor networks, considers

both energy and end-to-end delay [13]. To do so, DEED builds a dynamic delay-constrained minimum-energy dissemination tree. Like RAP and SPEED, it also assumes location information for each node. A Real-Time Power-Aware Routing protocol (RPAR) is proposed in [14]. It makes routing decisions based on real-time performance and energy efficiency. RPAR assumes each nodes knows its location and is capable of dynamically adjusting its transmission power.

III. System Implementation

The block diagram of system is shown in fig. 1. The system consists of four parts. Out of these, one is master, two are slave nodes used to communicate with master in wireless communication and the fourth node is used as Android app, which is to use for the user.

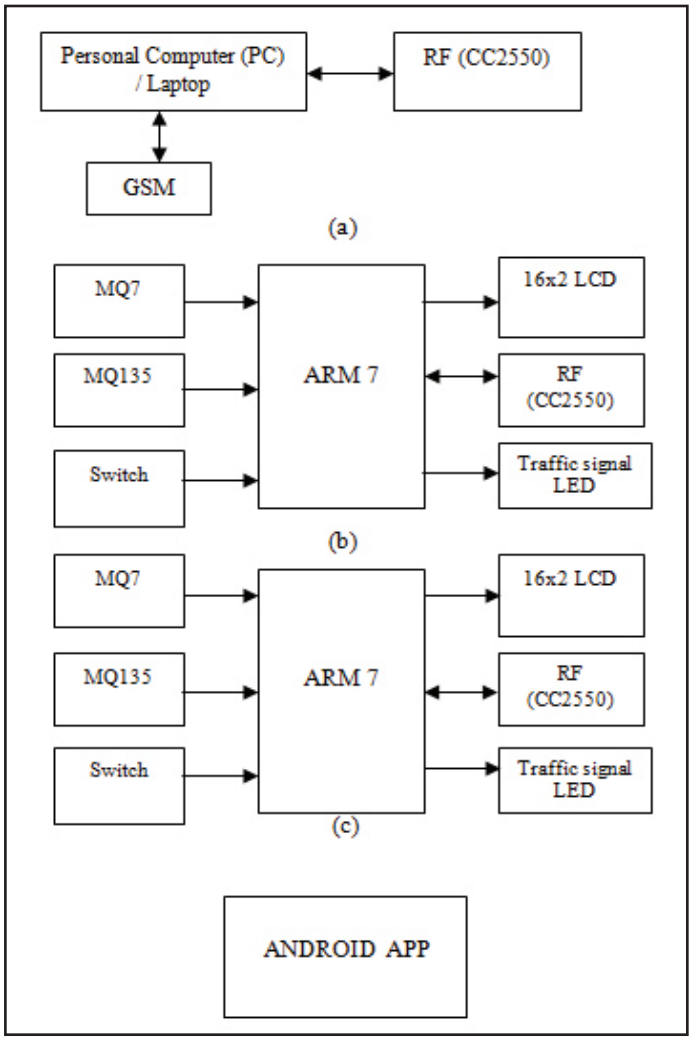

Fig. 1: Proposed System
(a) Master (b) Slave 1 (c) Slave2 (d) Android App

Here, Personal Computer (PC) or laptop is used as master and two microcontrollers are used as slaves. Zigbee/RF, which is used for wireless communication, is connected to master as well as all two slaves. Sensors are connected to the slaves as they take part in communication with master. Both of these two slaves are connected with the Carbon Monoxide Sensor (MQ7) and combustible gas sensor (MQ135).

A. Carbon Monoxide Sensor (MQ-7)

Sensitive material of MQ-7 gas sensor contains SnO_2, which with lower conductivity in pure air. It make detection by general method of cycle high and low temperature, and detect CO when low temperature (heated by 1.5V). . MQ-7 gas sensor has high sensitivity to Carbon Monoxide gas. The sensor could be used to detect different gases but specially contains CO gas in air; it is with low cost and suitable for different application.

B. Combustible Gas (MQ-135) Sensor

Sensitive material of MQ135 gas sensor is contains SnO_2, which with lower conductivity in clean air. When the target combustible gas exist, the sensor's conductivity is higher along with the gas concentration rising. MQ135 gas sensor has high sensitivity to Ammonia, Sulfide and Benze steam, also sensitive to smoke and other harmful gases. It is with low cost and suitable for different application.

C. RF (CC250)

The CC2550 is a low-cost 2.4 GHz transmitter designed for very low-power wireless applications. The circuit is intended for 2400-2483.5 MHz ISM (Industrial, scientific and medical) and SRD (Short range device) frequency band.
The RF transmitter is integrated with a highly configurable baseband modulator. The modulator supports various modulation formats and has a configurable data rate up to 500k Baud.

D. Direct Diffusion Protocol

Directed diffusion is a data-centric (DC) and application-aware paradigm in the sense that all data generated by sensor nodes is named by attribute-value pairs. The main idea of the DC paradigm is to combine the data coming from different sources enroute (in-network aggregation) by eliminating redundancy, minimizing the number of transmissions; thus saving network energy and prolonging its lifetime. Here the network route is fixed. When one slave wants to transfer the data it does so by sending the data to the nearest slave (Neighbour). The neighbouring slave will then attach its own data to the already received data to make a combined frame. In short the combined frame will contain the data's of both the slaves. The master will then separate the two data's and display it on its GUI.

E. Microcontroller

Here, ARM7 microcontroller is used. All the sensors are connected to the microcontrollers. Two sensors, carbon monoxide and combustible gas sensors are connected to both slaves microcontroller. Microcontroller consists of inbuilt 10 bit ADC (Analog-to-digital converter) which converts all the analog input received from sensors to digital value and displays it on LCD (Liquid Crystal Display). Microcontroller also sends the sensors data to master upon receiving request.

F. Liquid Crystal Display (LCD)

A 16×2 LCD is used here to display the patient body parameters corresponding to sensor outputs. LCD takes data from micro-controller and displays it.

IV. Proposed Method

A. Traffic Pollution Monitoring

Here we are connecting pollution monitoring sensors such as Mq7 (CO) and MQ135 (Combustible gas) to the µC. The µC will continuously scan these pollution sensors and display it on LCD. The µC will send these readings to the main server using RF network. We are designing a WSN based Network in which the PC is the server and the two signal units are the slaves.

B. Traffic Density Tracking

Here we are connecting mechanical switches to the µC. The µC will scan the status of all the mechanical switches of traffic junction, in which all the traffic lights are covered. The µC will analyze the traffic density at each signal and accordingly display the traffic density on LCD as Low, Medium and High. All this happens in real time since we are scanning the switches at every 20 seconds. So, the signal time is proportional to the traffic density.

C. Direct Diffusion Protocol Details

Here we are reconfiguring the WSN using RF. Here we are considering 1 Master and 2 slave structure. In this network we are using the direct diffusion protocol. Here the network route is fixed. When one slave wants to transfer the data it does so by sending the data to the nearest slave (Neighbour). The neighbouring slave will then attach its own data to the already received data to make a combined frame. In short the combined frame will contain the data's of both the slaves. The master will then separate the two data's and display it on its GUI.

V. Results

Below figure shows the hardware implementation of the proposed model. Presented study of the continuously monitoring system. In this project the system is developed using ARM7.

Fig. 2: Hardware Implementation

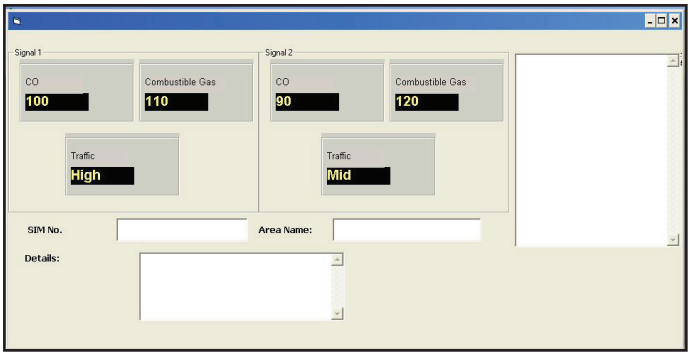

Fig. 3: Application Window

The fig. 3 shows the percentage of gases found as well as the gas detection on the application at the host side. The application is created using visual basic software. It shows all the details information as the values of the respective gases which are used in the project.

VI. Conclusion

In this paper, we proposed an energy efficient directed diffusion protocol. The protocol considers the communication cost, average remaining energy, minimum remaining energy and node connectivity. It selects a routing path with the least cost function. Since the proposed protocol consumes less energy (approximately 86% of the average dissipated energy in the original directed diffusion), the network has a longer lifetime. In addition, the proposed protocol has a slightly higher delivery fraction than the original directed diffusion.

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