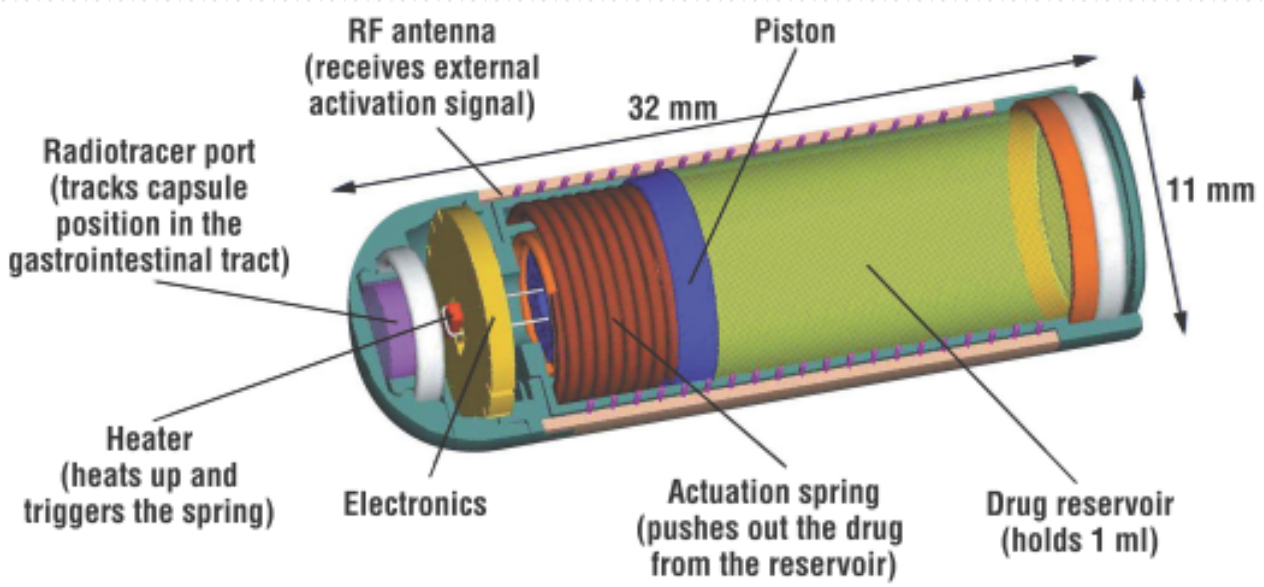
Swallowable Capsule

Brima Bah
Kurubel Medemdemia
Lauren King
Bathiya Senevirathna



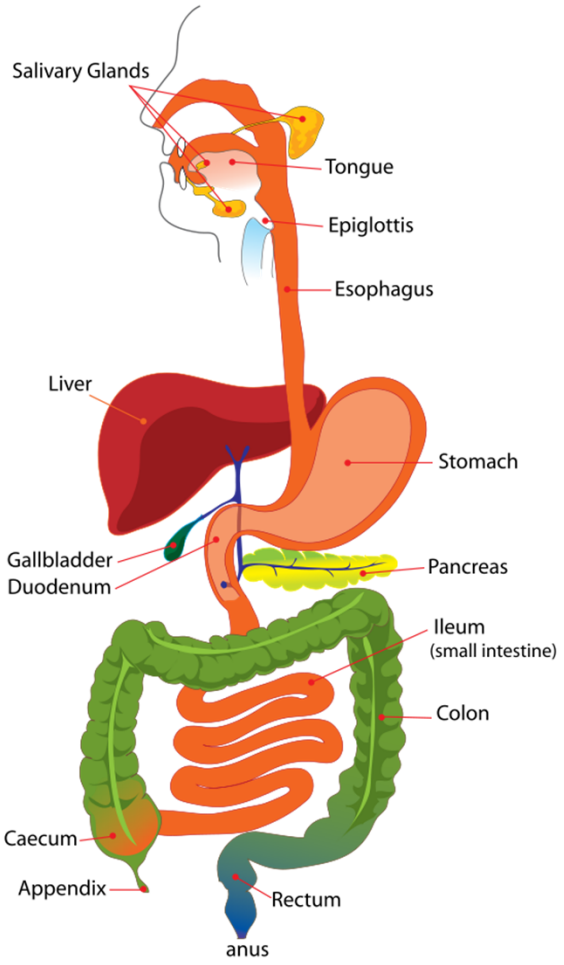
Topics

- Background
- Problem Statement
- Current Status of Art
- Solution Approach
- Tasks & Deliverables
- Conclusion

Background

- Over 3 million people suffer from Gastro-Intestinal (GI) disease in the U.S. every year
  - Internal bleeding
  - Hemorrhoids
  - Cancer

Source: Given Imaging



Source: Wikimedia Commons

Problem

- Need an endoscopic device to provide data about the GI tract
  - Information about acidity (pH), temperature, and pressure
  - Images
- **Problem Definition**:
  - Design a compact swallowable capsule that provides images, temperature, pressure, and acidity data

Design Requirements

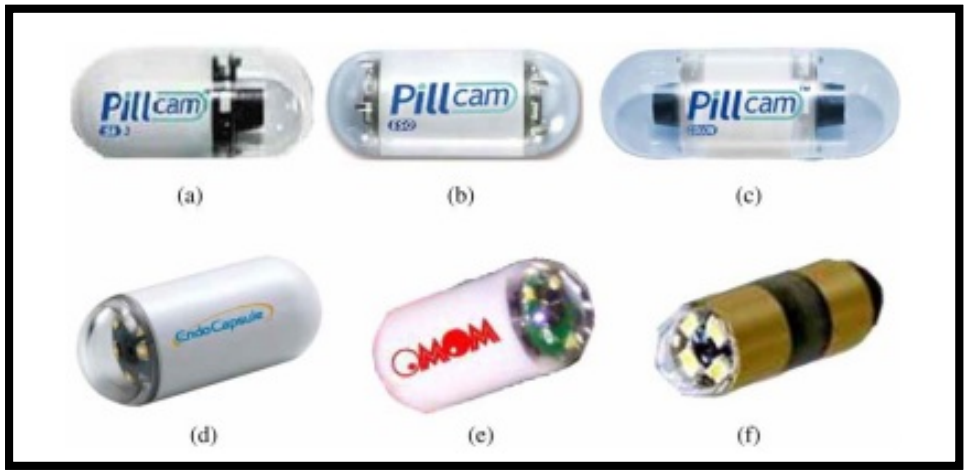
- Sensor Requirements:

Sensor	Time Interval (s)	Precision/Quality
Temperature	15	±0.5°C
Pressure	5	±3.6 mmHG
Acidity	2	±0.28
Image	0.5	QVGA

- Battery Life: 8 hours
- Capsule Size: 9 mm diameter, 23 mm length
- Compliance:
  - FDA Approval
    - Safe for human ingestion – pass material toxicity & reliability tests
  - FCC Code of Federal Regulations: Title 47, Part 15 C

Current Status of Art

- Several swallowable capsule products in the market
  - Phillips iPill
  - PillCam
  - SmartPill
- Provide either imaging OR numerical data



Source: Toenniies et al. (Fig 1)

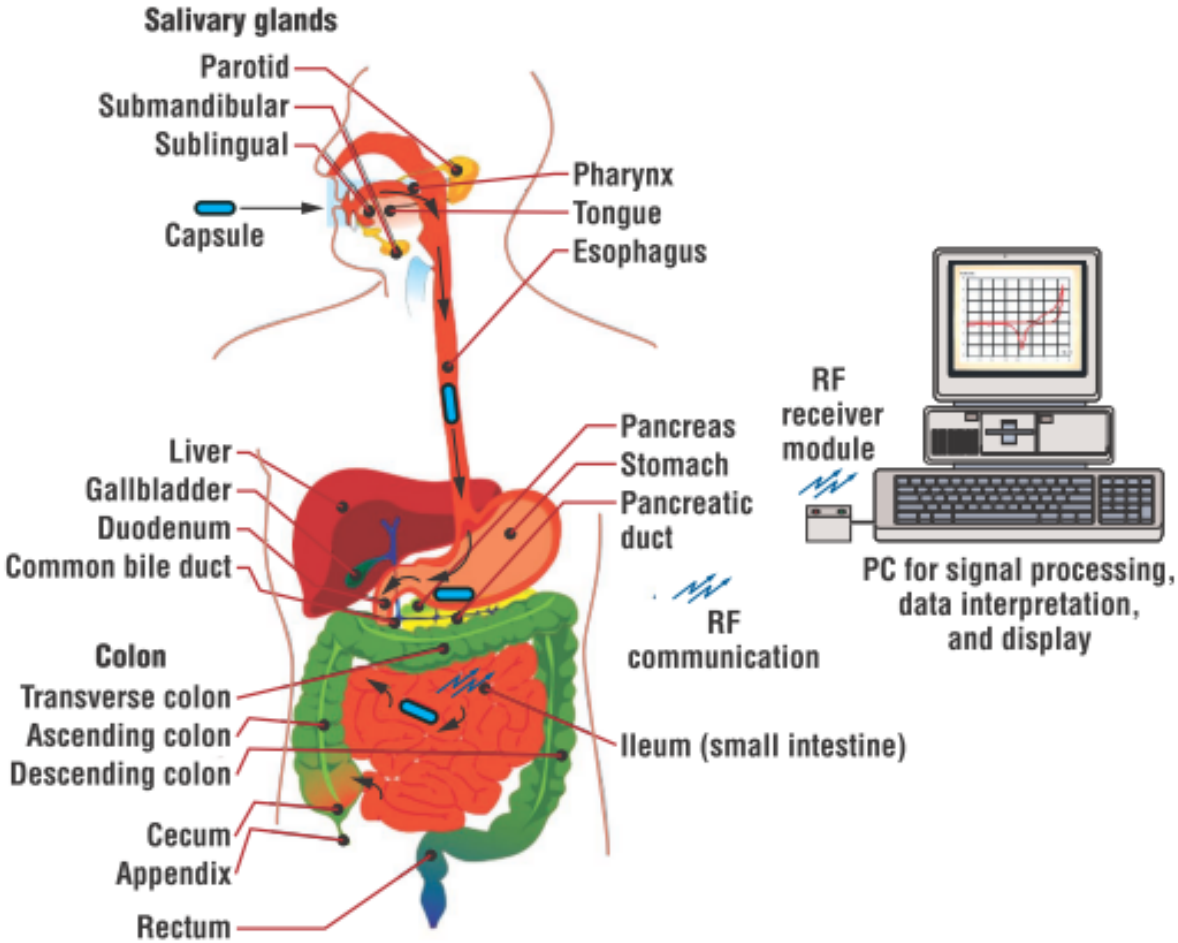
Current Status of Art

Product	Localization	pH	Temp.	Pressure	Power	Imaging
PillCam	RF	-	-	-	Battery	CMOS
EndoCapsule	RF	-	-	-	Battery	CCD
iPill	Time	X	X	-	Battery	-
NORIKA	-	-	-	-	Wireless	CCD
SmartPill	Time	X	X	X	Battery	-
CorTemp	-	-	X	-	Battery	-
MiRo	RF	-	-	-	Battery	CMOS

Adapted from Teonnies et al. (Table 1)

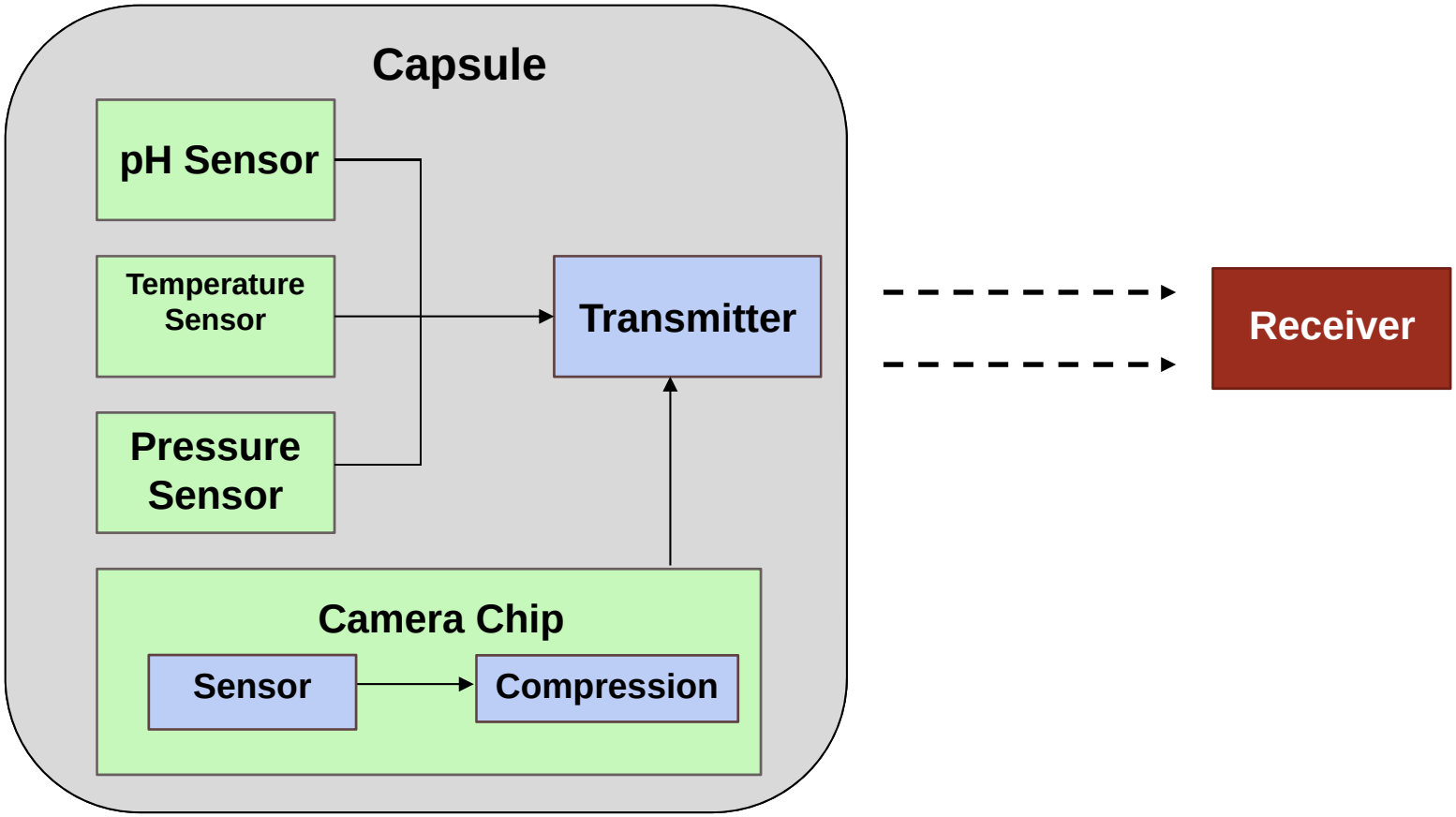
Solution Approach

- Main Limitations:
  - Size
  - Battery Life
- Two part system:
  - Capsule
  - Receiver



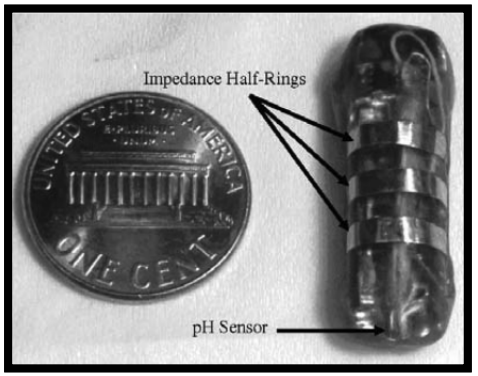
Source: Mc Caffery et al.

Solution Approach



Solution Approach

Source: Gonzalez-Guillaumin et al.



- Capsule Shell
  - Material – Silicon, plastic
- Sensors
  - Flush with capsule surface
  - pH – antimony electrode, Ion-Sensitive Field Effect Transistor (ISFET)
  - Temperature - thermistors
- Transmitter
  - Required throughput: 1.230 Mbps (2 fps, raw images)
  - Need Compression!

Transmitter

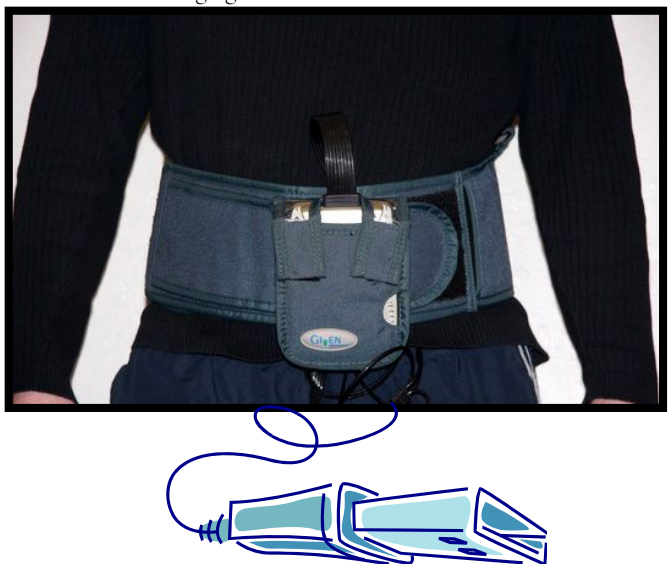
- Protocols:
  - ZigBee
  - Bluetooth Low Energy (BLE)

Product	EM-250	TI CC 2540
Protocol	ZigBee	BLE
Band	2.4 GHz	2.4 GHz
A/D Converter	Y	Y
Bitrate	250 kbps	1 Mbps
Modulation	O-QPSK	GFSK

Solution Approach

- Receiver
  - Carried at patient's waist
  - RF receiver
  - Data stored on device
    - Minimum 4.3 GB capacity
    - Flash memory, USB stick
  - Data transferred to PC via USB

Source: Given Imaging



Tasks

- Temperature, pH, pressure sensors
  - Available parts
  - Power requirements
- Camera, image processing
  - Technology to use
  - Image compression
- RF transmission/receiving
  - Communication protocol
  - Receiver design
- Microprocessor
  - Programming microprocessor
- Power
  - Battery technologies
  - Size restraints

Timeline & Deliverables

Milestone	Scheduled Completion Date
Initial proposal	September 2011
Peer evaluations	November 2011
Final proposal presentation	November 9, 2011
Selection of design / Complete research	November 2011
Finalize Design	December 2011
Ordering of components/Parts	December 2011
Commencement of the development of the design	January 2012
Completion of project prototype	March 2012
Testing of prototype	March 2012
Documentation of project	March 2012
Project Presentation	April 2012

Estimated Budget

Component	Unit Price	Quantity	Total Cost
Temperature Sensor	$20.00	1	$20.00
Acidity Sensor	$50.00	1	$50.00
Pressure Sensor	$20.00	1	$20.00
Camera	$20.00	1	$20.00
Microprocessor	$10.00	1	$10.00
Battery	$2.00	5	$10.00
Receiver	$50.00	1	$50.00
Misc.	$50.00	1	$50.00
Manufacturing	$220.00	1	$220.00
		Total	**$450.00**

Conclusion

- **Goal**: To provide images and environmental data of GI tract in a single package
- **Design**: Sensors, Processor/Transmitter SoC, Receiver
- Project is feasible
  - Have qualifications & knowledge
  - Technology exists

Thank you for listening!

Any Questions?