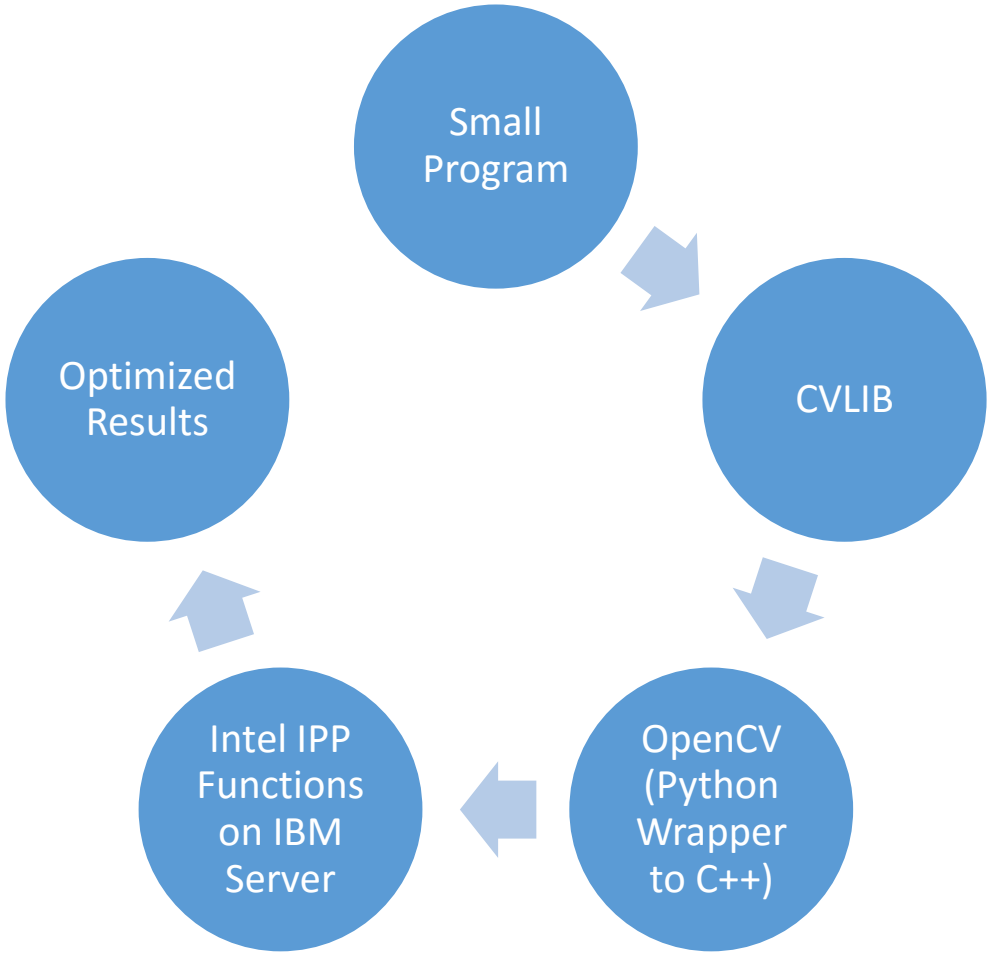
Integrating Computer Vision

William Watson

OpenCV and CVLIB

- Small Programs call upon functions in CVLIB
- CVLIB calls upon OpenCV, which has a Python Wrapper for C++
- OpenCV 3.0 supports optimization via Intel's IPP Low Level Functions
- Computation is done on a dedicated IBM Server



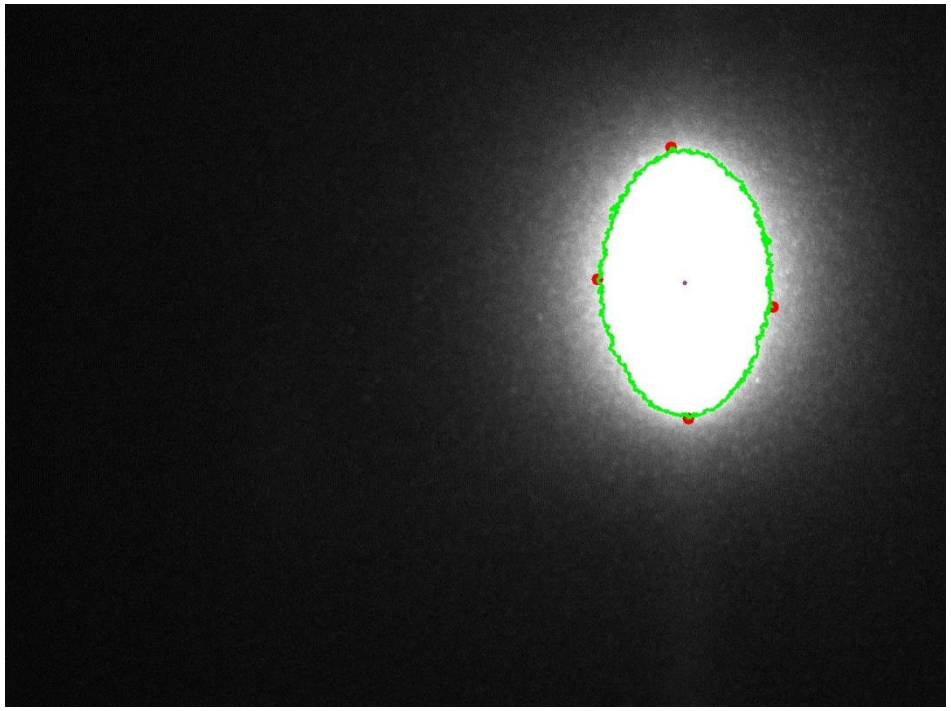
BPM-1 X-Ray Analysis

BPM-1 Image Results

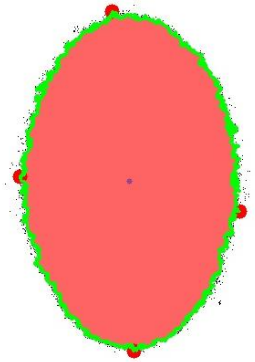
Process:

- Threshold
- Find Contours
- Interpret Contour Data (Plot, Draw, and Print)

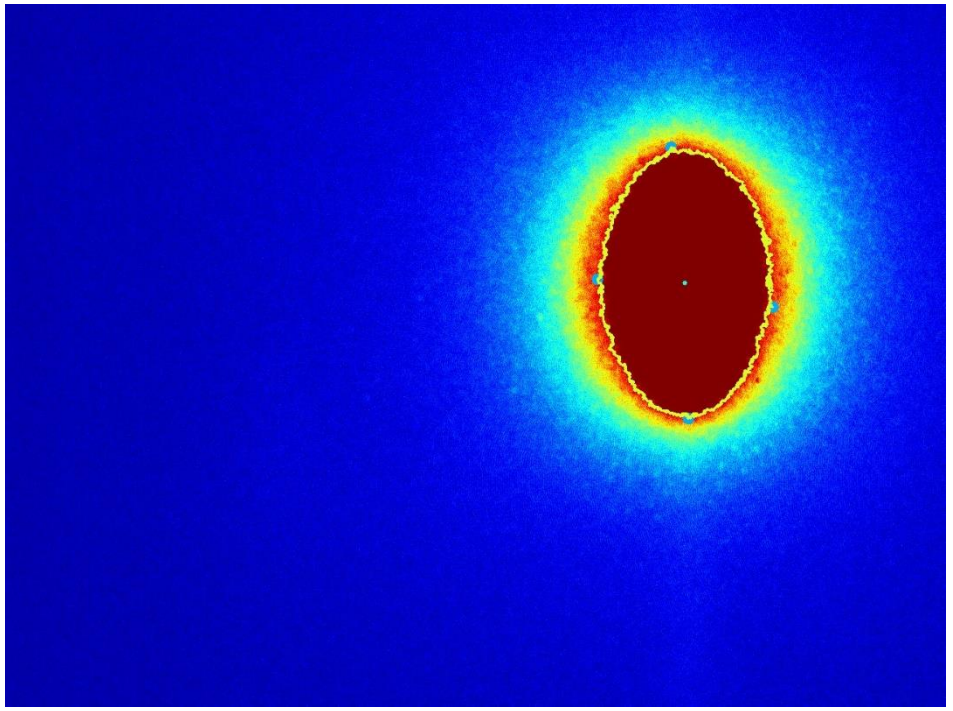
Result Superimposed on Original



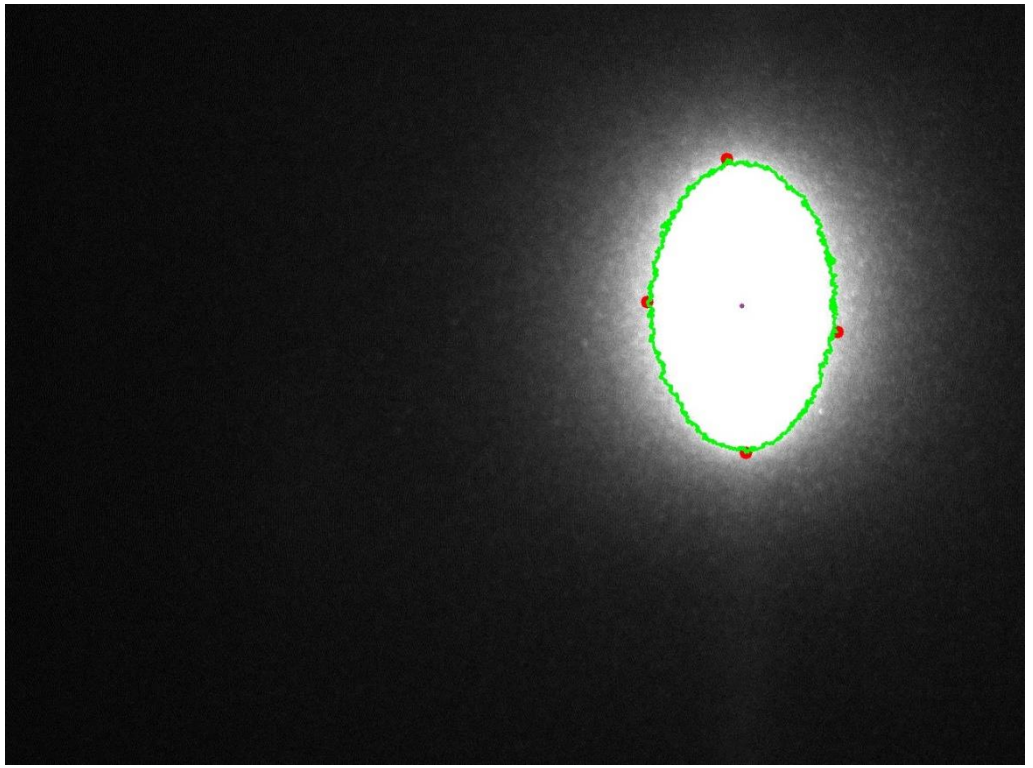
Thresholding Result



Jet Color Map



BPM-1 Data Results

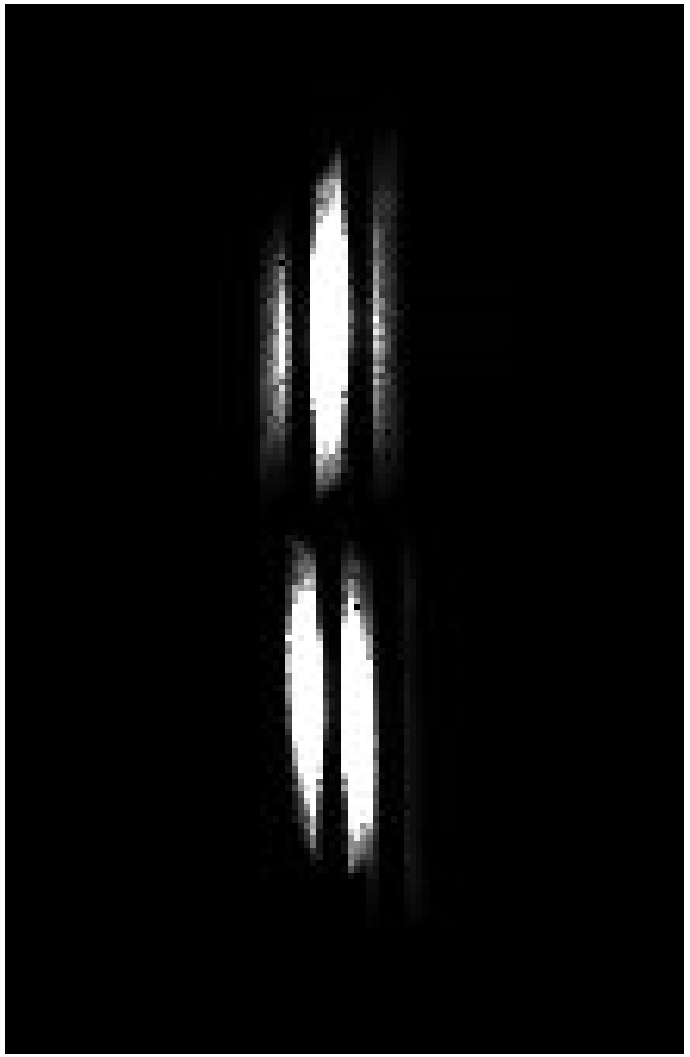


Console Output:

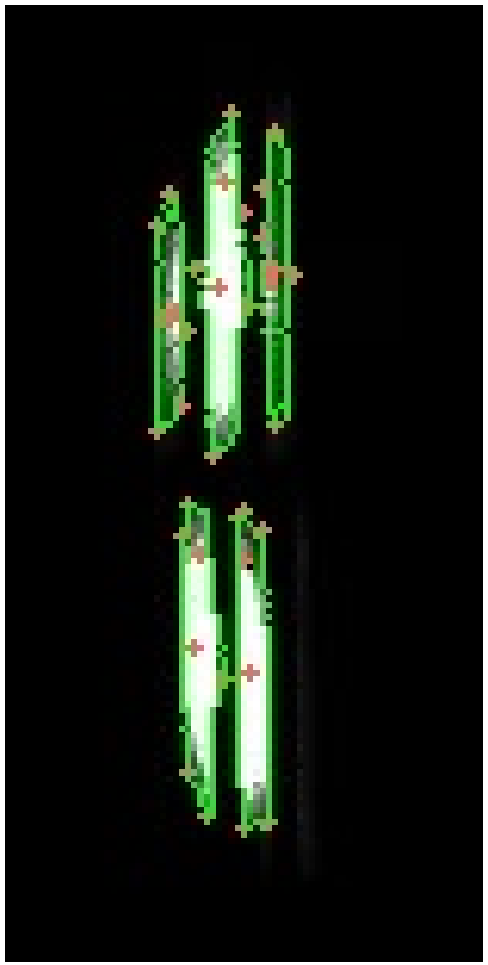
```
Object Details:

perimeter: 2356.99022925
orientation: 179.838363647
max: (925, 198)
solidity: 0.942924641105
height: 372
extent: 0.720742029114
extrema: {'B': (938, 568), 'R': (1054, 415), 'L': (813, 377), 'T': (914, 196)}
aspect ratio: 0.648793565684
area: 65058.5
min: (1047, 564)
sum intensity: 20426526
width: 241
centroid: (933, 382)
equivalent diameter: 287.810797089
mean intensity: 227.842390577
```

Merlin Analysis

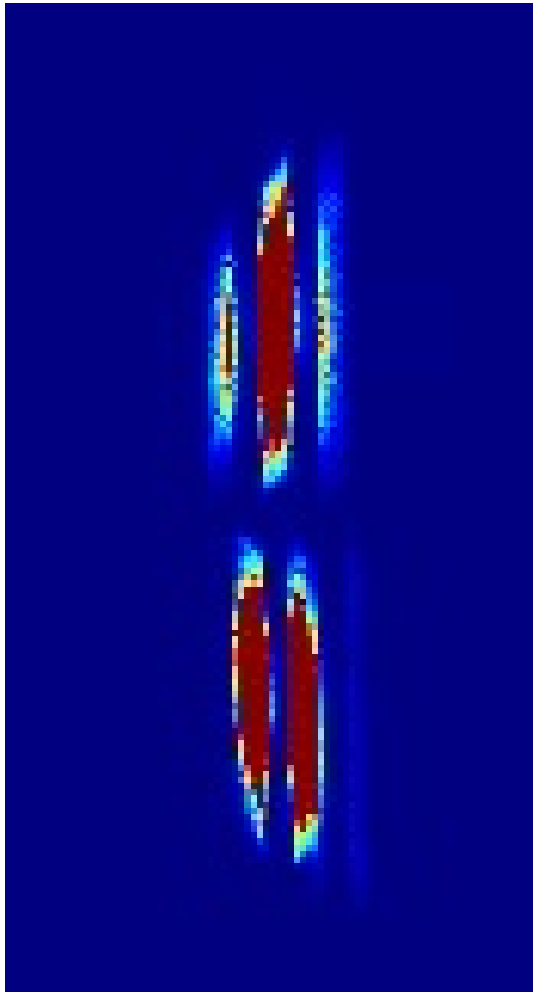


Merlin Image Results



Process:

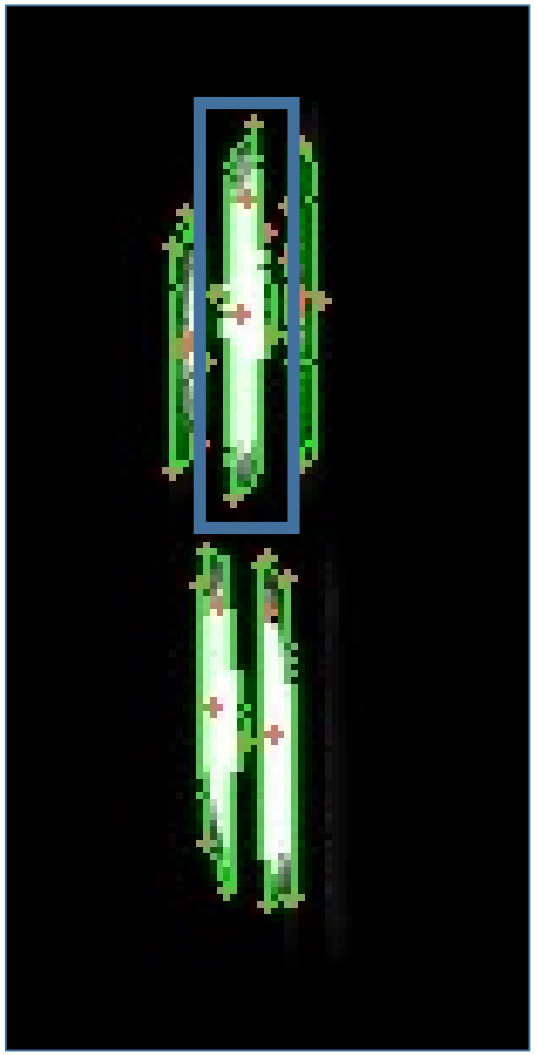
- Convert to Grayscale
- Threshold Image
- Find and filter contours by size
- For each object:
  - Print Object's Data
  - Plot Points of Interest
- Draw Contours
- Apply JET



Merlin Data Results for First Object (Largest)

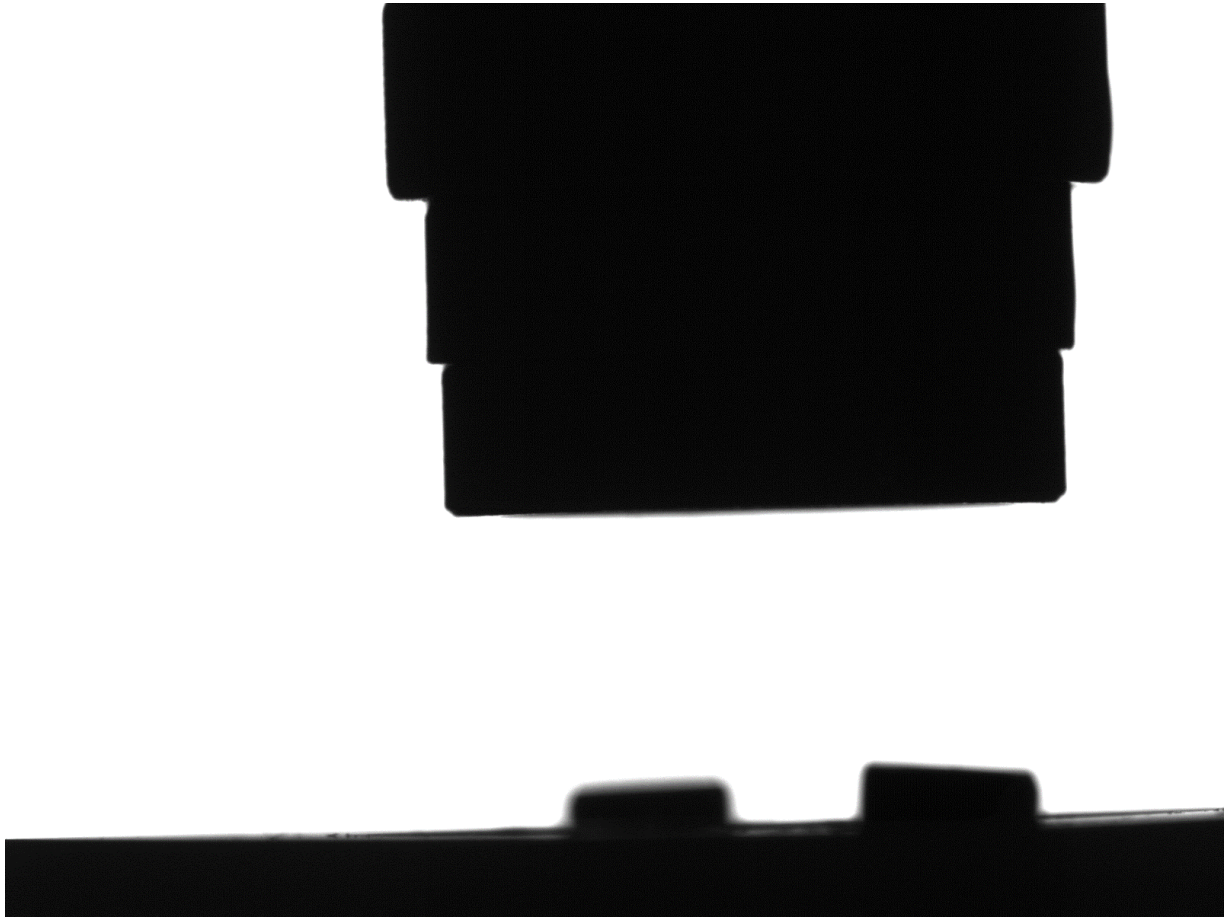
Console Output:

```
Object 1:
perimeter: 125.840619564
orientation: 179.981033325
max: (131, 78)
solidity: 0.771754636234
height: 55
extent: 0.483035714286
extrema: {'B': (129, 122), 'R': (135, 98), 'L': (126, 92), 'T': (132, 67)}
aspect ratio: 0.178571428571
area: 270.5
min: (134, 83)
sum intensity: 62689
width: 9
centroid: (130, 95)
equivalent diameter: 18.5583214987
mean intensity: 126.644444444
```

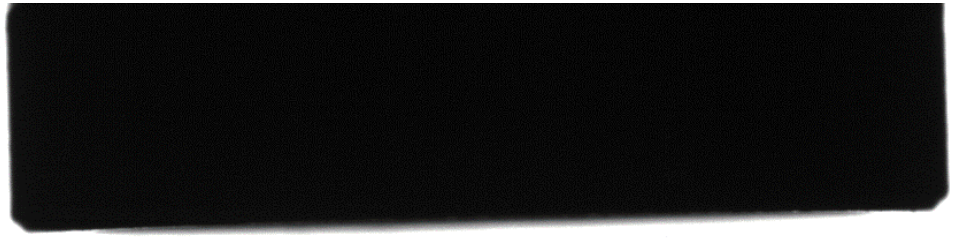


Match Game – Template Images

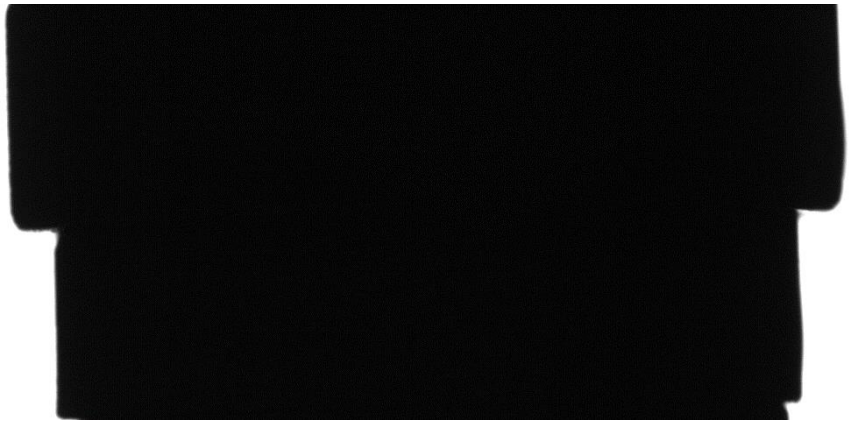
Pin and Gripper ‘Perfect’ Image



Pin Template Image



Gripper Template Image



Match Game – ‘Perfect’ vs Actual

‘Perfect’

Image 1

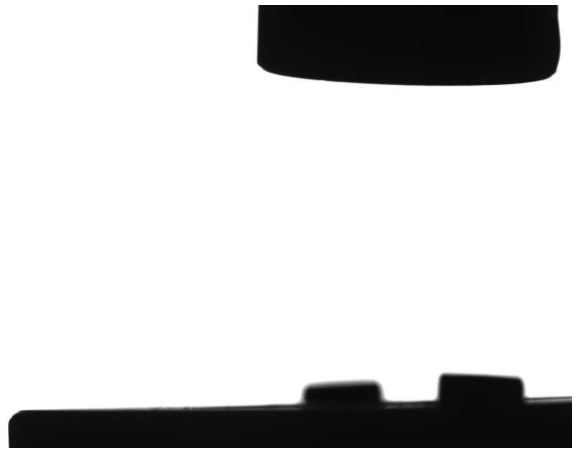
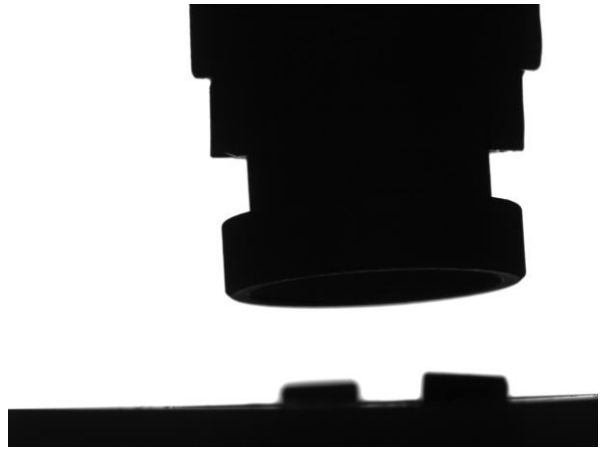


Image 2

Image 3

Image 4



Match Game - Results

Console Output:

```
Template: 0.0 Disim
Image-1: 1.36311088973 Disim
Image-2: 0.0286209618648 Disim
Image-3: 0.0045508842333 Disim
Image-4: 0.190357587177 Disim
```

Image 2

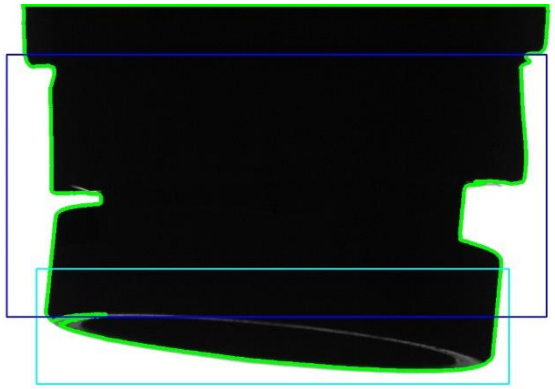


Image 3

‘Perfect’

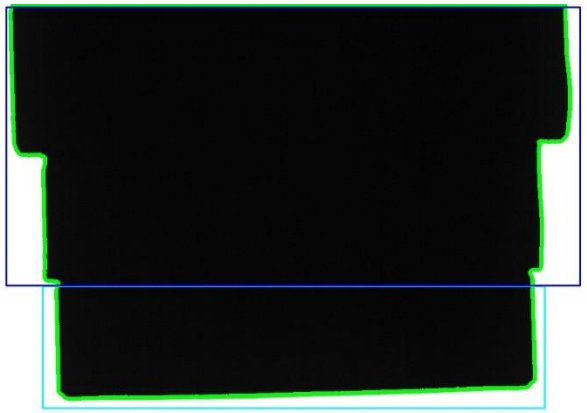


Image 1

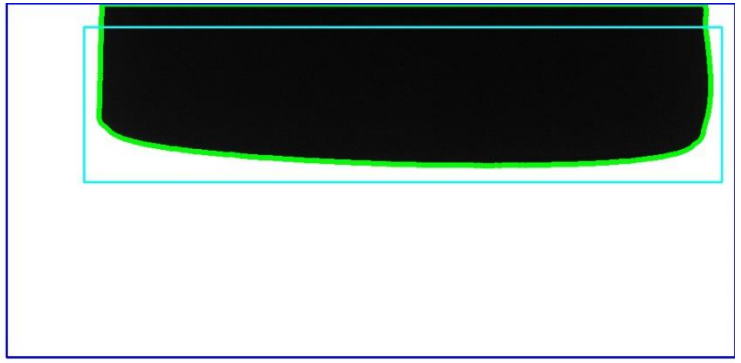
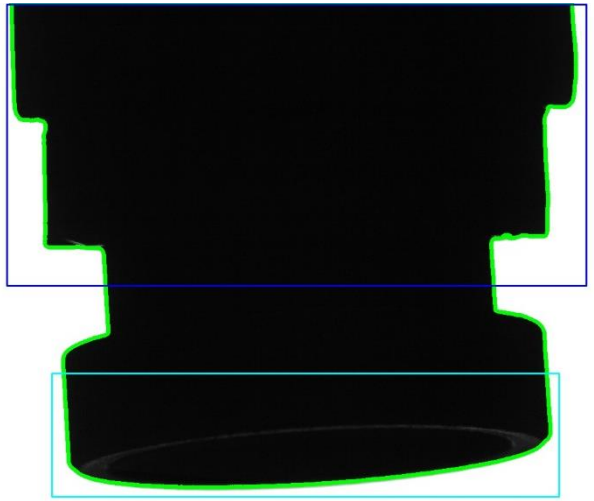


Image 4



Pin/Gripper – ‘Perfect’ vs Actual

‘Perfect’

Image 1

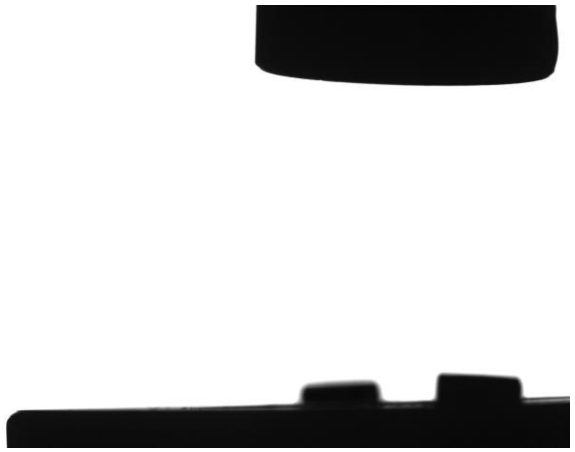
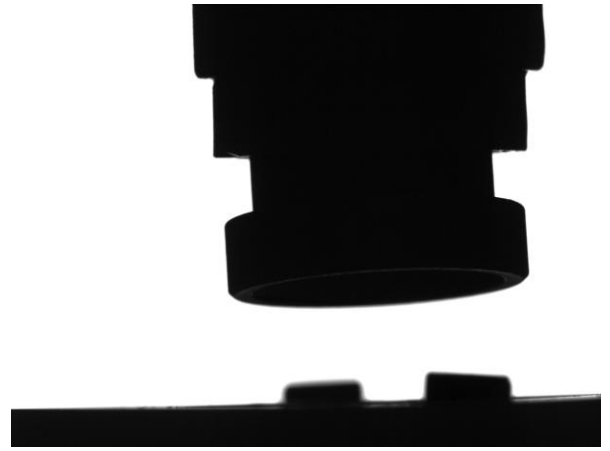


Image 2

Image 3

Image 4



Pin/Gripper Image Analysis – Results – Image 1

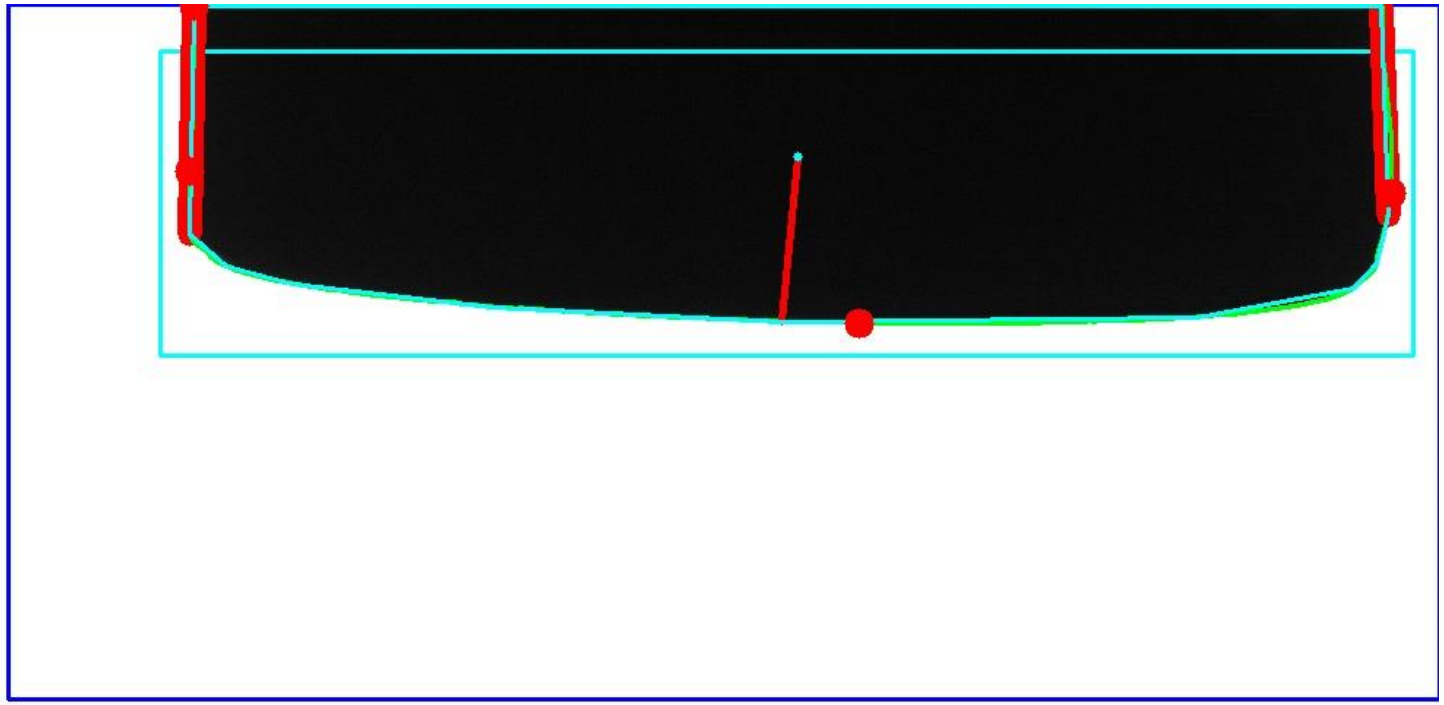
Console Output on Image 1:

Image 1:

```
perimeter: 2017.74725473
orientation: 91.0750732422
max: (745, 1)
solidity: 0.996730365951
height: 217
extent: 0.940458938544
extrema: {'B': (1203, 218), 'R': (1567, 129),
          'L': (745, 114), 'T': (748, 1)}
aspect ratio: 3.7752293578
area: 168731.5
min: (793, 1)
sum intensity: 4280971
width: 822
centroid: (1161, 104)
equivalent diameter: 463.503633473
mean intensity: 23.999971969
```

Error Results:

```
Image Dissimilarity: 1.36080901012
ERROR: Mount Centroid: Too High: 104
ERROR: Missing Component / Gripper Not Aligned
```



Pin/Gripper Image Analysis – Results – Image 2

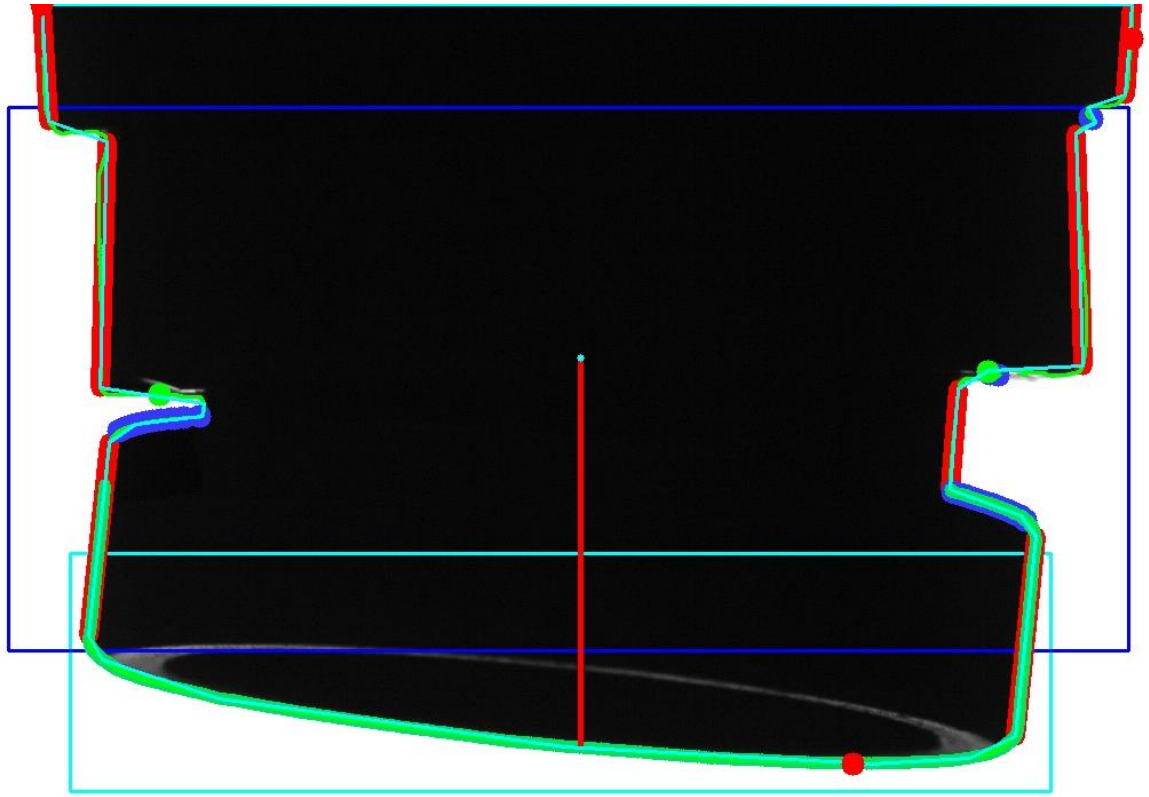
Console Output:

Image 2:

```
perimeter: 3512.21232665
orientation: 0.774656236172
max: (497, 66)
solidity: 0.941137856546
height: 664
extent: 0.839552497596
extrema: {'B': (1206, 665), 'R': (1450, 31)
          'L': (497, 1), 'T': (497, 1)}
aspect ratio: 1.43458646617
area: 532620.5
min: (515, 1)
sum intensity: 30095708
width: 953
centroid: (968, 310)
equivalent diameter: 823.500748595
mean intensity: 47.5601903943
```

Error Results:

```
Image Dissimilarity: 0.0274253192917
ERROR: Possible Kinks Detected
ERROR: 41 Possible Kink Points Detected: Adjust Gripper
ERROR: Possible Kink Distance on R: 115.004347744
ERROR: Possible Kink Distance on L: 27.3130005675
ERROR: Pin Not Mounted Correctly: Distance: 329
```



Pin/Gripper Image Analysis – Results – Image 3

Console Output:

Image 3:

perimeter: 3272.13917053

orientation: 160.072814941

max: (496, 1)

solidity: 0.967876787861

height: 677

extent: 0.902237973263

extrema: {'B': (593, 678), 'R': (1452, 189),
'L': (496, 22), 'T': (503, 1)}

aspect ratio: 1.41150442478

area: 585413.5

min: (525, 1)

sum intensity: 20199272

width: 956

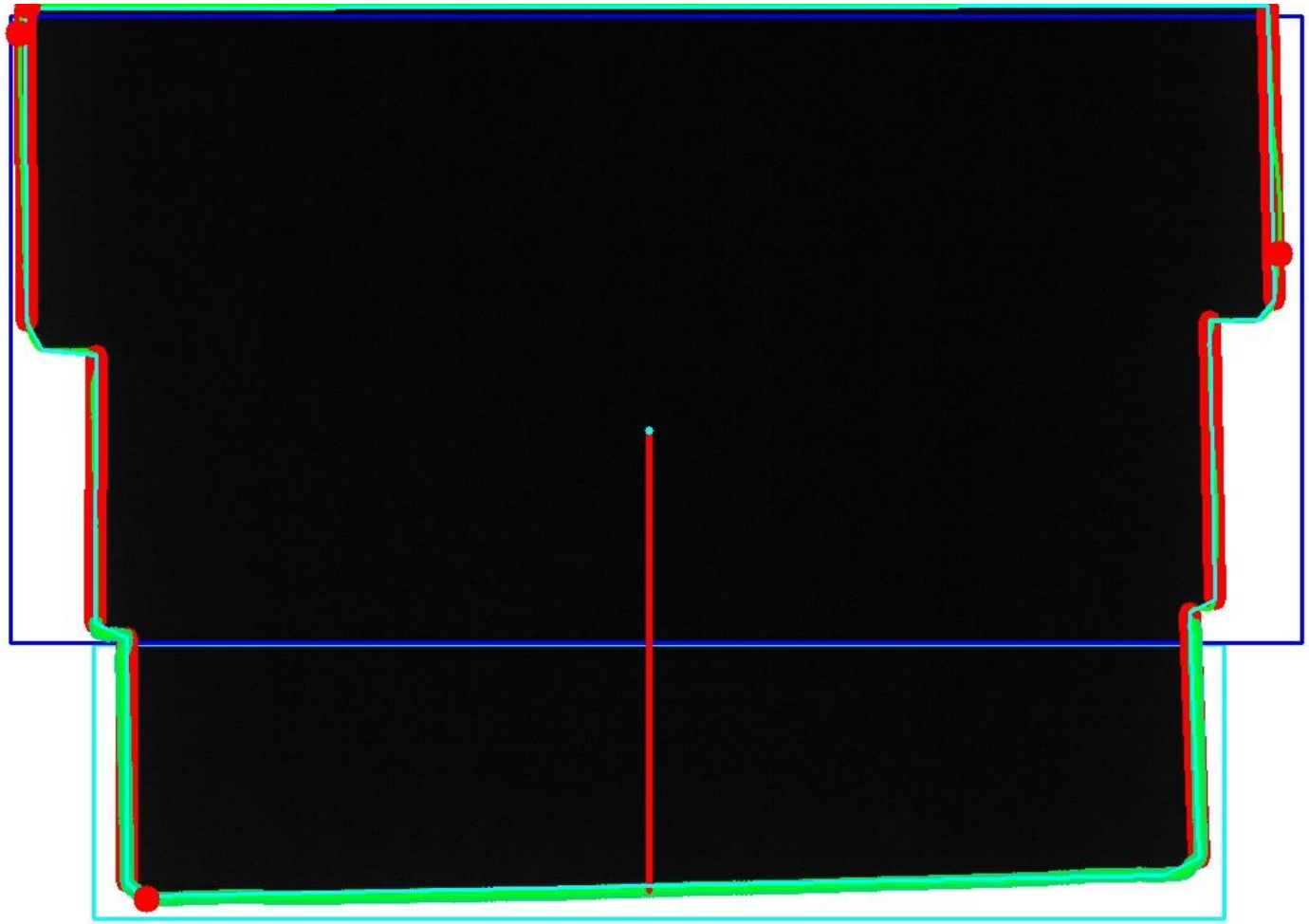
centroid: (974, 323)

equivalent diameter: 863.349070899

mean intensity: 31.2096685476

Error Results:

Image Dissimilarity: 0.00487836456791



Pin/Gripper Image Analysis – Results – Image 4

Console Output:

```
Image 4:
perimeter: 3790.45496655
orientation: 177.796310425
max: (1443, 1)
solidity: 0.925888779152
height: 821
extent: 0.845230278227
extrema: {'B': (828, 822), 'R': (1447, 125),
          'L': (492, 1), 'T': (492, 1)}
aspect ratio: 1.16301703163
area: 664209.0
min: (503, 1)
sum intensity: 35452804
width: 955
centroid: (974, 387)
equivalent diameter: 919.617945002
mean intensity: 45.2172411374
```

Error Results:

```
Image Dissimilarity: 0.190836638543
ERROR: Possible Kinks Detected
ERROR: 44 Possible Kink Points Detected: Adjust Gripper
ERROR: Possible Kink Distance on R: 125.015998976
ERROR: Possible Kink Distance on L: 157.003184681
ERROR: Pin Not Mounted Correctly: Distance: 411
```