InstraNode: Dual-Microcontroller Based Sensor Node for Real-Time Structural Health Monitoring

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1 Introduction

Fundamental studies indicate that the structural health monitoring technology can be used effectively to reduce the extent of natural or man-made disasters. InstraNode is a sensor node for real-time monitoring the health of civil engineering structures such as highway bridges and skyscrapers. It is specially designed to take civil engineers' requirements into account. To meet their requirements InstraNode has a dual-microcontroller architecture sharing a FIFO memory. Evaluation shows that IntraNode has many distinguished features over other sensor nodes such as high power-efficiency, low jitter, and high network performance.

2 Design

As shown in Fig. **??**, InstraNode consists of two separate boards: Main Board and Daughter Board. The main board includes two microcontrollers (PIC18F8680), one FIFO memory (CY7C464), three *MEMS*-type accelerometers (SD1221), one gyroscope (ADSR300), and 802.11b PC card. The daughter board can be plugged into the main board when the wired communication interface is needed. The daughter board has one microcontroller(MC9S12NE64), where the Fast Ethernet controller is intergraded and one optical transceiver(HFBR-5103).

IntraNode has a dual-microcontroller architecture, which is unique in sensor node design. In our current implementation, the one slower low-power microcontroller (runs at 3.0V and 4MHz) is dedicated to sampling data from sensors and the other faster/high-power (runs at 4.3V and 40MHz) microcontroller is responsible for networking tasks, such as transmitting/receiving data and running a routing algorithm. This unique architecture makes our design goals achievable such as,

- High Power Efficiency
- Low Jitter
- High Network Performance

Additionally, InstraNode has a capability of *Multimodal Operation*: Wired/Wireless and Battery-powered/AC-adaptor-powered. Also, it supports a smooth and fast transition in
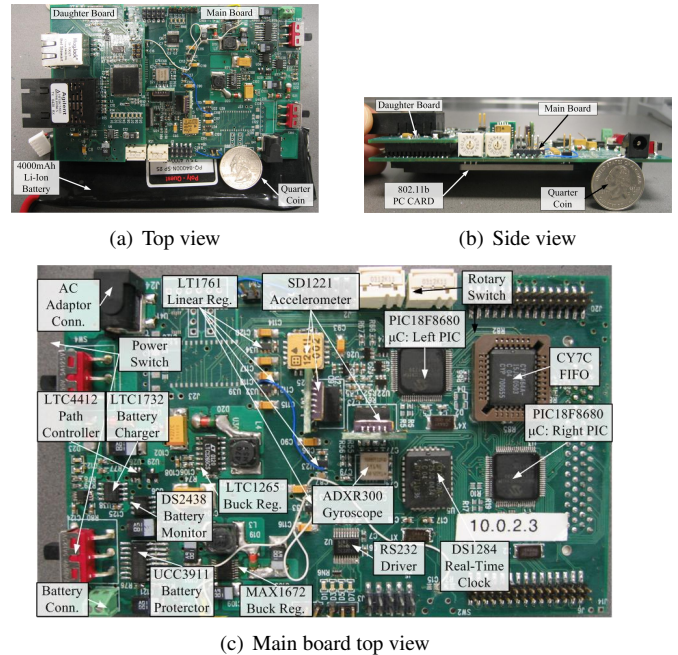

(a) Top view

(b) Side view

(c) Main board top view

Figure 1: Photo of InstraNode

between two modes. IntraNode can detect the sudden failure of the one communication interface or power source, and switch into the others automatically, guaranteeing a perfectly continuous monitoring.

3 Demonstration

We first demonstrate that a set of IntraNodes are sending tri-axis vibration data to a host computer through an an 802.11b wireless link. The vibration data will be shown on the screen of the host computer in real-time.

Secondly, we show how much our dual-microcontroller architecture can reduce power consumption and jitter in a qualitative manner.

Finally, the capability of smooth and fast transition between multiple modes will be demonstrated.