Bluetooth Ingestible Capsule

Group: sddec-19
Team: Jon Thomas, Chase Thompson, Cutler Thayer, Robert Zukowski
Client/Advisor: Dr. Santosh Pandey

Introduction

Problem Statement: Gastrointestinal (GI) ailments are difficult to diagnose in affordable, non-invasive ways. Standard methods of GI diagnosis involve endoscopic cameras, x-rays, and CT scans. New technology such as smart pills and ingestible capsules could provide significant benefits to patients with GI ailments.

Intended Uses: Imaging abnormalities in the GI tract using a Bluetooth ingestible capsule.

Intended Users: Gastroenterologists and Patients

Design Requirements

Functional Requirements:

- Capsule will receive data from an image sensor, then store or send the data via Bluetooth
- Desktop application should
  - Receive images via Bluetooth or USB
  - Analyze images for signs of abnormalities
  - Display the image data and analysis findings

Non-Functional Requirements:

- Electronics must fit in a standard 000 size capsule
- Desktop application should be able to work with USB endoscopic cameras
- Analysis of an image frame can be completed before another frame is received

Operating Environment:

- Capsule will be able to withstand the expected conditions of the human GI tract.
- Desktop application will be expected to run on a standard desktop computer.

Relevant Standards:

- IEEE 11073: Point-of-Care Devices
- IEEE 11073-10722: Endoscopic Devices

Technical Details

Capsule Imaging & Electronic Components:

- Image Sensor (MT9M114)
- Bluetooth Component
- Voltage Regulators
- Level Shifters
- I/O Breakouts
- FPGA (1 MB, 96 MHz GPIO Speed)

Application Software:

- Languages: C, C#, Python
- Libraries: OpenCvSharp, OpenCV, Amazon Rekognition, Nordic SDK
- Programming Tools: Visual Studio, Sublime Text 3, Amazon Rekognition

Design Approach
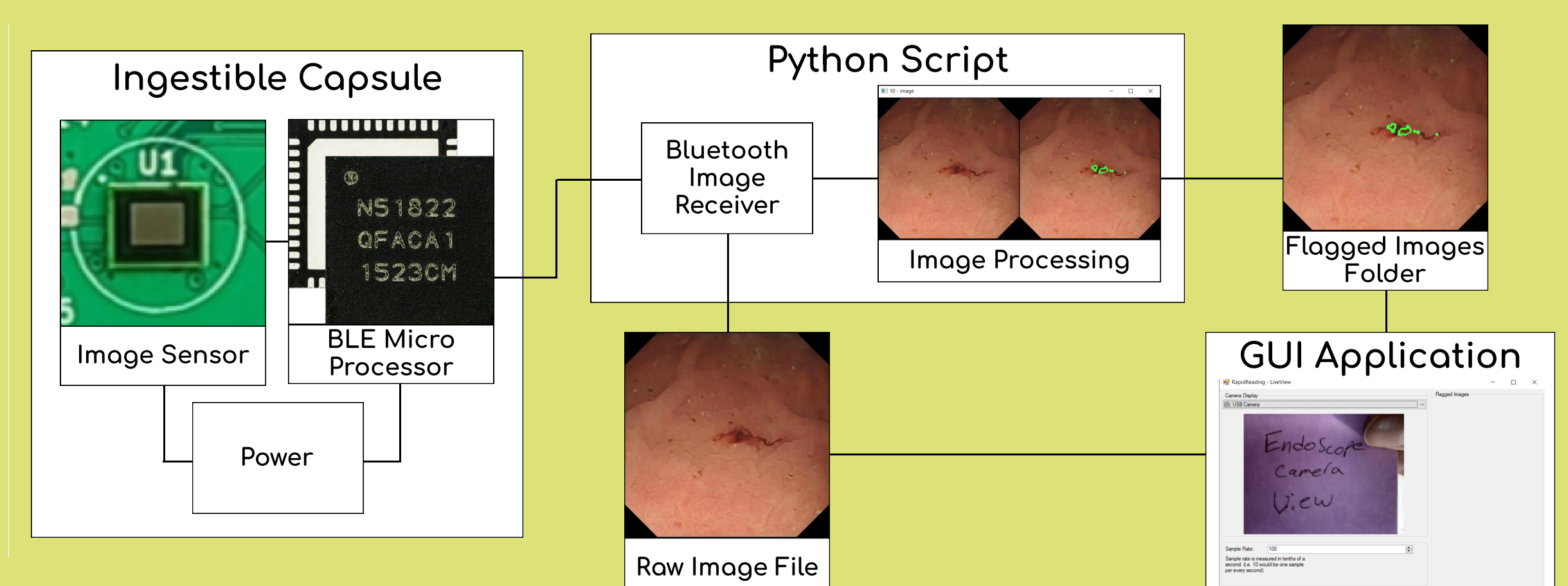
The project is categorized into two parts, the physical capsule and the desktop application. The figure shows the flow of data from the capsule imaging & electronic components, through the Bluetooth module, and finally to the desktop application.

Software Testing
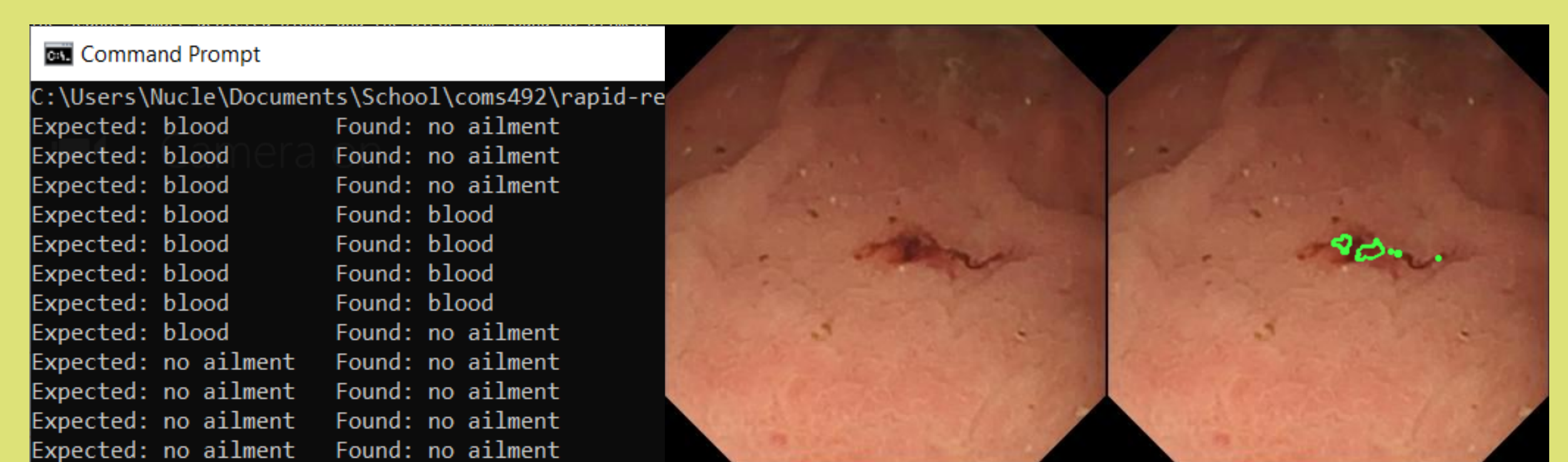
Initial Image Analysis Tests

- Run script through a folder of images
- List the findings for each image
- Have a script check those findings to the known diagnosis

GUI Testing

- Due to a lack of ability to test the image processing while using a camera the GUI is tested to make sure it displays the camera and sends the images to the analysis script.

Hardware Testing

Initial Sensor Test

- Connected board to external Arduino
- Set image sensor registers over I2C
- Viewed individual outputs with serial monitor