GENESIS TECH
PROJECT

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- Microcontroller Engineer: Hirenkumar Patel
- Sensor Engineer: Shih-Yang Yen
Introduction

- **Problem Statement**
  - The project challenge is to design, build, and test the DAQ device with multi-sensors, software controls, and USB interface

- **Market Research**
  - Current detection systems are evaluated at $2000 vs. our design will be less than $137.40
  - 1/10\textsuperscript{th} the current cost

- **Project Goals**
  - Construct a working prototype of a wireless DAQ node
Design Approach Overview

SENSOR UNIT
- CHANNEL 1 SEISMIC SENSOR
- CHANNEL 2 PIR SENSOR

SIGNAL CONDITIONING UNIT
- LPF
- AMP
- ADC (ADS8364)

CONTROL UNIT
- MCU (Cypress CY7C646 13-80NC)

HOST COMPUTER UNIT

STARGATE
w/ 802.11b wireless communication
Sensor Unit Overview

- Seismic Sensor
  - Larger Range of Detection

- Passive Infrared Sensor
  - Moderate Range of Detection
  - Identification of objects

- How each sensors complement each other?
Seismic Sensor

- **Purpose:**
  - Measures ground vibrations
  - **Examples:**
    - Detection of an earthquake
    - Military surveillance and security purposes

- **Cycle of operation:**
  - Measures ground motion relative to an inertial reference
  - The Suspended Mass used for reference inertial
  - Inside the sensor’s casing
    - Geophone has a suspended coil in a magnetic field
Seismic Sensor

- Factors for selection of the Product: Telonics SP-500
  - Range of detection: 100 ft long & 360 degrees wide
  - Signal Characteristics: Output Frequency- 300 Hz
  - Supply Voltage: None
  - Operating Temperature: -40ºC ~ 70ºC
  - Interlink with near components
  - Activates the PIR upon detecting an object

- Limitations
  - Cannot identify the type of object
  - Cannot determine the location & distance of an object
Passive Infrared Sensor

- Purpose: Detect objects based on the infrared energy that they emit
  - Examples:
    - Automatic Doors in a supermarket
    - Security Systems to detect an intruder
- Cycle of operation:
  - PIR monitors an area to sense infrared energy
  - An object moves into its detection zone
  - PIR detects a change in the infrared energy level
  - It reports the presence of an object in its zone
Passive Infrared Sensor (Cont)

- Factors for selection of the Product: Nicera RE200B
  - Range of operation--50 ft long & 180 degrees wide
  - Signal Characteristics: Vpp-3.9V ; Frequency-3.3 KHz
  - Supply voltage-- 2.2 [V] to 15 [V]
  - Operating temperature-- -30ºC ~ 70ºC
- Interlink with near components
  - Activates only once a seismic sensor detects an object
- Limitations
  - Omni-directional detection is unavailable
Signal Conditioning Unit
Overview

- Output frequency < 300Hz
- Output frequency < 4000Hz
- Sampling rate = 8kHz
- 16 bits resolution
- Variable gain control
Low Pass Filter

- **Purpose**
  - Eliminate unwanted frequency signals
  - No distortion in frequency range of interest
  - Lowest order & Filter type satisfying frequency limitations

- **Product Specifications:** Linear Technology LTC1563-2
  - Cut-off Frequency: Seismic -> 300Hz ; PIR -> 4000Hz
  - Stopband Frequency & Attenuation
    - Seismic $\rightarrow$ -96dB at 15.7 KHz ; PIR $\rightarrow$ -96dB at 12 KHz
    - 8th order Chebyshev I

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Amplifier

- **Purpose**
  - Minimize data lost from sampling
  - Have variable controlled gains
  - Prevent clipping caused by over amplification

- **Product Specifications:** Linear Technology LTC6911-1
  - Wide selection of gains: 0, 1, 2, 3, 10, 20, 50, 100V/V
  - 3-bit Digital Gain Control: G2, G1, G0 pins
  - Internal Vref automatically set to half of Vs
Analog-to-Digital Converter

- **Purpose**
  - Minimum 16-bit resolution
  - Differential input channels with separate ADCs for simultaneous sampling
  - Input analog range: 0-5V
  - Multi-channels for multi-sensors
  - Minimum sampling rate: 8kHz
  - Operating temperature: -10°C ~ 40°C
A/D Converter

- Texas Instruments ADS8364
  - 6 fully differential channels
  - One 16-bit output
  - 6 ADCs (1 per channel) for simultaneous sampling
  - Maximum sampling rate: 250kHz
  - Analog input range: +/- 2.5V at 2.5V
  - Operating temperature: -40°C~85°C
  - The chip is upgradeable for futuristic designs
Control Unit Overview

16-bit parallel input from ADC

MCU

Data Output to STARGATE

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CONTROL UNIT

CY7C64613
Microcontroller

- **Purpose**
  - Use the data from the ADC to our advantage

- **Algorithm**
  - Receives information from ADC--16-bit parallel interface
  - Checks for motion detection
  - If motion detected, sends information to Stargate

- **Features**
  - USB Compatibility
  - Enhanced 8051 Processor
    - Runs code from internal or external RAM
    - Code can be downloaded via USB, EEPROM, Flash
Microcontroller

- Product Specification: Cypress CY7C64613-80NC
  - Number of pins: 80
  - Supply Voltage: 3.3 V
  - I/O Ports: 4 ports with 8-bits each
  - USB interface with Stargate
- Limitations
  - None, meets all specifications
Stargate

Product Specifications

- A powerful signal computer
- Transmit data wirelessly through 802.11b PCMCIA card
- Small (3.5” by 2.5”), light and low power consumption
- 400MHz X-SCALE processor (PXA255)
- USB, serial, Ethernet connectors
- Linux embedded
# Cost Analysis

## Components | Item No. | Price($)/each | Quantity | Updated Cost ($)
--- | --- | --- | --- | ---
Seismic Sensor | SP-500 | 90.00 | 1 | 90.00
PIR Sensor | Nicera RE200B | 15-60 | 1 | 10.00
MCU | CY7C64613-80NC | 9.00 | 1 | 9.00
ADC | ADS8364 | 18.10 | 1 | 18.80
Amplifier | LTC6911-1 | 2.45 | 2 | 4.90
Low Pass Filter | LT1563-2 | 2.35 | 2 | 4.70
**Total Cost** | | | | **137.40**

* Stargate and the 802.11b PCMCIA card are not included
# ECE582 Time Schedule

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<th>Person</th>
<th>Task Name</th>
<th>Actual Start</th>
<th>Actual Finish</th>
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<th>Dec 2004</th>
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<td>11/15/2004</td>
<td>11/22/2004</td>
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Future Perspective

Future Plans

- ECE 682 or 683 – building the system
  - Ordering & receiving products: 1 week
  - Testing products & integrating to form a coherent system: 2 weeks
  - Experimenting: 3 weeks
  - Debugging to obtain accurate results: 4 weeks

- Sell our idea to a corporate and make millions so that we can retire in early 30’s!
Summary

Future applications
- Integrate with GPS Localization
- Possible intruder localization and identification

Final thoughts / Product Design Experience:
- Albert: “Helped me to learn the fun of teamwork!”
- Amar: “Learnt the importance of system integration”
- Eric: “Gained more knowledge in product research”
- Abdul: “Sometimes u gotta have a design experience”
- Hiren: “No design is perfect, you need to have tradeoffs”
Any Questions?

Group Pictures on 10/20/04