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Structural Monitoring Of Buildings Using Wireless Sensor Networks

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Abstract: *Present part of the structure of a buildings are found everywhere and is monitored using wireless sensor networks is one of the most emerging technologies for a risk mitigation. Buildings are subjected to natural risks such as earthquakes, strong winds and manmade risks such as fire and crimes. So we have to monitor different measurable factors such as aging of structural performance, fatigue, damage, gas leak, fire etc. To monitor these parameters by using different kinds of sensors which are placed in different parts of the building and provide risk control of the buildings from these hazards. In this paper a smart sensor based on the "Berkley Mote" platform is used for the monitoring of building and the "MICAz OEM Edition Mote" was proposed for the testing of building.*

Keywords: *Structural Performance, Fatigue, Damage, Gas leak, Fir.*

I. Introduction

Risk of buildings and civil engineering structures from natural hazards is large and growing. The 1995 Kobe earthquake in Japan killed over 6,400 people and the number of completely destroyed buildings and houses was over 100,000. The 2004 and 2007 Niigata earthquake in Japan, tsunami by the 2004 Indian Ocean earthquake, and the 2005 Hurricane Katrina in New Orleans caused heavy damage.Wireless sensor network (WSN) is key technology to realize the present computing and networking environment and it is expected that such an advanced technology will play an important role for natural hazard mitigation[3,8].A research on present part of the structure of buildings are monitored by using wireless sensor networks is discussed and actual application to high-risk buildings are described[4].

Role of sensor networks:

A wireless sensor network plays an important role in such strategies and can be connected to the internet so that this information can be used to monitoring future risks. Wireless sensors [2] are easy to install, remove, and replace at any location, and are expected to become increasingly smaller by using MEMS technology. They will provide a present, networked sensing environment in buildings.For example, the acceleration and strain at numerous locations on each beam and column, temperature and light in each room, images and sounds in desired regions can be obtained by the "smart dust" sensors [1, 3]. Additionally, a single type of sensor such as a condenser microphone can be used for multiple purposes, for example, to detect earthquake, fires and intrusions. Furthermore, a fiber optic network is not only utilized as infrastructure for information technology, but also as a "wired" sensor network.The following table shows the various kinds of hazards, and possible applications and combinations of sensors.

Sensor Application

Hazard	Application	Sensor
Earthqu-ake / Wind	observation	acceleration
	experiment	acceleration, strain
	structural control	acceleration
	health monitoring	acceleration, strain
	damage detection	acceleration, strain
Fire	fire detection	temperature, smoke,acoustic, olfactory
	gas leak detection	olfactory
	alarm, warning	sounder
	evacuation control	temperature, smoke, acoustic, olfactory
Crime	surveillance	acceleration, smoke, acoustic, light, camera
	Security alert	sounder

II. Berkeley Mote

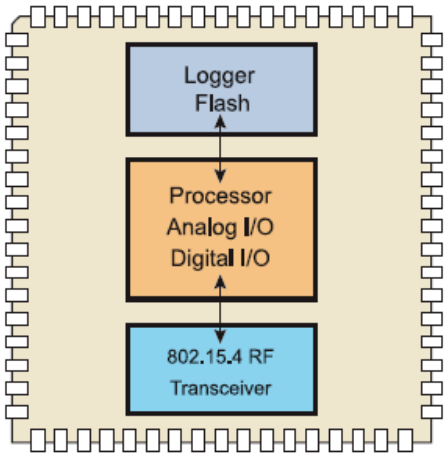
The Berkeley motes are a family of embedded sensor nodes sharing roughly the same architecture.Let us take the MICA mote as an example. The MICA motes have a two-CPU design. The main microcontroller (MCU), an Atmel ATmega128L, takes care of regular processing. A separate and much less capable coprocessor is only active when the MCU is being reprogrammed.The ATmega103L MCU has integrated 512 KB flash memory and 4 KB of data memory. Given these small memory sizes, writing software for motes is challenging [5].

MICAz OEM **EDITION MOTE:**

MICAz OEM EDITION Mote

- OEM Module for Battery-Powered Mesh Network Sensor Nodes
- Postage Stamp Form Factor.
- It is a IEEE 802.15.4, 2.4 GHz Radio for up to 250 kbps Data Rate [6, 8].
- XMesh™ Mesh Networking Protocols.
- Analog and Digital I/O Interface for Easy Sensor Integration [6, 8].

Internal Architecture of MICAz OEM MOTE:



MICAz OEM Mote Powerful design features include:

- Optimized processor/radio module integration based on MEMSIC's extensive Mote development and deployment.
- Flexible onboard hardware interface for both standard and custom sensing devices.
- Comprehensive software support, including sensor board drivers and algorithms, via MEMSIC's industry leading XMesh™ software technology.

The MICAz OEM Edition is the functional equivalent of MEMSIC's popular MPR2400 MICAz Mote in a postage stamp form factor. This inherent design continuity makes the MICAz OEM Edition an ideal solution for next-generation mesh networking products and designs [7, 9, 12].

The MICAz OEM Edition is offered in a 68-pin LCC form factor for high-volume surface-mount integra-tion.By utilizing open platform, standards based interfaces the OEM Module offers users an attractive value proposition consisting of easily differentiated, low-power 2.4 GHz IEEE 802.15.4 compliant radio modules that can be rapidly designed and built[7,9,12].

Processor & Radio Platform:

- IEEE 802.15.4 compliant/ZigBee capable RF transceiver.
- 2.4 GHz globally compatible ISM band.
- Direct sequence spread spectrum radio for RF interference resistance and inherent data security.
- 250 kbps high data rate radio.
- 68-pin package designed for easy sensor integration including light, temperature, RH, barometric pressure, acoustic, magnetic, acceleration or seismic, etc.

Software support:

- Optimized, industry proven, XMesh™ networking stack for low-power, self forming, high reliability wireless networks.
- Open interfaces for integration and customization of sensor node applications and works with operating system called TinyOS.

Specifications

Processor/radio	**MICAz Mote**	**Remarks**
Processor Performance		
Program Flash Memory	128k bytes	
Measurement Flash	512k bytes	>100,000 Measurements
Configuration EEPROM	4k bytes	
RAM	4k bytes	
Serial Communications	UART	0-3v transmission levels
Analog to Digital Converter	10 bit ADC	8 channel, 0-3v input
Other Interfaces	Digital I/O,I2C,SPI	
Current draw	8 mA	Active mode
	<15uA	Sleep mode
RF Transceiver		
Frequency band	2400MHz to 2483.5MHz	ISM band
Transmit(TX) data rate	250 kbps	
RF Power	3 dbm (max), 0 dbm (typ)	
Receive Sensitivity	-90 dbm (min),-94 dbm(typ)	
Current Draw	19.7mA	Receive mode
	11mA TX, -10 dbm	
	14mA TX, -5 dbm	
	17.4mA TX, 0 dbm	
	1 uA	Sleep mode, voltage regulator OFF
Electromaechanical		
External Power	2.4V - 3.6V	
Size (in)	0.95 x 0.95	LCC68
(mm)	24.13 x 24.13	

OEM Design Kit:

For prototyping and development, MEMSIC provides Mote Works™, a fully integrated software platform and a complete OEM Design kit, consisting of pre-programmed OEM Edition Reference Designs, OEM Edition Modules, sensor or data acquisition boards and an Ethernet base station. The Mote Works™ software platform is optimized for low-power battery-operated networks providing an end-to-end platform across all tiers of wireless sensor networking applications [6].

TinyOS:

TinyOS is an open-source operating system designed for embedded systems with very limited resources, like the Mica series of motes. TinyOS uses the NesC language, an extension to C, with similar syntax, that attempts to embody the structuring concepts and execution model. As an embedded operating system, it responds to hardware events with handlers, while also allowing tasks, which are equivalent to functions in other programming languages.TinyOS does not implement object sharing[10,11].

III. Conclusion

The feasibility of structural monitoring of buildings using the smart sensors was discussed and the MICAz OEM EDITION Mote was proposed as a wireless sensor to check the performance of the building. Further research on more effective modes of communication is needed to achieve a wireless sensor network for building risk monitoring.

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