Matters of the Heart
Swallowable Capsule Technology
Project Proposal

Presented By:
Cimoya Collins
Gilbert Hopkins
Michelle Lilley
Ashley Wells

Presented On:
Wednesday, November 9th, 2011
Outline

- Background of Swallowable Capsule
- Our Problem
- Current Status of Art
- Design Requirements
- Solution Approach
- Task and Project Management
- Cost and Resources
- Conclusion
Background

- Gastrointestinal (GI) diseases are ailments that affect over 3 million people in the United States alone.

- Two Capsule Design Types:
  - Analog
    - provide a high frame rate (30 frame/s)
    - weak to channel noise
    - restoration of the data is impossible
  - Digital
    - transmits 640×480×8 resolution images by using a digital transmitter
    - 1 frame/s
    - restoration is possible
Problem Formulation

- Endoscopy
  - Invasive
  - Use of anesthesia
  - May cause bleeding due to a puncture of esophagus or stomach lining
Problem Formulation

* To design a swallowable pill that:
  * gives a more accurate diagnosis than endoscopy procedure
  * will eliminate the endoscopy procedure
  * eliminate the need for surgical procedures that detect certain issues within the body
* Swallowable pill will be focused primarily on two classes of diseases:
  * Vascular and blood related
    * Cholesterol Levels, Stomach (Internal) Bleeding
  * Digestive related
    * Stomach ulcers, Acidity in stomach
Death from heart disease or stroke at all ages is highest in African Americans

African American women are one third more likely to die from heart disease or stroke than Caucasian women
**Ingestible Thermometer Pill**
* Developed at John Hopkins University with NASA support
* Came to be known as CorTemp

**Olympus Optical (Imaging)**
* Used a magnetic field outside of the body to control tracking
* Issues: improper illumination and capsule needed to be opened to retrieve images

**PillCam**
* Developed by Given Imaging which was founded by Dr. Gavriel D. Meron
* Also developed PillCam SB, PillCam ESO, PillCam COLON 2, and PillCam Express
**Design Requirements**

* **Size**
  - According to Food Drug Administration (FDA) the size of a pill capsule is given the following credentials:
    - Length 15mm
    - Width 1 cm

* **Communication Standards**
  - Medical Implant Communication Service: Operations in the 402-405 MHz range

* **Regulations**
  - FDA and HHS standards and regulations must be approved
  - Must satisfy and meet ROHS Directive – restricts the use of certain hazardous substances in electrical and electronic equipment such as
    - Lead
    - Mercury
    - Cadmium

* **Lifespan**: The pill must have a battery life of 8+ hours
The Swallowable Capsule contains:

- 16 bit Microprocessor (EM250)
- Power Supply (as research shows a watch battery has been used as a source of power i.e. Eveready SR92W)
- Surface Mount Technology (SMT)
- pH Sensor used to determine pH level (chemical sensor to detect dissolved oxygen, and conductivity)
- Camera/Video Camera which will take still images as well as video segments
- Magnet used as a source to navigate the pill
Design Requirements

- Camera
- 16-bit Microprocessor
- Power Supply
- pH Sensor
- Sensor 1
- Sensor 2
- Sensor 3
- Magnet
Solution Approach Requirements

- Ember 250 Development Kit
  - Hardware
  - EM250 Breakout Board (3)
  - EM250 InSight Adapter (3)
  - MC Card to SMA Cable (1)
  - InSight Port Cable (3)
  - Power Supplies and Battery Pack (3)
  - Extended Debug Cable (3)
  - 8 Port Switch w/4 x POE ports (1)
- Sample Chips
  - EM250Chips (10)
- Software
  - InSight Desktop
  - xIDE Compiler (1 Seat)
- Surface Mounted Technology
- Pill Capsule Shell
- Sensors for Detection
- Video/Camera
- Magnet
## Task and Project Management

<table>
<thead>
<tr>
<th>Task</th>
<th>Date of Task Assignment</th>
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<tbody>
<tr>
<td>Research Swallowable Capsule Technology</td>
<td>October 2011</td>
</tr>
<tr>
<td>Evaluate Potential Solutions</td>
<td>October/ November 2011</td>
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<tr>
<td>Select Best Solution for Problem</td>
<td>November/ December 2011</td>
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<tr>
<td>Go to Nanotechnology Lab</td>
<td>November/December/ January 2011</td>
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<tr>
<td>Develop Capsule</td>
<td>February/ March 2011</td>
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<tr>
<td>Test Capsule</td>
<td>March 2011</td>
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## Cost and Resources

<table>
<thead>
<tr>
<th>Item</th>
<th>Price</th>
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<tbody>
<tr>
<td>EM-250 Development Kit</td>
<td>$2500*</td>
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<tr>
<td>SMT Components (i.e. transistors, resistors)</td>
<td>$50</td>
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<td>Fiber Optic Cables</td>
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<td>Camera/Video Camera</td>
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<td>Pill Capsule</td>
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<td>Cost of Etching</td>
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<td><strong>Total</strong></td>
<td><strong>$2640</strong></td>
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Conclusion

* **Our Goal:**
  To design a swallowable pill that will eliminate the endoscopy procedure

* Swallowable pill will be focused primarily on two classes of diseases:
  * Vascular and blood related
    * Cholesterol Levels
  * Digestive related
    * Acidity in stomach, stomach ulcers

* **Goal Deadline:**
  * Electrical and Computer Engineering Day
  * April 2012