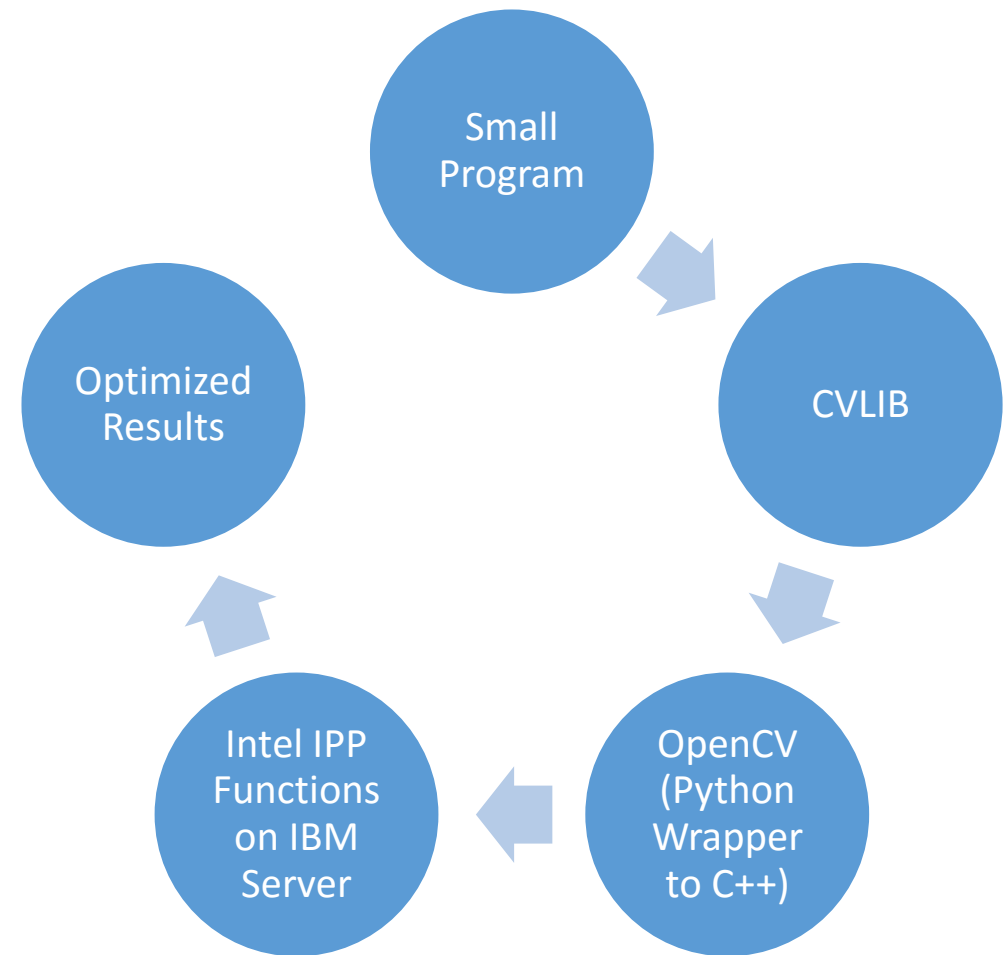


Integrating Computer Vision

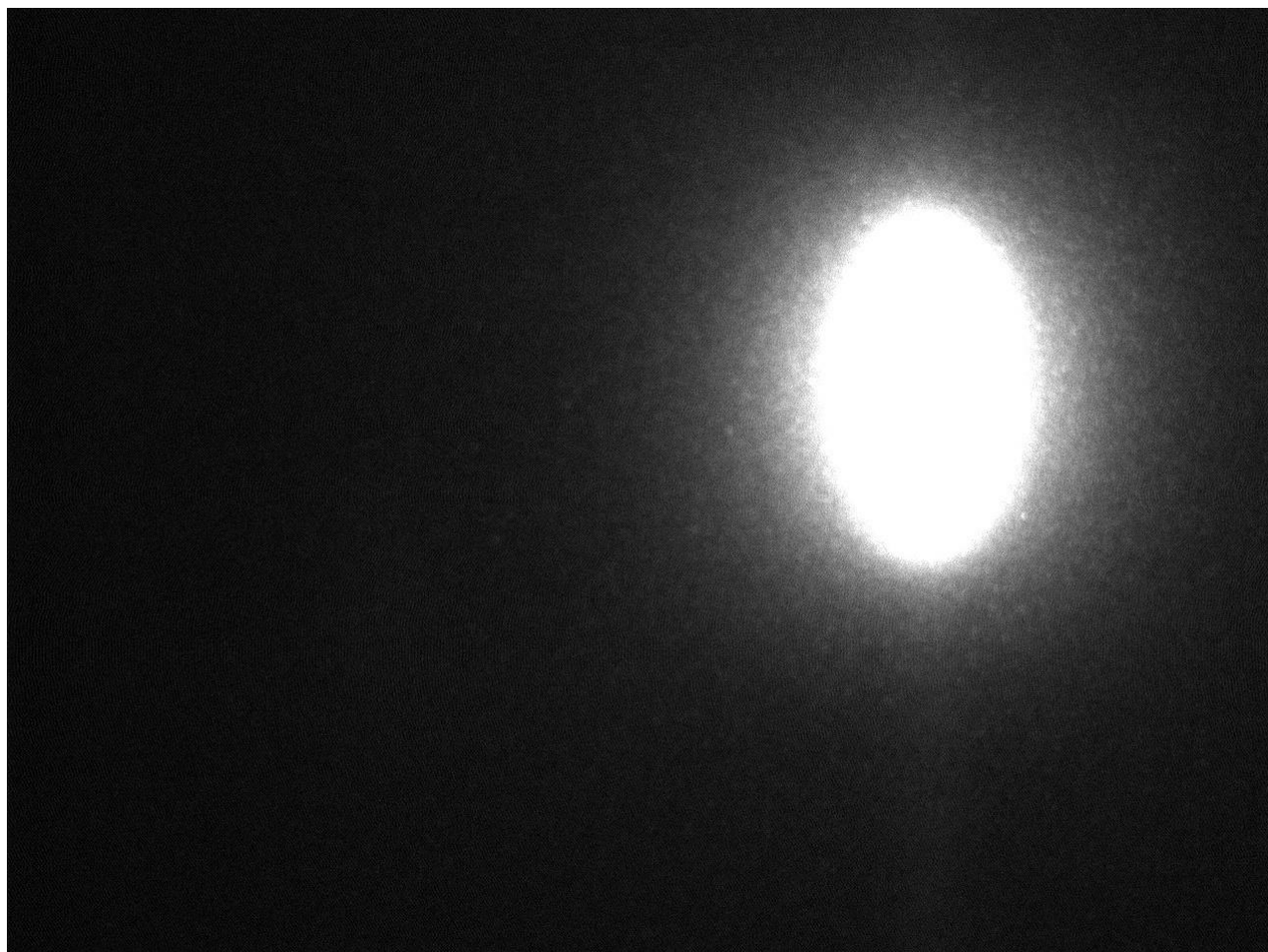
William Watson

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

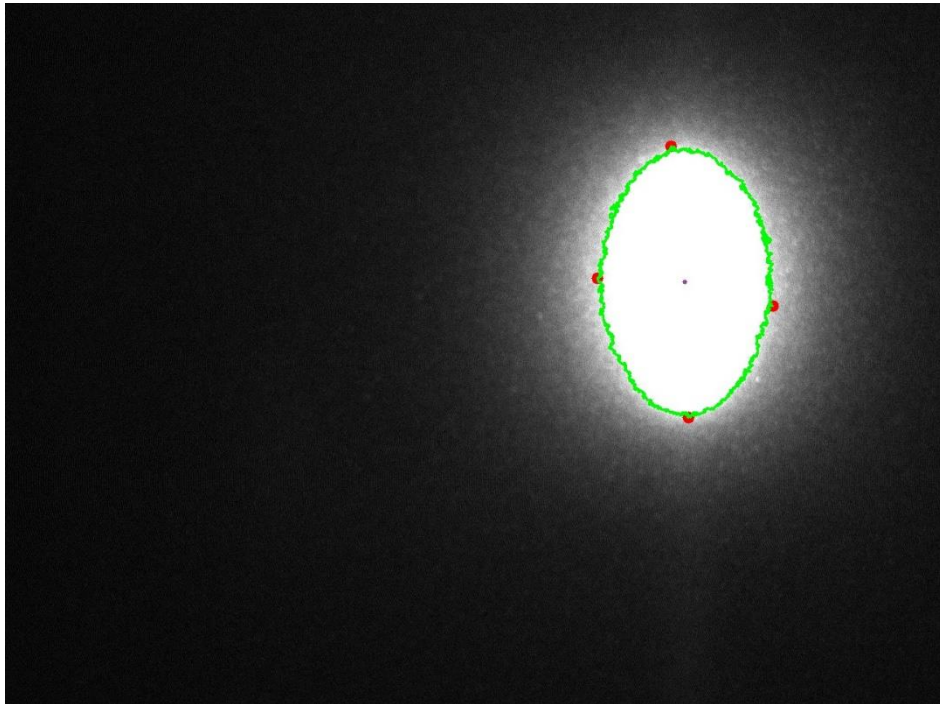


BPM-1 Image Results

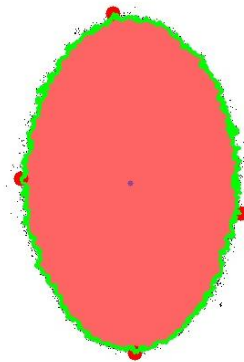
Process:

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

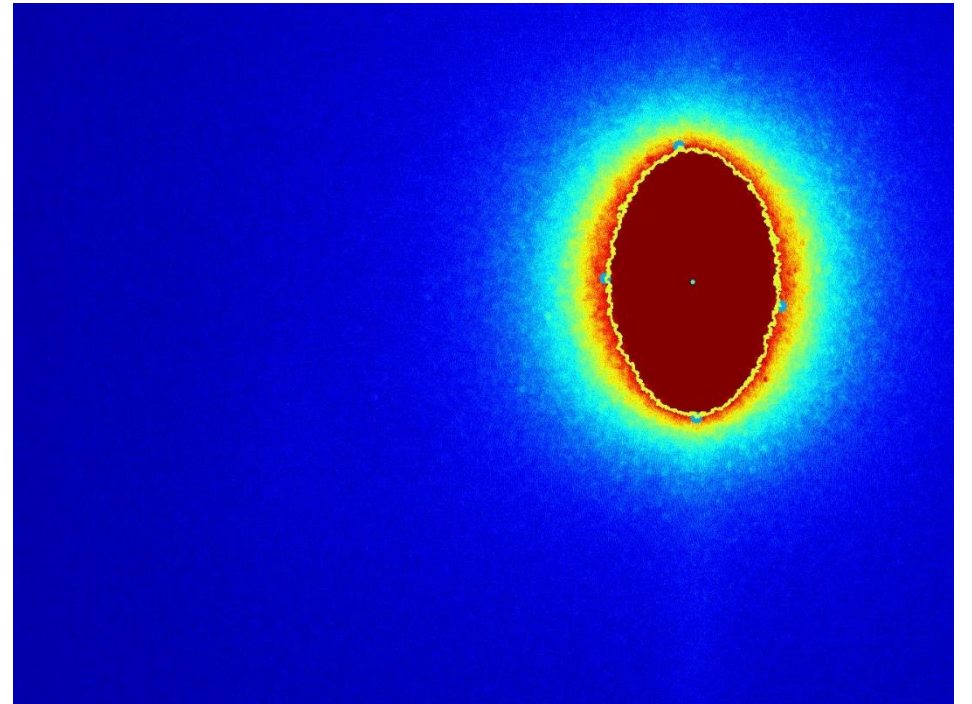
Result Superimposed on Original



Thresholding Result



Jet Color Map

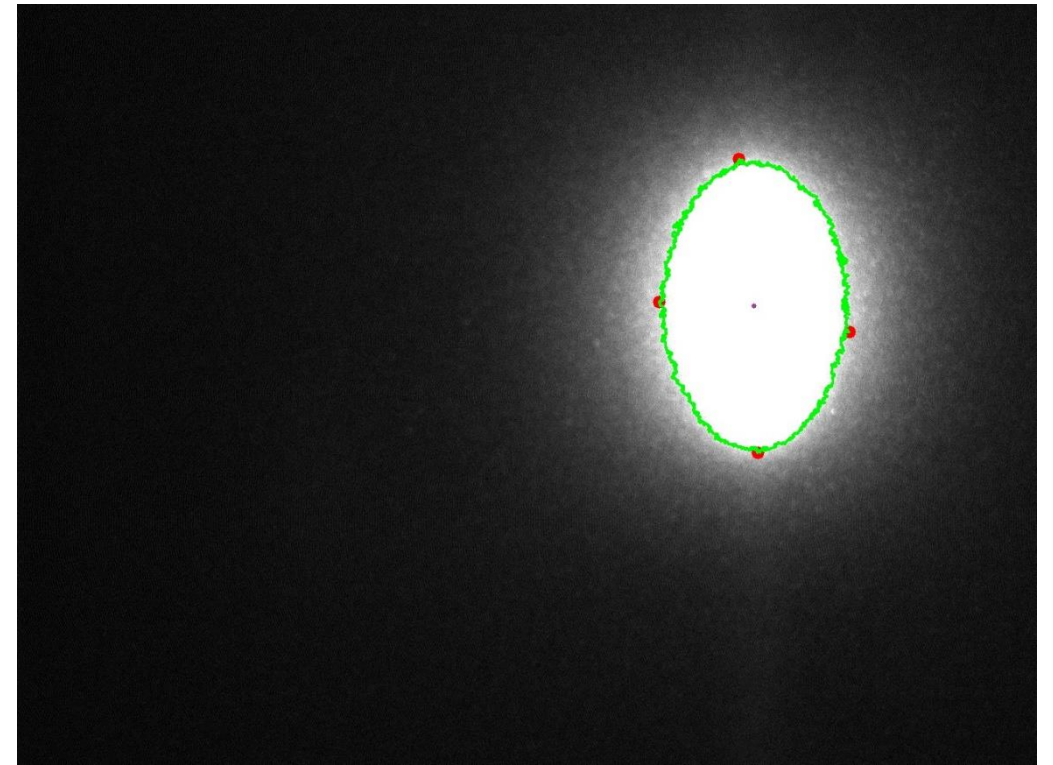


BPM-1 Data Results

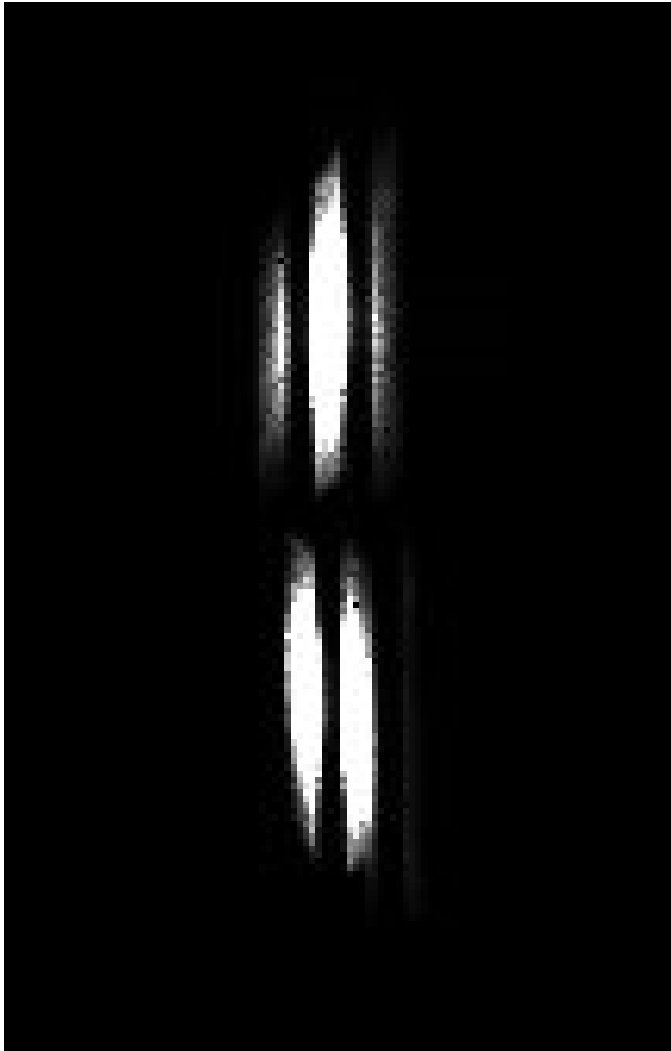
Console Output:

Object Details:

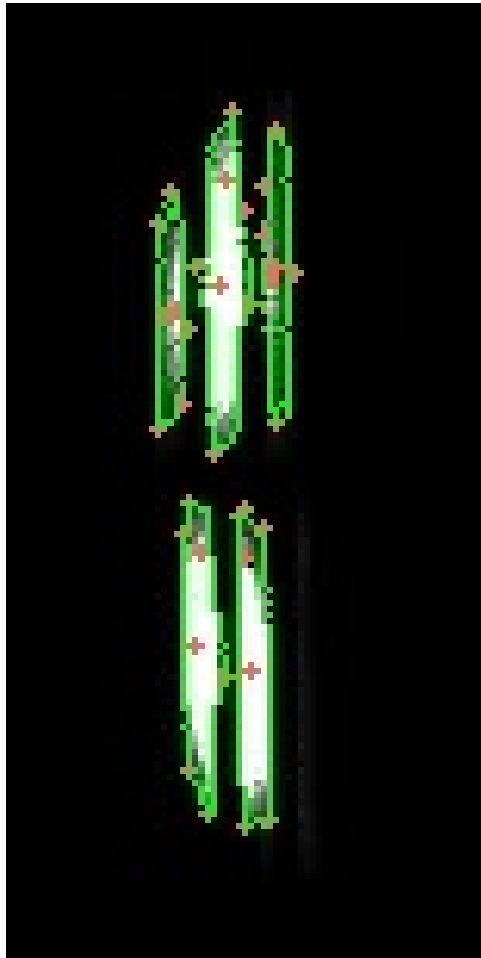
```
perimeter: 2356.99022925
orientation: 179.838363647
max: (925, 198)
solidity: 0.942924641105
height: 372
extent: 0.720742029114
extrema: {'B': (938, 568), 'R': (1054, 415), 'L': (813, 377), 'T': (914, 196)}
aspect ratio: 0.648793565684
area: 65058.5
min: (1047, 564)
sum intensity: 20426526
width: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



Merlin Analysis

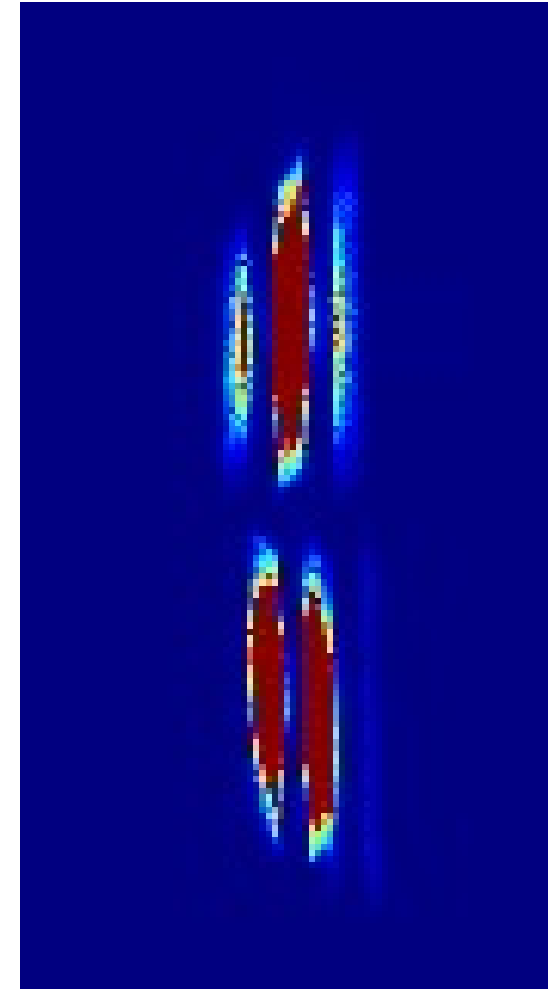


Merlin Image Results



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)

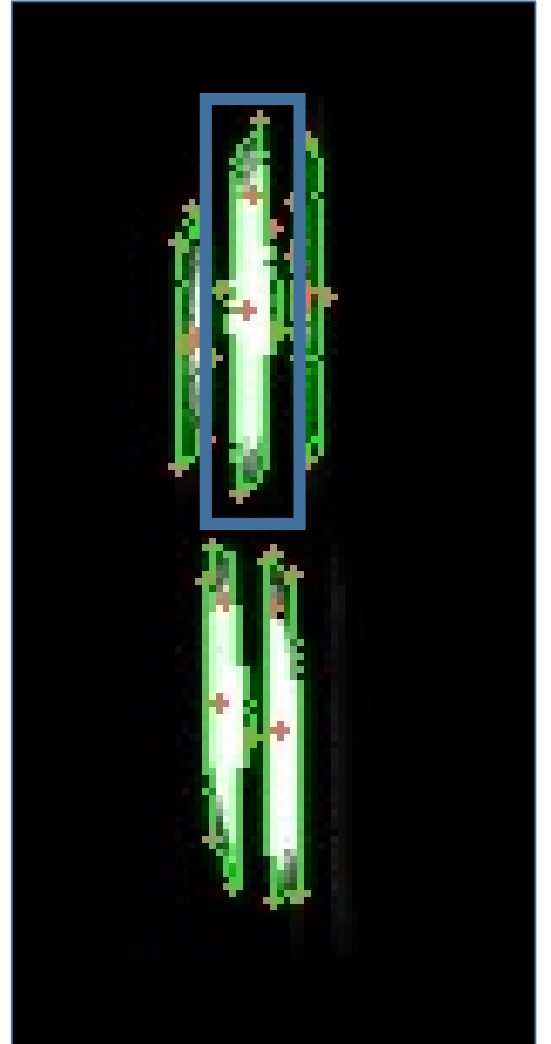
sum intensity: 62689

width: 9

centroid: (130, 95)

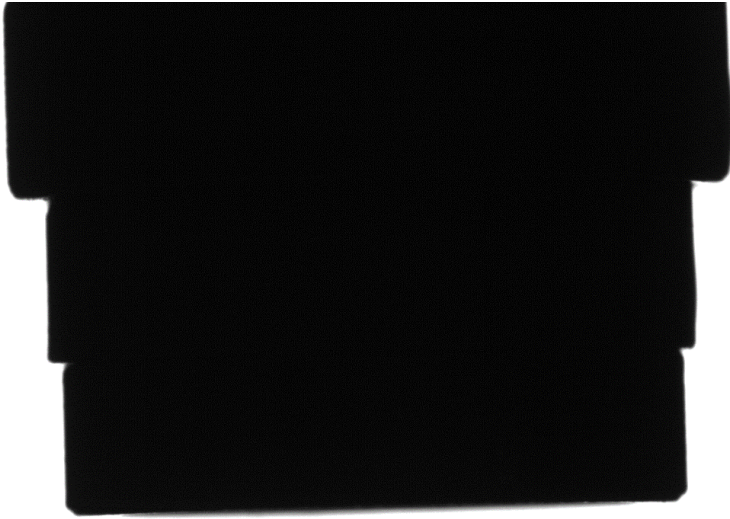
equivalent diameter: 18.5583214987

mean intensity: 126.644444444

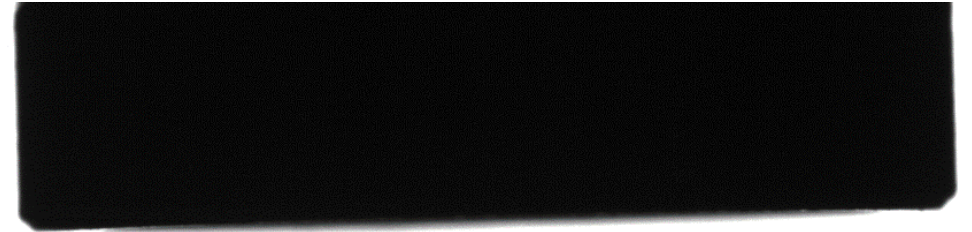


Match Game – Template Images

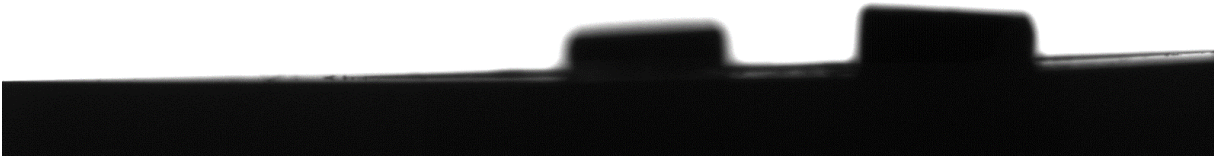
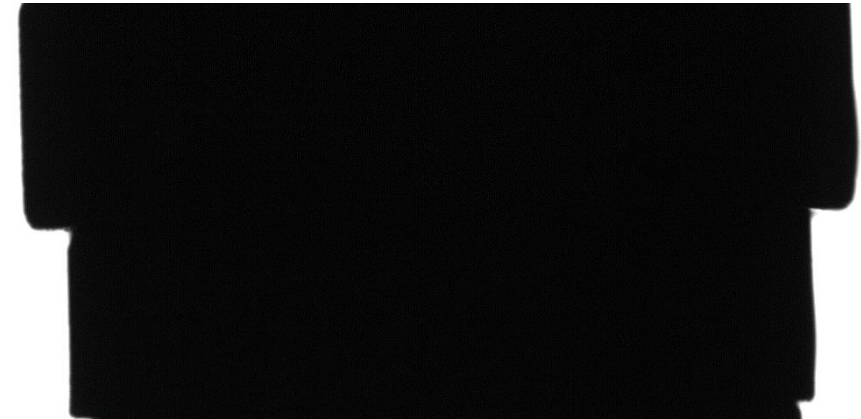
Pin and Gripper 'Perfect' Image



Pin Template Image



Gripper Template Image



Match Game – ‘Perfect’ vs Actual

‘Perfect’



Image 1



Image 2

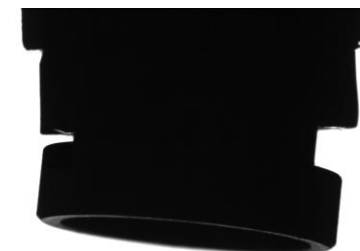


Image 3

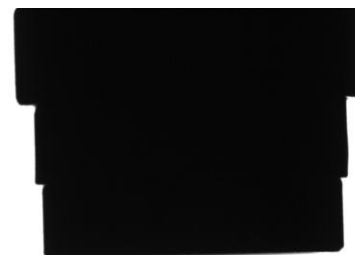


Image 4



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

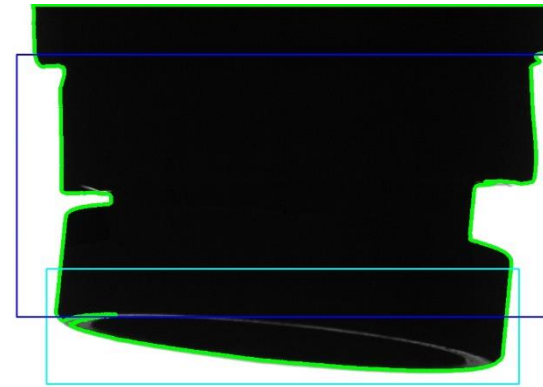
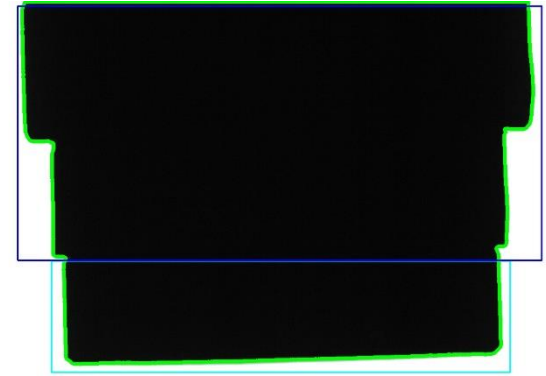


Image 3



'Perfect'



Image 1

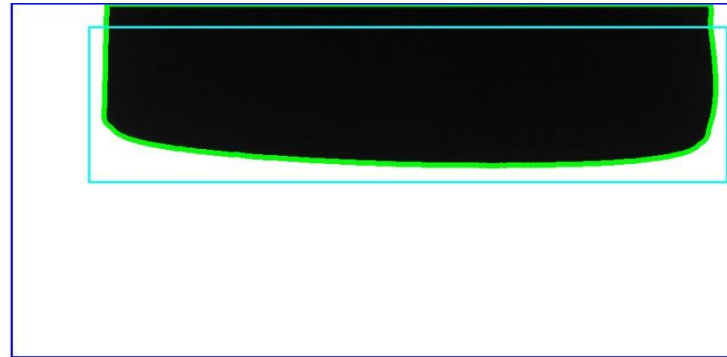
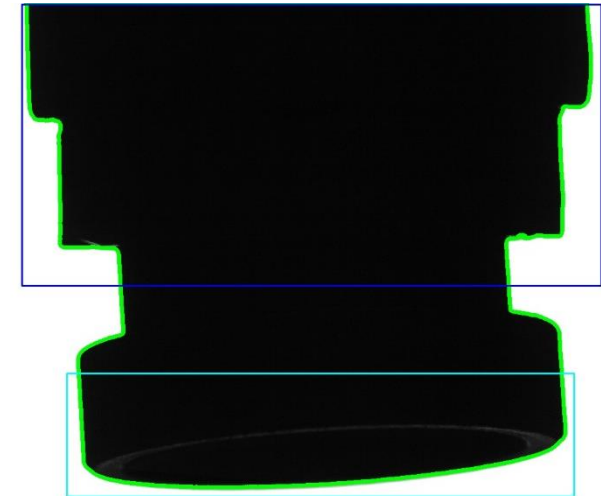


Image 4



Pin/Gripper – ‘Perfect’ vs Actual

‘Perfect’



Image 1



Image 2



Image 3



Image 4



Pin/Gripper Image Analysis – Results – Image 1

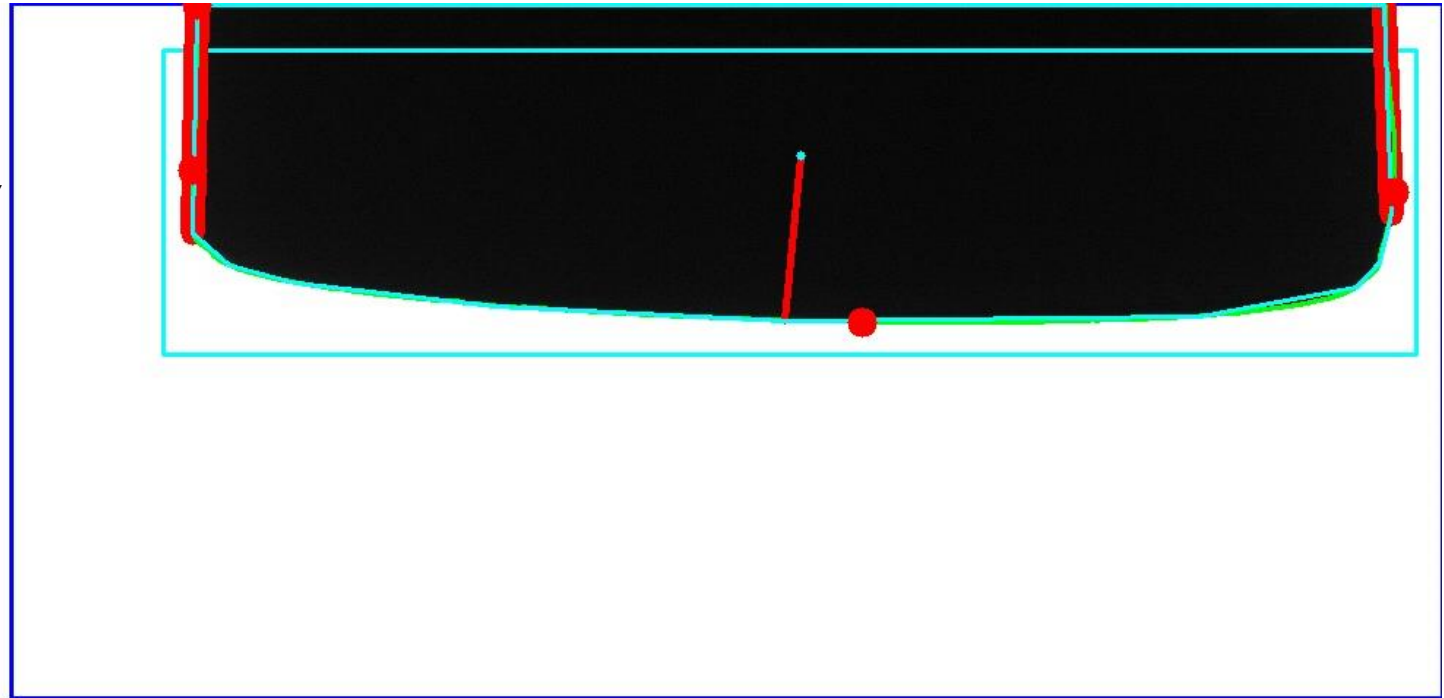
Console Output on Image 1:

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

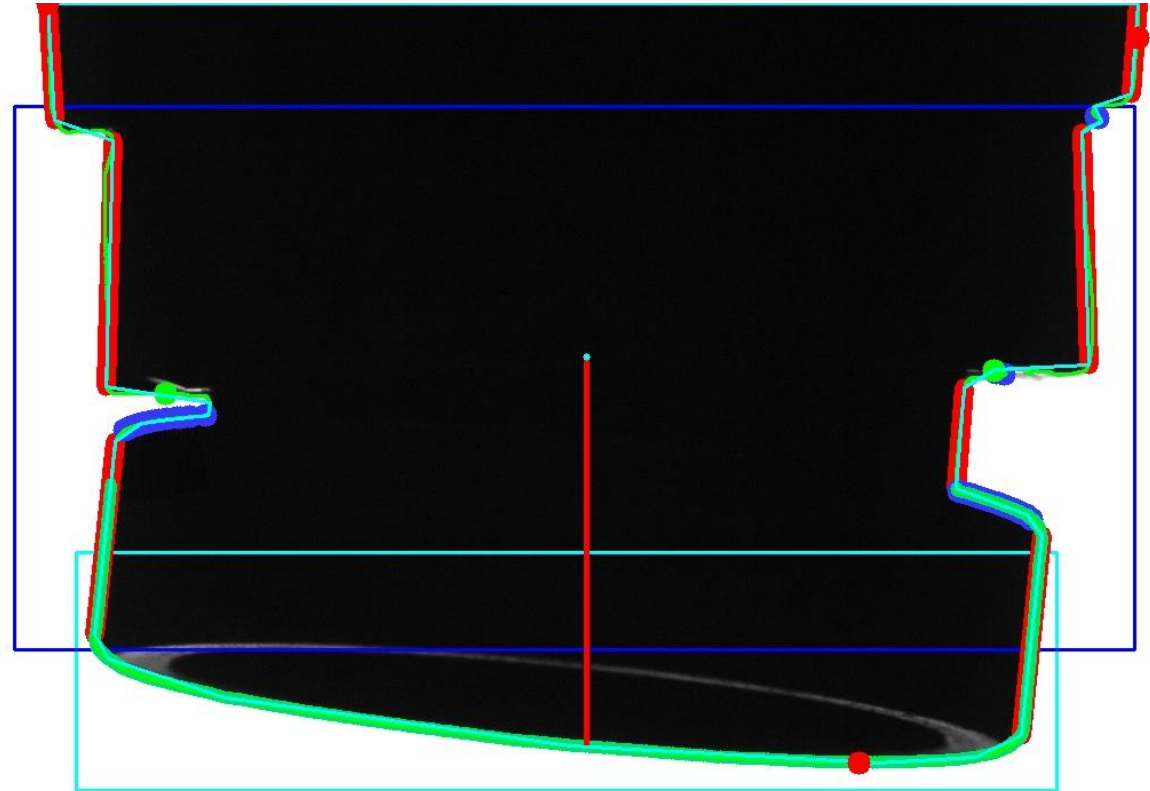
Console Output:

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

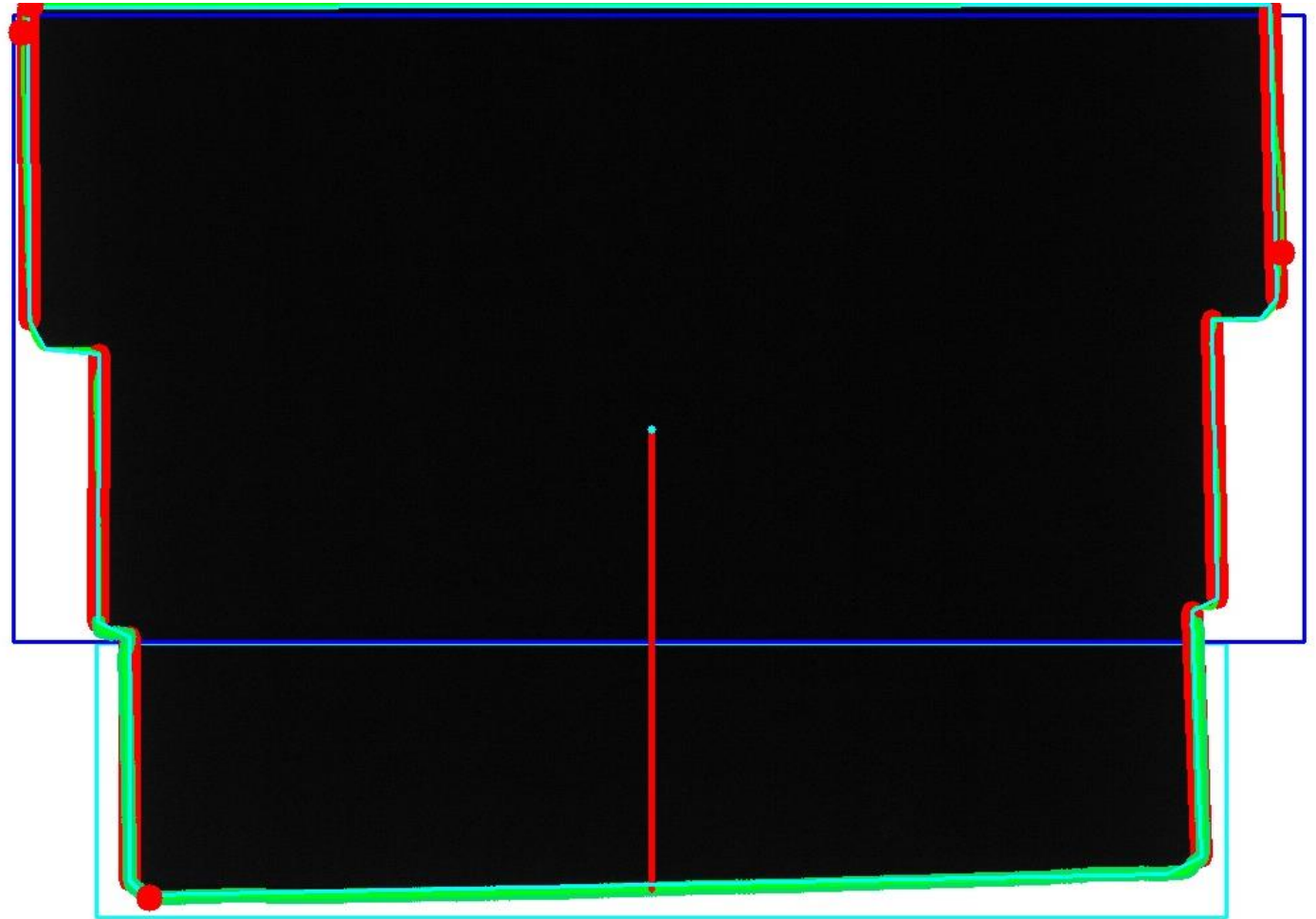
Console Output:

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

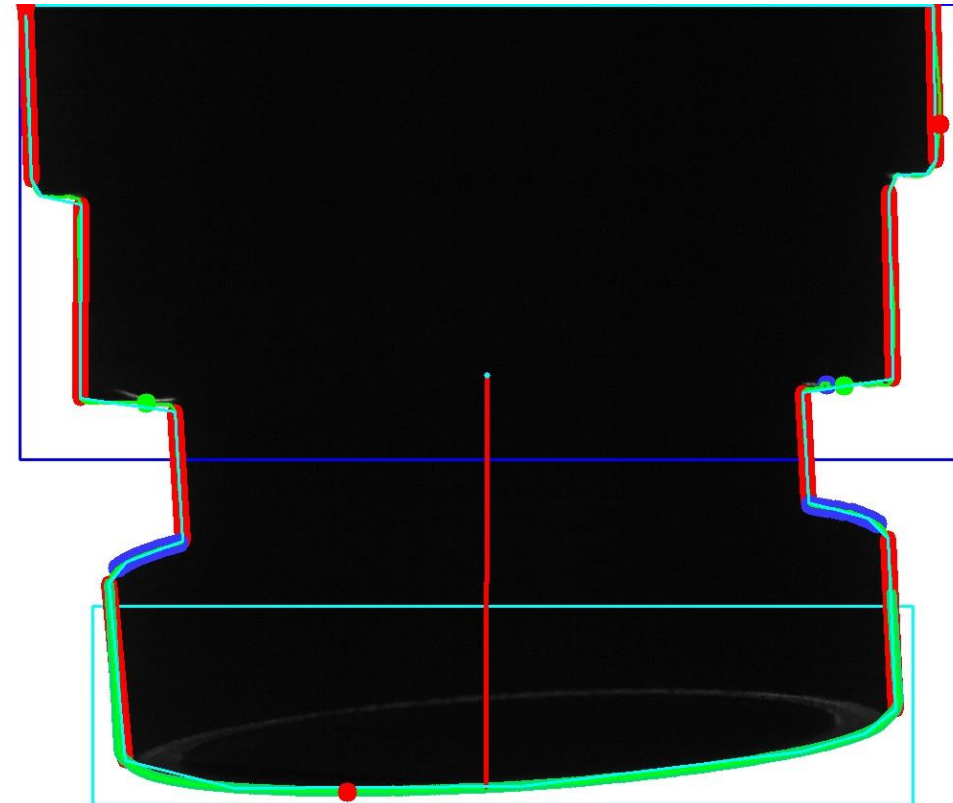
ERROR: Possible Kinks Detected

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
```



Time Analysis – No Display or Drawing on Img

BPM-1:

Real	0m0.505s
User	0m0.484s
Sys	0m0.052s

Merlin:

Real	0m0.332s
User	0m0.320s
Sys	0m0.016s

Match Game (All Img):

Real	0m1.542s
User	0m1.640s
Sys	0m0.072s

Pin/Gripper (All Img):

Real	0m3.177s
User	0m3.260s
Sys	0m0.260s

Match Game (Single):

Real	0m0.653s
User	0m0.616s
Sys	0m0.120s

Pin/Gripper (Single):

Real	0m0.794s
User	0m0.792s
Sys	0m0.080s