Embedded System Design : Project Specification
Crowd Information Monitor

Abhinav Golas, Mohit Rajani, Nilay Vaish, Pulkit Gambhir

August 1, 2005

1 Introduction

Efficient organisation of large exhibitions, conferences, gatherings etc. require the presence of a sophisticated, accurate yet easy to install and use crowd information monitoring system. We wish to build such a system, which can relay to a central server the crowd density figures in different areas of an exhibition space along with some other general useful information such as temperature and humidity values. The project is to be based on *Berkeley motes* programmed using *TinyOS* which will be capacitated to form an ad-hoc network to relay all the information to a base station.

2 System Specification

The project requires information to be collected from different portions of an exhibition area and then be relayed back to a base station in a wireless manner. To achieve this objective, a *wireless network mote* is placed on the entrance and exit of every section or room in the area being covered. This mote would be interfaced with a *sensor board* which would carry a variety of sensors including temperature, humidity and light sensors in particular. This light sensor can be used to create a trip switch which can be used to count the number of people entering and exiting the room.

The data about the number of people that entered as well as the number that exited the room will be logged in the on board flash memory. This data will be sent out periodically on the network and routed to the base station along with the temperature and humidity data as a single message

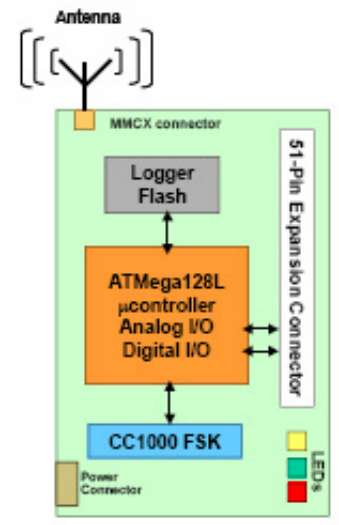

Figure 1: Block diagram of Wireless Network Mote

packet. What we will be able to achieve is a wireless ad hoc network which is established using these network motes interfaced with sensor devices.

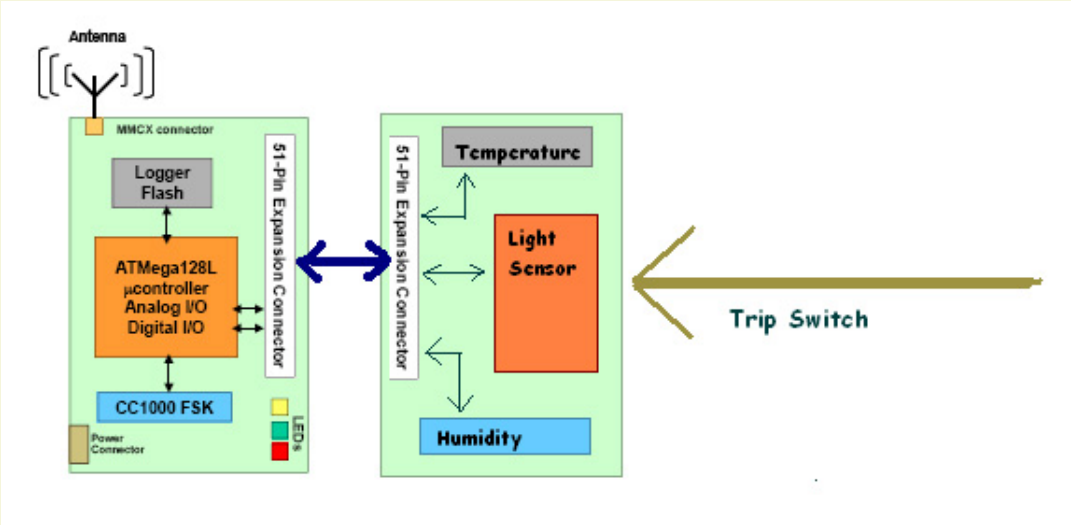

Figure 2: Mote interfaced with sensors

The overall structure of the system would therefore consist of a large number of these network mote cum sensor devices interacting together in a network tree structure with a common base station as the root of this tree.

The base station will be connected to a sever where the data processing will take place and the results will be displayed.

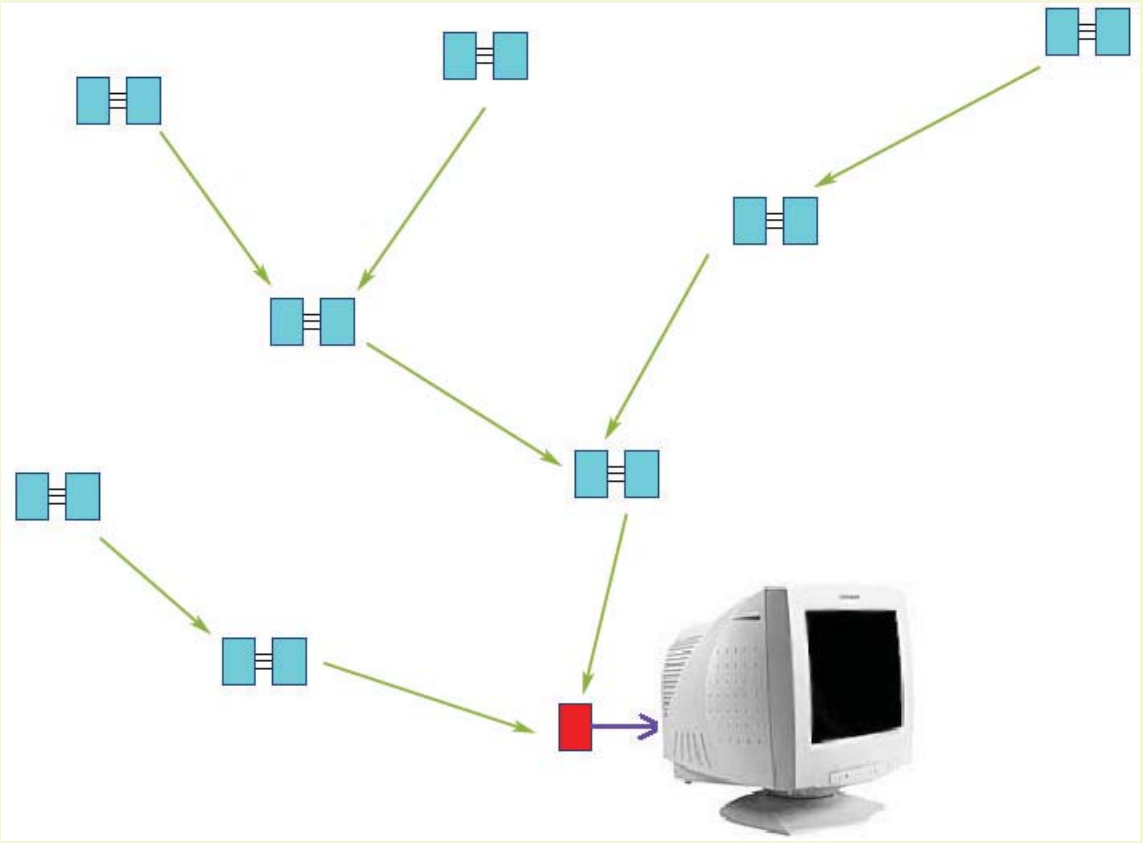

Figure 3: Networking setup

Once the data has been collated and processed on a server which is interfaced with a networking base station; the results can be easily over another networking medium. We propose to implement a web based interface for displaying and managing this information. A user may be able to log into a webpage and view crowd density values as well as certain sensor readings such as temperature and humidity. In order to display information in a useful manner it would be required to either feed in locational information of sensors by hand or figure out this information from GPS.

3 Hardware and Software Required

3.1 Network Motes

The wireless networking motes to be used in this project have been procured from Crossbow Technology, Inc.. In particular, the motes being used are MICA2 MPR410($433\,\mathrm{MHz}$) ones. These motes use the Chipcon CC1000, FSK modulated radio. They also utilize a powerful Atmega128L microcontroller and a frequency tunable radio with extended range. The motes also have a 51-pin expansion pad using which they can be interfaced with a variety of sensors attached on a daughter board. These motes also have a $512\,\mathrm{Kb}$ flash data logger memory. The motes are powered by 2 AA batteries, and run on a voltage of around $3000\,\mathrm{mV}$. When operating at full power, the radio transceivers have a range of around $60\,\mathrm{m}$ in open ground.

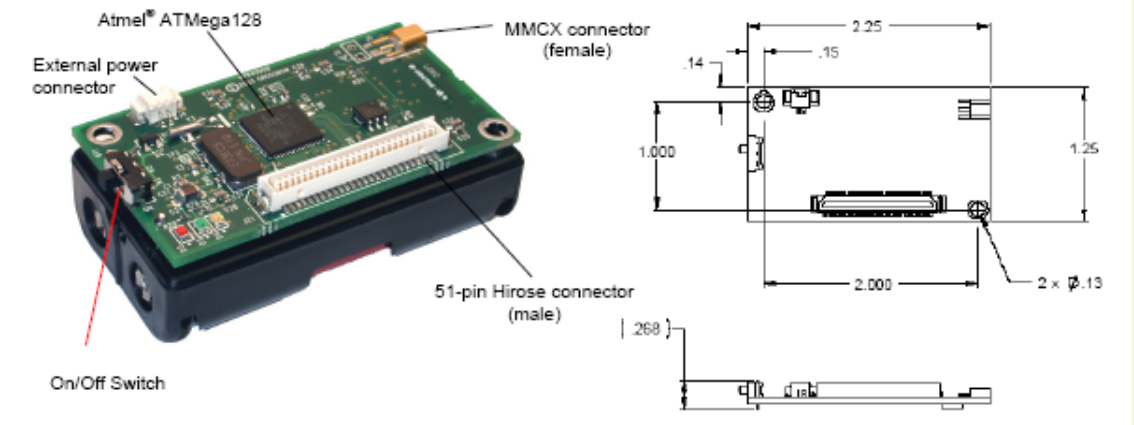

Figure 4: The MICA2 MPR410($433\,\mathrm{MHz}$) Wireless Networking Mote

3.2 Mote programmer

The MICA2 MPR410($433\,\mathrm{MHz}$) network motes can be interfaced with a PC using mote programming boards which in turn connect via a serial or parallel port. We will be using MIB510 Serial Interface Boards for this purpose. The programming board provides power to the devices through an external power adapter option and provides an interface via an RS-232 cable. The board has an in-system processor (Atmega16L) to program the motes.

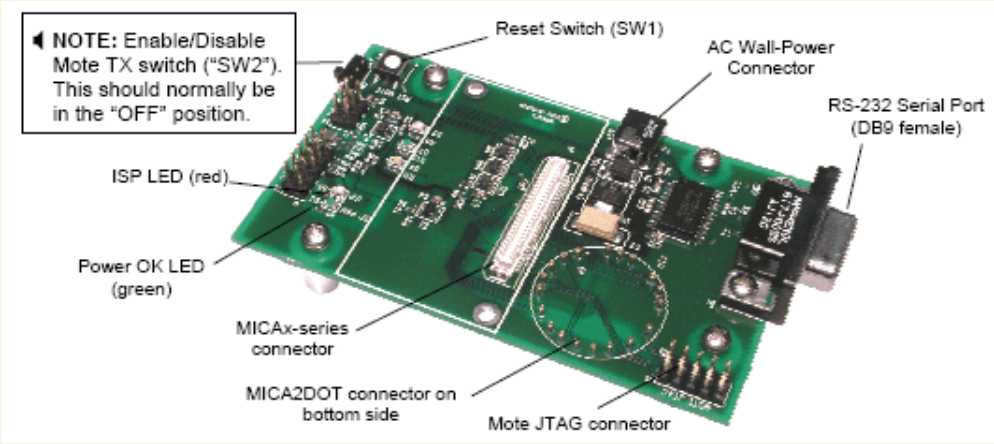

Figure 5: The MIB510 Serial Interface Board

3.3 Sensor Boards

Sensor boards compatible with the networking motes and programming board have also been procured from Crossbow Technology, Inc.. These are available in two varieties, the MTS400CA which has 5 basic environmental sensors and the MTS420CA which has an additional GPS module. The sensors available on the boards are :-

a $Sensirion^{®}$ SHT11 Humidity and Temperature sensor

b $Intersema^{®}$ MS55ER Pressure sensor

c TAOS TLS2550 Digital Light sensor

d ADXL202JE 2-Axis accelerometer

e LeadTek GPS-9546

3.4 Software Tools

The motes can be programmed using *TinyOS* and *NesC* which is a C-based language. At the programmer's level, nearly every aspect of these motes is configurable from controlling sensors to power management options. The firmware for the sensor boards has been provided by the manufacturer, and these can now be accessed cleanly using provided modules. The major issues in programming the motes may be summarized as follows :-

- The programs need to be resource efficient and use minimum space

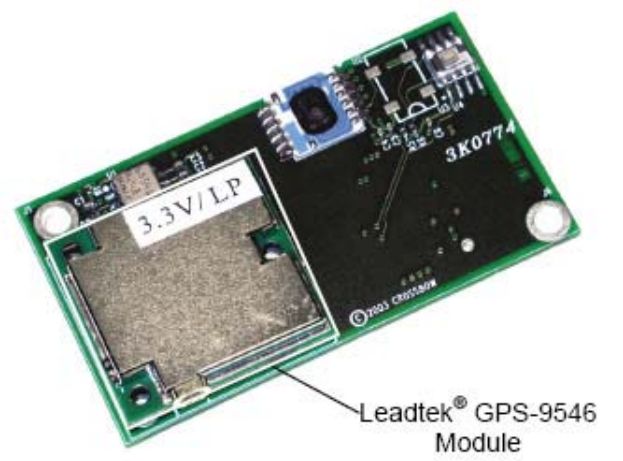

Figure 6: The MIS420CA Sensor Board

- The power management needs to be done carefully to enhance battery life. There are no direct modules available to dynamically control power management
- Multi-hop networking algorithms must be implemented from scratch
- All communication must be done with care, as flooding network with excessive traffic leads to a lot of interference and packet loss