Gas Leak Detection and Localization System Through Wireless Sensor Networks

Petros Spachos *, Liang Song § and Dimitrios Hatzinakos*
*Department of Electrical and Computer Engineering, University of Toronto, Toronto, ON M5S 3G4, Canada
§Omesh Networks Inc., Toronto Ontario, Canada
E-mail: {petros,dimitris}@comm.utoronto.ca, songl@omeshnet.com

***Abstract*—In this demonstration proposal we use a prototype of a Wireless Sensor Network (WSN) to monitor and locate gas leaks of a complex indoor environment. Specifically, a mobile node is moving inside a building to monitor any leakage of carbon dioxide (CO_2), supporting and displaying the level and the location of the leakage. Throughout the demonstration, the technological advantages of cognitive networking along with multihop routing are explored.**

I. Introduction

Wireless Sensor Networks (WSNs) can be an attractive solution for a plethora of communication applications, such as event monitoring and tracking. Typically, they consist of spatially distributed autonomous inch scale sensor nodes for data acquisition. For instance, in a large building a number of gas detection sensors can be deployed to monitor the air quality. Each sensor communicates with a control room to report all the collected data of the area that it monitors. As a consequence, the location of the event is important in such monitoring applications. However, in an indoor environment the deployment of widely used location systems can be impossible or infeasible.

A location system based on WSNs can alleviate the problem. Their deployment would have the least impact on the existing infrastructure and with low cost. A number of nodes can serve as stationary nodes in order to monitor the location of any other mobile nodes in the area.

The proposed demonstration shows that the technology of cognitive networking, [1], along with opportunistic routing, [2], and the potential of an easily deploying and inexpensive WSN can alleviate the problem.

II. System Modules

The proposed demonstration is a monitoring system supporting real time location system through the use of a WSN. The system consist of three different modules.

A. Stationary Nodes

A number of fixed wireless location stations being deployed in a building infrastructure. In this demonstration, RapidMesh boards from Omesh Networks, [3], are used, shown in Figure 1. The number of the stations depends on the size of the monitoring area. Each wireless station can be either just a wireless node, shown in Figure 2, or a wireless sensor node, shown in Figure 3. In the second case, the station will also be able to monitor the area around it. However, there is a great difference in the energy consumption. A sensor attached to the wireless node will increase the energy consumption of the node. In the proposed demonstration the station nodes are not connected with sensor nodes and are powered up with 3 AA batteries.

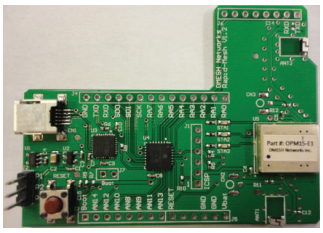

Fig. 1: RapidMesh board

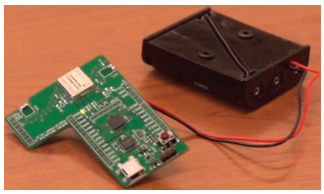

Fig. 2: Stationary Node

B. Mobile Node

The mobile node, is a board that has a sensor and a radio component, and its set up was presented in [4]. In this demonstration, iAQ-2000 sensors from Applied Sensors, [5], are used. The sensor component can monitor the area around the board and pass all the data to the radio component. The radio component can transmit all the data to a control room for processing. Any number of mobile prototypes can monitor different areas simultaneously. During the demonstration, the mobile prototype is powered with one 9V battery.

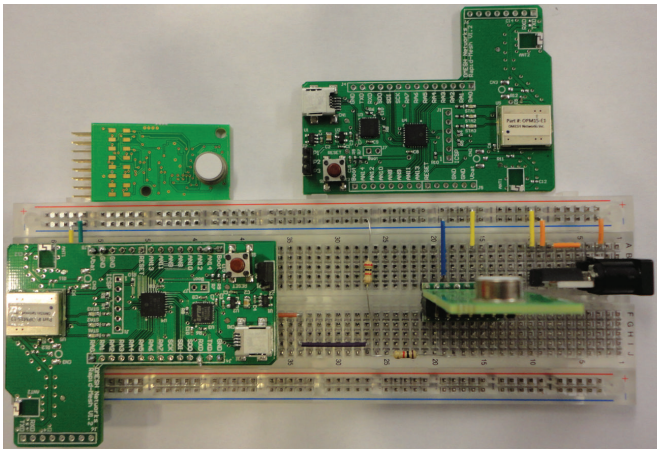

Fig. 3: Gas Leak Monitoring Board

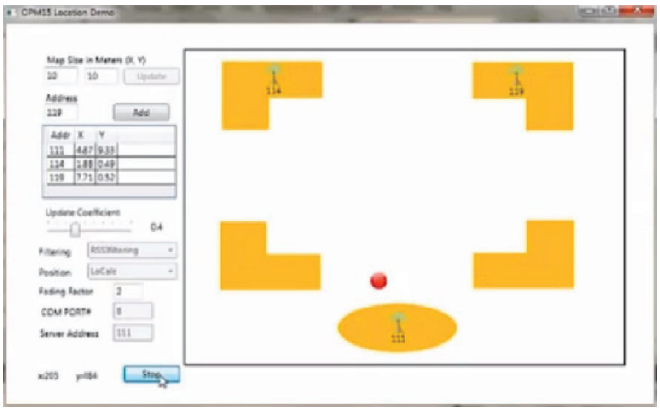

Fig. 4: Location System

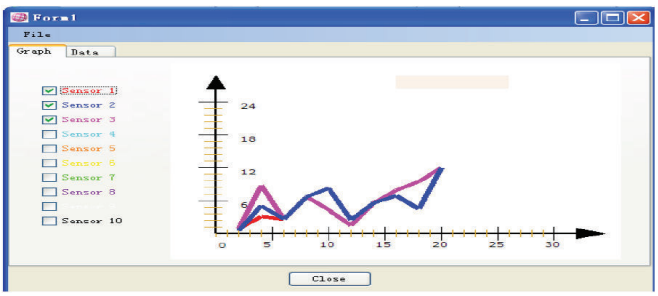

Fig. 5: Gas Concentration Levels

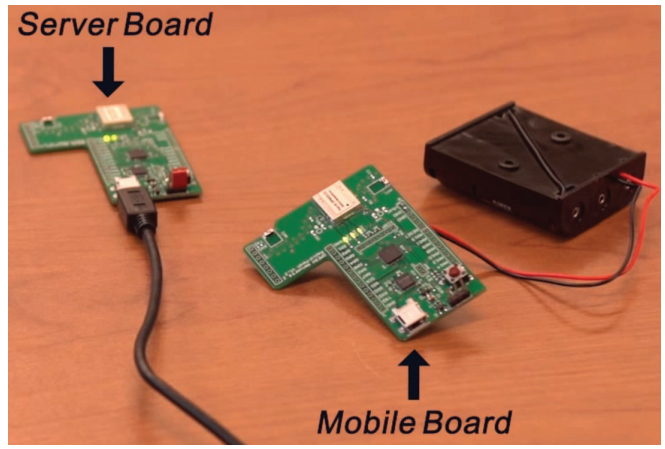

Fig. 6: Server and mobile board

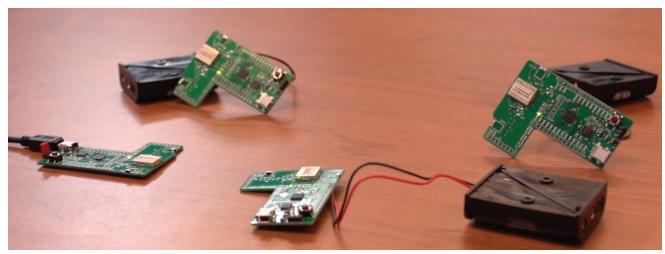

Fig. 7: System overview

C. Control Room

The control room is a remote server that can process the data from the mobile prototype. The server is a software and computer which is connected to another RapidMesh board. This board is loaded with a serial pass-through program, so that whatever information mobile terminal sends is fed directly into the computer software mapping the location of mobile terminal. A Graphical User Interphase (GUI) has been created, shown in Figure 4, to display the location of the mobile prototype, along with the gas levels, Figure 5.

III. Demonstration Description

During the demonstration, three stationary nodes are placed at fixed locations. One mobile node moves inside the area of the triangle that the stationary nodes create. The mobile node collects information about neighbor stationary node and radio signal strength data, and streams all the location data along with the monitoring data to a remote server for processing in real-time. At the server side, a RapidMesh board is connected to a laptop and receives the data transmission from the mobile node. The server maps out the location of the mobile node according to the position of the stationary nodes by localization and tracking algorithms while the monitoring data are also displayed. The location accuracy in typical indoor environment can be in sub one meter range. With the proposed system, it is easy to extend the wireless network coverage. For instance a wireless network can be extended to the entire floor or building by multiple wireless hops without any cabling. Figure 6 and Figure 7 show an overview of the proposed demonstration along with the different modules.

IV. Conclusions

This work demonstrates a gas leak detection system with real time location system based on WSNs. The location system was recorded and uploaded online [6]. Due to its exibility a gas monitoring system along with an accurate indoor location system can be deployed in buildings, shopping malls, mining tunnels, hospitals, and a number of other applications.

V. Acknowledgement

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References

[1] L. Song and D. Hatzinakos, "Cognitive networking of large scale wireless systems," *International Journal of Communication Networks and Distributed Systems*, vol. 2, no. 4, pp. 452–475, June 2009.
[2] P. Spachos, L. Song, and D. Hatzinakos, "Opportunistic multihop wireless communications with calibrated channel model," *IEEE International Conference on Communications (ICC) 2012*, pp. 5670 –5674, June 2012.
[3] "Omesh Networks," http://www.omeshnet.com/.
[4] P. Spachos, L. Song, and D. Hatzinakos, "Prototypes of opportunistic wireless sensor networks supporting indoor air quality monitoring," *IEEE Consumer Communications and Networking Conference (CCNC) 2013*, Jan. 2013.
[5] "Applied Sensor," http://www.appliedsensor.com/.
[6] "Location Demo," http://www.youtube.com/watch?v=zIe9qGMxv_w.