

Wireless Sensor Network Proposal

ECE 290 - Fall 2007

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Abstract:

At the direction of the Electrical Engineering Department, our project is to continue work on the wireless sensor network begun by a previous design team. They tried to build a wireless sensor network that supports video and audio acquisition and transmission. Their finished product will include a base station that controls three wireless sensor nodes. Our intention is to replace their fixed station with a portable model. This receiver will have all of the functions of the original; in addition, we intend to add a user friendly interface as well as support for several node types. The receiver will be implemented by either a custom design or a modified PDA. Each option will cost under one thousand dollars. We plan to have a proof of concept completed by the end of April 2007.

Background:

Today, wireless sensor networks are found in a variety of fields. However, they are usually used in low-bandwidth telemetry applications. The lack of wireless sensors which provide audio and video transmission is certainly not due to a lack of desire for them. The usefulness of the sensor itself is affected largely by the ease of which it can be accessed. A portable receiver device would allow the sensor to be accessed from various locations without being constrained by the distance to a non-mobile receiver station. This becomes especially important when the wireless sensor's transmission power is very low.

Our portable receiver design will interface with an existing wireless sensor implementation. The existing wireless sensors provide audio and video transmission, plus a flexible standard by which future sensors can be supported (for example, a temperature sensor). The sensors operate continuously for approximately two hours, but support power-saving modes of operation when continuous use is not required. The sensors transmit and receive data through a low-power digital radio which operates through a specification known as ZigBee. Specifically, the hardware chosen is a commercial implementation of ZigBee known as Xbee.

Objectives:

In order for the receiver to be useful, the most important requirement is that it is portable. In addition, the device's output must be visible in a variety of operating environments (indoors, outdoors, and under different lighting conditions). Audio output should have adjustable volume. Further, the device should use rechargeable batteries, which should last for at least five hours. The device should have an easy to use user interface. Also, it should offer enough functionality to make use of all features provided by the wireless sensor, such as putting individual sensors into power-saving mode. Sensor outputs should be able to be selectively used or ignored on a per-sensor basis. Simultaneous display of multiple video channels should be accomplished by dividing the receiver's screen into multiple subsections.

Solution:

Receiver Specifications:

Battery life: 5 hours

Screen size: 5" to 9" diagonal

Illumination: Dimmable CCFL (dimnable as required by ambient lighting)

Weight: 5 lbs

Image Decoding: JPEG

Transceiver: XBee

XBee Specifications:

Typical range: 30 m indoor, 100 m outdoor

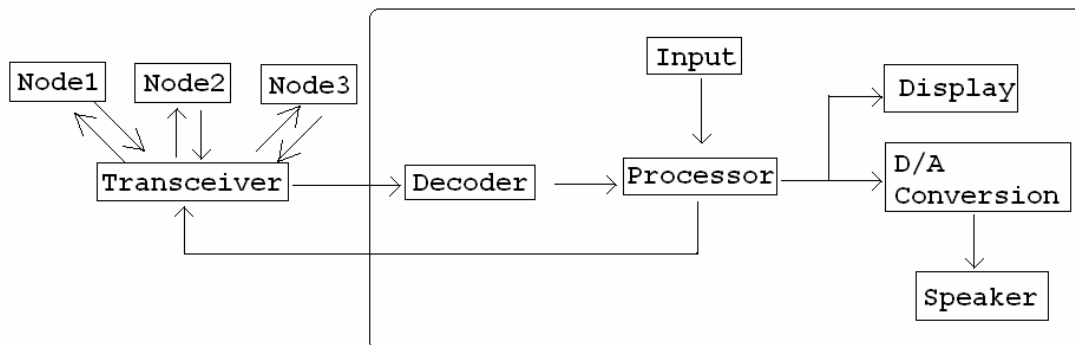
Transmit Power Output: 1 mW (0 dBm)

Power-down Current: < 10 μ A

Operating Frequency: 2.4 GHz

RF Data Rate: 250kbps

Handheld receiver block diagram:



Enclosed functionality can be accomplished by either individual components or a modified PDA.

Design:

The portable base station will use an XBee transceiver to communicate with multiple wireless sensor nodes. When the nodes send data, the data may be processed by audio or image decoder chips. Alternatively, decoding may be done on a processor. The processor will provide a graphical user interface, and will divide the screen into multiple subsections, if necessary. It will also respond to user input, which may come from either a touchscreen device or from buttons (i.e. arrows). The graphical output will be sent to the LCD, while the audio will be converted to an analog signal and sent to a speaker.

Methods:

Currently, two options are being considered for the design of the portable receiver. Each option has its own advantages and disadvantages, as discussed below.

Custom design

Implementing the receiver through a custom design would require separately choosing and interfacing between five to ten components. These components would include, at minimum, an Xbee transceiver, an LCD display, a speaker, input device(s), a processor, a PCB, and glue logic. Additionally, decoder chips may be used for audio and/or image decoding. Finally, a frame buffer and a high-speed logic device may be used to assist in supplying output to the LCD.

This custom design offers more flexibility in screen choice. Many PDA's include screens which are undesirably small and/or perform marginally in outdoor conditions. By using a custom design, we obtain maximum flexibility of parameters such as size, contrast, and backlighting. Additionally, a custom solution allows more flexibility in terms of PCB design. Attempting to modify the PCB of an existing PDA may actually prove more difficult than designing from scratch.

However, a custom design will require a large time investment spent building interfaces between components. Additionally, by using only a low-level processor with no operating system, programming the user interface will be more time-consuming.

Modified PDA

Our second option in designing our receiver is to use an existing device, such as a PDA, and modify it for our needs. While in some ways simplifying the project, this approach does have some challenges of its own.

If we were to modify an existing PDA in order to create our device, many of the most challenging tasks would be taken care of. PDAs are already equipped with input and output devices, as well as an operating system in order to tie everything together. The operating system in particular would be helpful as programming for this project could be both very complicated and time consuming.

The downfall to this approach is that although much work is done for us, adapting the device to our particular needs could be more trouble than designing our own. First off, finding ways to interface the hardware that we need to add to the device may be very troublesome, as most PDAs are not intended to have extra features added aftermarket. Second, the PDA would have many features built in that are not needed; for the best performance, we would need to eliminate those features which are meaningless to this project. Finding ways take only the features we want from the operating system could be extremely troublesome.

Milestones and timeline:

The timeline for our project has changed as circumstances have dictated. The original goal for our project was to make a second implementation of the same project which we have built off of. After the original team changed their specifications, we chose to instead improve the functionality of their network through the portable base station. As such, the project statement and specifications have only just been completed. From this point on we will be concentrating on continued research and the design of the device. By the end of this semester we plan to have a working proof of concept to present. Next semester we will be working out the bugs and adding the features that we don't have enough time for this semester.

Senior Design Timeline - Spring 2007							
	January		February		March		April
Goals							
Project Specs							
Oral Presentation							
Written Proposal							
Design							
Research							
Order Parts							
Proof of Concept							

Budget:

Due to the need for a high-quality PDA, both options will cost approximately the same amount. Additionally, the PDA method may incur some additional costs, such as additional PCB material.

Custom design method

- LCD - \$250
- Backlighting and optics - \$100
- Battery - \$150
- Power regulation - \$20
- Housing - \$50
- Speaker, D/A, and amplifier - \$50
- PCB - \$50
- Buttons, touch screen - \$50
- Decoder - \$25
- XBee transceiver - \$50
- Processor - \$50
- TOTAL: \$855

PDA method

- PDA - \$700+
- XBee transceiver - \$40
- Glue logic - \$100
- TOTAL: \$840

Conclusion:

In conclusion, although some early setbacks have slowed our progress up until now, we now have the goals of our project set and can concentrate on finding a solution which fulfills our specifications. While some more research is still needed before a final decision can be made as to which method will be implemented, we are well on our way to completing the project in the allotted time and at the given budget.