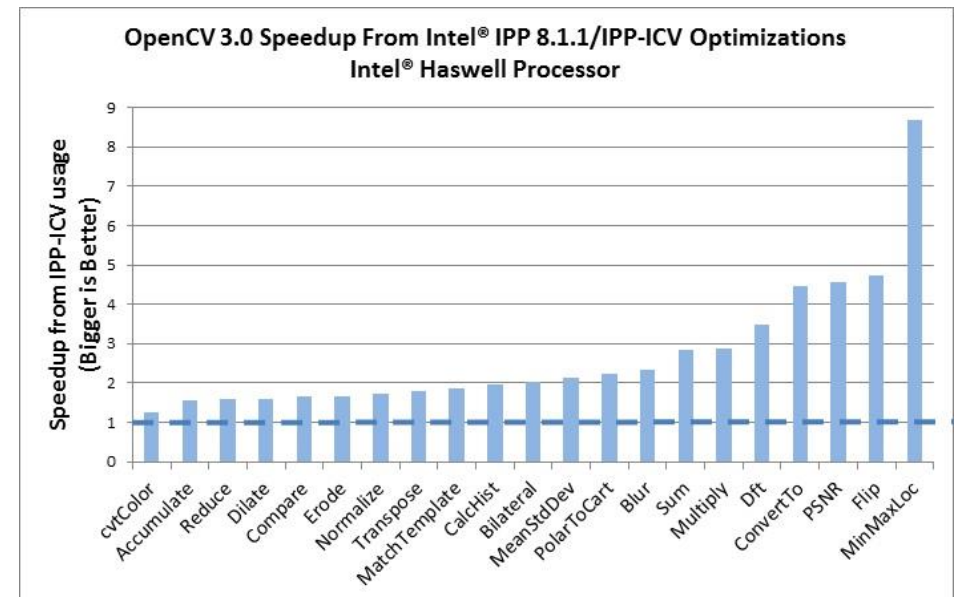
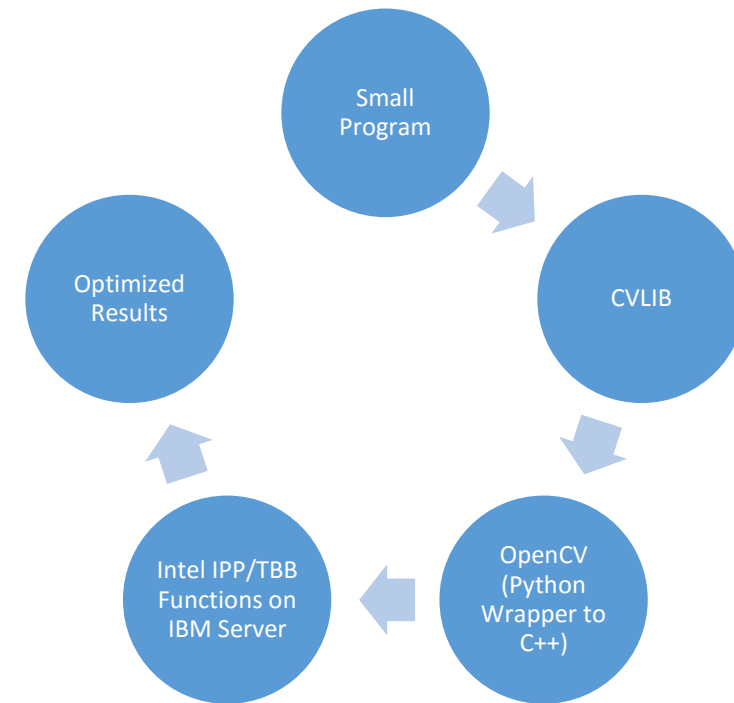


Development of Computer Vision and Image Processing at NSLS-II

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, Intel TBB
- Computation is done on a dedicated IBM Server



BPM-1 X-Ray Analysis (IXS)



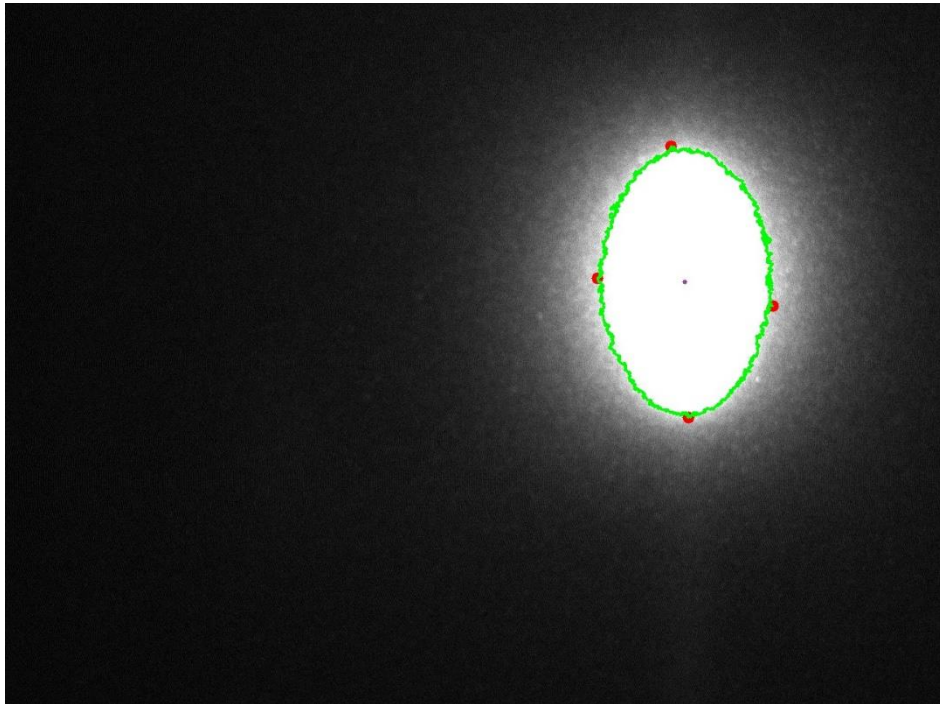
Images Courtesy of: Yong Cai, Alessandro Cunsolo, Alexey Suvorov, and the IXS Beamline Staff

BPM-1 Image Results

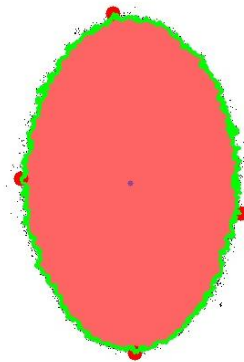
Process:

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

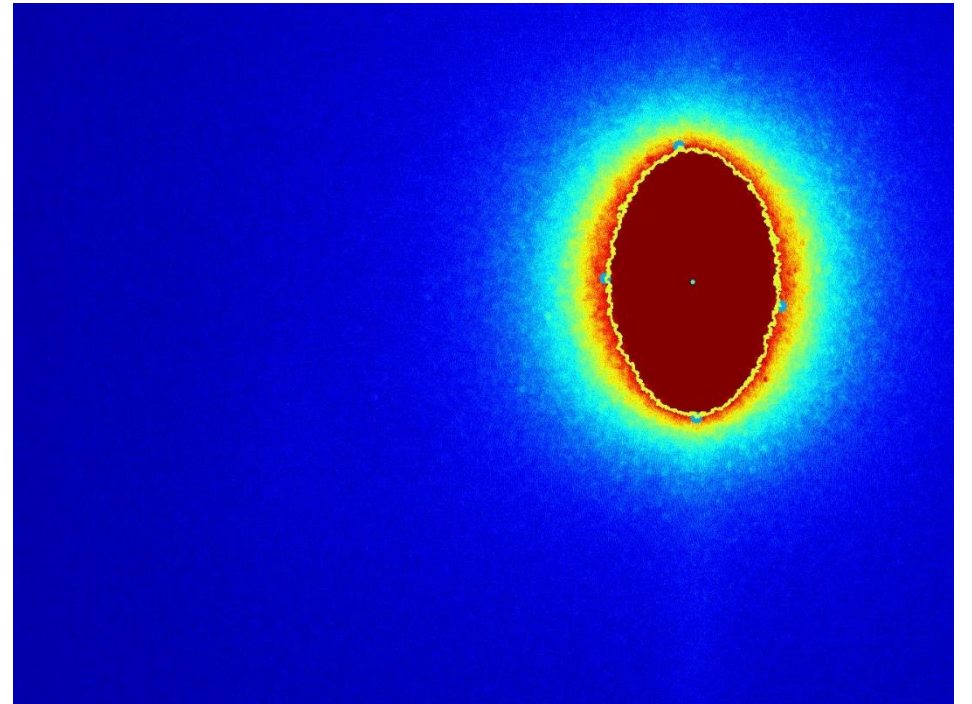
Result Superimposed on Original



Thresholding Result



Jet Color Map

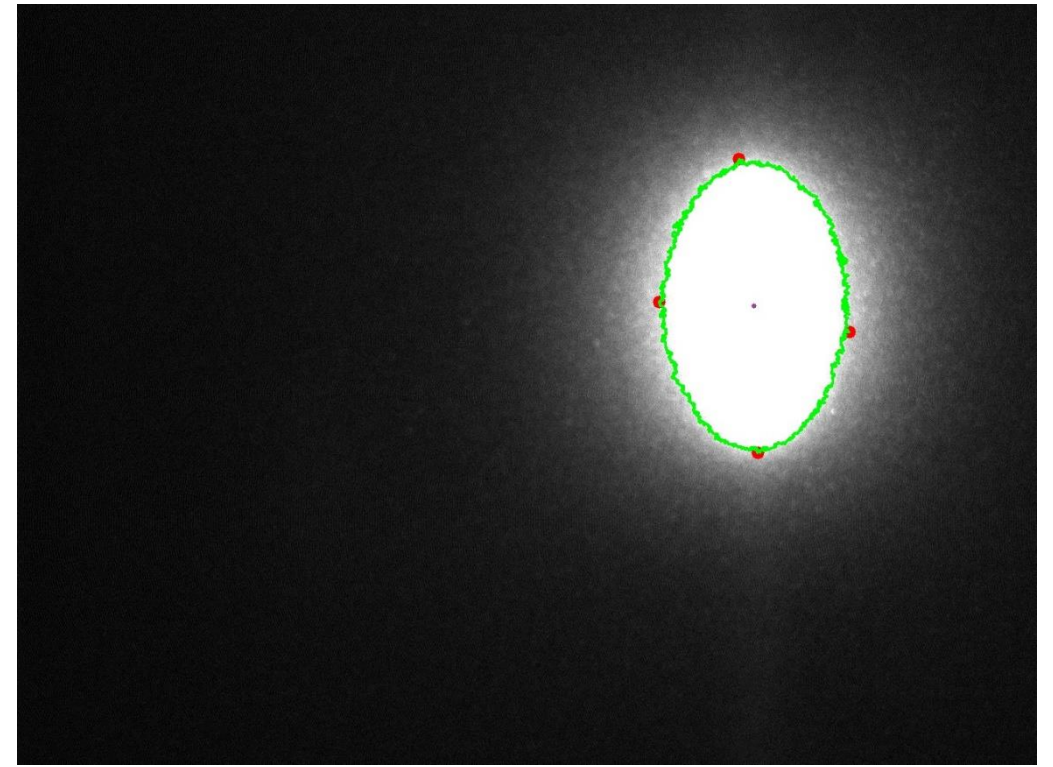


BPM-1 Data Results

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
```



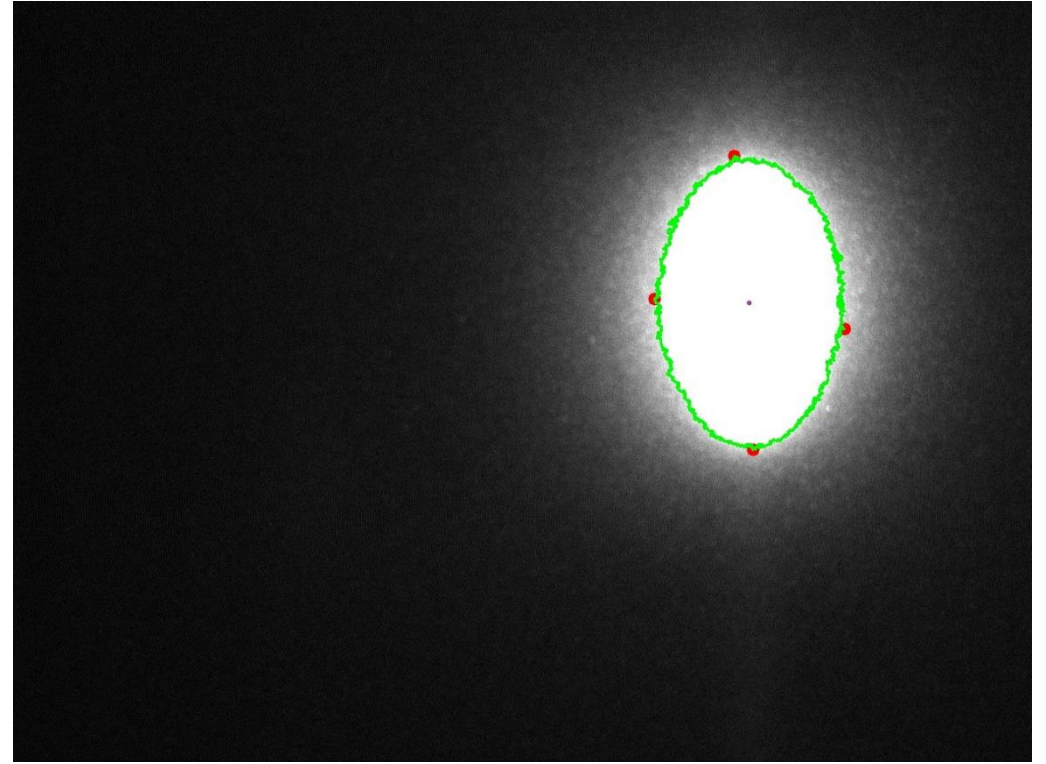
BPM-1 Time

BPM-1 (Single):

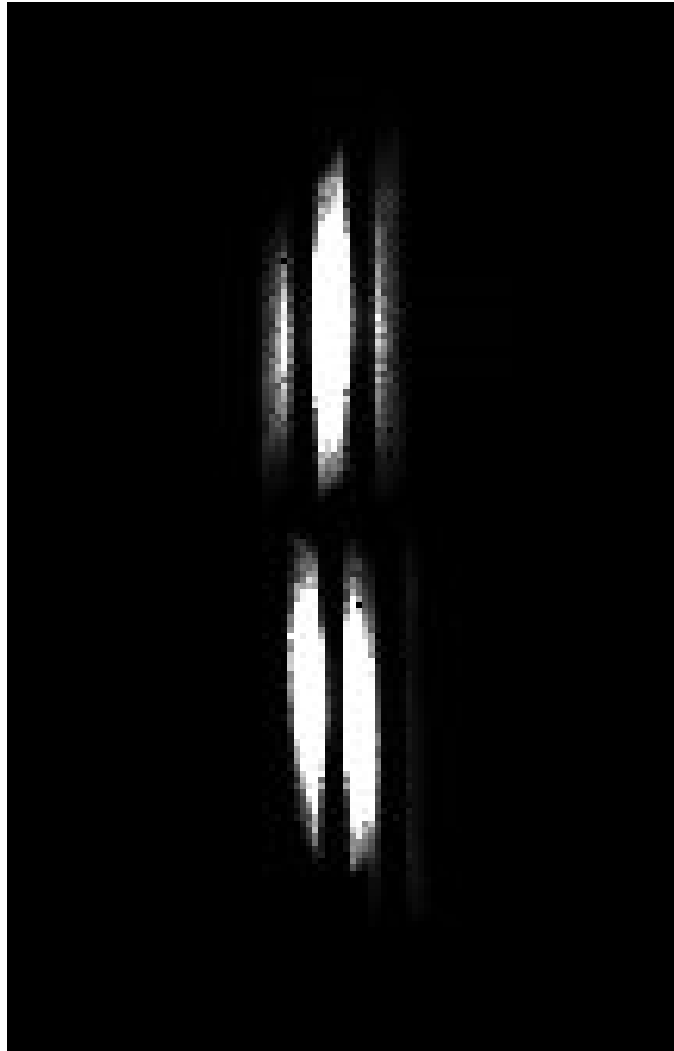
Real 0m0.350s

User 0m0.300s

Sys 0m0.068s

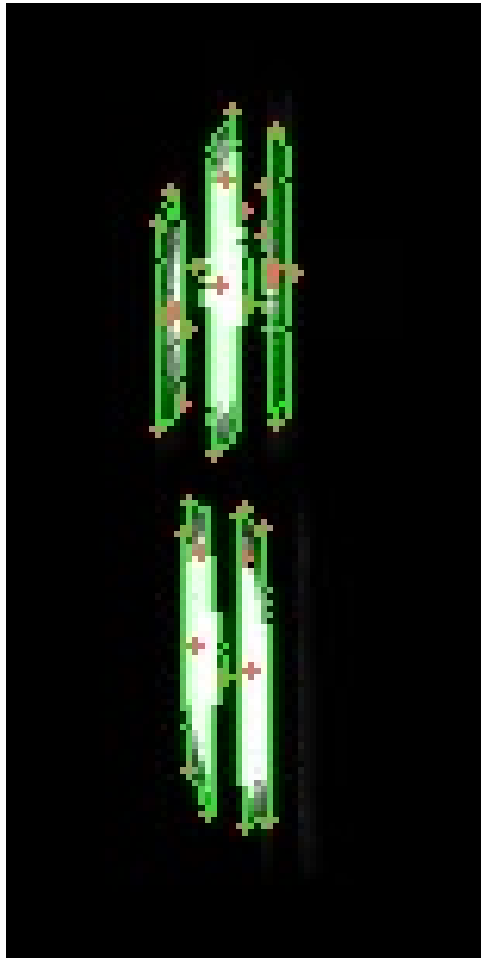


Merlin Analysis (IXS)



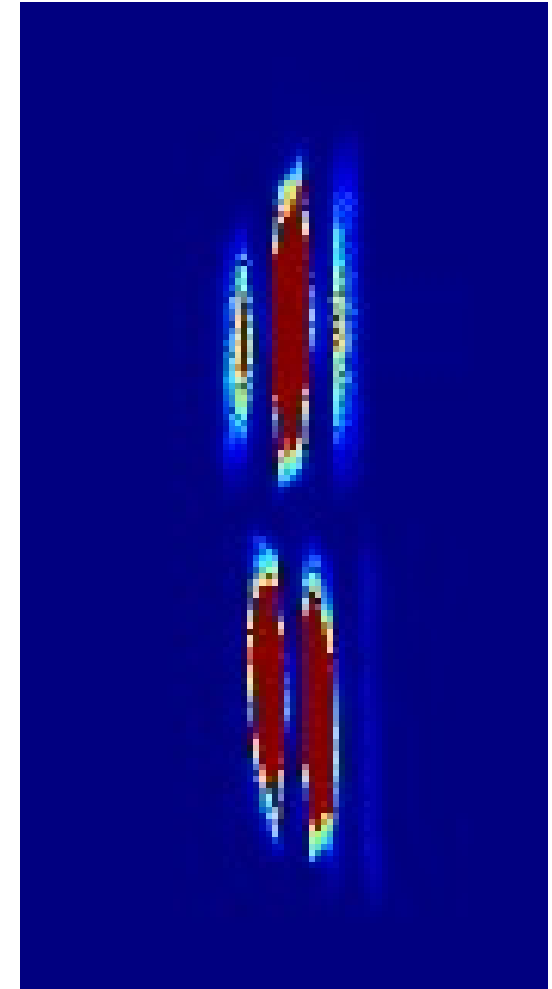
Images Courtesy of: Yong Cai, Alessandro Cunsolo, Alexey Suvorov, and the IXS Beamline Staff

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)

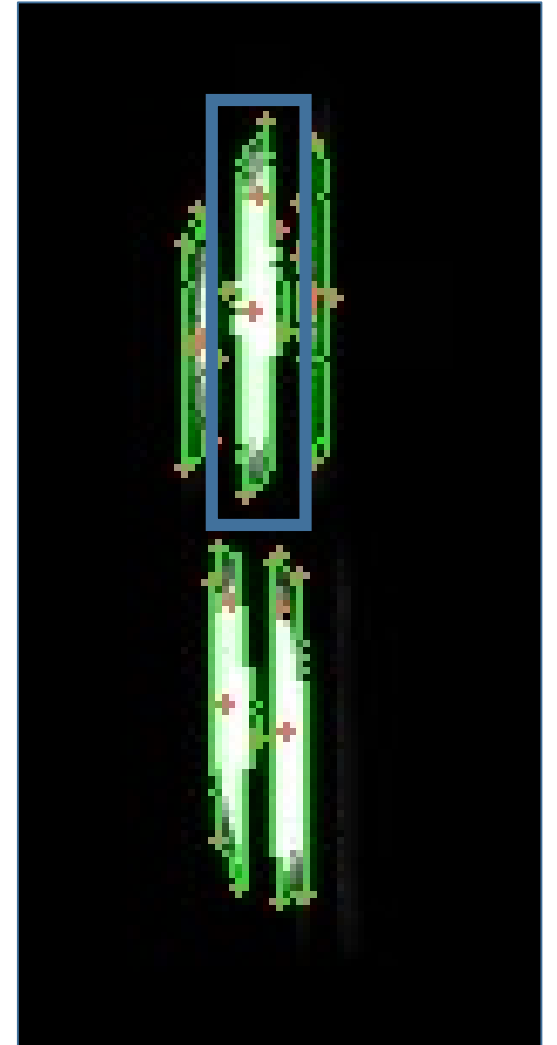
sum intensity: 62689

width: 9

centroid: (130, 95)

equivalent diameter: 18.5583214987

mean intensity: 126.644444444



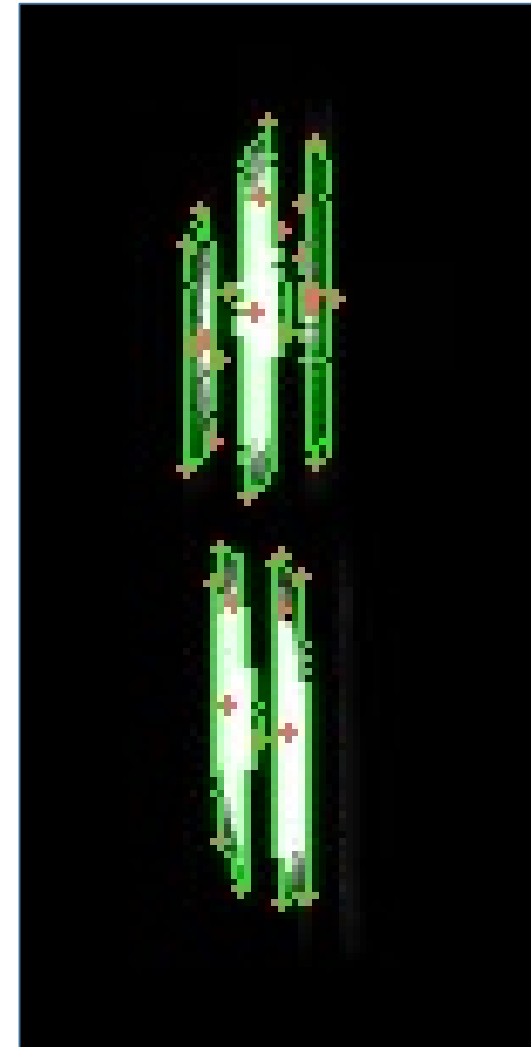
Merlin - Time

Merlin:

Real 0m0.321s

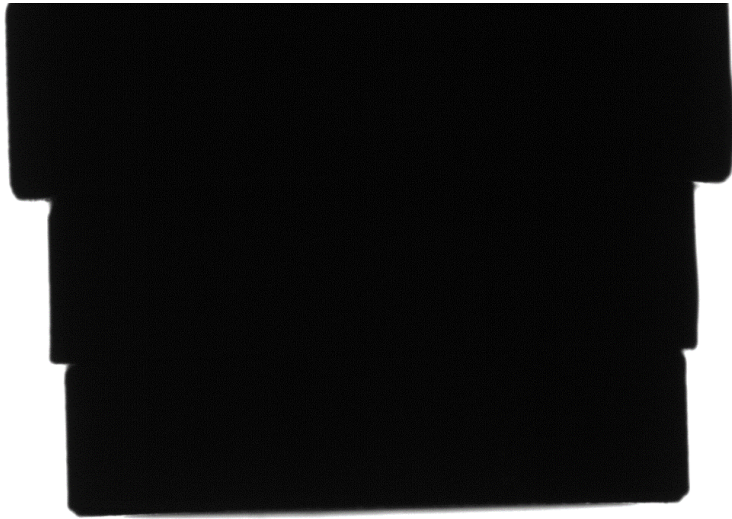
User 0m0.284s

Sys 0m0.036s

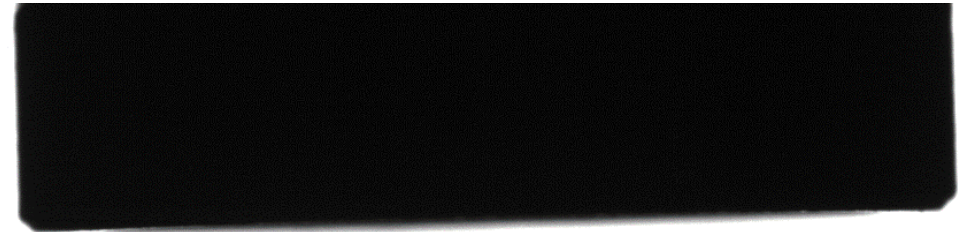


Match Game – Template Images (AMX)

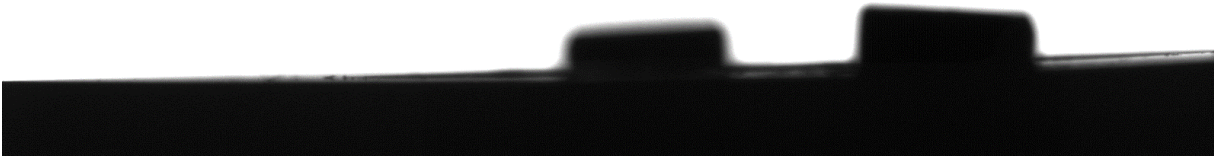
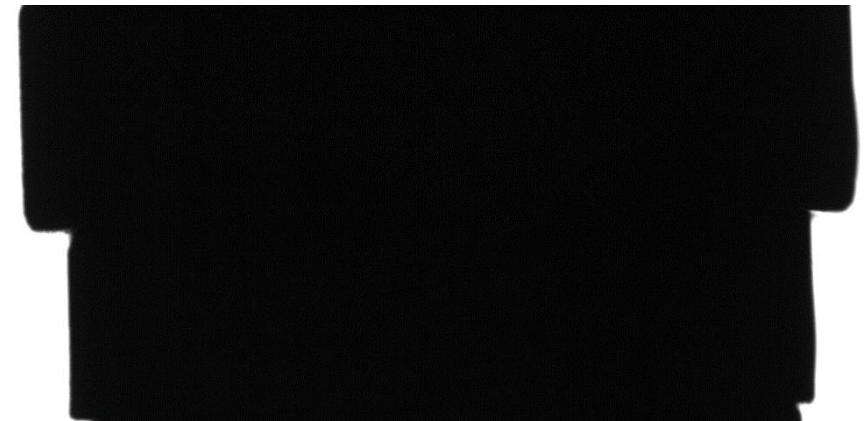
Pin and Gripper 'Perfect' Image



Pin Template Image



Gripper Template Image



Images Courtesy of: Jean Jakoncic, AMX Beamline

Match Game – ‘Perfect’ vs Actual



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

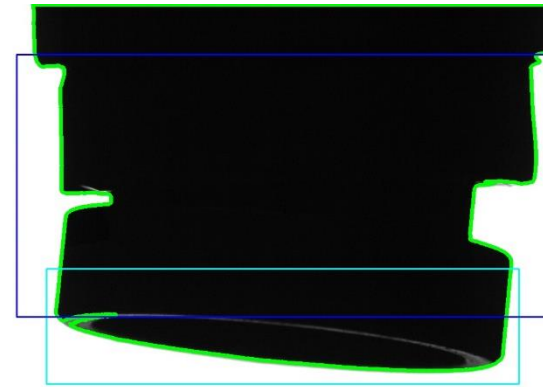


Image 3

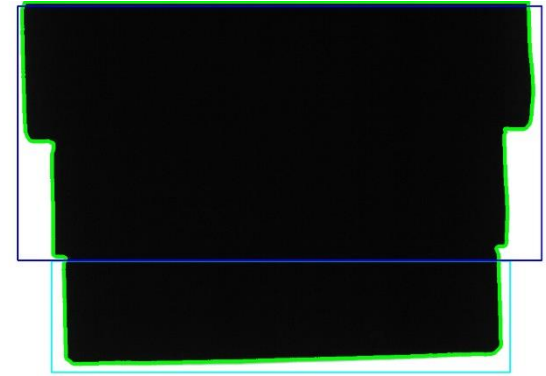
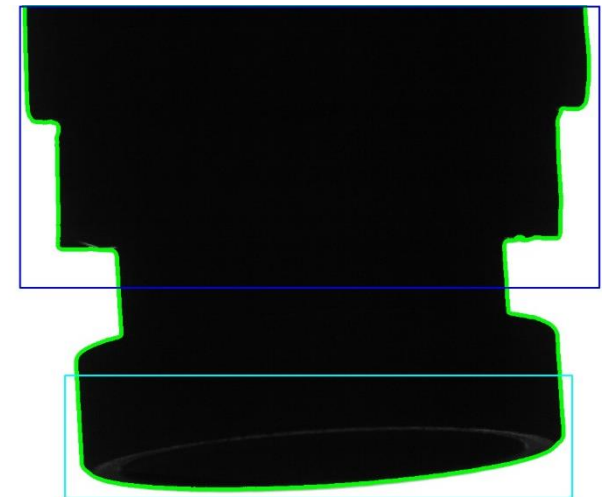


Image 4



'Perfect'



Image 1

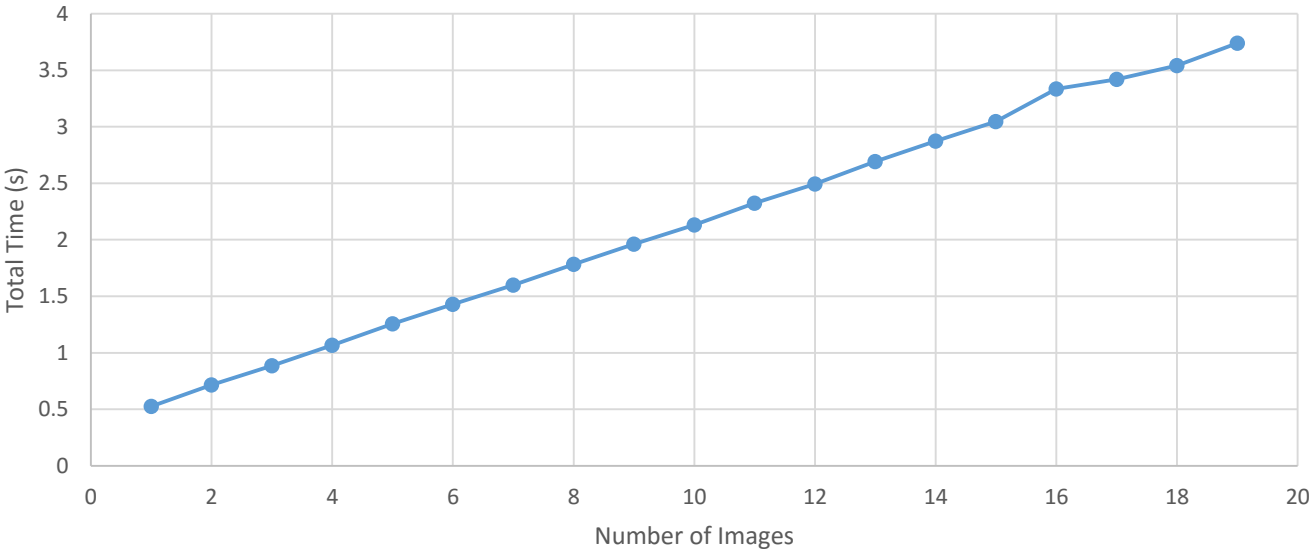


Images Courtesy of: Jean Jakoncic, AMX Beamline

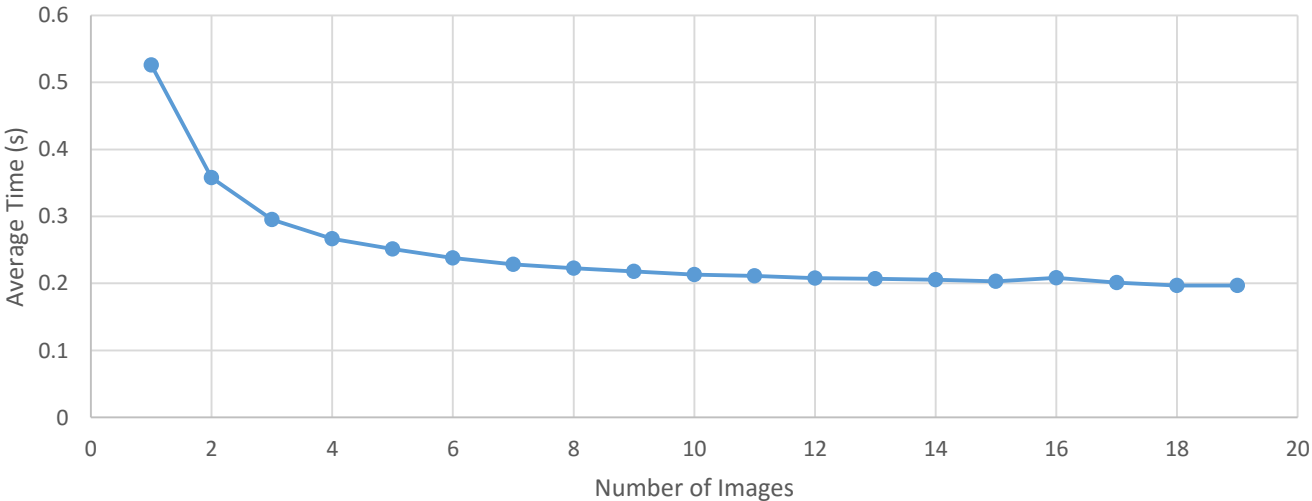
Match Game Time – 1-19 Images

Number of Image	Total Time	Average Time
1	0.526	0.526
2	0.716	0.358
3	0.886	0.29533333
4	1.066	0.2665
5	1.256	0.2512
6	1.429	0.23816667
7	1.6	0.22857143
8	1.783	0.222875
9	1.962	0.218
10	2.131	0.2131
11	2.324	0.21127273
12	2.493	0.20775
13	2.692	0.20707692
14	2.875	0.20535714
15	3.046	0.20306667
16	3.335	0.2084375
17	3.42	0.20117647
18	3.543	0.19683333
19	3.74	0.19684211

Total Computation Time



Average Time Per Photo



Pin/Gripper – ‘Perfect’ vs Actual

‘Perfect’



Image 1



Image 2



Image 3



Image 4



Pin/Gripper Image Analysis – Results – Image 1

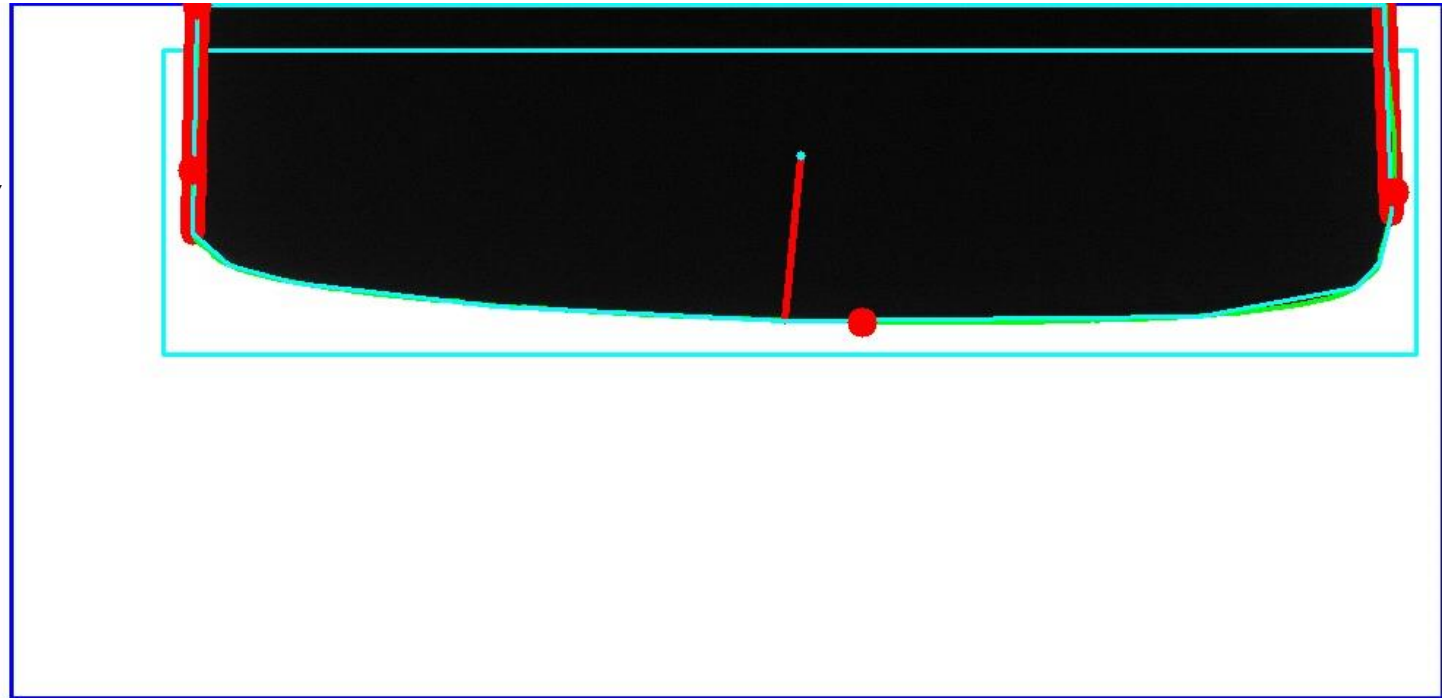
Console Output on Image 1:

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:

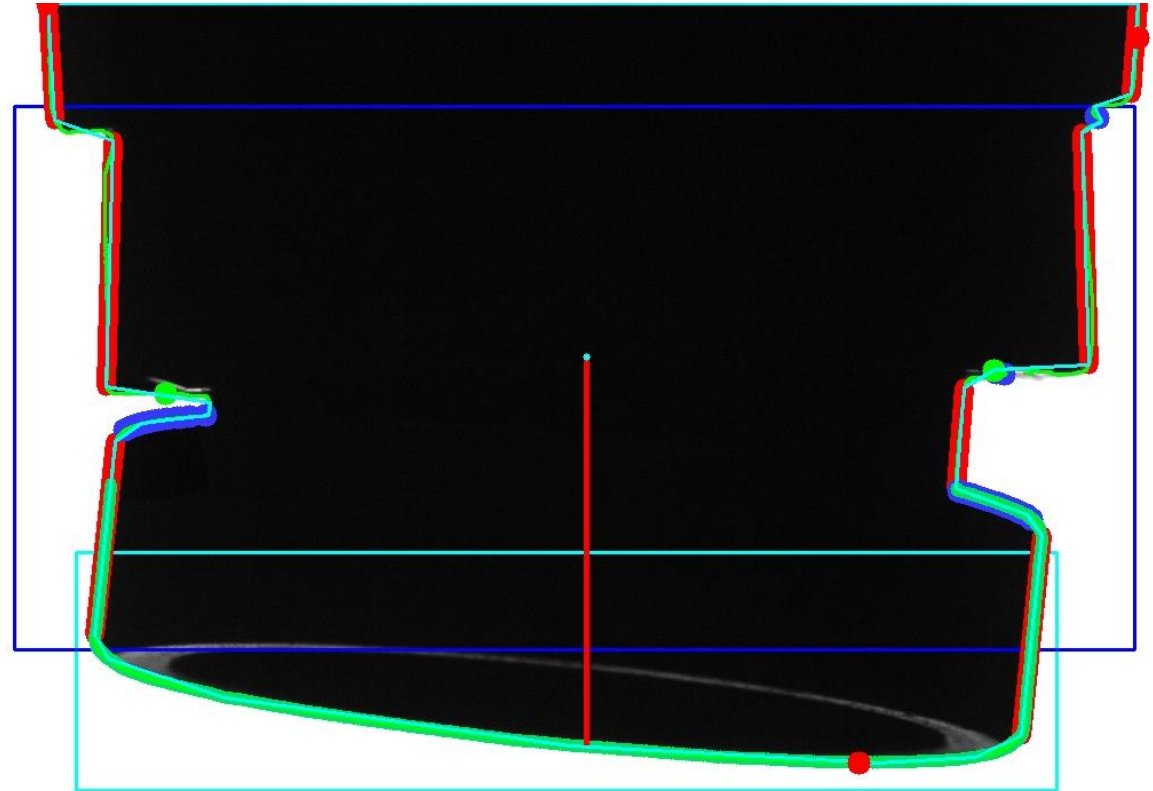
```

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
```



Images Courtesy of: Jean Jakoncic, AMX Beamline

Pin/Gripper Image Analysis – Results – Image 3

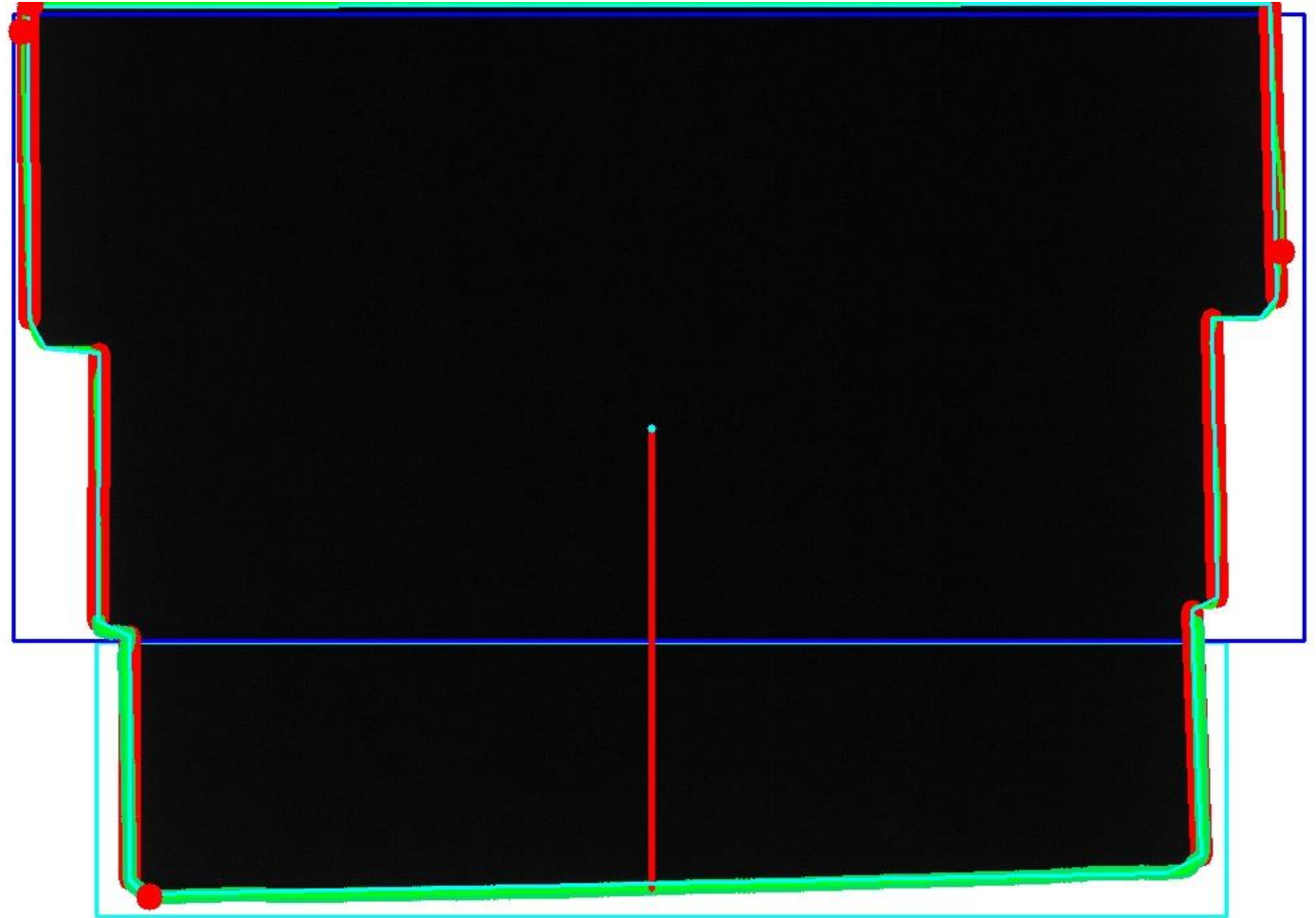
Console Output:

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

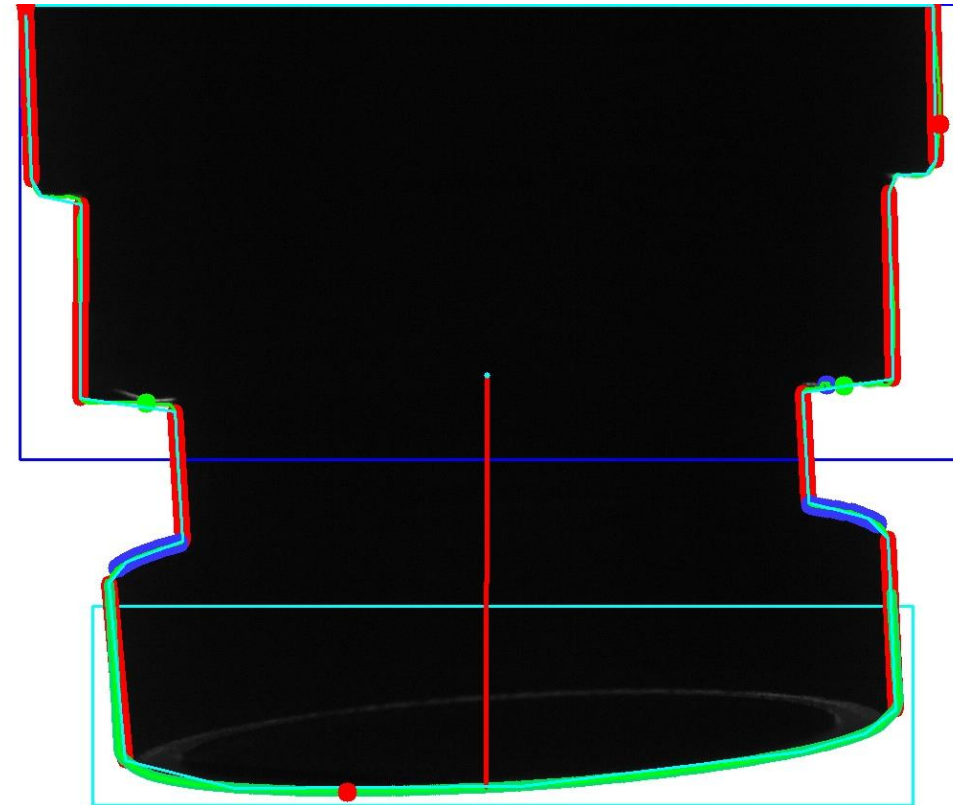
ERROR: Possible Kinks Detected

ERROR: 44 Possible Kink Points Detected: Adjust Gripper

ERROR: Possible Kink Distance on R: 125.015998976

ERROR: Possible Kink Distance on L: 157.003184681

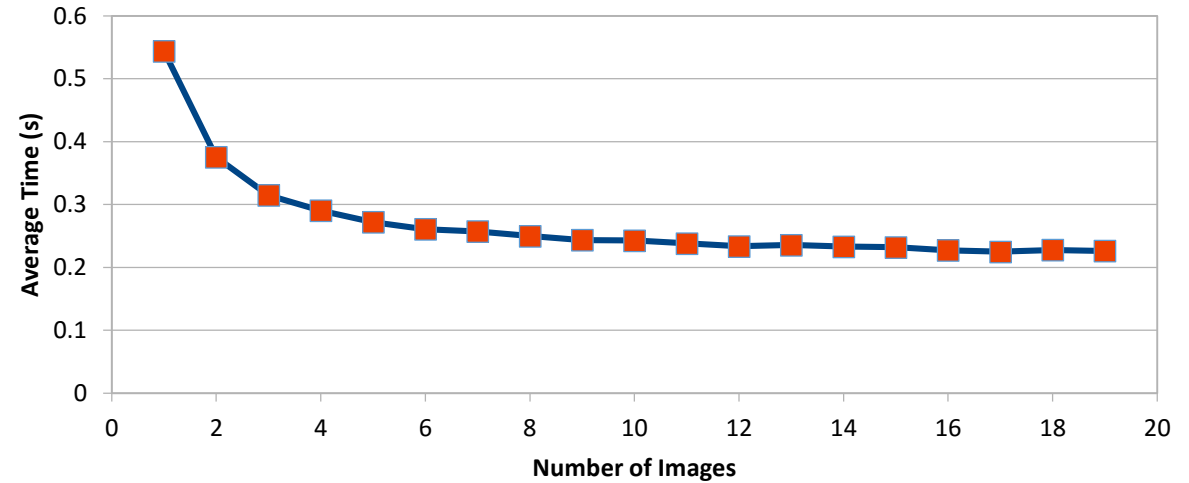
ERROR: Pin Not Mounted Correctly: Distance: 411



Pin/Gripper Time – 1-19 Images

Number of Images	Total Time	Average Time
1	0.544	0.544
2	0.751	0.3755
3	0.945	0.315
4	1.162	0.2905
5	1.361	0.2722
6	1.565	0.26083333
7	1.802	0.25742857
8	1.999	0.249875
9	2.192	0.24355556
10	2.429	0.2429
11	2.621	0.23827273
12	2.803	0.23358333
13	3.064	0.23569231
14	3.264	0.23314286
15	3.482	0.23213333
16	3.637	0.2273125
17	3.824	0.22494118
18	4.1	0.22777778
19	4.302	0.22642105

Average Time Per Photo



Total Time

