Proposal: EE 498/499 Capstone Design Course

Two Semester-6 credits

Title: Distributed Sensing Capstone
Prepared by: Professor Charles Creusere

Proposed Academic Year: Fall 2006/ Spring 2007

NOTE: This proposed capstone is designed to build upon the Capstone executed in the 2005-2006 academic year.

1.Design Project Description

The goal of this project is add to the capabilities of the distributed sensor network being designed and built by the current capstone group (2005-2006). The current group is designing, constructing, and analyzing a distributed system of pyroelectric sensor nodes. These nodes would then be spread over an area in a random fashion (e.g., dropped from a helicopter) where they would self-organize and then monitor the area for signs of intruders. . The current capstone design class is focusing only on a portion of the overall problem. Specifically, the students will design, build, and test a pyroelectric sensor node data acquisition system. This system will consist of a small array of nodes connected directly to a computer and it will be used in controlled situations to collect data for algorithm design.

The exact scope of the capstone effort proposed for the 2006-2007 academic year depends in part on the availability of funding. At the very least, I propose that the students add audio capability to the existing sensor network. While this may not seem like a great leap forward, it is important to note that even voice-grade audio requires two orders of magnitude more communications bandwidth than the pyroelectric data being collected by the current system.

If additional funding should become available (i.e., I land the DoD HBCU/MI grant that is currently being reviewed), we may also consider sensor nodes having video capability.

1.1Distributed Sensor-Node Design Concept

The students in the class will first begin by formulating the outline of their design based on the available resources. Once the framework is complete, the students will then decide which aspect to work on first. There are numerous phases of this project, so everyone will be able to show their skills in more than one area. Once the design has been further refined, individual subsystem designs will be simulated and tested. The various subsystems of this project include:

- Sensors & optics
- Sensor Amplification and Filtering
- Data Acquisition

- Testing
- Algorithm Development (i.e., DSP and computer programming)

Students will use techniques they have learned in their coursework to analyze, simulate, and optimize these subsystems separately and in various combinations.

In Fall semester, the students will study the problem, develop design objective for the system, and formulate a basic design. System hardware will be fabricated and debugged during the Spring 2007 semester and this hardware will be integrated to form a computer-controlled data acquisition system. Students will then begin experimenting with algorithm development. Students will write reports and give presentations to the review panel at the end of each semester. They will also do a preliminary report approximately mid-semester during the Fall.

1.2Academic Disciplines Needed

The collection of skills for this capstone should include students who have experience in the following areas:

- Circuit design
- Computer hardware and software design
- Communications
- Basic control systems
- Written and verbal communications skills

1.3Design Tools

Design tools will be employed in the design process and may include:

a.TopSpice
b.VHDL
c.Assembly language / C programming
d.Matlab
e.Labview
f.Microsoft Word (reports)
g.PowerPoint (presentations)

1.4Teamwork

This capstone is not intended for a large group, so there will be just one team of at most 6 or 7 students. Sub-teams will be formed to work on individual tasks and team hierarchies will be established. In addition, a graduate student RA (funded by the Sandia Labs collaboration) will also be involved and will help to guide the student-directed teams.

1.5Team Members

Unknown at this time

1.6Review Board

TBD

2.Budget

We hope to have some money to pursue this. We will again ask Rincon Research (currently supporting our 05-06 capstone effort) if they would be willing to donate another $3K for this next years efforts.

3.Timeline

The goal is to have a complete multi-node data acquisition system ready for demonstration in May of 2007. The group will meet at least once a week with Dr. Creusere and the graduate student RA to track the status of the project and to ensure that it is progressing according to plan. At the end of Fall semester, the group will present the findings of their initial R&D efforts in both a written form and as an oral presentation to their review board. At the end of the Spring semester, the team will present a final report containing all of the relevant details to their review board, and they will demonstrate the resulting system.

4.Schedule of Major Milestones

- A preliminary report will be submitted at the midpoint of the Fall 2006 semester. This report will detail the initial specification for the proposed system.
- A final report at the end of the Fall 2006 semester will be presented, detailing the final system specifications along with a rough system and subsystem design. In addition, key components will be identified and their availability will be ascertained.
- A final report will be presented in May of 2007. This report will include a users manual and a servicing manual. The report will describe the design and document the supporting analysis. All major components of the design will be specified and priced.
- By the end of the Spring 2007 semester, the working distributed data acquisition system will be complete and ready to demonstrate.
- At end of Spring 2007, the system, along with a fully detailed report, will be presented to the review board.

Original Capstone write-up follows:

Proposal: EE 498/499 Capstone Design Course

Two Semester-6 credits

Title: Pyronet: A low-cost, flexible, and non-destructive alternative to land mines
Prepared by: Professor Charles Creusere

Proposed Academic Year: Fall 2005/ Spring 2006

NOTE: This Capstone will *only* be offered if funding (~$3K) is available. I am submitting a proposal to Sandia Labs to support it.

5.Design Project Description

The goal of this project will be to design, construct, and analyze a distributed system of sensor nodes. In the conceptualized system, each node would consist of 4 pyroelectric sensors (each facing in a different direction), differential GPS, short-range communications, and local processing. These nodes would then be spread over an area in a random fashion (e.g., dropped from a helicopter) where they would self-organize and then monitor the area for signs of intruders. The goal would be to develop a system that can tell the difference between human intrusion and native wildlife, issuing a warning when the former occurs. The proposed capstone design class will focus only on a portion of the overall problem. Specifically, the students will design, build, and test a pyroelectric sensor node data acquisition system. This system will consist of a small array of nodes connected directly to a computer and it will be used in controlled situations to collect data for algorithm design. Once the system is operational, the students will experiment with algorithms for network organization (e.g., determining overlapping fields of view between sensors) and intruder detection/classification. The system built by the students will continue to be used afterwards to support a collaborative research project with Sandia National Laboratories.

5.1Distributed Sensor-Node Design Concept

The students in the class will first begin by formulating the outline of their design based on the available resources. Once the framework is complete, the students will then decide which aspect to work on first. There are numerous phases of this project, so everyone will be able to show their skills in more than one area. Once the design has been further refined, individual subsystem designs will be simulated and tested. The various subsystems of this project include:

- Sensors & optics
- Sensor Amplification and Filtering
- Data Acquisition
- Testing
- Algorithm Development

Students will use techniques they have learned in their coursework to analyze, simulate, and optimize these subsystems separately and in various combinations.

In Fall semester, the students will study the problem, develop design objective for the system, and formulate a basic design. System hardware will be fabricated and debugged during the Spring 2006 semester and this hardware will be integrated to form a computer-controlled data acquisition system. Students will then begin experimenting with algorithm development. Students will write reports and give presentations to the review panel at the end of each semester.

5.2Academic Disciplines Needed

The collection of skills for this capstone should include students who have experience in the following areas:

- Circuit design
- Computer hardware and software design
- Communications
- Basic control systems
- Written and verbal communications skills

5.3Design Tools

Design tools will be employed in the design process and may include:

h.TopSpice
i.VHDL
j.Assembly language / C programming
k.Matlab
l.Labview
m.Microsoft Word (reports)
n.PowerPoint (presentations)

5.4Teamwork

This capstone is not intended for a large group, so there will be just one team of at most 6 or 7 students. Sub-teams will be formed to work on individual tasks and team hierarchies will be established. In addition, a graduate student RA (funded by the Sandia Labs collaboration) will also be involved and will help to guide the student-directed teams.

5.5Team Members

Unknown at this time

5.6Review Board

TBD

6.Budget

This capstone will only be offered if we receive at least $3K (after indirect costs) from Sandia Labs to support it. Note that the students involved in this capstone will be directly exposed to funded research since the proposed pyroelectric data acquisition system is being built to support the collaborative research project.

7.Timeline

The goal is to have a complete multi-node data acquisition system ready for demonstration in May of 2006. The group will meet at least once a week with Dr. Creusere and the graduate student RA to track the status of the project and to ensure that it is progressing according to plan. At the end of Fall semester, the group will present the findings of their initial R&D efforts in both a written form and as an oral presentation to their review board. At the end of the Spring semester, the team will present a final report containing all of the relevant details to their review board, and they will demonstrate the resulting system.

8.Schedule of Major Milestones

- A preliminary report will be presented at the end of the Fall 2005 semester. This report will detail the design specification for the proposed system and it will present a rough system and subsystem design. In addition, key components (e.g., the pyroelectric sensors and optics) will be identified and their availability will be ascertained.
- A final report will be presented in May of 2006. This report will include a users manual and a servicing manual. The report will describe the design and document the supporting analysis. All major components of the design will be specified and priced.
- By the end of the Spring 2006 semester, the working distributed data acquisition system will be complete and ready to demonstrate.
- At end of Spring 2004, the system, along with a fully detailed report, will be presented to the review board.