

Project Description

Multispectral Image Capture System

The Sixth Sensor

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Revision History:

2/25/15 - 20 Use Cases/User Stories Added

2/5/15 - Hardware changed

2/5/15 - Software changed

Intro:

We will develop a new FLIR product centering around a multi-wavelength image capture system. We will give users the ability to capture a stack of images at different wavelengths with a single shutter click. Four sensors will be used to capture images in the visible light, near-infrared (NIR), short-wavelength infrared (SWIR), and long-wavelength infrared (LWIR) spectrums. We will develop a database to store the images and create a GUI for users to review and manipulate the captured images. We aim to allow users a lot of control over the images within the GUI. Some features we hope to make available are changing the transparency of the images and allowing them to be annotated. Once this basic functionality is complete we will then move onto storing the images on a cloud system, this will allow authorized users to access images from different devices (laptops, PCs, etc.). Agile is the development process being used with the assistance of Trello to manage our workflow.

This product can have many applications, all centering around discovering what cannot be seen by the naked eye. For example, when one has a stroke the left and right side of their face differ in temperature, this asymmetrical behavior cannot be seen with the naked eye but would be captured by a LWIR sensor. Thus, in this situation using our camera system would be advantageous for doctors looking to diagnose a patient as they would be able to clearly see the temperature difference. There are many more possible applications for our product and we hope to discover these different possibilities throughout the development process.

Glossary Terms:

Agile - Philosophy that outlines the most important aspects in product development

Trello - Web application that assists with managing a project's workflow

GitHub - Web application that assists with managing a project's workflow and documents

Visible - Light wavelengths the naked eye can see

Infrared (IR) - Light wavelengths larger than those in the visible spectrum. Broken into multiple regions.

Often used for thermal imaging.

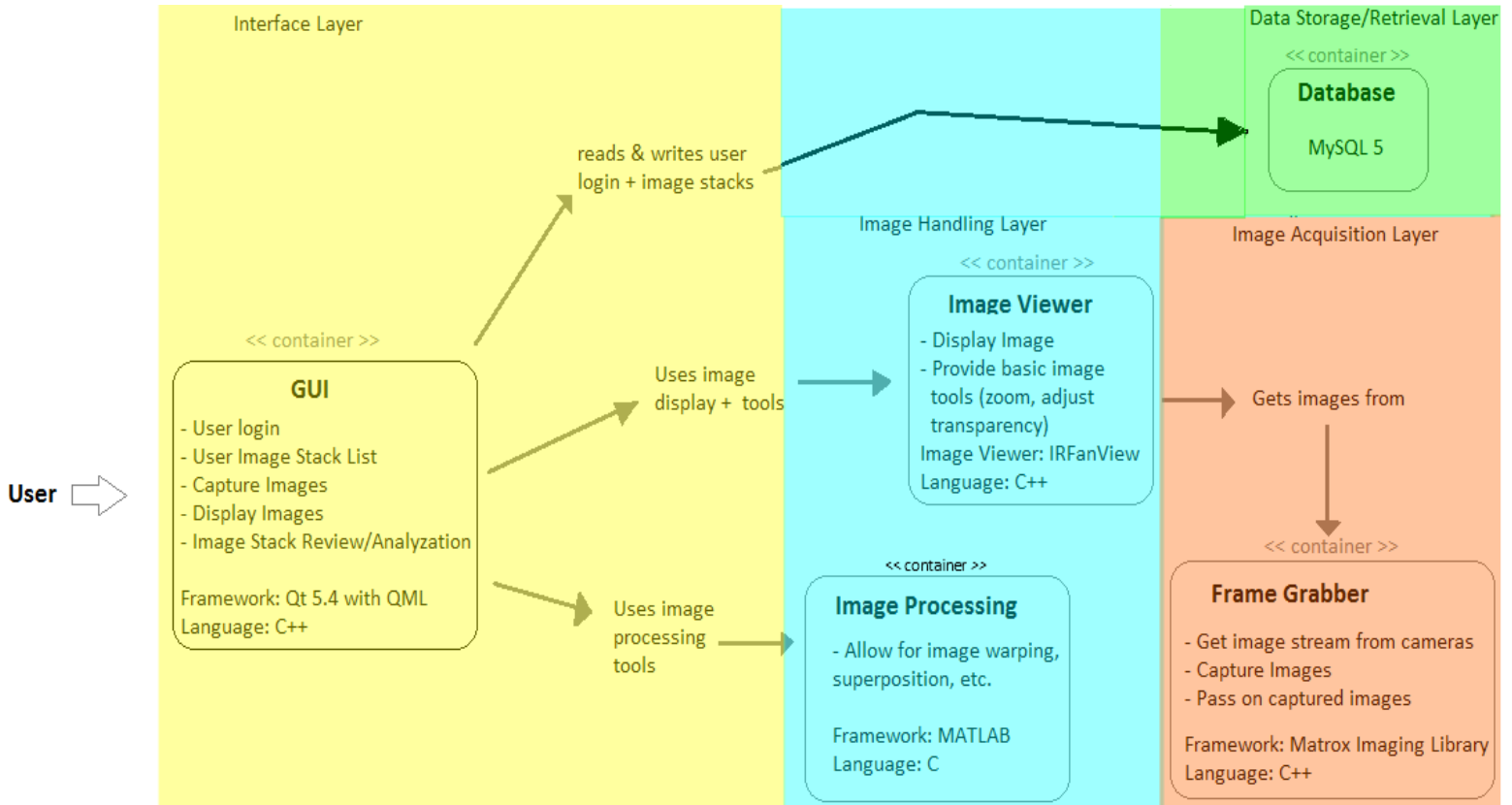
- Long-Wavelength Infrared (LWIR)
- Near-Infrared (NIR)
- Short-Wavelength Infrared (SWIR)

Graphical User Interface (GUI) - Interface between user and electronics

Cloud System - Allows for the outsourcing of computer resources (storage, servers, etc.)

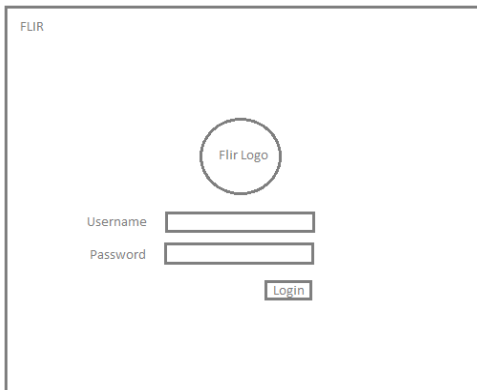
System Architecture Overview

Software Architecture:



High Level Picture:

GUI Design



Login Screen

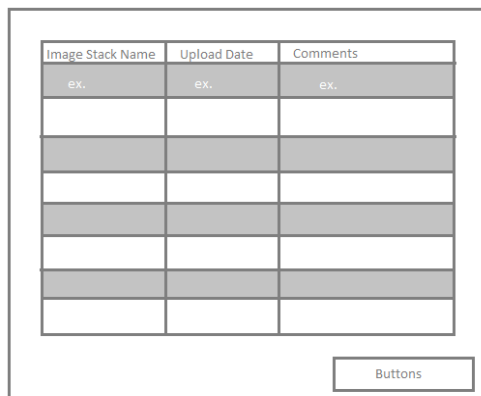


Image Stack Menu

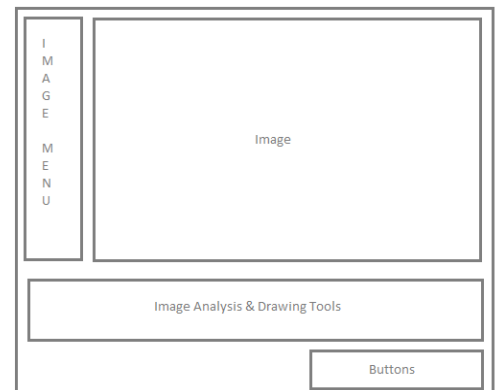


Image Review Page

Camera System Design



Requirements:

Use Cases/User Stories:

GUI Use Cases/User Stories

- As a user, I can see an Image Menu to guide me through the images I took. Acceptance Test: Go to the Menu screen and ensure the Menu can be seen within the GUI once images have been taken.
- As a user, I will be able to press an image from the Image Menu and have it pop up for review. Acceptance Test: Click an image from the menu and ensure image pops up once chosen and only one image is visible at a time within the GUI.
- As a user, I will be able to zoom in on desired areas of the photo. Acceptance Test: Test that it is possible to zoom in/zoom out on the image.
- As a user, I can use a drawing tool to annotate the images, such as being able to draw circles, arrows, etc. Acceptance Test: It is possible to draw on the image and that a copy of the annotated image is stored.
- As a user, I will be able to create a unique username and password that will allow me to login to the application. Acceptance Test: Create a login in account and attempt to log in.
- As a user, I will be able to access my personal pictures by through my login account information. Acceptance Test: Create different accounts, ensure each account can only access their own pictures and all pictures are present.

- As a user with Administrator permission, I can create other user accounts and select their permission status. Acceptance Test: Create a normal user account (not administrator), and log in as this user. Make sure I do not have administrative permissions while in this account. Log in with an administrator account and ensure I have administrator permissions.
- As a user, I will have the ability to adjust the transparency of captured images. The option should be able to blend different variants of the captured image, such as NIR and SWIR together. Acceptance Test: Attempt to stack two images together to create “one” image by adjusting the transparency of the images.
- As a user, I will be able to look at the previous images that have been captured to see what work has been completed. Acceptance Test: Log into the same account and take multiple pictures. Log out then log back in and make sure the images have been properly stored.
- As a user, I will be able to delete images from my image list. Acceptance Test: Attempt to delete the image, logout then log back in and make sure the image has been properly deleted from the database.
- As a user, I will be able to view the captured images as thumbnails from both my image stack menu and when reviewing an image stack. Acceptance Test: Take an image and click this image stack from within the image stack menu and ensure thumbnails appear. Then move to the image review page and ensure the image menu contains thumbnails.
- As a user, I will be able to take the captured images from the program and be able to store or upload them anywhere I choose to on the cloud. Test: Capture an image out in the woods and it will be saved to my Cloud if I have an internet signal.
- As a user, all my personal information relevant to the program(name, permissions, photos) which is stored in a cloud database can be accessed and modified only through the GUI. Test: Log in through a computer and use another computer to verify all information is correct.
- As a user, I won't be able to exit the program unless I have verified to do so. Test: If exit is clicked on, a window should pop up and ask if we are sure we want to do this.

Frame Grabber Use Cases/User Stories

- The cameras and PC can be interfaced with a frame grabber. Acceptance Test: Acquire a snapshot and obtain 4 different images into the frame grabber and then locally store the images on the PC. If the image can be opened within the PC it has worked.
- As a user, I can have my four images automatically synchronized to have them at the same dimensions and resolution. Acceptance Test: After taking picture, check synchronization process by verifying size and resolution of images and verify four images have been taken.
- As a user, I can use the focal laser to change the point of focus of my image. Acceptance Test: Physically move the “focusing” lasers for our camera system and see that image changes its focus.

Image Viewer Use Cases/User Stories

- As a user, I can access images from the frame grabber from within the GUI. Acceptance Test: Capture an image and from within the GUI attempt to review the image, if it is present it has worked.
- As a user, I will be able to resample the image so that it keeps its quality when resized or rescaled. Acceptance Test: When handling an image, click and drag the picture to how big or small it wants to be.
- As a user, I will be able to manipulate the image in many different ways such as morphing it, changing the color of it, shading or unshading certain parts and more. Acceptance Test: Be able to adjust the image so it becomes distorted and now challenging to be able to blend together with other pictures.
- As a user, I can give a permission to other users to view and/or edit my images. Acceptance Test: I give permission to another user and the other user will test if they can also view/edit my captured image.

Camera System Use Cases/User Stories

- As a user, I can press a button on the camera device, and an image will be captured. Test: Press the capture button and check that the image was captured by the device.
- As a user, I can press a button, and lights will turn on and focus on the image subject so that better photos can be captured. Acceptance Test: Press the light button and ensure the lights turn on.

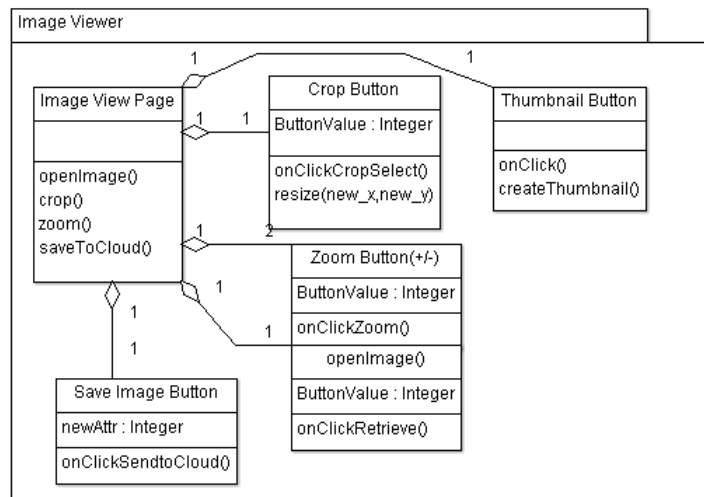
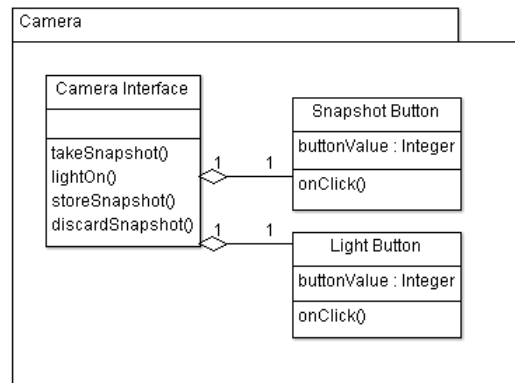
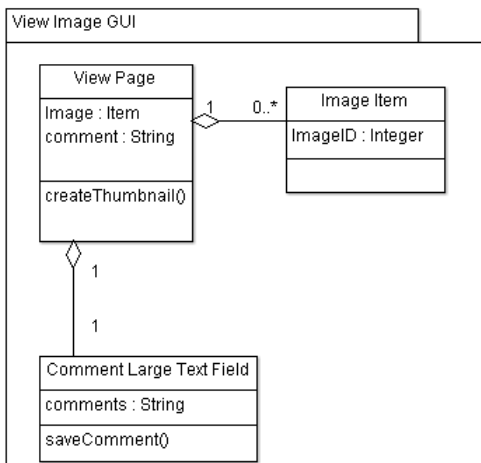
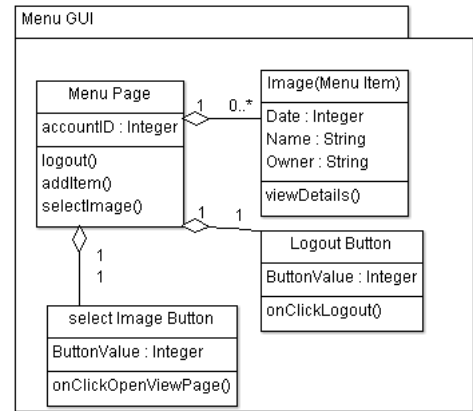
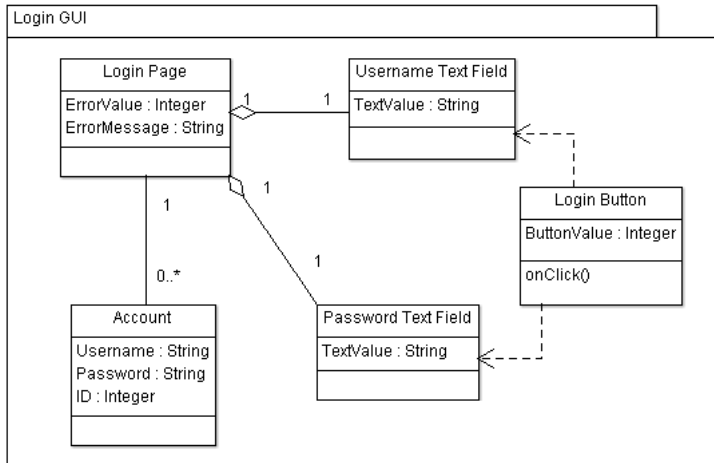
- As a user, I can take a single shot, and capture the same image in SWIR, LWIR, NIR, and visible wavelength. Acceptance Test: Make sure there are four images captured after one sequence of capturing on the camera.
- As a user, I will have the ability to capture an image by itself. Acceptance Test: Attempt to take a picture in only one wavelength and ensure only one image in that wavelength has been taken.
- As a user, I can take a picture with a timer so that I can have time to hold still. Acceptance Test: After the shutter tap is pressed, test if picture is captured right away or after a certain time frame.
- As a user, I can watch a live feed from one of my cameras to see where the focus of the image is. Acceptance Test: Among the four lenses, ensure the cameras are streaming images.
- As a user, I can switch the between live feed and image stills from the camera system. Acceptance Test: Attempt to switch between a live feed from the cameras and looking at stills from an image stack, if the live feed stops and we see stills it has worked.
- As a user, I will be able to store my captured images into individual folders of my choosing. Acceptance Test: Move the captured images into the folder that is on the computer or whatever system is currently using the camera.
- As a user, I will be able to name the captured images directly after capturing them or at a later time. Acceptance Test: Once the image has been captured and stored on the database, a user will be able to review the image(s) either directly after it is captured or once loaded and rename them.

Prototyping Code and Test Cases:

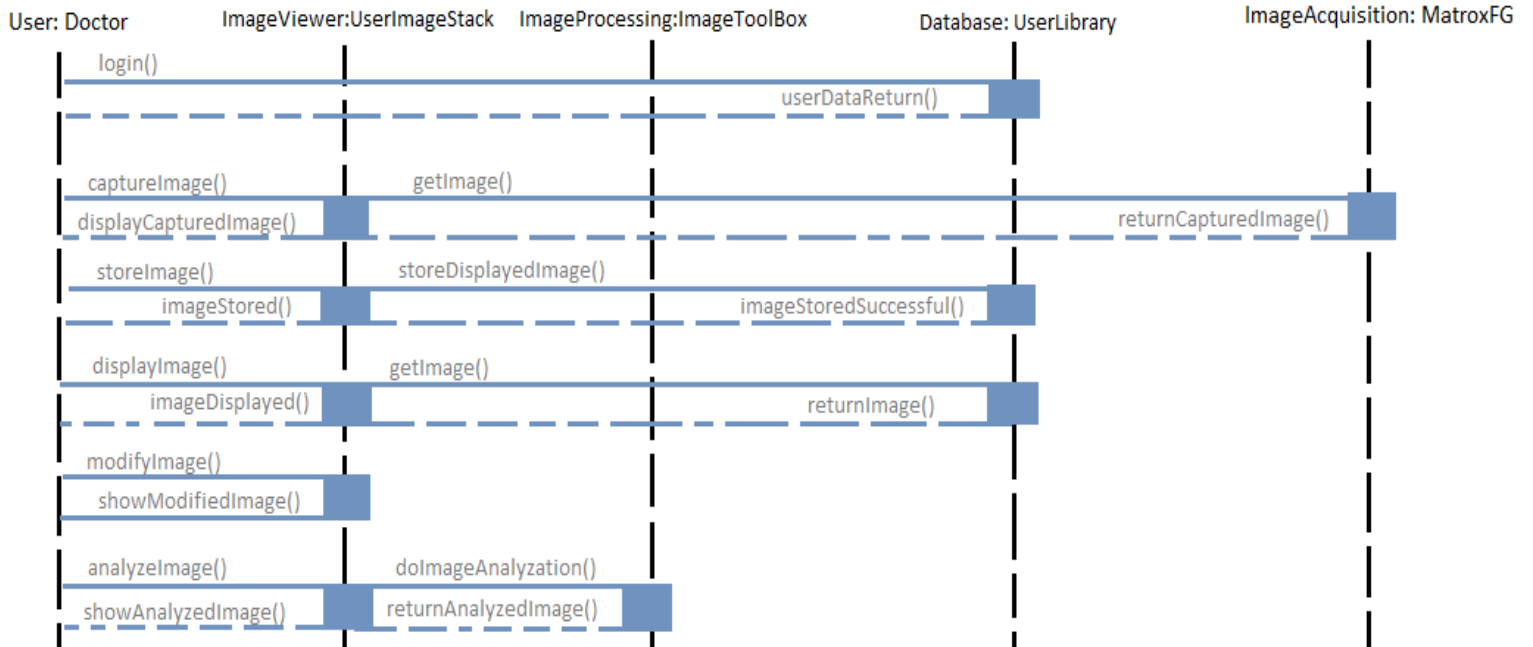
Private GitHub Repository: <https://github.com/jsyramirez/The-Sixth-Sensor.git>

Systems Models:

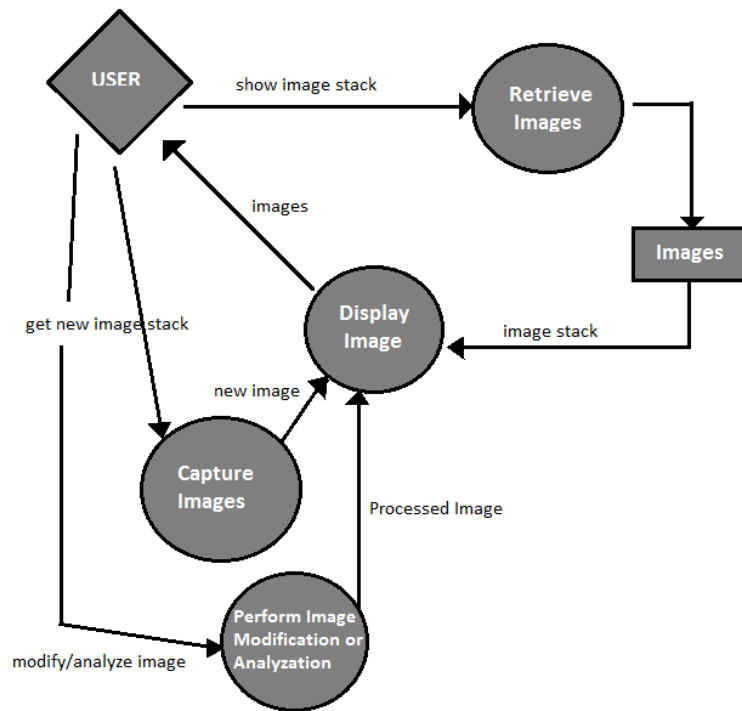
UML:



Sequence Diagram



Dataflow Diagram



Appendices:

Hardware:

FLIR TauSWIR Camera (InGaAs sensor, 640x480 resolution)

FLIR TauLWIR Camera (uncooled micro-bolometer, 640x480 resolution)

Imperx b600 Monochrome Camera (NIR)

Imperx b600 Color Camera (Visible)

HP workstation Z420

Matrox Radiant eV-CLDB Frame Grabber

Candescent Lights

Laser Pointers

Software:

Matrox Imaging Library LITE X WIN (Image Acquisition)

Qt with QML (GUI Implementation)

MySQL (Database)

IRFanView (Image Viewer)

Matlab (Image Processing)

Programming Languages: C++/C