

Militarizing Your Backyard With Python:

Computer Vision and the Squirrel Hordes



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PyCon 2012

Overview

- Background & Goals
- OpenCV
 - Working with Python
- Detecting Squirrels
 - SVMs
 - Squirrely features
- Shooting Squirrels
- Wet Squirrels
- Next Steps

The Great Backyard Bird Count



The screenshot shows the top section of the GBBC website. At the top is a banner with the title "THE GREAT BACKYARD BIRD COUNT" in yellow and blue, featuring illustrations of various birds in flight. Below the banner is a navigation bar with several links and logos. On the left, there are three main navigation links: "Home" (with a birdhouse icon), "Submit Your Bird Checklist" (with a checklist and pencil icon), and "Explore the Results" (with a map of the United States and a bird icon). To the right of these links, it states "GBBC is a joint project of" followed by the logos for "The Cornell Lab of Ornithology" and "Audubon". Further right, it says "Canadian Partner" followed by the logo for "BIRD STUDIES CANADA / ÉTUDES D'OISEAUX". Below the navigation bar, there is a language dropdown menu set to "English". To the right of the menu, a blue box contains the text "Next GBBC: Feb. 15-18, 2013" and "Data entry for the 2012 GBBC is closed". On the far right, there is a small map of North America with black dots indicating bird sighting locations.

THE GREAT BACKYARD BIRD COUNT

Home Submit Your Bird Checklist Explore the Results

GBBC is a joint project of
The Cornell Lab of Ornithology Audubon

Canadian Partner
BIRD STUDIES CANADA / ÉTUDES D'OISEAUX

English

Next GBBC: Feb. 15-18, 2013
Data entry for the 2012 GBBC is closed

<http://www.birdsource.org/gbbc/>

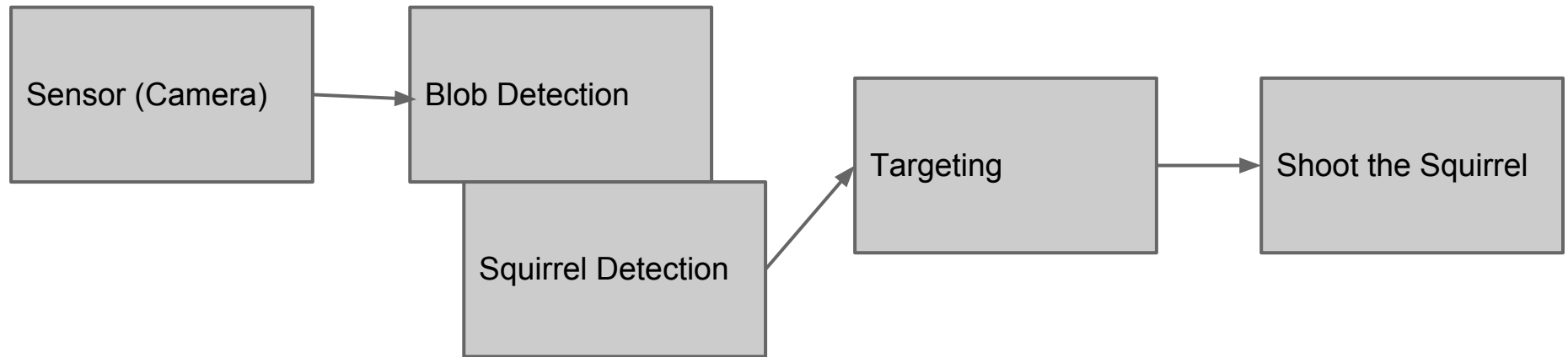
Squirrels...



Sentry Water Gun



System





OpenCV

Open Source Computer Vision

- Image Processing
- Video Analysis
- Feature Detectors
- Object Detection

C, C++, Python Interfaces

<http://opencv.willowgarage.com/wiki/>

<http://code.opencv.org>



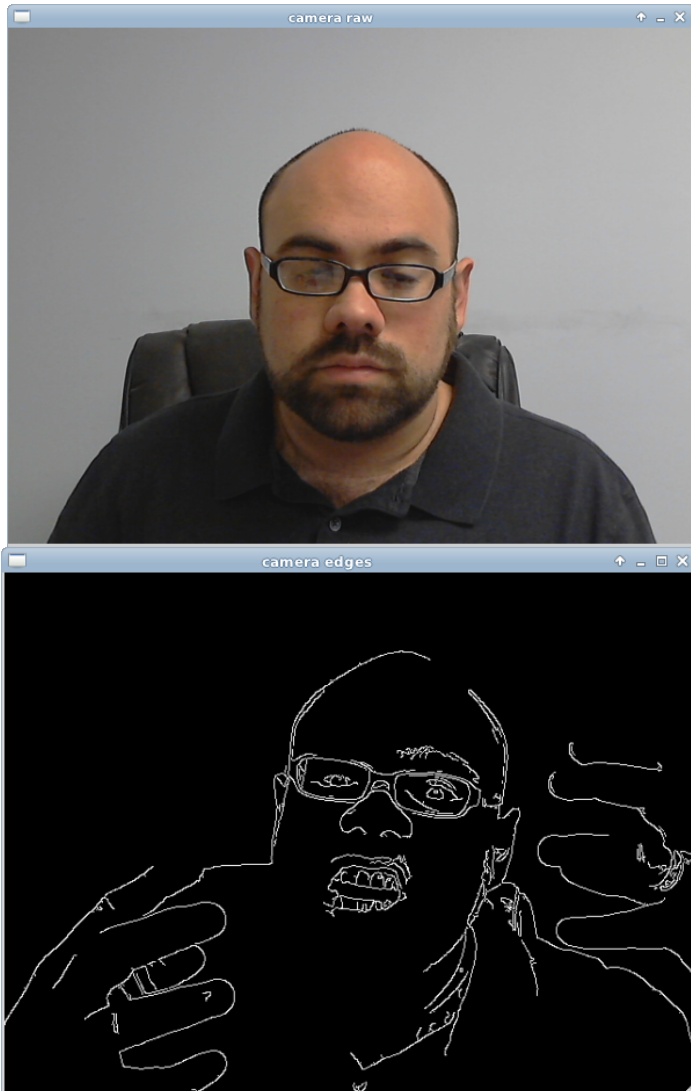
Python & OpenCV

- Support for native Python structures
- Works with numpy
- Efficient data sharing

Sensor : Webcam



OpenCV



```
import cv
```

```
cv.NamedWindow("camera raw", 1)  
capture = cv.CreateCameraCapture(0)  
img = cv.QueryFrame(capture)  
cv.ShowImage("camera raw", img)
```

```
# Convert to Gray Scale  
gray = cv.CreateImage(cv.GetSize(img),  
                      cv.IPL_DEPTH_8U, 1)  
cv.CvtColor(img, gray, cv.CV_BGR2GRAY)
```

```
# Canny Edge Filter  
cv.Canny(gray, edges, 50, 200, 3)
```

Blob Detection

How do I find regions of interest (i.e. Blobs)?

- Birds
- Squirrels
- Neighbor Children

cvBlobsLib <http://opencv.willowgarage.com/wiki/cvBlobsLib>

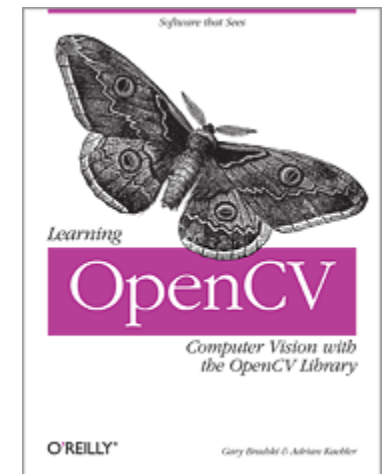
cvFindContours (OpenCV function)

Background Subtraction

Foreground Segmentation

Noisy Background

Codebook Approach



Squirrel Detection



Support Vector Machines (SVMs)

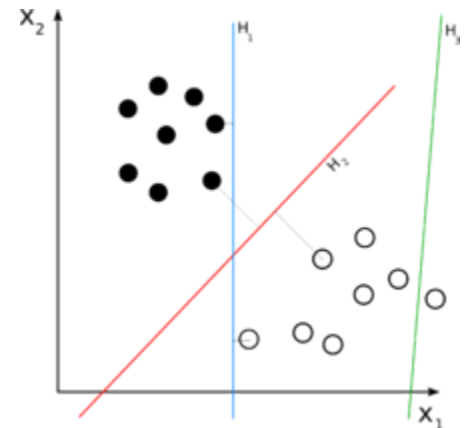
Supervised Learning

Classification

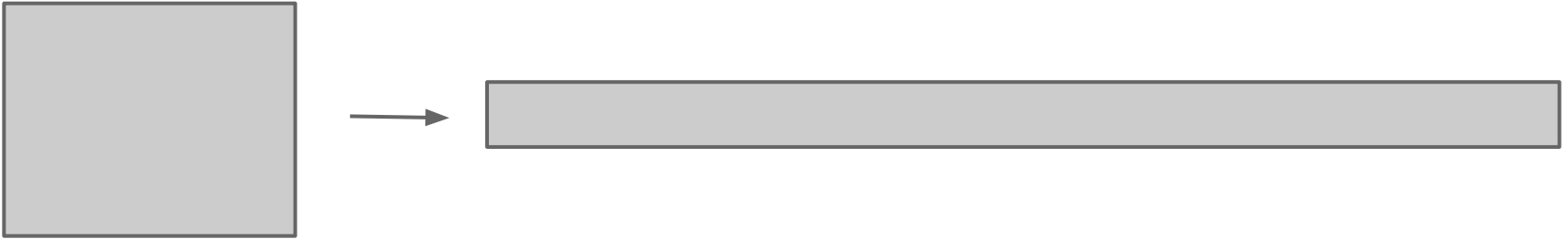
Features

```
from svm import *  
  
...  
  
c = my_trained_model.predict(vector)
```

libsvm <http://www.csie.ntu.edu.tw/~cjlin/libsvm/>



Squirrely Features



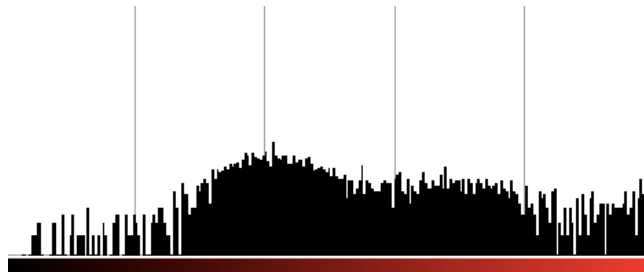
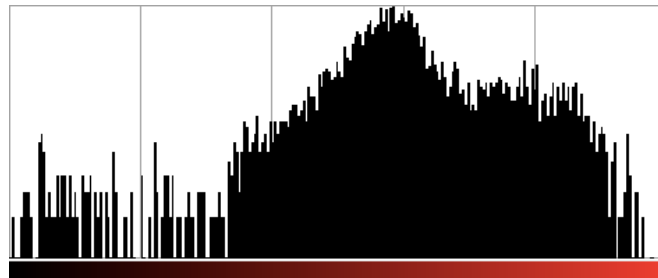
What is squirrel-ness?

- blob size
- histogram analysis of blob
- entropy of blob (texture)

Blob Size



Color Histogram



Entropy



Measure of randomness

Calculate entropy for regions of the blob

- Overall Entropy
- Stdev Entropy
- Left Mean Entropy - Right Mean Entropy

```
h_prob = [ h / histo_sum for h in histogram ]  
  
entropy = -sum( [p * math.log(p)  
                 for p in h_prob  
                 if p != 0] )
```

SVM & Classifying Blobs

- blob size
- color histograms
- entropy of blob (texture)

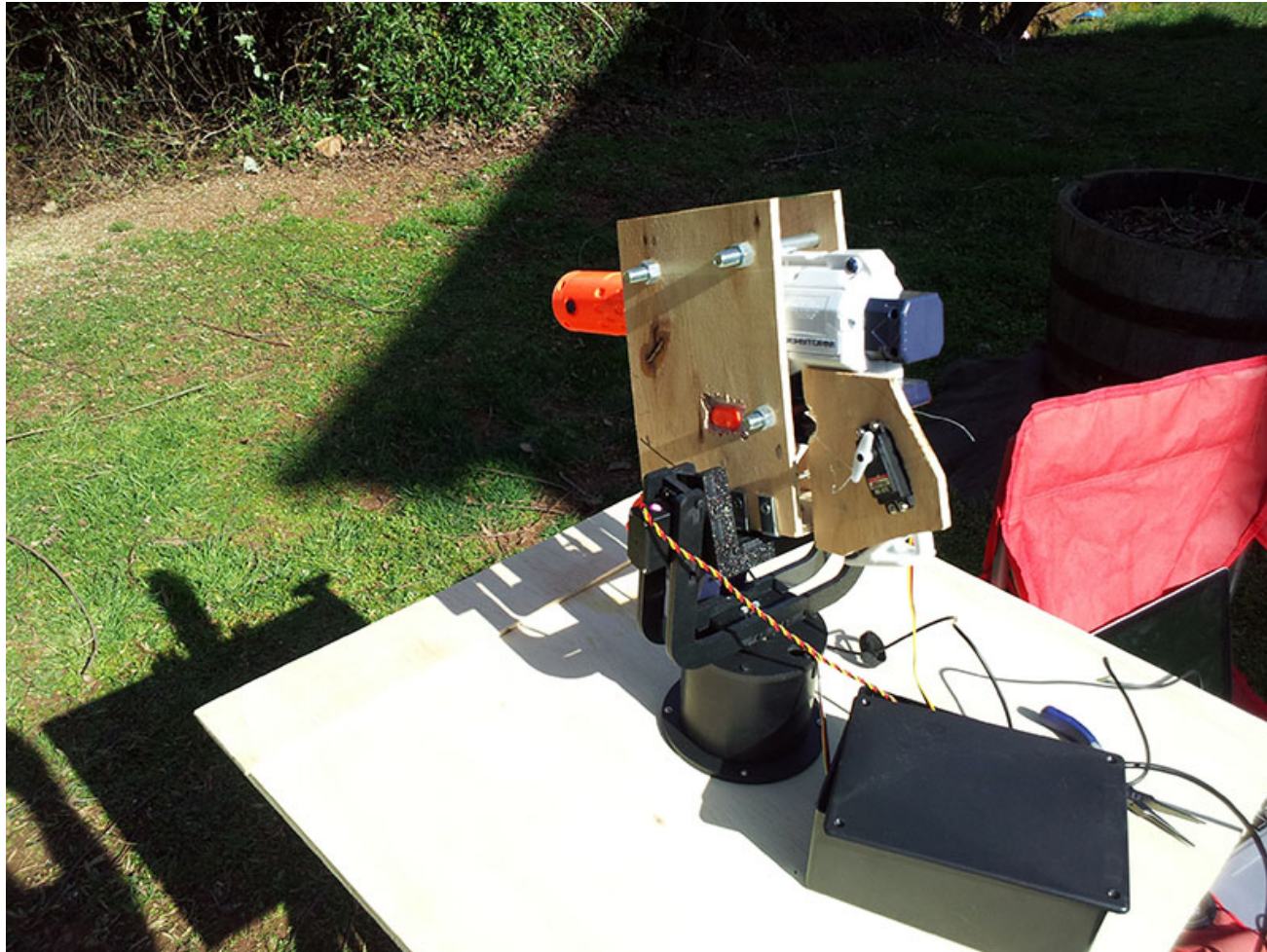
Classify!

Shoot the Squirrel

The Gun



The Turret



Python and Arduino

Arduino Uno



pyserial

```
import serial

arduino = serial.Serial(device, BAUD_RATE)

arduino.write("a")
```

Project Sentry Gun

<https://sites.google.com/site/projectsentrygun/>

Python-On-A-Chip

<http://code.google.com/p/python-on-a-chip/>

Results

- Squirrels get wet
- False positives extremely low
- More satisfying if it camps the feeder
- Need stronger firepower
- Need larger water reservoir
- Squirrels are extremely persistent...no really



Next Steps

- Better Optics
- Stronger Firepower
 - Laminar water jet
 - Pressurized water pump
- Python-On-A-Chip
- Bird Classifier & Counter

Questions?

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no animals were harmed in the development of this project. Bird seed and other snacks were provided to all participants free of charge.