ENGR 090 – Senior Design
Project Proposal
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Advisor:
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Project Description:
I would like to make improvements on a previous senior design project, "Function-Specific Sensor Fusion", worked on by Anteneh Tesfaye '03 and David A. Whitehead '03. Sensor fusion involves the use of different types of sensors within a specific target area. An example would be a fire alarm system that uses both smoke detectors and temperature sensors to detect a fire.

For this project, a room in Hicks will be setup with different types of sensors that will communicate wirelessly with a control station. The control station will most likely be an Altera Programming Board and it will be responsible for interpreting the output of the sensors. The control station will then trigger a response based on the signals it receives. For example, if a person walks in to an unlit room, infrared sensors will detect the person's entrance. The output from the sensors will be transmitted to the control station and the control station could trigger a series of relay switches that would turn on different lamp or lights in the room.

The control station could also perform other types of functions. For example, the display on the Altera board could be used to report on the number of people present in the room or report on devices that are currently turned on.

While a goal of the project is to set up a functional wireless sensor-fusion network, heavy emphasis will be placed on testing different methods of wireless communication. Since there are many ways in which a signal can be encoded and modulated, this project will explore different modes of communication to find ones that work well for this project. Hence, the encoding, modulating, and transmission of the signals will be performed through a communications modeling system called the Telecommunications Instructional Modeling System (TIMS). The TIMS will also handle the demodulation and decoding of the signals.

A factor that will be placed in to consideration during the design process is energy conservation. This will be done by making sure that unnecessary devices are not turned on by keeping functions responsive to specific situations. Smart methods of transmission and interpretation (at the control station) will also be explored especially during times when the room has been static for a long time. However, this should be done without reducing the system's capability to respond to sudden changes in the environment.

Project Stages and Parts:

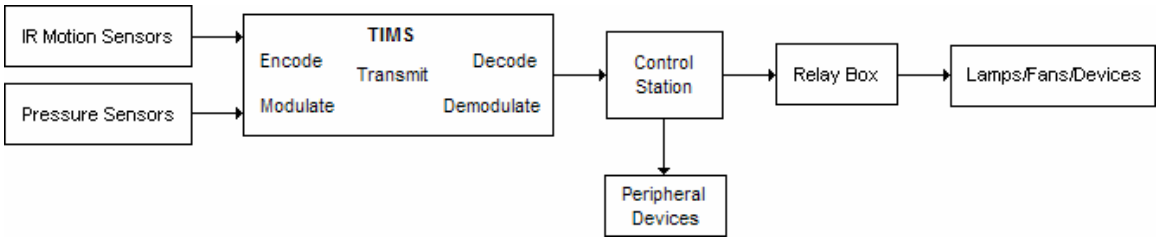

Figure 1. Project Flow Chart

The general setup flow of the project is shown in Figure 1. Descriptions of the main stages have been placed below.

Sensors: The sensors to be used in this project are IR sensors and piezoelectric pressure sensors. Other sensors may be added through the course of the project, if time permits.

TIMS Wireless System (TIMS): This is where the outputs from the sensors will be encoded, modulated, and transmitted. The TIMS will also handle the demodulation and decoding of the transmitted signal.

Control Station: This will be an Altera Programming Board that takes the output of the TIMS and, through a relay box, will turn on or off specific devices or appliances. It may also communicate directly with peripheral devices such as external displays. Other functions may be added through the course of the project, if time permits.

Relay Box: The relay box will control (turn on or off) the devices and appliances.

Devices: Devices to be controlled are lamps, lights, and fans, which are relay controlled. Peripheral devices, such as displays, are also being considered. Other devices may be added through the course of the project, if time permits.

Project Path:

Task 1: Determine desired input characteristic for the TIMS.

- This involves figuring out what the different sensors will output and whether the outputs need to be modified before sending it the TIMS system for transmission.
- Includes time studying the sensors and the TIMS.

Task 2: Determine desired output characteristic of the TIMS that will be the inputs to the Control Station.

- This may change over the course of the project but a general idea is needed so the output obtained from the TIMS will be usable or transformable to a useable signal that can be inputted to the Control Station.
- A decision needs to be made whether the Control Station can be flexible to the output of the TIMS or whether additional circuitry is needed to make the output fit the Control Station.
- Tweaking at the TIMS may be needed as well.

Task 3: Determine wireless system characteristics based on Task 1 and Task 2.

- This task involves research to determine modulation/demodulation techniques and transmission techniques to be used based on the criteria determined in Task 1 and Task 2.

Task 4: If additional circuitry is needed to transform the outputs from the sensors before being inputted to the TIMS, design and test circuitry.

Task 5: If additional circuitry is needed to transform the output from the TIMS to the Control Station, design and test circuitry.

Task 6: Using the determined criteria, setup the TIMS and the additional circuitry if any.

Task 7: Test entire setup with the different sensors, using one sensor at a time.

- Individual sensors should be tested with the system before multiple sensors are tested.
- See if desired output is obtained.

Task 8: Test entire setup with multiple sensors.

- This task should be relatively straight forward since the TIMS system has a multiplex function.
- See if desired output is obtained.

Task 9: Write VHDL code to be used at Control Station.

- Indirectly requires Task 7 and Task 8 to see if the actual output wanted was obtained.
- If the output desired is not obtained, it will most likely change parts of the code so it is better to obtain a useable output before starting the code.

Task 10: Design and setup Control Station.

- Involves the design and setting up of the Altera Board and any peripheral circuitry or devices.

- Also involves making modifications to the relay box and setting up devices to be turned on and off.

Task 11: Test VHDL code and Control Station using dummy inputs to see if it properly performs the desired function.

- Test and modify as needed.

Task 12: Test Entire Setup - Control Station with TIMS output.

- Test and modify as needed.

Task 13: Optimize and finalize setup for compactness, efficiency, and aesthetics.

Task 14: Write Report.

Task 15: Presentation.

CPM:

The project will follow a CPM schedule as shown below.

Task	Needs	Feeds	Duration	Effort	Action
1	- -	3, 4	1 day	3 hours	Sensor - TIMS Characterization
2	- -	3, 5	1 day	3 hours	TIMS - Control Station Characterization
3	1, 2	4, 5	1 day	3 hours	TIMS Wireless System Characterization
4	1, 3	6	3 days	9 hours	Design and Build Pre-TIMS Circuitry
5	2, 3	6	3 days	9 hours	Design and Build Post-TIMS Circuitry
6	3, 4, 5	7	1 day	3 hours	Preliminary TIMS and Circuit Setup
7	6	8, 9	3 days	9 hours	Test Setup - One sensor
8	7	9	3 days	9 hours	Test Setup - Multiple sensor
9	7, 8	10, 11, 12	2 days	6 hours	Write VHDL Code
10	9	11, 12	4 days	12 hours	Design and Setup Control Station
11	9, 10	12	5 days	15 hours	Test w/ Dummy Inputs - VHDL Code and Control Station
12	9, 10, 11	13	10 days	30 hours	Test Entire Setup
13	12	14, 15	3 days	15 hours	Optimize and Finalize
14	13	15	7 days	20 hours	Write Report
15	13, 14	- -	3 days	10 hours	Presentation (Preparation)

Table 1. CPM Schedule

Materials:

Altera Programming Board	Available
IR Emitters	Available
IR Receivers	Available
FlexiForce Pressure Sensors	Available
Resistors, Capacitors	Available
Op-Amps	Available
LM555 Timers	Available
Relay Switches	Available
Lamps, Fans, and other Appliances	Available
TIMS-301 and Modules	To be purchased by Engineering Department

Much of the materials are either already available in Hicks or were purchased for a previous senior design project. Therefore, there are practically no costs unless some of the sensors have gone bad and need to be replaced. Since further functionality may be considered for this project, small purchases may be made in the future. The TIMS-301 setup has been purchased by the Swarthmore College Engineering Department and its costs are not included for this project since it was purchased with uses in future course/lab work, research, and projects (including this one) in mind.

Additional Notes:

Through out the course of the project, I will maintain a site that will track my progress as ell as provide additional information on the project. The website will contain updates, logs, and a calendar. The site can be found at:

http://engin.swarthmore.edu/~mchano1/e90/

Additional information regarding the Telecommunications Instructional Modeling System (TIMS) can be obtained at:

http://www.qpsk.com/