

Self-Navigating Aerial Drone

Michael Bowen

Goals

- ▶ Waypoint Navigation
- ▶ Image Analysis
 - Object Recognition and Identification
 - Object Tracking
- ▶ Mapping

On Board Components

- ▶ Parrot AR Drone
- ▶ Six Degrees Of Freedom
- ▶ Front Facing Camera
- ▶ Ground Facing Camera
- ▶ Altitude Range Finder
- ▶ Wi-Fi
- ▶ Arm 9 32bit Processor
- ▶ Linux OS

Enhancements

- ▶ Arduino
- ▶ Xbee Serial Transceiver
- ▶ GPS Receiver
- ▶ Ultrasonic Range Finder
- ▶ Digital Compass
- ▶ Drone Performance/Life

Software Packages

- ▶ AR Drone SDK
 - Open Source
 - Does not include on board software
- ▶ Autopilot
 - Simon Levy
 - Open Source

Configuration

- ▶ Data Transmission
 - ▶ AR Drone
 - ▶ Wi-Fi
 - ▶ Arduino
 - ▶ Xbee Transceivers
- ▶ Control
 - ▶ Logitech Gamepad
 - ▶ 64bit computer running linux

Limitations

- ▶ GPS
 - Unusable Heading and Speed Data
 - Spikes in Data
- ▶ Yaw Gyro
 - Constant Increasing Change
 - Off by 90° in period of 15 minutes

Yaw Gyro Solution

- ▶ Use for specific tasks
- ▶ Short time periods
- ▶ Estimate error over time

GPS Solutions

- ▶ Digital Compass
- ▶ Inertial Navigation System
- ▶ Kalman Filter

Software Design

- ▶ Characteristics
 - ▶ Selective Data Processing
 - ▶ Call and Response Arduino Communications
- ▶ Structure
 - ▶ Multithreaded C Program
 - ▶ Python Modules
- ▶ Functionality
 - ▶ Combine sensor data
 - ▶ Artificial Intelligence
 - ▶ Control Drone Movement

OpenCV

- ▶ Open Computer Vision Libraries
- ▶ Library of programming functions for real time computer vision
- ▶ Over 500 Functions
- ▶ C++, C, Python and soon Java
- ▶ Runs on Windows, Linux, Android , iPhone, and Mac

Template Matching

- ▶ Template matching
 - Technique for finding small parts of an image which match a template image
 - Slides the template from the top left to the bottom right of the image, and compare for the best match with template
- ▶ Region of Interest is a rectangular area in an image, to segment object for further processing

Checking Main Area to Template 1
Width: 889 , Height 582

One or More Matches Found for Template 1

Checking Main Area to Template 2
Width: 789 , Height 626

One or More Matches Found for Template 2

Checking Main Area to Template 3
Width: 897 , Height 609

One or More Matches Found for Template 3

Terminal 1

```

135
136
137
138     if found_item >
139         amount +
140
141     cv.ShowImage("Main Area"
142     cv.WaitKey(5)
143     cv.MoveWindow("Main Area"
144
145     while True:
146         cv.WaitKey(5)
147         cv.WaitKey(27)
148         sleep(0.5)
149
150     else:
151         print "!!ERRORS!!"

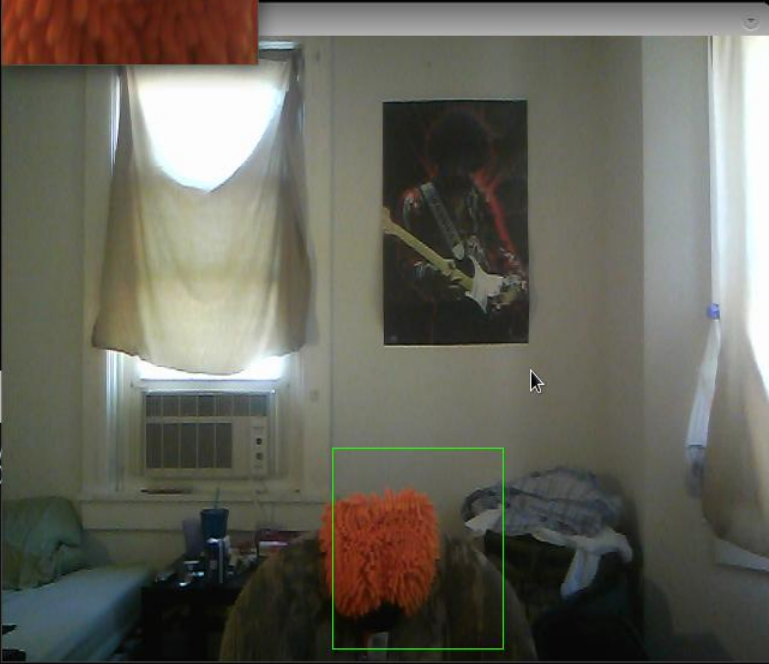
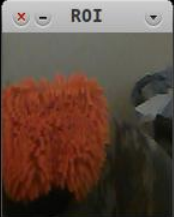
```




```

1 2video.py * video.py * 2video.py *
2 name__ == '__main__':
3
4 ready = 0
5
6 try:
7     img_path = "orange.png"
8     template_img = cv.LoadImageM(img_path, cv.CV_LOAD_IMAGE_COLOR)
9     cv.imshow("Template", template_img)
10 except:
11     print("Could Not Load Template Image")
12     ready += 1
13
14 try:
15     camera = cv.VideoCapture(0)
16     ret, frame = camera.read()
17     img = cv.cvtColor(frame, cv.COLOR_BGR2RGB)
18     cv.imshow("ROI", img)
19 except:
20     print("Could Not Start Video Feed")
21     ready += 1

```



```

81 cv.Resize(template_img, resized)
82 size_x = ((template_img.width + resized.width) // 2)
83 size_y = ((template_img.height + resized.height) // 2)
84 print(size_x, size_y)
85 except:
86     ready += 4
87
88 if ready == 0:
89     cv.ShowImage("Template", resized)
90     cv.ShowImage("Actual Template", template_img)
91
92 while True:
93     img = cv.QueryFrame(capture)
94     img = check_template(img, resized)
95
96
97

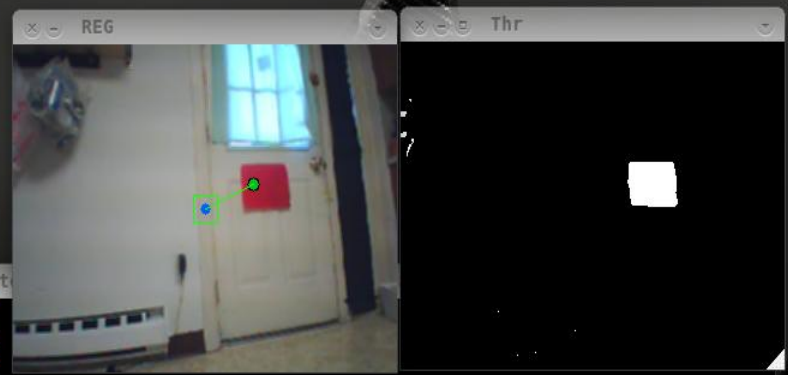
```

Blob Tracking

- ▶ Color based object recognition and tracking
- ▶ Steps
 - Covert to HSV color space
 - Blur
 - Threshold and Erode
 - Determine movement area from Image Center



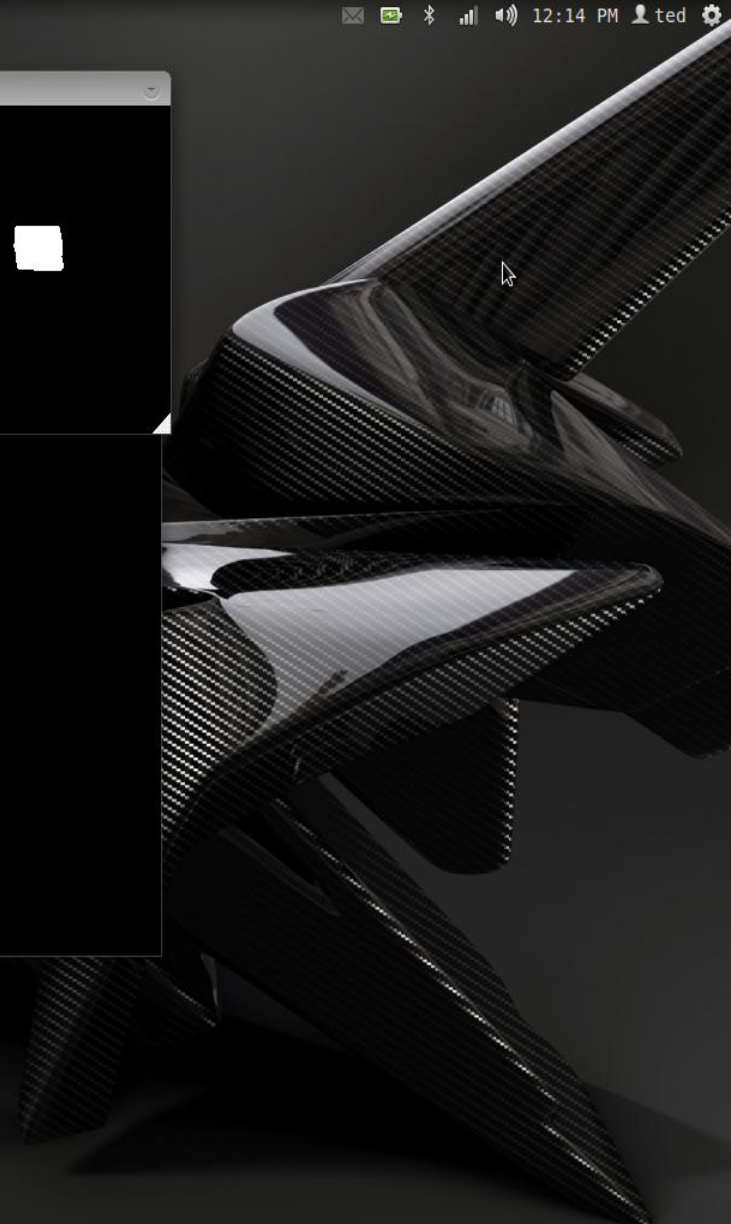
- arduino-0022
- libsiftfast-1.2-win32.zip
- opencv-python-examples.zip
- libsiftfast-1.2-win32
- python.zip
- Self-Navigating Aerial Drone.pptx
- test.kml
- Screenshot at 2011-11-07 14:33:26.png
- Screenshot at 2011-11-07 14:37:02.png
- from_me.txt.zip
- virtualbox-4.1_4.1-6-74713-Ubuntu-o...



```

340425.0
337365.0
337875.0
344760.0
331245.0
343995.0
328440.0
336855.0
340425.0
337110.0
330735.0
337110.0
342720.0
329205.0
332520.0
339915.0
344250.0
344250.0
344760.0
333030.0
332265.0
343995.0
340425.0

```



Pyramid Segmentation

- ▶ Image Pyramid
 - ▶ Collection of images from a single image
 - ▶ Down sampled until stopping point reached
- ▶ Component
 - ▶ Area
 - ▶ Color
 - ▶ Position

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- 

arduino-0022

opencv-python-examples.zip

python.zip

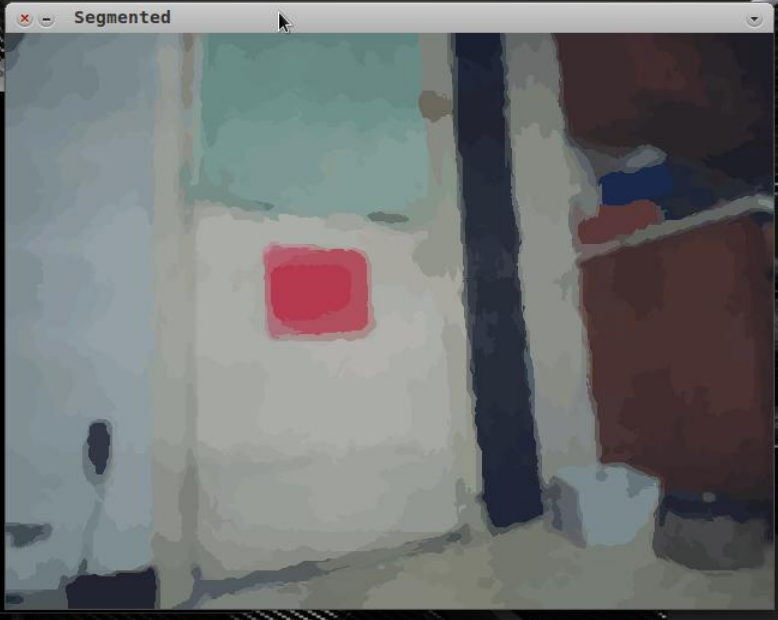
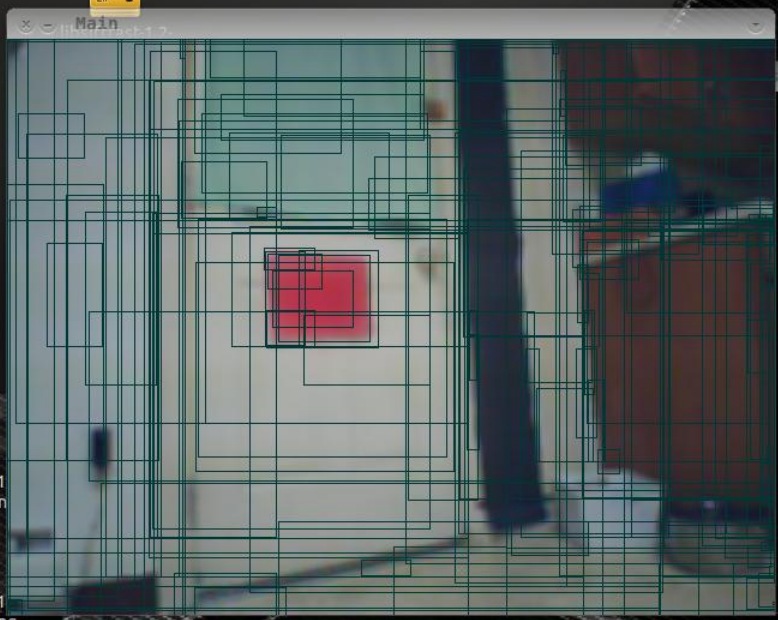
test.kml

Screenshot at 2011-07-14 14:33:26.png

Screenshot at 2011-07-14 14:37:02.png

from_me.txt.zip

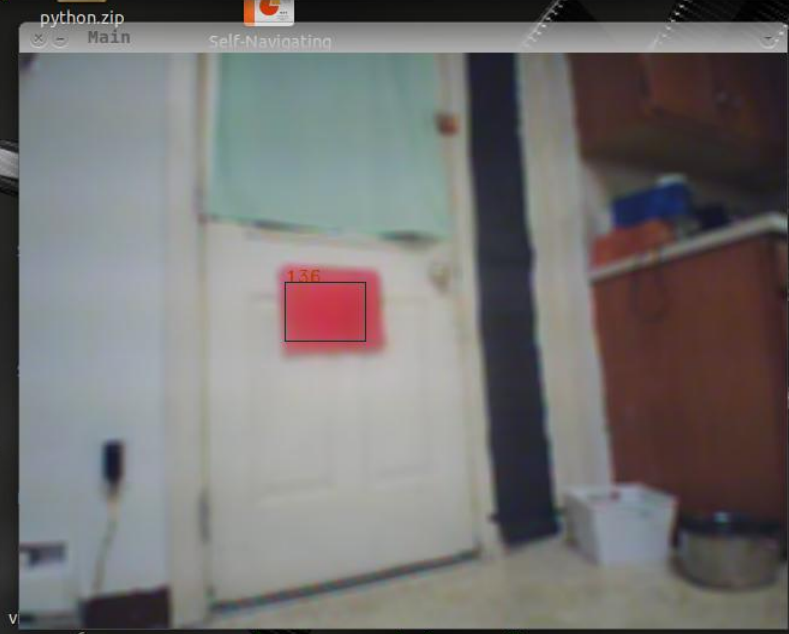
virtualbox-4.1_4.1.6-74713-Ubuntu-o...



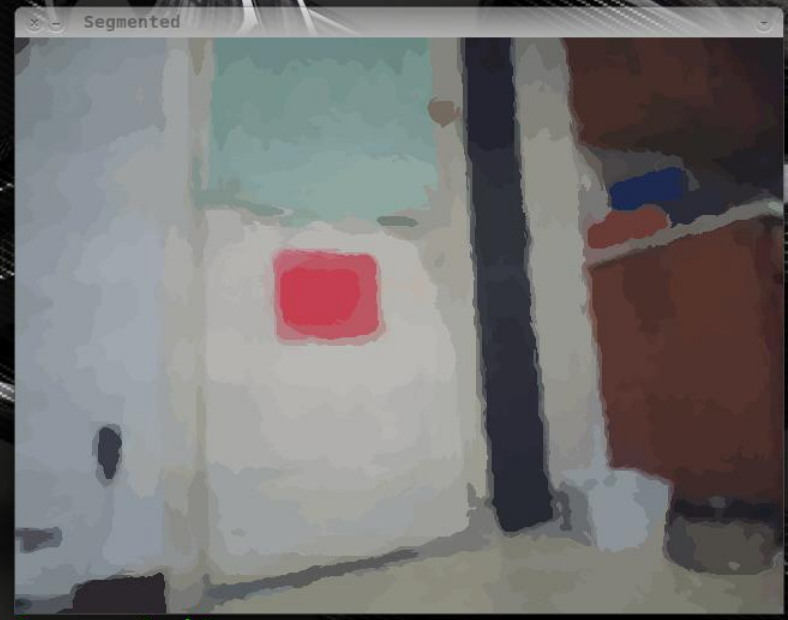
```
159  
160  
161  
162  
163  
164  
165  
166  
167  
168  
169
```



Eroded Image



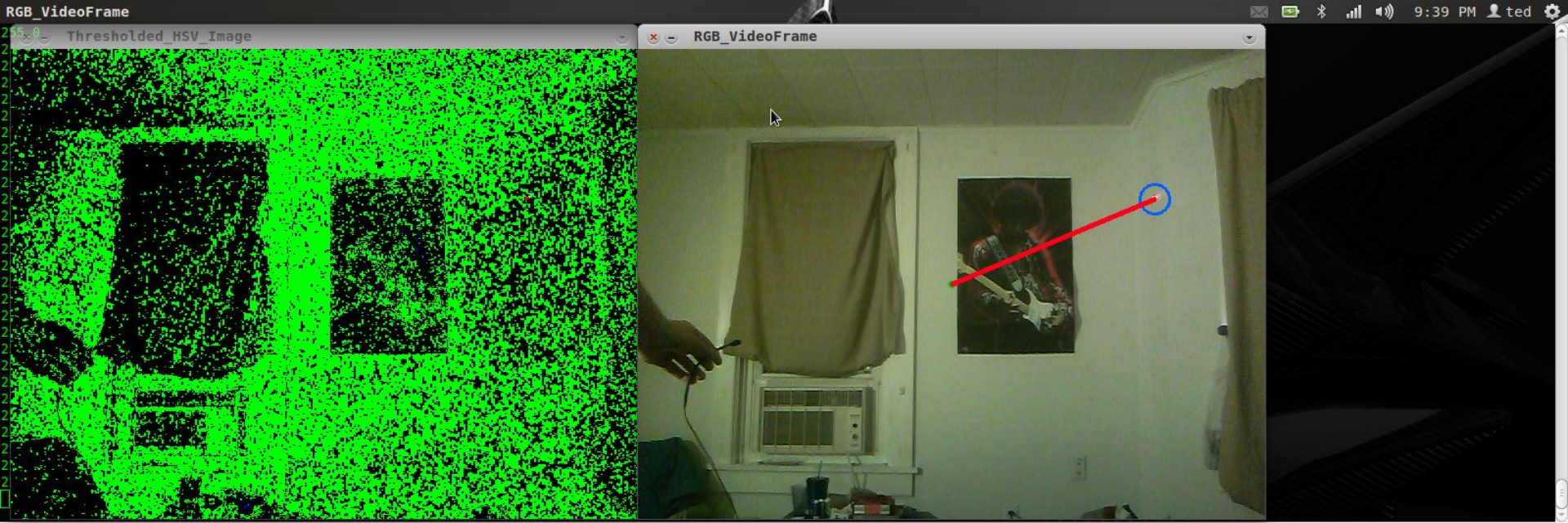
Main Image(Blurred)



Segmented Image

Laser Tracking

- ▶ Convert to HSV Colorspace
- ▶ Spilt image into separate H,S, and V images
- ▶ Threshold each image
- ▶ Perform AND operation between all three images
- ▶ AND
 - ▶ Calculates joining area of 2 images



Navigation Type 1

- ▶ Navigate through a series of defined waypoints
- ▶ Calculate distance and bearing information between waypoints

Navigation Type 2

- ▶ Pattern Based
- ▶ Starting waypoint given
- ▶ Distance and bearing information given between waypoints
- ▶ Populate Pattern Area with a Series of GPS coordinates

Mapping

- ▶ Visualize navigation data
- ▶ Log Images and image descriptions
- ▶ Perform in real time
- ▶ Maintain archive of past flights

Google Earth

- ▶ KML
- ▶ Real Time
- ▶ Simulate
- ▶ Place marks
 - Lines
 - Icons
 - Overlays
 - Descriptions

Search

Fly To Find Businesses Directions

Fly to e.g., Tokyo, Japan

Places

- Mount Fuji
Located near Tokyo, Japan
- Google Headquarters
Located in Mountain View, California
- 222test.kml
- 333test.kml
- 444test.kml
- Temporary Places
- all3.kml
- all3.kml
- test.kml

Layers Earth Gallery >>

- Primary Database
- Borders and Labels
- Places
- Photos
- Roads
- 3D Buildings
- Ocean
- Weather
- Gallery
- Global Awareness
- More



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Google earth

Imagery Date: 8/29/2010 1992

lat 40.511880° lon -75.779068° elev 469 ft

Eye alt 677 ft

Search

Fly To Find Businesses Directions

Fly to e.g., Reservoir Rd. Clayville, NY

Places

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 333test.kml
- 444test.kml
- all3.kml
- all3.kml
- test.kml

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