Abstract
Infant death in the developing world due to SIDS is of immediate and major concern. We hope to further the Engineering World Health legacy project to reduce SIDS in the developing world by monitoring for apnea as a possible preventative measure for SIDS. Our prototype implements transthoracic impedance to monitor the rhythmic breathing pattern of an infant and trigger an audiovisual alarm in the event of apnea lasting longer than 20 seconds so that caregivers will be alerted to the presence of a possible SIDS episode and be able to take preventative measures.

Preliminary Research
• Wide variety of methods available to detect respiration
  - Standard U.S. methods:
  - Advanced visual output system
  - Multi-method monitoring for hospital and home
  - Not feasible for the developing world
• Four design options researched and considered (Table 1)

Design Criteria
• Intended for use in impoverished regions with distribution through non-profit organization (EWH)
  - Kit Assembly
    - Small & portable
    - 10 cm x 10 cm x 10 cm circuitry housing
    - Theft concerns for expensive/scarce components
  - Must be low cost ($10-$20)
  - Use for infants 0-8 months
  - No additional risk of harm to the infant
  - Power may be unreliable - battery powered optimal
  - Human element may be untrained or unskilled
  - Straightforward assembly, operation, and repair
  - Training/instructions to be included
  - Must have ~12 hours uninterrupted operation
  - Audiovisual alert after 20 seconds of respiratory arrest

Microcontroller (Figure 8)
• Inputs slowly oscillating voltage signal
• Compares the peak to peak voltage difference
• Checks reasonable, noise free readings
• Good values are compared
• Alarm triggered if voltage change is too shallow for too long

Output
• 2.86 kHz square wave signal sent to speaker to alarm caregiver

Testing
• Figure 9: Waveform showing the oscillating respiration waveform with minimal cardiogenic artifact.

Future Work
• More elasticity and durability of band
• Protocol to determine placement based on infant size
• Circuit
  - Eliminate cardiogenic artifact from signal
  - Phase sensitive demodulation (Figure 12)

Client Requirements
• Cost
  - Prototype cost $235, far exceeded budget (Table 2)
  - Bulk purchasing expected to reduce costs considerably
  - Microcontroller will not be prototyping kit $19% cost decrease
• Power
  - Total circuit draw is 180 mA
  - Expected battery life 6.3 hours
  - Current draw greatly reduced with TIA, as measured with a 30 kHz sine at 3 mA

TABLE 2: PROTOTYPE COSTS

<table>
<thead>
<tr>
<th>Item</th>
<th>Price</th>
</tr>
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<tbody>
<tr>
<td>Banana plugs</td>
<td>$7.00</td>
</tr>
<tr>
<td>Electrode strap</td>
<td>$6.00</td>
</tr>
<tr>
<td>Voltage regulator(2)</td>
<td>$5.00</td>
</tr>
<tr>
<td>Operational amplifier(4)</td>
<td>$3.00</td>
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<tr>
<td>Passive components (R7)</td>
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<td>Mbed microcontroller</td>
<td>$50.00</td>
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<td>Circuitry housing</td>
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<tr>
<td>On/Off switch</td>
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<tr>
<td>Speaker</td>
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<tr>
<td>LEDs</td>
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<tr>
<td>8-Volt batteries</td>
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<td>Breadboard</td>
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<td>Assembly (10 hours)</td>
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<td>TOTAL</td>
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</table>

Acknowledgments:
Special thanks to: Professor Paul Thompson, Tim Balgeman, Amit Nimunkar, Dr. Laura Houser, Dr. George Dittrangier, Bryan Culver

References: