Person Localization in Indoor Environment using Zigbee Technology

K. Henny Davis

Abstract--- ZigBee technology based on wireless sensor network was designed and deployed in the indoor environment like chemical plant for person tracking. Because of the complex indoor environment in the chemical workshop, the method of positioning through GPS signal is hard to reach. This paper proposed a low power consumption, low cost ZigBee scheme which can overcome the above mentioned disadvantage. The project presents a new approach to establish a wireless technology for the locality of people location, and continuously track locations of these moving (people) in an indoor environment like chemical plant. Each person id will be transmitted and it will be received through RF receiver in the chemical plant section. Zigbee transceiver is used to transmit the processed information to monitoring section for further analysis. We can give any voice command or alert in case of any gas leakage or fire accident, to the staffs working in chemical plant through Zigbee. The temperature inside the chemical plant is always monitored by LM-35 and gas sensor MQ-5 is used for detecting the leakage of gas. The main advantage of this project is during the disaster like chemical explosions, the rescuers could get the exact location of the staffs who work in the workshop.

Index Terms--- ZigBee, Temperature Sensor, Gas Sensor, Indoor Localization, Nano Id, RFID

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I. INTRODUCTION

Chemical industry plays an important role in the National Development Program, there is growing concern to the safety of the staffs during the chemical process in plant. In recent years, safety accidents in chemical plant occurred frequently. It is necessary to establish an emergency succor mechanism. Based on this background, a wireless staff location services system was presented on this paper. The system consisted of Nano ID, Monitoring centre and processing section system. Monitoring centre was software on PC for acquisition and display of location data. Indoor positioning system was deployed in chemical plant, and it's function included personnel location estimation. The sensors are used for monitoring the temperature and leakage of any gases.

II. OVERVIEW

With the development of information technology, the need of indoor localization is increasing GPS cannot achieve personnel location inside the building because of the signal attenuation , this leads researchers to study other indoor location-based technologies. As the results from the research are validated, some of the new wireless technologies had been applied in many fields.

RFID, Cellular-Based, UWB, WLAN, Bluetooth, ZigBee and CSS are some of pop indoor location based techniques now; each of them has its own features. A commonly used RFID location-based system called Spot ON , it collects signal strength index and discerns location through data clustering algorithms. A number of Cellular-Based systems have used global system of CDMA mobile cellular network to estimate the location of mobile clients. In UWB system, it estimates the tag position through

distance measurement between tag and readers by time of flight.CSS (Chirp spread spectrum) is a speed spectrum technique that uses wideband linear frequency modulated chirp pulses to encode information. ZigBee is based on wireless media access control and physical layer standard by IEEE 802.15.4 , that's a new protocol for short-distance wireless communication. Moreover, with advantages of ad-hoc, low-power and low-cost, it would be considered as a novel wireless solution. Wireless indoor positioning systems have become very popular recent years. The usage of these systems covers many areas ,for example: collection and analysis of the data in the field of industry, water monitoring of the grand national park, location detection of patients and equipment in a hospital, location detection of goods stored in the warehouse and intelligent home avoids indoor wiring. According to the advantage of the wireless sensor networks, this paper proposes a new system to solve the problem of location detection to staff after a fire hazard, or chemical explosions.

III.   OVERVIEW SYSTEM ARCHITECTURE

Personnel location and tracking system in the chemical plant mainly consists of three parts: Nano ID, Processing Section, and Monitoring center. The definition of each component and its functionality is discussed below.

A. Nano ID

'Nanotechnology' refers to materials and working devices that are engineered at the scale of atoms and molecules. In the metric system 'nano' refers to one billionth, so 1 nanometer (nm) is a billionth of a meter.To help put this into real terms, consider that 1nm is roughly the width of 1/50,000th of a human hair. A DNA strand is 2nm wide, and a single red blood cell is 2,500nm wide. Nano materials are special because they are able to utilize unusual properties (electrical, optical and others), which are determined by the particular arrangement of the atoms. Properties can include super strength, water or fire resistance and electrical conductivity.

The field of aerosol science and technology is undergoing significant changes as global interest in ultra-fine particles expands to meet the evolving needs of the research community and industry. Traditional applications in environmental studies, safety, and metrology to name a few, have been well served with laboratory style instruments. These products provide single-particle detection limits for sizes as low as a few nanometers, and are configurable to provide flexibility for concentration, flow, and the aerosol range of interest. Similarly, characteristics which have been associated with these capabilities include a degree of complexity, high capital cost, specialized operator training requirements, and measurement and analysis largely confined to the laboratory.

A RF transmitter module along with the encoder unit works equivalent to a nano id. Here the staff id detail is encoded and transmitted through the RF transmitter.

Fig. 1: RF Transmitter

The block diagram set up equivalent for the working of the nano id is shown below
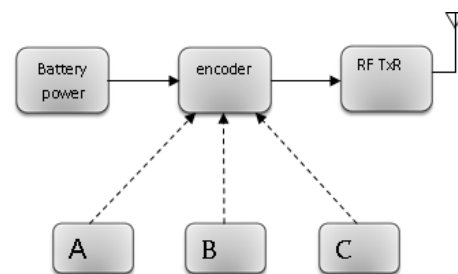

Fig 2: Equivalent diagram for Nano id

B. Processing Section

In each section of the chemical plant, Processing circuit is placed. The collected details are processed here and then it is transmitted through Zigbee to monitoring section for

further analysis. Zigbee is a wireless technology developed as an open global standard to address the unique needs of low-cost, low-power, wireless sensor networks. The standard takes full advantage of the IEEE 802.15.4 physical radio specification and operates in unlicensed bands worldwide at the following frequencies: 2.400-2.484GHz, 902-928MHz and 868.0-868.6MHz.The 802.15.4 specification was developed at the Institute of Electrical and Electronics Engineers (IEEE). The specification is a packet-based radio protocol that meets the needs of low cost, battery operated devices. The protocol allows devices to intercommunicate and be powered by batteries that last years instead of hours. The ZigBee protocol carries all the benefits of the 802.15.4 protocol with added networking functionality.

ZigBee PRO uses Stochastic addressing to assign addresses using probability analysis to simplify network formation. In networks which have used a tree cluster approach this can lead to address table 'churning' when a new node joins the network, something which can be problematic in large networks. By using Stochastic addressing nodes do not need a new address when joining a network. In the rare case of a collision the stack provides a conflict resolution system using the unique IEEE address assigned to each node. Another benefit is that the entire 16 bit address space is available to all nodes at any point in the network. This address space is constant even if the network undergoes change such as nodes joining or leaving or a change in the RF environment. ZigBee PRO networks have the ability to aggregate routes through the use of 'many to one' routing. This allows each device to share the same routing path reducing broadcast and network traffic and greatly improves the efficiency and stability of the network routing table.

The RS-232 serial communication protocol is a standard protocol used in asynchronous serial communication. It is the primary protocol used over modem lines. It is the protocol used by the MicroStamp11 when it communicates with a host PC. The various components in a serial link are the UART, the serial channel, and the interface logic. An interface chip known as the universal asynchronous receiver/transmitter or UART is used to implement serial data transmission. The UART sits between the host computer and the serial channel.

A frame is a complete and non divisible packet of bits. A frame includes both information (e.g., data and characters) and overhead (e.g., start bit, error checking and stop bits). In asynchronous serial protocols such as RS-232, the frame consists of one start bit, seven or eight data bits, parity bits, and stop bits. A timing diagram for an RS-232 frame consisting of one start bit, 7 data bits, one parity bits and two stop bits. Determining the position: Each person working in the indoor environment, say for example, a chemical plant is provided with an ID. Whenever the staffs enter in to any section of the chemical plant, his ID will be received by the RF receiver located in that particular section. It is then decoded and processed.

The processed information's are transmitted to the monitoring section for further analyzing through Zigbee PRO module and RS 232.
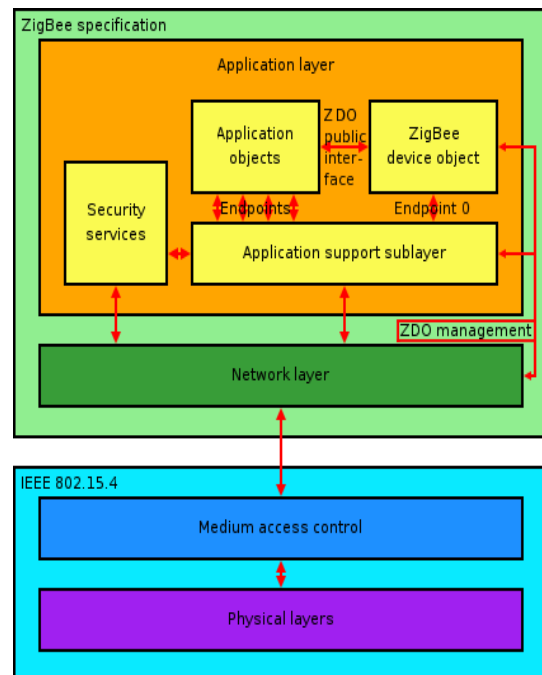

Fig. 3: IEEE 802.15.4/ZigBee Architecture

C. *Monitoring Section*

In this section the processed details are received through the ZigBee module and are given to PC for further analysis. The controller an give voice commands to any staff working through the Zigbee module and voice kit.
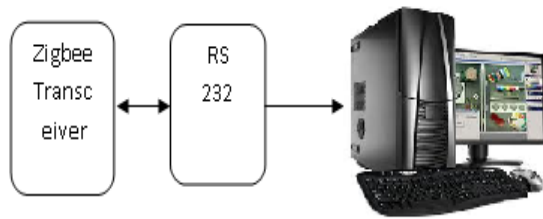

Fig. 4: Monitoring Section

IV. SIMULATION RESULTS

It's possible to do the simulation of this project using Visual Basic simulator. Microsoft Visual Basic 6.0 is Easy to learn Programming language. With Visual Basic you can develop Windows based applications and games. Visual Basic is much easier to learn than other language (like Visual C++), and yet it's powerful programming language. Visual Basic suits more for application developing than for Games developing. You can create sophisticated games using Visual Basic, But If you want to make a really advanced professional game like Quake 2, You may choose other language (like C++), that would be much more harder to program with. However, Visual Basic will be probably powerful enough to suit all your application. The features of VB are Visual Basic is event driven meaning code remains idle until called upon to respond to some event like button pressing, menu selection, Full set of objects - you 'draw' the application. Lots of icons and pictures of your use. Response to mouse and keyboard actions. Clipboard and printer access. Full array of mathematical, string handling and graphic functions. Can handle fixed and dynamic variable and control arrays.
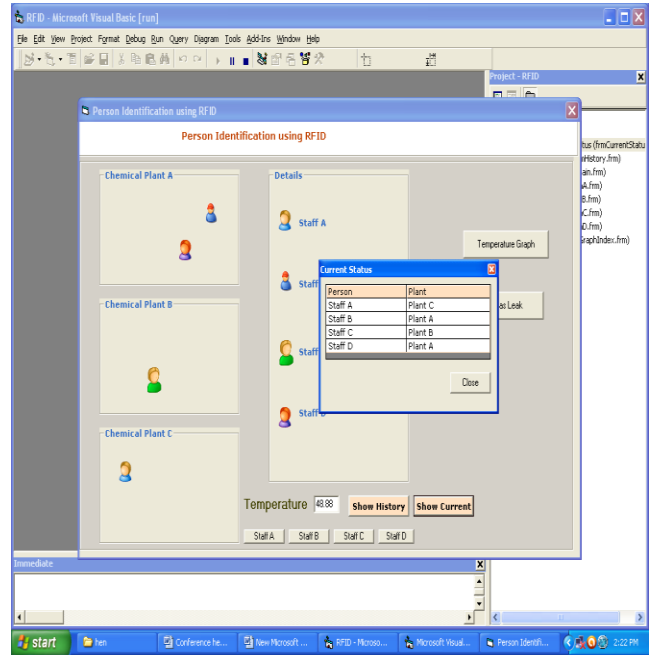

Fig. 5: Current Status of Staffs

The entire chemical plant is shown with 3 plant sections A,B, C and consider four staffs-A,B,C and D.

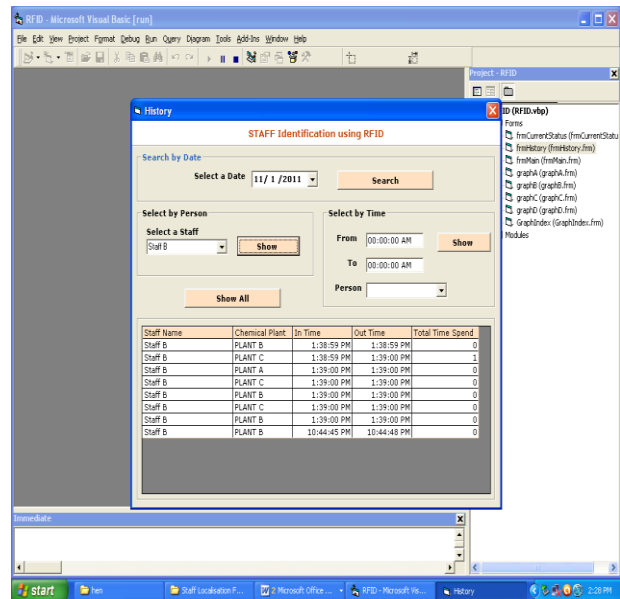The current position of Staffs are shown in accordance to the movements of staffs.

Fig. 6: History of Staffs

History of each staffs can be viewed by searching the name of staff, date and time. Also temperature and pressure graphs are obtained.
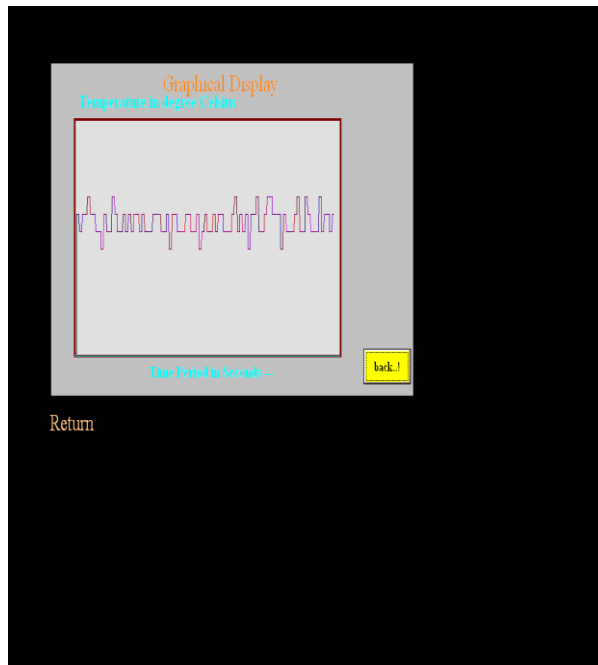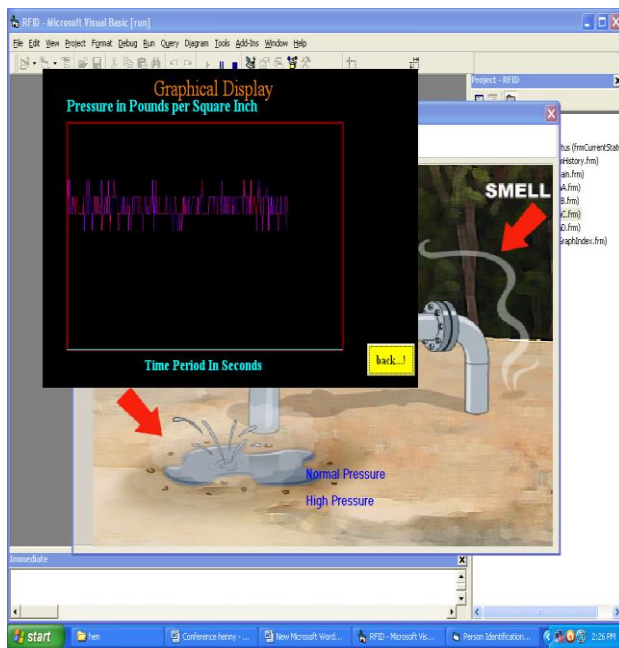
Fig. 7: Temperature Graph

Fig. 8: Pressure Graph

V.   CONCLUSION

In the paper we propose a new concept for person localization system using Zigbee communication module. This wireless technology based human tracking system helps to determine the exact position of staffs. The temperature sensor and gas sensor located in each chemical plant sections will keep on monitor the temperature variations and detect the leakage of gas. It also ensure security to staffs by alerting them by activating the alarm unit at proper time. It gives an easy way of conveying information to people. It is a low cost and compact system . During the disaster like chemical explosions, the rescuers could get the exact location of the staffs who work in the workshop.

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