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1. Introduction

1.1 Product Overview

Eye in the Sky incorporates both existing products and new components.

It includes a UAV with on-board thermal and optical cameras as well as a GPS device. The UAV is an X8 series multicopter made by 3D Robotics, Inc. that comes with an existing API and GUI to automate flight routes. The cameras are Canon ELPH 110 Powershots, one of which is in a stock configuration, and the other which has had an 830nm near-infrared filter installed by MaxMax. After the UAV collects imagery during a flight, images are uploaded to the AWS server. On this server, image processing occurs in C++ with the OpenCV library.

The relevant images and results of the image processing are then accessible via a web application. We will build on top of Django using Python, and run this application from the AWS server using a MySQL database. Farmers will be the users of the web application in order to review the data about their own farm's conditions.

1.2 Definitions & acronyms

Item	Definition	Version used (if applicable)
API	Application Programming Interface; a protocol used as an	

	interface so that software components can communicate with each other	
Python	a high-level programming language	2.7.5
Django	a high-level web application framework on top of the Python language	1.6.1
OpenCV	an open source, cross-platform computer vision and image processing library	2.4.8
UAV	unmanned aerial vehicle (a.k.a. drone)	
APM	type of autopilot UAV provided by 3D Robotics	
IR	infrared; part of the electromagnetic spectrum with wavelengths between 0.8 micrometers and 1 millimeter that is used for thermal imaging	
GPS	Global Positioning System; used to acquire geolocation data	
CWSI	crop water stress index; measure of the relative transpiration rate occurring from a plant at the time of measurement - using a measure of plant temperature and the vapor pressure deficit, which is a measurement of the dryness of the air	
GUI	graphical user interface	
AWS	Amazon Web Services	
HTML	HyperText Markup Language; the standard markup language for creating web pages and other information that can be displayed in a web browser (latest standard is HTML5)	
CSS	style sheet language used for describing the look and formatting o HTML documents (latest standard is CSS3)	
jQuery	cross-platform JavaScript library that simplifies the client-side scripting	2.1.0
Twitter Bootstrap	front-end framework with responsive CSS and Javascript components	3.1.0
NIR	Near-InfraRed (electromagnetic radiation with a wavelength of 700-1400nm)	

2. Components

2.1 UAV & Cameras

The UAV is a small multicopter capable of lifting two Camera. The model of the UAV is an 3DR-X8 multicopter, built by 3DRobotics capable of lifting a payload of up to 1000 grams. The cameras are Canon-ELPH 110 point and shoots, one of which has undergone a MaxMax filter conversion to view into the infrared spectrum at 830nm, the other of which is in its' stock configuration. A small custom circuit will be used to trigger the cameras to shoot at timed intervals when the motors on the X8 are running.

2.2 Web Server

The web server is a Django on Python 2.7 based server which provides a user-accessible interface to the service. It utilizes a MySQL database to store and retrieve user and job data. It utilizes a multi-threaded job handler in order to run multiple image analysis jobs in parallel. The web server will also provide a front-end interface for the user, allowing them to register, log in or out, and to create, manage, process, and view jobs and job results.

2.3 Analysis Server

The image analysis server is a C++ OpenCV based server which analyzes the images it is given. This server is capable of generating expanded Normalized Difference Vegetation Index images using a specialized color scale. It runs on the same physical hardware as the web server, but is launched as child processes of the web server. Multiple instances of the Analysis server may be running at once. The Analysis server pulls data directly from the file system, and reports back to the web server through it's main function's return value.

3. Design Specifications

3.1 User Case View

Use Case View diagram may be viewed in the Software Requirements Specification section 3.3.1.

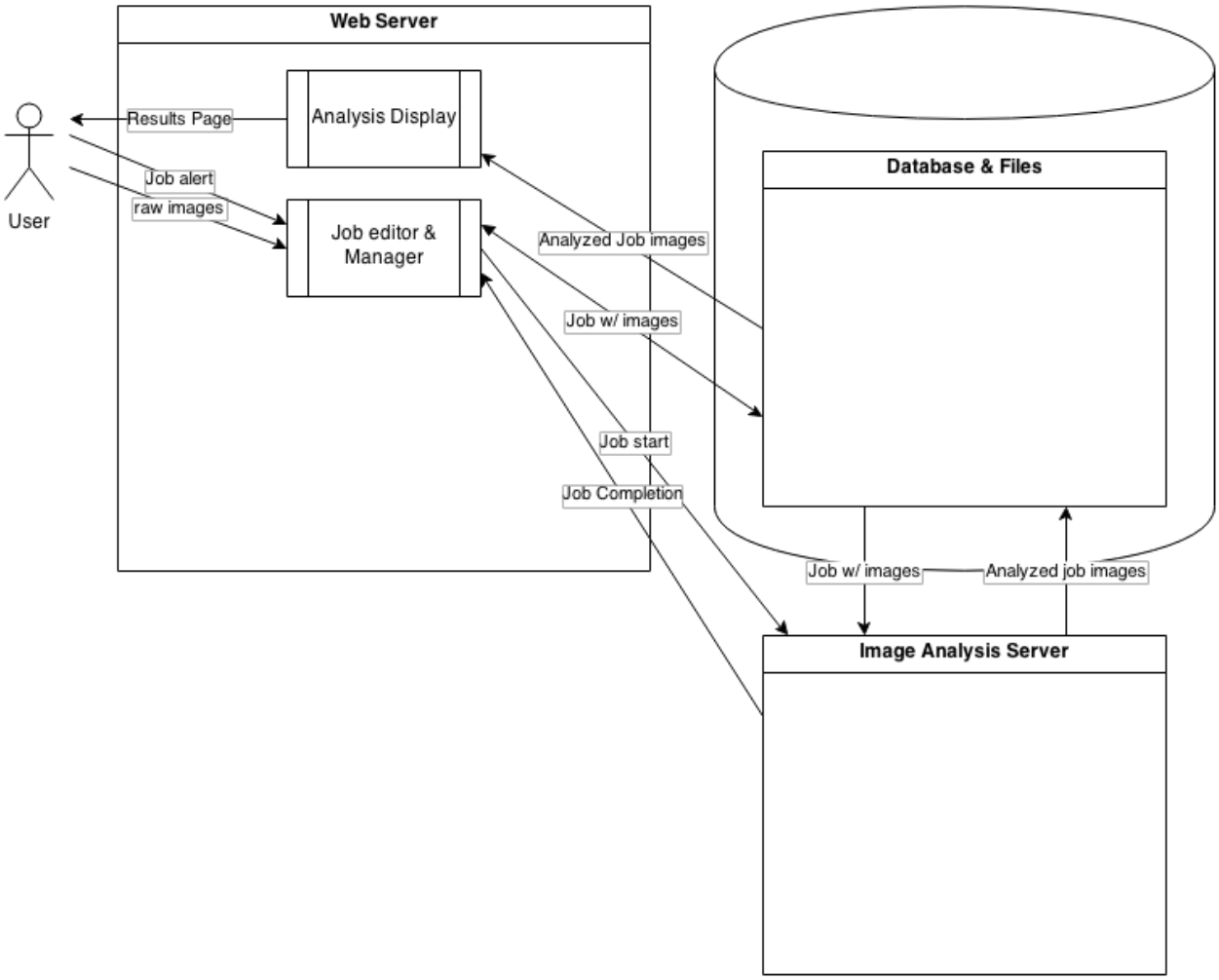
3.2 Detailed Design

3.2.1 User Stories

User stories may be viewed in the Software Requirements Specification section 3.3.2.

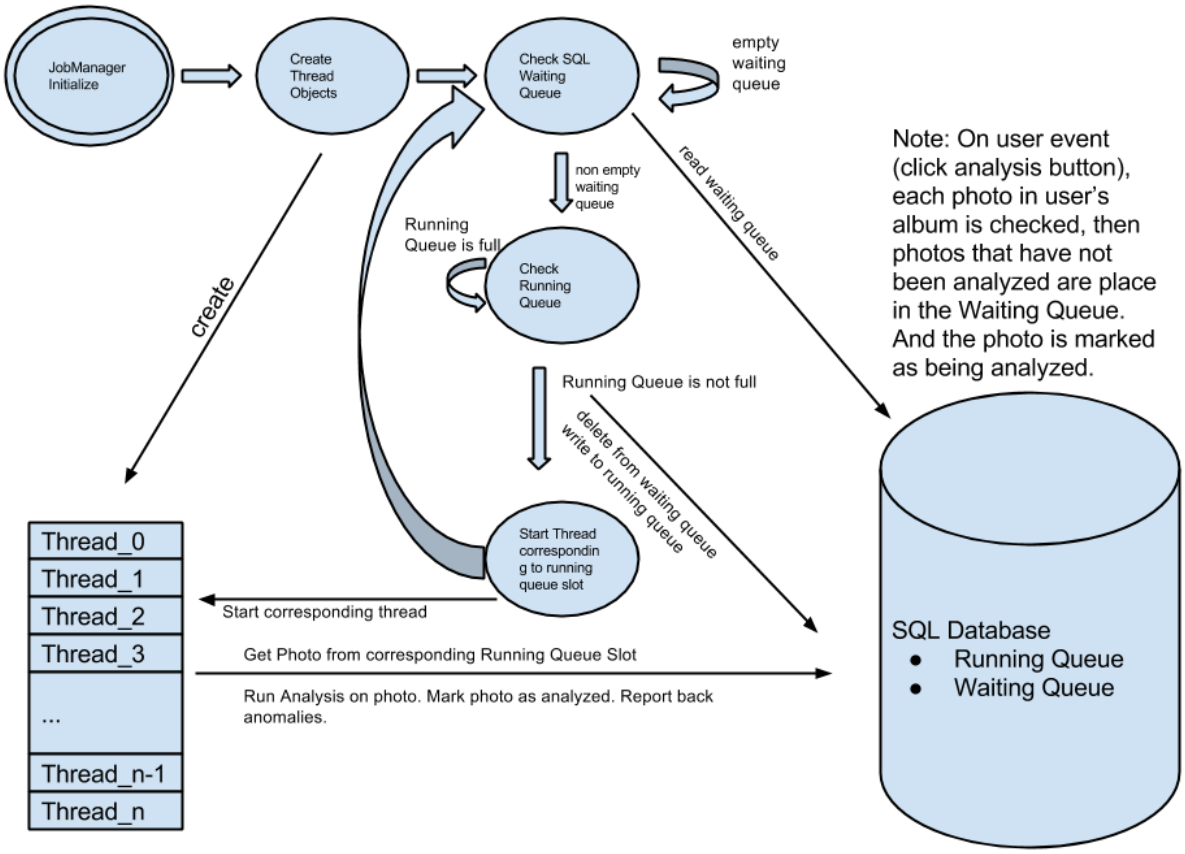
3.2.2 Dataflow diagram

Dataflow overview:



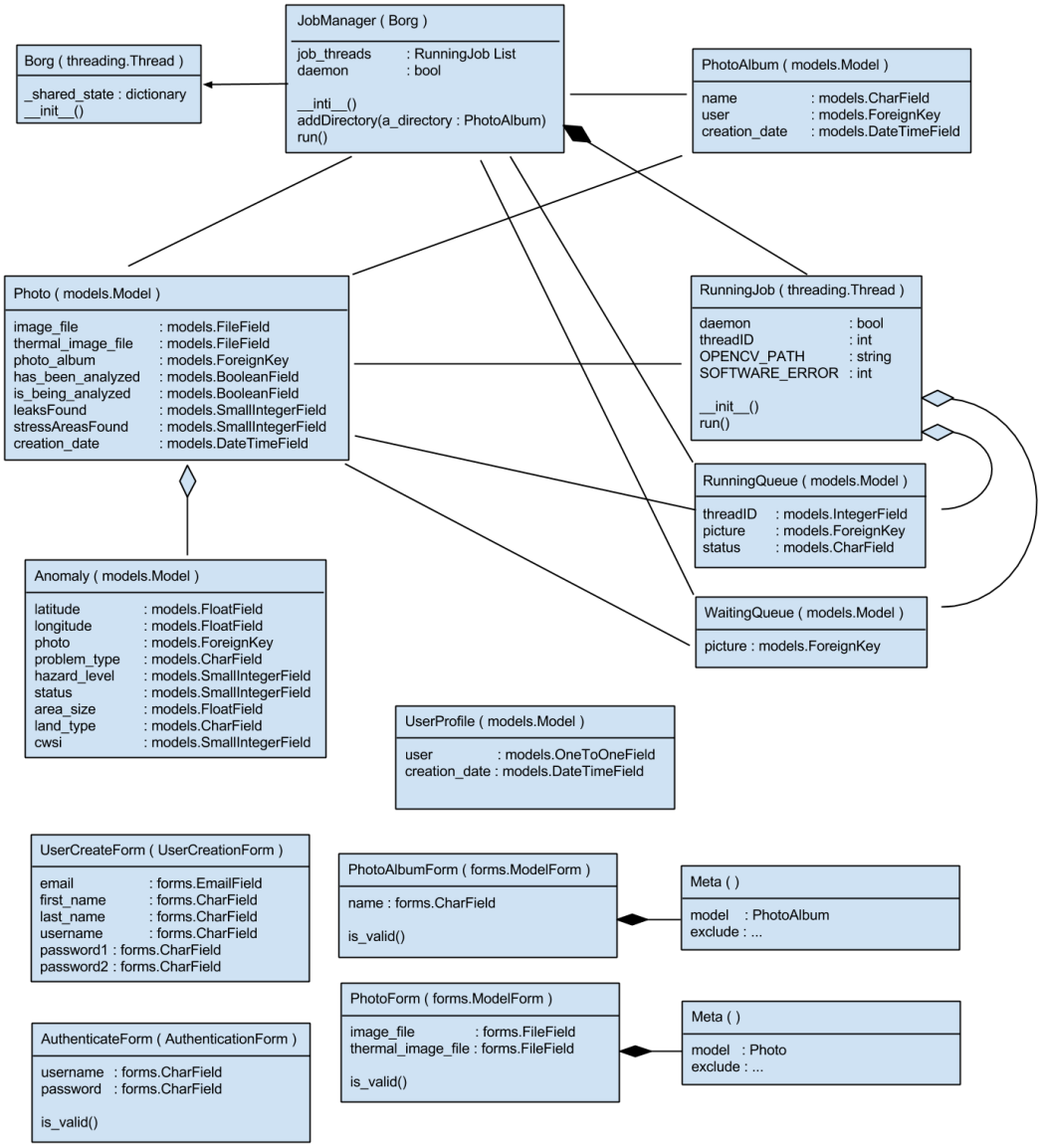
3.2.3 Function specific diagrams & Testcode

Threading on Website end:



4. Class Diagram

4.1 Web Server



4.2 Analysis Server

Single Function

- Libraries include
  - vector
  - stdio.h
  - opencv2/opencv.hpp
  - opencv2/core/core.hpp
  - opencv2/imgproc/imgproc.hpp
  - opencv2/features2d/features2d.hpp

        - opencv2/calib3d/calib3d.hpp
        - opencv2/highgui/highgui.hpp
        - opencv2/contrib/contrib.hpp
        - fstream
    - Input: (Path to Visual Picture, Path to Thermal Picture)
    - Output: Error Code (if not error, then 0), and an “analyzed” photo (saved to same path as the Visual Picture)
    - Algorithm Description
        - ??? Work in progress

5. UI Mockups

UI Mockups may be viewed in the Software Requirements Specification section 3.1.1.