In [109]:
```
import cv2
import numpy as np
import math
from start_openpose import op, opWrapper
from get_pose_data import get_pose_data
from get_video_frames import get_video_frames
from get_wrist_points import get_wrist_points

import matplotlib.pyplot as plt
import matplotlib.patches as patches
```

In [2]:
```
frames, index = get_video_frames("two_hand.mp4", 10)
```

```
Opened two_hand.mp4 successfully.
Reading frame 0 of 409
Reading frame 10 of 409
Reading frame 20 of 409
Reading frame 30 of 409
Reading frame 40 of 409
Reading frame 50 of 409
Reading frame 60 of 409
Reading frame 70 of 409
Reading frame 80 of 409
Reading frame 90 of 409
Reading frame 100 of 409
Reading frame 110 of 409
Reading frame 120 of 409
Reading frame 130 of 409
Reading frame 140 of 409
Reading frame 150 of 409
Reading frame 160 of 409
Reading frame 170 of 409
Reading frame 180 of 409
Reading frame 190 of 409
Reading frame 200 of 409
Reading frame 210 of 409
Reading frame 220 of 409
Reading frame 230 of 409
Reading frame 240 of 409
Reading frame 250 of 409
Reading frame 260 of 409
Reading frame 270 of 409
Reading frame 280 of 409
Reading frame 290 of 409
Reading frame 300 of 409
Reading frame 310 of 409
Reading frame 320 of 409
Reading frame 330 of 409
Reading frame 340 of 409
Reading frame 350 of 409
Reading frame 360 of 409
Reading frame 370 of 409
Reading frame 380 of 409
Reading frame 390 of 409
Reading frame 400 of 409
Reading frame 409 of 409
```

In [3]:
```
left_wrist_points = get_wrist_points(frames, "left")
```

```
7
[0. 0. 0.]
[0. 0. 0.]
[0. 0. 0.]
[1.5221179e+03 7.0686230e+02 6.5055591e-01]
[1.5015419e+03 4.8615991e+02 6.9646561e-01]
[1.5132517e+03 4.4202164e+02 6.7886859e-01]
[1.5045101e+03 4.3609903e+02 7.2015142e-01]
[1.5016021e+03 4.3318231e+02 7.1269095e-01]
[1.5103732e+03 4.3904672e+02 7.0864272e-01]
[1.4987030e+03 4.3906046e+02 7.2027814e-01]
[1.5016034e+03 4.5372321e+02 7.0337915e-01]
[1.4985868e+03 4.6265216e+02 7.2365141e-01]
[1.5016228e+03 4.6846536e+02 7.1229118e-01]
[1.5045199e+03 4.6553775e+02 6.9568914e-01]
[1.4868062e+03 4.8618390e+02 7.0923489e-01]
[1.4487129e+03 5.0087100e+02 7.3791575e-01]
[1.4515118e+03 4.9201495e+02 7.1840411e-01]
[1.4661555e+03 5.0388858e+02 7.1768188e-01]
[1.4750594e+03 5.0667886e+02 7.2226763e-01]
[1.5133588e+03 5.0672400e+02 7.1612030e-01]
[1.5221270e+03 5.0969910e+02 7.2282696e-01]
[1.5103718e+03 4.8015494e+02 6.9629478e-01]
[1.4986427e+03 4.5975201e+02 6.7651540e-01]
[1.3631906e+03 7.6273761e+02 5.4977006e-01]
[1.2896083e+03 8.3051691e+02 6.8280834e-01]
[1.2954875e+03 8.0999493e+02 7.0520091e-01]
[1.3809330e+03 8.2753253e+02 6.4990944e-01]
[1.7016946e+03 8.0399011e+02 4.5127630e-01]
[1.7547485e+03 7.7158191e+02 6.3867426e-01]
[1.7546581e+03 7.6575586e+02 6.3771832e-01]
[1.7076627e+03 6.9810870e+02 7.0646220e-01]
[1.5663094e+03 5.2723700e+02 7.0336413e-01]
[1.4073763e+03 4.5082965e+02 6.7625773e-01]
[1.4220046e+03 4.5960162e+02 7.1324676e-01]
[1.4396995e+03 4.8326254e+02 7.0143968e-01]
[1.4485442e+03 4.8907950e+02 7.1004564e-01]
[1.4721637e+03 5.5386078e+02 7.2399777e-01]
[0. 0. 0.]
[0. 0. 0.]
[0. 0. 0.]
[0. 0. 0.]
[0. 0. 0.]
```

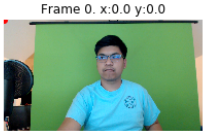
In [8]:
```
plt.imshow(cv2.cvtColor(frames[4], cv2.COLOR_BGR2RGB))
plt.plot(left_wrist_points[4][0], left_wrist_points[4][1], 'ro')
plt.axis("off")
plt.show()
```

In [25]:
```
def getGradientsXY(points):
    gradient_x = []
    gradient_y = []

    for i in range(len(points) - 1):
        dx = points[i + 1][0] - points[i][0]
        dy = points[i + 1][1] - points[i][1]
        gradient_x.append(dx)
        gradient_y.append(dy)

    return gradient_x, gradient_y
```

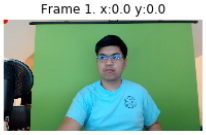
In [26]:
```
gradient_x, gradient_y = getGradientsXY(left_wrist_points)
```

In [22]:
```
i1 = 0
i2 = 40
fig, plots = plt.subplots(math.ceil((i2 - i1) / 5), 5, figsize=(20, 32))
i = i1
for y in range(math.ceil((i2 - i1) / 5)):
    for x in range(5):
        plots[y][x].imshow(cv2.cvtColor(frames[i], cv2.COLOR_BGR2RGB))
        plots[y][x].plot(left_wrist_points[i][0], left_wrist_points[i][1], 'r
o')
        plots[y][x].axis("off")
        plots[y][x].set_title("Frame " + str(i) + ". x:" + str(gradient_x[i])
+ " y:" + str(gradient_y[i]))
        if i == i2:
            break
        else:
            i += 1
    if i == i2:
        break
```

Frame 0. x:0.0 y:0.0

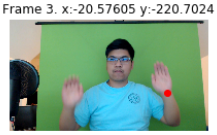


Frame 1. x:0.0 y:0.0

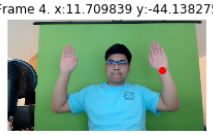


Frame 2. x:1522.1179 y:706.8623

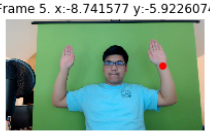
Frame 3. x:-20.57605 y:-220.7024



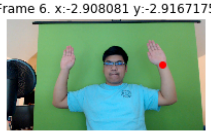
Frame 4. x:11.709839 y:-44.138275



Frame 5. x:-8.741577 y:-5.9226074



Frame 6. x:-2.908081 y:-2.9167175



Frame 7. x:8.771118 y:5.8644104

Frame 8. x:-11.670166 y:0.01373291

Frame 9. x:2.9003906 y:14.66275

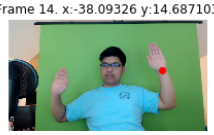
Frame 10. x:-3.0166016 y:8.928955

Frame 11. x:3.0360107 y:5.813202

Frame 12. x:2.8970947 y:-2.9276123

Frame 13. x:-17.713745 y:20.646149

Frame 14. x:-38.09326 y:14.687103

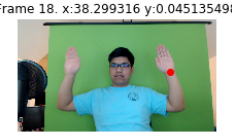


Frame 15. x:2.7989502 y:-8.856049

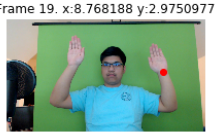
Frame 16. x:14.643677 y:11.873627

Frame 17. x:8.903931 y:2.7902832

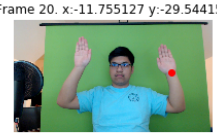
Frame 18. x:38.299316 y:0.045135498



Frame 19. x:8.768188 y:2.9750977

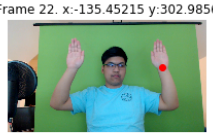


Frame 20. x:-11.755127 y:-29.544159

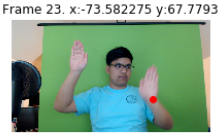


Frame 21. x:-11.729126 y:-20.402924

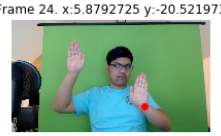
Frame 22. x:-135.45215 y:302.9856



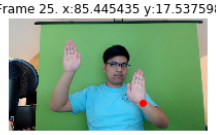
Frame 23. x:-73.582275 y:67.7793



Frame 24. x:5.8792725 y:-20.521973

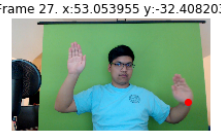


Frame 25. x:85.445435 y:17.537598

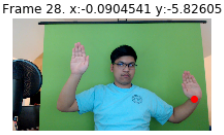


Frame 26. x:320.7616 y:-23.54242

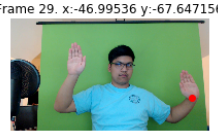
Frame 27. x:53.053955 y:-32.408203



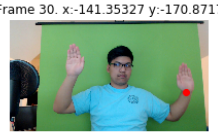
Frame 28. x:-0.0904541 y:-5.82605



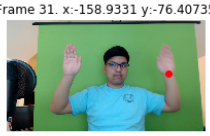
Frame 29. x:-46.99536 y:-67.647156



Frame 30. x:-141.35327 y:-170.8717



Frame 31. x:-158.9331 y:-76.40735

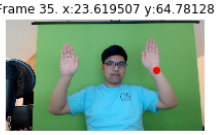


Frame 32. x:14.628296 y:8.771973

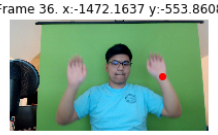
Frame 33. x:17.694824 y:23.66092

Frame 34. x:8.844727 y:5.8169556

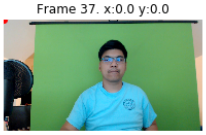
Frame 35. x:23.619507 y:64.78128



Frame 36. x:-1472.1637 y:-553.8608

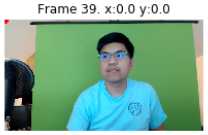


Frame 37. x:0.0 y:0.0



Frame 38. x:0.0 y:0.0

Frame 39. x:0.0 y:0.0



In [45]:
```
def getAngleAndDistance(gradient_x, gradient_y):
    angles = []
    distances = []
    for i in range(len(gradient_x)):
        angle = int(math.atan2(gradient_y[i], gradient_x[i]) * 180 / math.pi)
        distance = math.sqrt(gradient_x[i] ** 2 + gradient_y[i] ** 2)
        angles.append(angle)
        distances.append(distance)
    return angles, distances
```

In [46]:
```
angles, distances = getAngleAndDistance(gradient_x, gradient_y)
```

In [47]:
```
print(distances)
```

```
[0.0, 0.0, 1678.242318598664, 221.65946836369022, 45.66516899347089, 10.55899
8518596995, 4.118759105160198, 10.55101052943067, 11.670174095748102, 14.9468
56207899835, 9.42476120514741, 6.558252633651643, 4.118746370102667, 27.20368
029258348, 40.826554971983995, 9.287826372070676, 18.852593461155553, 9.33089
8221718742, 38.29934300218783, 9.25917573138925, 31.79686048799378, 23.534053
772097554, 331.88485310407293, 100.04191289920021, 21.347533964695096, 87.226
656593395, 321.6243887165427, 62.1692349898482, 5.8267519486579085, 82.369300
52520336, 221.76087712197423, 176.3457256046683, 17.056803486416822, 29.54565
790471237, 10.586130550250065, 68.95284917006727, 1572.9042281632842, 0.0, 0.
0, 0.0, 0.0]
```

In [53]:
```
i1 = 22
i2 = 40
fig, plots = plt.subplots(math.ceil((i2 - i1) / 5), 5, figsize=(20, 16))
i = i1
for y in range(math.ceil((i2 - i1) / 5)):
    for x in range(5):
        plots[y][x].imshow(cv2.cvtColor(frames[i], cv2.COLOR_BGR2RGB))
        plots[y][x].plot(left_wrist_points[i][0], left_wrist_points[i][1], 'r
o')
        plots[y][x].axis("off")
        plots[y][x].set_title("Frame " + str(i) + ".\nx:" + str(gradient_x[i])
+ "\ny:" + str(gradient_y[i]) + "\nAngle:" + str(angles[i]) + "\nDistance:" +
str(distances[i]))
        if i == i2:
            break
        else:
            i += 1
    if i == i2:
        break
    print("Finished row " + str(y))
plt.show()
```

```
Finished row 0
Finished row 1
Finished row 2
```

3/4 time signature?

In [54]:
```
frames, index = get_video_frames("3-4_test_conduct.mp4", 5)
```

```
Opened 3-4_test_conduct.mp4 successfully.
Reading frame 0 of 535
Reading frame 5 of 535
Reading frame 10 of 535
Reading frame 15 of 535
Reading frame 20 of 535
Reading frame 25 of 535
Reading frame 30 of 535
Reading frame 35 of 535
Reading frame 40 of 535
Reading frame 45 of 535
Reading frame 50 of 535
Reading frame 55 of 535
Reading frame 60 of 535
Reading frame 65 of 535
Reading frame 70 of 535
Reading frame 75 of 535
Reading frame 80 of 535
Reading frame 85 of 535
Reading frame 90 of 535
Reading frame 95 of 535
Reading frame 100 of 535
Reading frame 105 of 535
Reading frame 110 of 535
Reading frame 115 of 535
Reading frame 120 of 535
Reading frame 125 of 535
Reading frame 130 of 535
Reading frame 135 of 535
Reading frame 140 of 535
Reading frame 145 of 535
Reading frame 150 of 535
Reading frame 155 of 535
Reading frame 160 of 535
Reading frame 165 of 535
Reading frame 170 of 535
Reading frame 175 of 535
Reading frame 180 of 535
Reading frame 185 of 535
Reading frame 190 of 535
Reading frame 195 of 535
Reading frame 200 of 535
Reading frame 205 of 535
Reading frame 210 of 535
Reading frame 215 of 535
Reading frame 220 of 535
Reading frame 225 of 535
Reading frame 230 of 535
Reading frame 235 of 535
Reading frame 240 of 535
Reading frame 245 of 535
Reading frame 250 of 535
Reading frame 255 of 535
Reading frame 260 of 535
Reading frame 265 of 535
Reading frame 270 of 535
Reading frame 275 of 535
```

```
Reading frame 280 of 535
Reading frame 285 of 535
Reading frame 290 of 535
Reading frame 295 of 535
Reading frame 300 of 535
Reading frame 305 of 535
Reading frame 310 of 535
Reading frame 315 of 535
Reading frame 320 of 535
Reading frame 325 of 535
Reading frame 330 of 535
Reading frame 335 of 535
Reading frame 340 of 535
Reading frame 345 of 535
Reading frame 350 of 535
Reading frame 355 of 535
Reading frame 360 of 535
Reading frame 365 of 535
Reading frame 370 of 535
Reading frame 375 of 535
Reading frame 380 of 535
Reading frame 385 of 535
Reading frame 390 of 535
Reading frame 395 of 535
Reading frame 400 of 535
Reading frame 405 of 535
Reading frame 410 of 535
Reading frame 415 of 535
Reading frame 420 of 535
Reading frame 425 of 535
Reading frame 430 of 535
Reading frame 435 of 535
Reading frame 440 of 535
Reading frame 445 of 535
Reading frame 450 of 535
Reading frame 455 of 535
Reading frame 460 of 535
Reading frame 465 of 535
Reading frame 470 of 535
Reading frame 475 of 535
Reading frame 480 of 535
Reading frame 485 of 535
Reading frame 490 of 535
Reading frame 495 of 535
Reading frame 500 of 535
Reading frame 505 of 535
Reading frame 510 of 535
Reading frame 515 of 535
Reading frame 520 of 535
Reading frame 525 of 535
Reading frame 530 of 535
Reading frame 535 of 535
Reading frame 535 of 535
```

In [64]:
```
left_wrist_points = get_wrist_points(frames, "left")
right_wrist_points = get_wrist_points(frames, "right")
```

```
7
[0. 0. 0.]
[0. 0. 0.]
[1.4838677e+03 9.0704517e+02 1.1988044e-01]
[1.5515969e+03 7.1565784e+02 6.4841861e-01]
[1.5397607e+03 6.4206226e+02 6.5879524e-01]
[1.5133212e+03 6.2439606e+02 7.2818637e-01]
[1.4897993e+03 6.2148401e+02 6.8970215e-01]
[1.4897059e+03 6.2161664e+02 6.7343384e-01]
[1.4897014e+03 6.5103833e+02 6.6407382e-01]
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```
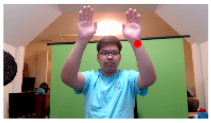

In [67]:
```
gradient_x, gradient_y = getGradientsXY(left_wrist_points)
angles, distances = getAngleAndDistance(gradient_x, gradient_y)
```

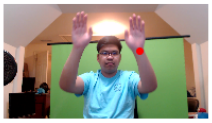
In [71]:
```
i1 = 13
i2 = 63
fig, plots = plt.subplots(math.ceil((i2 - i1) / 5), 5, figsize=(20, 35))
i = i1
for y in range(math.ceil((i2 - i1) / 5)):
    for x in range(5):
        plots[y][x].imshow(cv2.cvtColor(frames[i], cv2.COLOR_BGR2RGB))
        plots[y][x].plot(left_wrist_points[i][0], left_wrist_points[i][1], 'r
o')
        plots[y][x].axis("off")
        plots[y][x].set_title("Frame " + str(i) + ".\nx:" + str(gradient_x[i])
+ "\ny:" + str(gradient_y[i]) + "\nAngle:" + str(angles[i]) + "\nDistance:" +
str(distances[i]))
        if i == i2:
            break
        else:
            i += 1
    if i == i2:
        break
    print("Finished row " + str(y))
plt.show()
```

```
Finished row 0
Finished row 1
Finished row 2
Finished row 3
Finished row 4
Finished row 5
Finished row 6
Finished row 7
Finished row 8
```

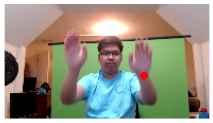
Frame 13.
x:23.452637
y:73.61252
Angle:72
Distance:77.25819711255409



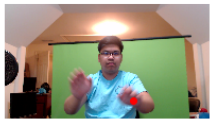
Frame 14.
x:26.626099
y:226.60602
Angle:83
Distance:228.1649327839769



Frame 15.
x:-94.29785
y:238.45923
Angle:111
Distance:256.42716017140293

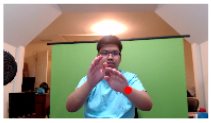


Frame 16.
x:-44.10913
y:-23.627075
Angle:-151
Distance:50.038526231838794

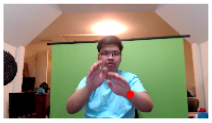


Frame 17.
x:-0.107543945
y:-64.79486
Angle:-90
Distance:64.7949500883741

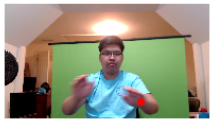
Frame 18.
x:17.69934
y:35.36017
Angle:63
Distance:39.54248574360504



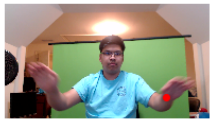
Frame 19.
x:91.30322
y:73.56232
Angle:38
Distance:117.25055622174337



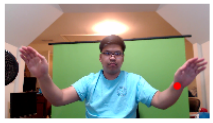
Frame 20.
x:241.34021
y:-44.1474
Angle:-10
Distance:245.34483867024156



Frame 21.
x:102.9646
y:-111.85864
Angle:-47
Distance:152.03310393509574



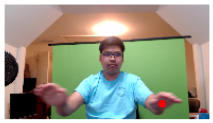
Frame 22.
x:-5.8476562
y:23.534302
Angle:103
Distance:24.2499163471947



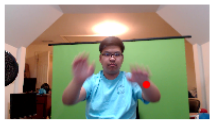
Frame 23.
x:-50.022705
y:106.01996
Angle:115
Distance:117.22842071292487

Frame 24.
x:-85.38281
y:26.412292
Angle:162
Distance:89.37468245808755

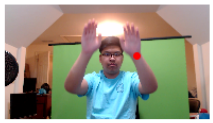
Frame 25.
x:-153.00854
y:-179.51996
Angle:-130
Distance:235.87927063976747



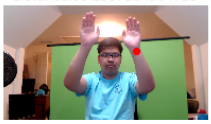
Frame 26.
x:-88.201416
y:-264.78894
Angle:-108
Distance:279.09258815138384



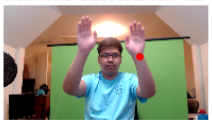
Frame 27.
x:8.707886
y:-53.060333
Angle:-80
Distance:53.770124036562486



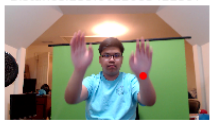
Frame 28.
x:29.404663
y:56.00244
Angle:62
Distance:63.2527284364711



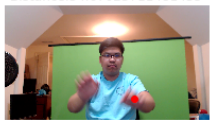
Frame 29.
x:26.531128
y:176.55765
Angle:81
Distance:178.53992190087885



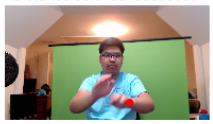
Frame 30.
x:-88.35022
y:217.82672
Angle:112
Distance:235.0622083422397



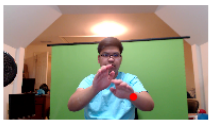
Frame 31.
x:-44.099487
y:32.312073
Angle:143
Distance:54.67023711481435



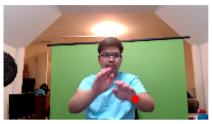
Frame 32.
x:47.099
y:-49.93396
Angle:-46
Distance:68.6419410156085



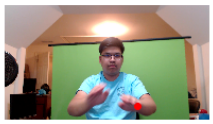
Frame 33.
x:17.618286
y:20.565552
Angle:49
Distance:27.080360510172646



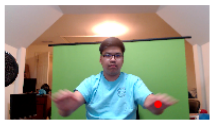
Frame 34.
x:8.843384
y:61.72052
Angle:81
Distance:62.350846251851394



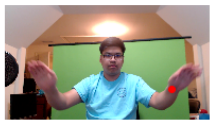
Frame 35.
x:191.3147
y:-14.648132
Angle:-4
Distance:191.87464962945356



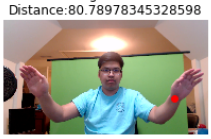
Frame 36.
x:135.43457
y:-138.28363
Angle:-45
Distance:193.55848021810047



Frame 37.
x:38.171875
y:-50.05902
Angle:-52
Distance:62.9523440715513



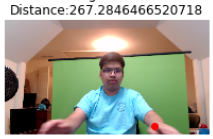
Frame 38.
x:-14.616333
y:79.456604
Angle:100
Distance:80.78978345328598



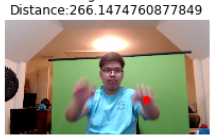
Frame 39.
x:20.563232
y:111.84259
Angle:79
Distance:113.71724381031498

Frame 40.
x:-209.01892
y:73.57941
Angle:160
Distance:221.59160270530268

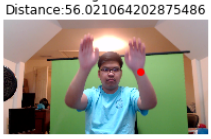
Frame 41.
x:-76.5354
y:-256.0926
Angle:-106
Distance:267.2846466520718



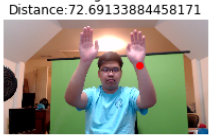
Frame 42.
x:-47.07898
y:-261.95047
Angle:-100
Distance:266.1474760877849



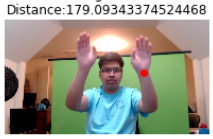
Frame 43.
x:-2.8763428
y:-55.947174
Angle:-92
Distance:56.021064202875486



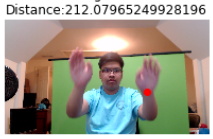
Frame 44.
x:26.484741
y:67.694824
Angle:68
Distance:72.69133884458171



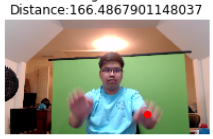
Frame 45.
x:29.472778
y:176.65167
Angle:80
Distance:179.09343374524468



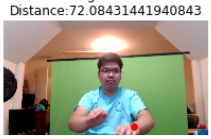
Frame 46.
x:8.77124
y:211.8982
Angle:87
Distance:212.07965249928196



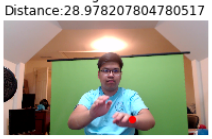
Frame 47.
x:-117.71582
y:117.732056
Angle:134
Distance:166.4867901148037



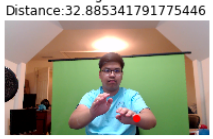
Frame 48.
x:-14.67688
y:-70.57434
Angle:-101
Distance:72.08431441940843



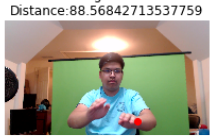
Frame 49.
x:26.437988
y:-11.864624
Angle:-24
Distance:28.978207804780517



Frame 50.
x:14.739746
y:29.397034
Angle:63
Distance:32.885341791775446



Frame 51.
x:82.41931
y:32.42566
Angle:21
Distance:88.56842713537759



Frame 52.
x:229.56226
y:-88.34216
Angle:-21
Distance:245.9739154746851

Frame 53.
x:17.60376
y:-147.09003
Angle:-83
Distance:148.1396920417629

Frame 54.
x:-11.768677
y:-41.267273
Angle:-105
Distance:42.91258054807702

Frame 55.
x:-17.662842
y:61.82434
Angle:105
Distance:64.29794007748299

Frame 56.
x:-26.474243
y:111.86145
Angle:103
Distance:114.95159673057303

Frame 57.
x:38.294067
y:47.07019
Angle:50
Distance:60.67980243710776

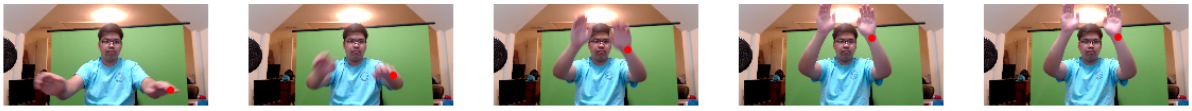
Frame 58.
x:-208.98267
y:-138.40063
Angle:-146
Distance:250.65611981064055

Frame 59.
x:-97.13428
y:-235.37659
Angle:-112
Distance:254.63150924896502

Frame 60.
x:-8.795288
y:-114.814514
Angle:-94
Distance:115.15089992851708

Frame 61.
x:5.8756104
y:-2.9552307
Angle:-26
Distance:6.576943482332841

Frame 62.
x:5.8339844
y:47.19565
Angle:82
Distance:47.554858659017064



Estimate a bounding box

In [96]:
```
points = np.array(left_wrist_points)
```

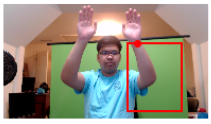
In [134]:
```
xy_max = np.amax(points, axis=0).astype(int)
xy_min = np.amin(points[np.sum(points, axis=1) > 0], axis=0).astype(int)
print(xy_max)
print(xy_min)
```

```
[1678 1004    0]
[1165  362    0]
```

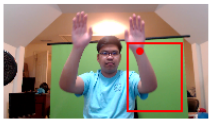
In [111]:
```
i1 = 13
i2 = 63
fig, plots = plt.subplots(math.ceil((i2 - i1) / 5), 5, figsize=(20, 35))
i = i1
for y in range(math.ceil((i2 - i1) / 5)):
    for x in range(5):
        plots[y][x].imshow(cv2.cvtColor(frames[i], cv2.COLOR_BGR2RGB))
        plots[y][x].plot(left_wrist_points[i][0], left_wrist_points[i][1], 'r
o')
        plots[y][x].axis("off")
        plots[y][x].set_title("Frame " + str(i) + ".\nx:" + str(gradient_x[i])
+ "\ny:" + str(gradient_y[i]) + "\nAngle:" + str(angles[i]) + "\nDistance:" +
str(distances[i]))
        rect = patches.Rectangle(xy_min[0:2], xy_max[0] - xy_min[0], xy_max[1]
- xy_min[1], linewidth=2, edgecolor='r', facecolor='none')
        plots[y][x].add_patch(rect)
        if i == i2:
            break
        else:
            i += 1
    if i == i2:
        break
    print("Finished row " + str(y))
plt.show()
```

```
Finished row 0
Finished row 1
Finished row 2
Finished row 3
Finished row 4
Finished row 5
Finished row 6
Finished row 7
Finished row 8
```

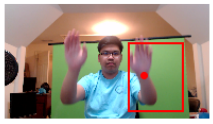
Frame 13.
x:23.452637
y:73.61252
Angle:72
Distance:77.25819711255409



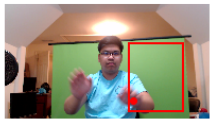
Frame 14.
x:26.626099
y:226.60602
Angle:83
Distance:228.1649327839769



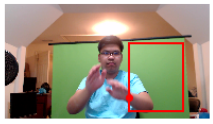
Frame 15.
x:-94.29785
y:238.45923
Angle:111
Distance:256.42716017140293



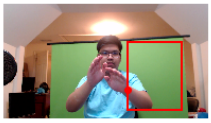
Frame 16.
x:-44.10913
y:-23.627075
Angle:-151
Distance:50.038526231838794



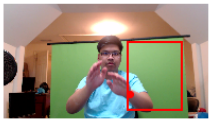
Frame 17.
x:-0.107543945
y:-64.79486
Angle:-90
Distance:64.7949500883741



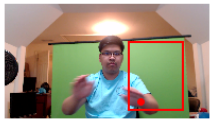
Frame 18.
x:17.69934
y:35.36017
Angle:63
Distance:39.54248574360504



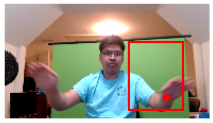
Frame 19.
x:91.30322
y:73.56232
Angle:38
Distance:117.25055622174337



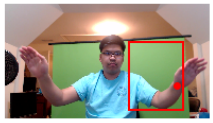
Frame 20.
x:241.34021
y:-44.1474
Angle:-10
Distance:245.34483867024156



Frame 21.
x:102.9646
y:-111.85864
Angle:-47
Distance:152.03310393509574



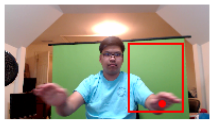
Frame 22.
x:-5.8476562
y:23.534302
Angle:103
Distance:24.2499163471947



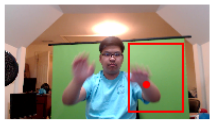
Frame 23.
x:-50.022705
y:106.01996
Angle:115
Distance:117.22842071292487

Frame 24.
x:-85.38281
y:26.412292
Angle:162
Distance:89.37468245808755

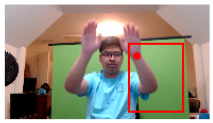
Frame 25.
x:-153.00854
y:-179.51996
Angle:-130
Distance:235.87927063976747



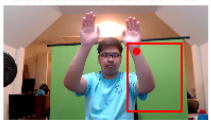
Frame 26.
x:-88.201416
y:-264.78894
Angle:-108
Distance:279.09258815138384



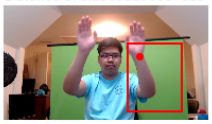
Frame 27.
x:8.707886
y:-53.060333
Angle:-80
Distance:53.770124036562486



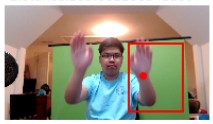
Frame 28.
x:29.404663
y:56.00244
Angle:62
Distance:63.2527284364711



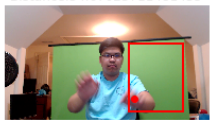
Frame 29.
x:26.531128
y:176.55765
Angle:81
Distance:178.53992190087885



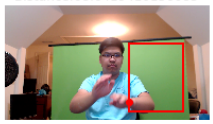
Frame 30.
x:-88.35022
y:217.82672
Angle:112
Distance:235.0622083422397



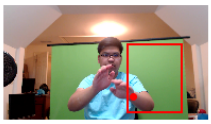
Frame 31.
x:-44.099487
y:32.312073
Angle:143
Distance:54.67023711481435



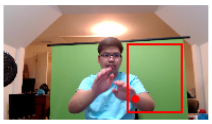
Frame 32.
x:47.099
y:-49.93396
Angle:-46
Distance:68.6419410156085



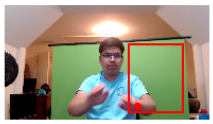
Frame 33.
x:17.618286
y:20.565552
Angle:49
Distance:27.080360510172646



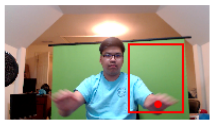
Frame 34.
x:8.843384
y:61.72052
Angle:81
Distance:62.350846251851394



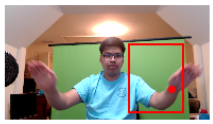
Frame 35.
x:191.3147
y:-14.648132
Angle:-4
Distance:191.87464962945356



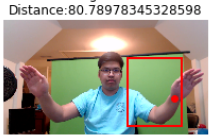
Frame 36.
x:135.43457
y:-138.28363
Angle:-45
Distance:193.55848021810047



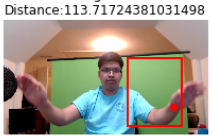
Frame 37.
x:38.171875
y:-50.05902
Angle:-52
Distance:62.9523440715513



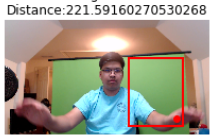
Frame 38.
x:-14.616333
y:79.456604
Angle:100
Distance:80.78978345328598



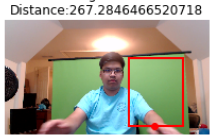
Frame 39.
x:20.563232
y:111.84259
Angle:79
Distance:113.71724381031498



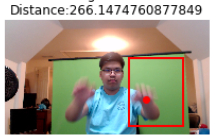
Frame 40.
x:-209.01892
y:73.57941
Angle:160
Distance:221.59160270530268



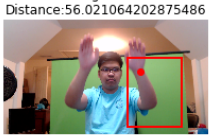
Frame 41.
x:-76.5354
y:-256.0926
Angle:-106
Distance:267.2846466520718



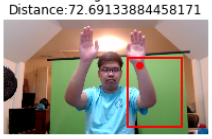
Frame 42.
x:-47.07898
y:-261.95047
Angle:-100
Distance:266.1474760877849



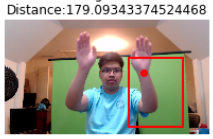
Frame 43.
x:-2.8763428
y:-55.947174
Angle:-92
Distance:56.021064202875486



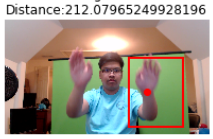
Frame 44.
x:26.484741
y:67.694824
Angle:68
Distance:72.69133884458171



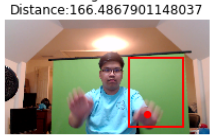
Frame 45.
x:29.472778
y:176.65167
Angle:80
Distance:179.09343374524468



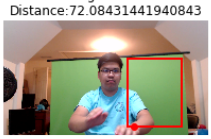
Frame 46.
x:8.77124
y:211.8982
Angle:87
Distance:212.07965249928196



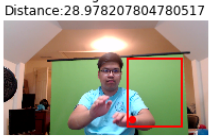
Frame 47.
x:-117.71582
y:117.732056
Angle:134
Distance:166.4867901148037



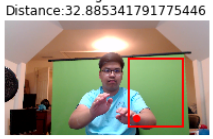
Frame 48.
x:-14.67688
y:-70.57434
Angle:-101
Distance:72.08431441940843



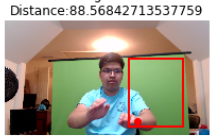
Frame 49.
x:26.437988
y:-11.864624
Angle:-24
Distance:28.978207804780517



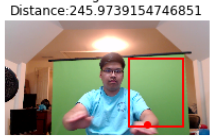
Frame 50.
x:14.739746
y:29.397034
Angle:63
Distance:32.885341791775446



Frame 51.
x:82.41931
y:32.42566
Angle:21
Distance:88.56842713537759



Frame 52.
x:229.56226
y:-88.34216
Angle:-21
Distance:245.9739154746851



Frame 53.
x:17.60376
y:-147.09003
Angle:-83
Distance:148.1396920417629

Frame 54.
x:-11.768677
y:-41.267273
Angle:-105
Distance:42.91258054807702

Frame 55.
x:-17.662842
y:61.82434
Angle:105
Distance:64.29794007748299

Frame 56.
x:-26.474243
y:111.86145
Angle:103
Distance:114.95159673057303

Frame 57.
x:38.294067
y:47.07019
Angle:50
Distance:60.67980243710776

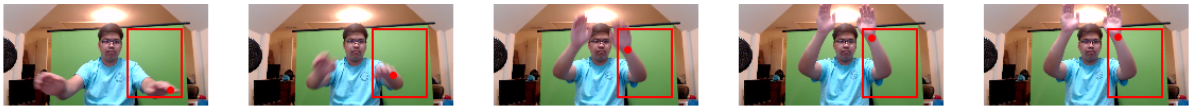
Frame 58.
x:-208.98267
y:-138.40063
Angle:-146
Distance:250.65611981064055

Frame 59.
x:-97.13428
y:-235.37659
Angle:-112
Distance:254.63150924896502

Frame 60.
x:-8.795288
y:-114.814514
Angle:-94
Distance:115.15089992851708

Frame 61.
x:5.8756104
y:-2.9552307
Angle:-26
Distance:6.576943482332841

Frame 62.
x:5.8339844
y:47.19565
Angle:82
Distance:47.554858659017064



Idea? Assume the points closest to the four corners are the end of the motion

In [143]:
```
top_left = np.array(xy_min)
top_right = np.array([xy_max[0], xy_min[1], 0])
bottom_left = np.array([xy_min[0], xy_max[1], 0])
bottom_right = np.array(xy_max)
print(top_left, top_right, bottom_left, bottom_right)
```

```
[1165  362    0] [1678  362    0] [1165 1004    0] [1678 1004    0]
```

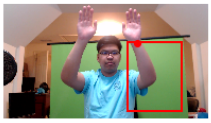
In [149]:
```
# Find the frames with the shortest distance to each corner.
# The first beat is close to the bottom_left...
diff_bl = np.add(np.array(left_wrist_points), bottom_left * -1)
```

In [158]:
```
dist_bl = np.array(diff_bl[:, 0] ** 2 + diff_bl[:, 1] ** 2) ** (1/2)
```

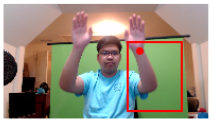
In [163]:
```
i1 = 13
i2 = 63
fig, plots = plt.subplots(math.ceil((i2 - i1) / 5), 5, figsize=(20, 38))
i = i1
for y in range(math.ceil((i2 - i1) / 5)):
    for x in range(5):
        plots[y][x].imshow(cv2.cvtColor(frames[i], cv2.COLOR_BGR2RGB))
        plots[y][x].plot(left_wrist_points[i][0], left_wrist_points[i][1], 'r
o')
        plots[y][x].axis("off")
        plots[y][x].set_title("Frame " + str(index[i]) + ".\nx:" + str(gradien
t_x[i]) + "\ny:" + str(gradient_y[i]) + "\nAngle:" + str(angles[i]) + "\nDista
nce:" + str(distances[i]) + "\nBL Dist:" + str(dist_bl[i]))
        rect = patches.Rectangle(xy_min[0:2], xy_max[0] - xy_min[0], xy_max[1]
- xy_min[1], linewidth=2, edgecolor='r', facecolor='none')
        plots[y][x].add_patch(rect)
        if i == i2:
            break
        else:
            i += 1
    if i == i2:
        break
    print("Finished row " + str(y))
plt.show()
```

```
Finished row 0
Finished row 1
Finished row 2
Finished row 3
Finished row 4
Finished row 5
Finished row 6
Finished row 7
Finished row 8
```

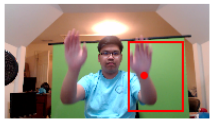
Frame 65.
x:23.452637
y:73.61252
Angle:72
Distance:77.25819711255409
BL Dist:644.7441712806014



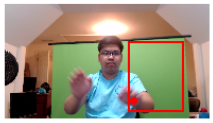
Frame 70.
x:26.626099
y:226.60602
Angle:83
Distance:228.1649327839769
BL Dist:576.064520165903



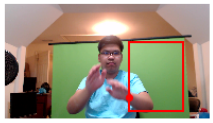
Frame 75.
x:-94.29785
y:238.45923
Angle:111
Distance:256.42716017140293
BL Dist:365.9178258150726



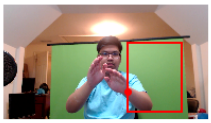
Frame 80.
x:-44.10913
y:-23.627075
Angle:-151
Distance:50.038526231838794
BL Dist:109.57989724586857



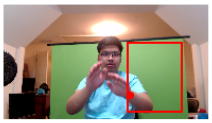
Frame 85.
x:-0.107543945
y:-64.79486
Angle:-90
Distance:64.7949500883741
BL Dist:123.47256028998822



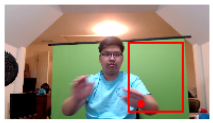
Frame 90.
x:17.69934
y:35.36017
Angle:63
Distance:39.54248574360504
BL Dist:188.26530846775657



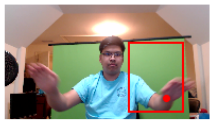
Frame 95.
x:91.30322
y:73.56232
Angle:38
Distance:117.25055622174337
BL Dist:154.03521874242747



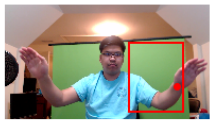
Frame 100.
x:241.34021
y:-44.1474
Angle:-10
Distance:245.34483867024156
BL Dist:135.58486342629757



Frame 105.
x:102.9646
y:-111.85864
Angle:-47
Distance:152.03310393509574
BL Dist:372.35999927892715



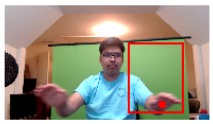
Frame 110.
x:-5.8476562
y:23.534302
Angle:103
Distance:24.2499163471947
BL Dist:511.5981816523319



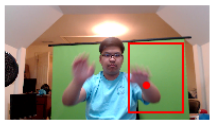
Frame 115.
x:-50.022705
y:106.01996
Angle:115
Distance:117.22842071292487
BL Dist:495.9140145816869

Frame 120.
x:-85.38281
y:26.412292
Angle:162
Distance:89.37468245808755
BL Dist:412.1890254346929

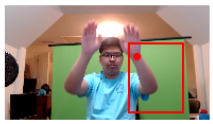
Frame 125.
x:-153.00854
y:-179.51996
Angle:-130
Distance:235.87927063976747
BL Dist:322.9076259720235



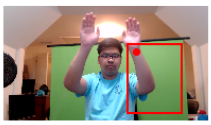
Frame 130.
x:-88.201416
y:-264.78894
Angle:-108
Distance:279.09258815138384
BL Dist:304.3451913023595



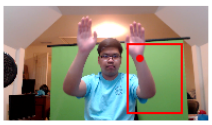
Frame 135.
x:8.707886
y:-53.060333
Angle:-80
Distance:53.770124036562486
BL Dist:528.5864366026293



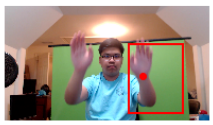
Frame 140.
x:29.404663
y:56.00244
Angle:62
Distance:63.2527284364711
BL Dist:582.339515888009



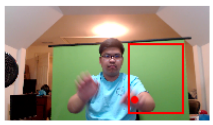
Frame 145.
x:26.531128
y:176.55765
Angle:81
Distance:178.53992190087885
BL Dist:532.2174793210063



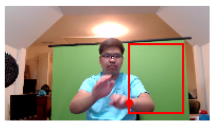
Frame 150.
x:-88.35022
y:217.82672
Angle:112
Distance:235.0622083422397
BL Dist:370.24305525686464



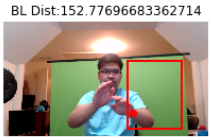
Frame 155.
x:-44.099487
y:32.312073
Angle:143
Distance:54.67023711481435
BL Dist:135.20111293530232



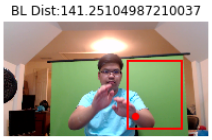
Frame 160.
x:47.099
y:-49.93396
Angle:-46
Distance:68.6419410156085
BL Dist:94.13458044788706



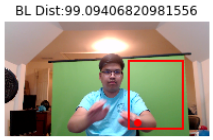
Frame 165.
x:17.618286
y:20.565552
Angle:49
Distance:27.080360510172646
BL Dist:152.77696683362714



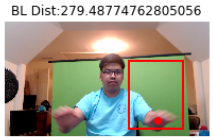
Frame 170.
x:8.843384
y:61.72052
Angle:81
Distance:62.350846251851394
BL Dist:141.25104987210037



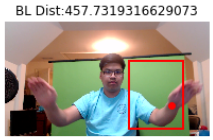
Frame 175.
x:191.3147
y:-14.648132
Angle:-4
Distance:191.87464962945356
BL Dist:99.09406820981556



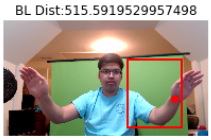
Frame 180.
x:135.43457
y:-138.28363
Angle:-45
Distance:193.55848021810047
BL Dist:279.48774762805056



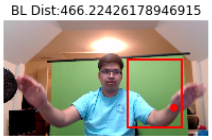
Frame 185.
x:38.171875
y:-50.05902
Angle:-52
Distance:62.9523440715513
BL Dist:457.7319316629073



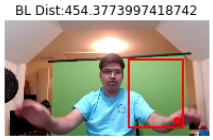
Frame 190.
x:-14.616333
y:79.456604
Angle:100
Distance:80.78978345328598
BL Dist:515.5919529957498



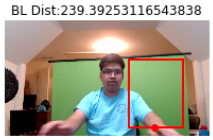
Frame 195.
x:20.563232
y:111.84259
Angle:79
Distance:113.71724381031498
BL Dist:466.22426178946915



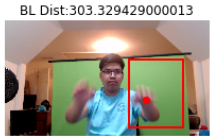
Frame 200.
x:-209.01892
y:73.57941
Angle:160
Distance:221.59160270530268
BL Dist:454.3773997418742



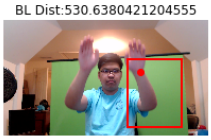
Frame 205.
x:-76.5354
y:-256.0926
Angle:-106
Distance:267.2846466520718
BL Dist:239.39253116543838



Frame 210.
x:-47.07898
y:-261.95047
Angle:-100
Distance:266.1474760877849
BL Dist:303.329429000013

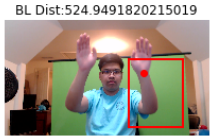


Frame 215.
x:-2.8763428
y:-55.947174
Angle:-92
Distance:56.021064202875486
BL Dist:530.6380421204555

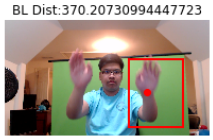


Frame 220.
x:26.484741
y:67.694824
Angle:68
Distance:72.69133884458171
BL Dist:584.8024690742967

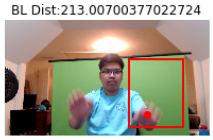
Frame 225.
x:29.472778
y:176.65167
Angle:80
Distance:179.09343374524468
BL Dist:524.9491820215019



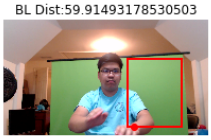
Frame 230.
x:8.77124
y:211.8982
Angle:87
Distance:212.07965249928196
BL Dist:370.20730994447723



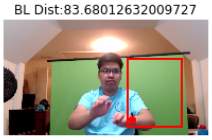
Frame 235.
x:-117.71582
y:117.732056
Angle:134
Distance:166.4867901148037
BL Dist:213.00700377022724



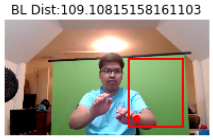
Frame 240.
x:-14.67688
y:-70.57434
Angle:-101
Distance:72.08431441940843
BL Dist:59.91493178530503



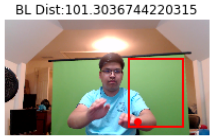
Frame 245.
x:26.437988
y:-11.864624
Angle:-24
Distance:28.978207804780517
BL Dist:83.68012632009727



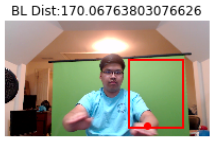
Frame 250.
x:14.739746
y:29.397034
Angle:63
Distance:32.885341791775446
BL Dist:109.10815158161103



Frame 255.
x:82.41931
y:32.42566
Angle:21
Distance:88.56842713537759
BL Dist:101.3036744220315



Frame 260.
x:229.56226
y:-88.34216
Angle:-21
Distance:245.9739154746851
BL Dist:170.06763803076626



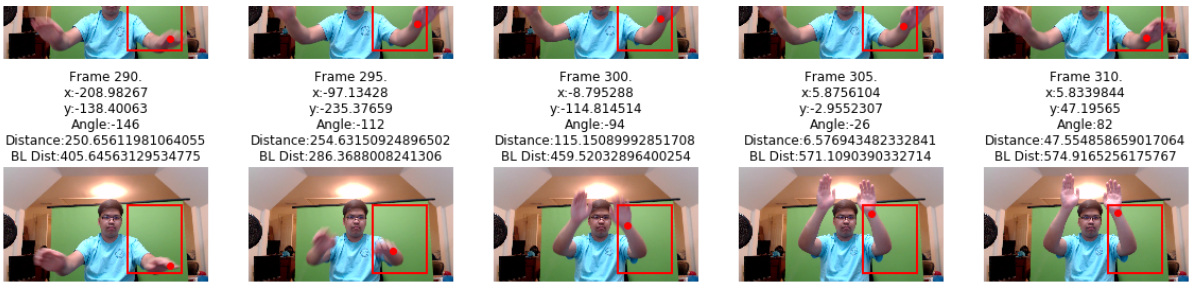
Frame 265.
x:17.60376
y:-147.09003
Angle:-83
Distance:148.1396920417629
BL Dist:412.9816354047052

Frame 270.
x:-11.768677
y:-41.267273
Angle:-105
Distance:42.91258054807702
BL Dist:488.39262099445057

Frame 275.
x:-17.662842
y:61.82434
Angle:105
Distance:64.29794007748299
BL Dist:501.69272260768383

Frame 280.
x:-26.474243
y:111.86145
Angle:103
Distance:114.95159673057303
BL Dist:452.55841254043867

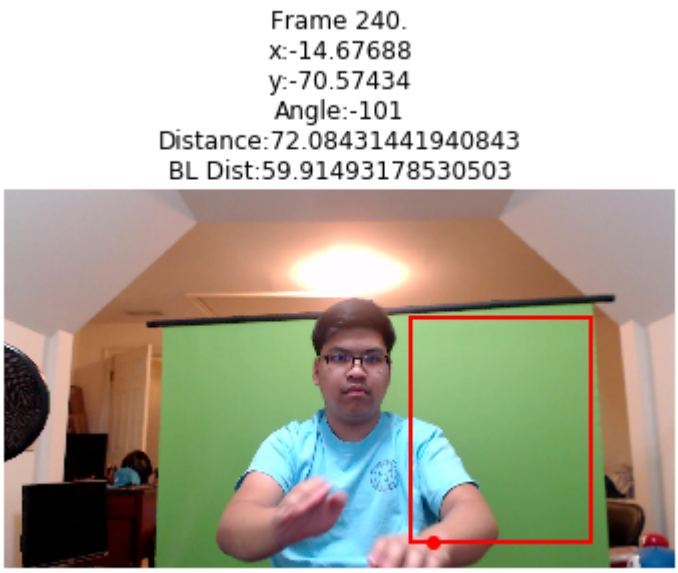
Frame 285.
x:38.294067
y:47.07019
Angle:50
Distance:60.67980243710776
BL Dist:380.66956232644077



In [170]:
```
# Index of frame with the minimum distance
np.where(dist_bl==np.amin(dist_bl))[0].item()
```

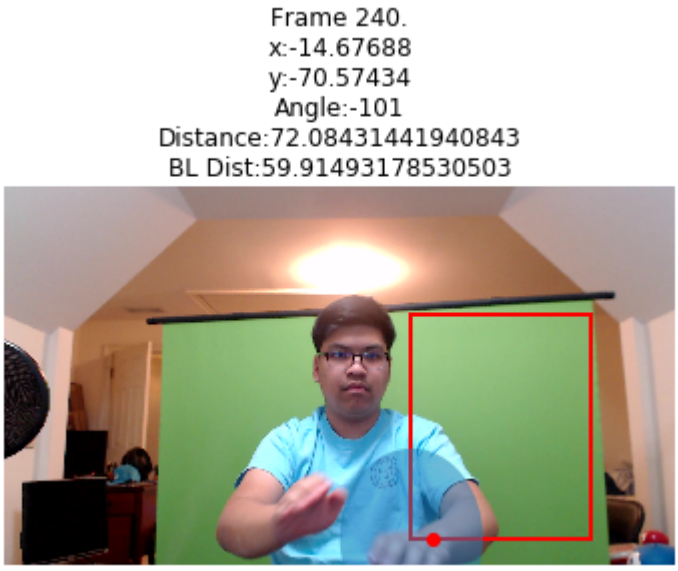
Out[170]: 48

In [185]:
```
i = 48
fig, plot = plt.subplots()
plot.imshow(cv2.cvtColor(frames[i], cv2.COLOR_BGR2RGB))
plot.plot(left_wrist_points[i][0], left_wrist_points[i][1], 'ro')
plot.axis("off")
plot.set_title("Frame " + str(index[i]) + ".\nx:" + str(gradient_x[i]) + "\n
y:" + str(gradient_y[i]) + "\nAngle:" + str(angles[i]) + "\nDistance:" + str(d
istances[i]) + "\nBL Dist:" + str(dist_bl[i]))
rect = patches.Rectangle(xy_min[0:2], xy_max[0] - xy_min[0], xy_max[1] - xy_mi
n[1], linewidth=2, edgecolor='r', facecolor='none')
plot.add_patch(rect)
plt.show()
```



In [175]:
```
# Dimensions of bounding box?
width, height = xy_max[0] - xy_min[0], xy_max[1] - xy_min[1]
```

In [195]:
```
i = 48
fig, plot = plt.subplots()
plot.imshow(cv2.cvtColor(frames[i], cv2.COLOR_BGR2RGB))
plot.plot(left_wrist_points[i][0], left_wrist_points[i][1], 'ro')
plot.axis("off")
plot.set_title("Frame " + str(index[i]) + ".\nx:" + str(gradient_x[i]) + "\n
y:" + str(gradient_y[i]) + "\nAngle:" + str(angles[i]) + "\nDistance:" + str(d
istances[i]) + "\nBL Dist:" + str(dist_bl[i]))
rect = patches.Rectangle(xy_min[0:2], xy_max[0] - xy_min[0], xy_max[1] - xy_mi
n[1], linewidth=2, edgecolor='r', facecolor='none')
plot.add_patch(rect)
ellipse = patches.Ellipse(bottom_left[0:2], width=width*0.8, height=height*0.8
, edgecolor='none', alpha=0.5)
plot.add_patch(ellipse)
plt.show()
```

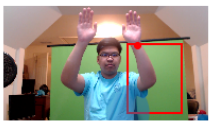


In [214]:
```
def nearCorner(coord, corner: str, xy_min, xy_max, threshold=0.8):
    width, height = xy_max[0] - xy_min[0], xy_max[1] - xy_min[1]
    top_left = np.array(xy_min)
    top_right = np.array([xy_max[0], xy_min[1], 0])
    bottom_left = np.array([xy_min[0], xy_max[1], 0])
    bottom_right = np.array(xy_max)
    corner_coord = None
    if corner == "bl": corner_coord = bottom_left
    elif corner == "br": corner_coord = bottom_right
    elif corner == "tl": corner_coord = top_left
    elif corner == "tr": corner_coord = top_right

    a = (width * threshold) / 2
    b = (height * threshold) / 2
    x = coord[0]
    y = coord[1]
    h = corner_coord[0] # centerpoint
    k = corner_coord[1]
    inside = ((x - h) ** 2) / (a ** 2) + ((y - k) ** 2) / (b ** 2) < 1
    return inside
```

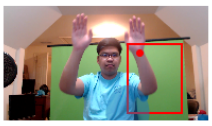
In [222]:
```
# Just a helper function
def plotRegionDetection(i1, i2, corner_code, corner_point, corner_threshold):
    fig, plots = plt.subplots(math.ceil((i2 - i1) / 5), 5, figsize=(20, 38))
    i = i1
    for y in range(math.ceil((i2 - i1) / 5)):
        for x in range(5):
            plots[y][x].imshow(cv2.cvtColor(frames[i], cv2.COLOR_BGR2RGB))
            plots[y][x].plot(left_wrist_points[i][0], left_wrist_points[i][1],
'ro')
            plots[y][x].axis("off")
            inside = nearCorner(left_wrist_points[i][0:2], corner_code, xy_min
, xy_max, corner_threshold)
            plots[y][x].set_title("Frame " + str(index[i]) + ".\nx:" + str(gra
dient_x[i]) + "\ny:" + str(gradient_y[i]) + "\nAngle:" + str(angles[i]) + "\nD
istance:" + str(distances[i]) + "\nInside BL:" + str(inside))
            rect = patches.Rectangle(xy_min[0:2], xy_max[0] - xy_min[0], xy_ma
x[1] - xy_min[1], linewidth=2, edgecolor='r', facecolor='none')
            plots[y][x].add_patch(rect)
            ellipse = patches.Ellipse(corner_point[0:2], width=width*0.8, heig
ht=height*0.8, edgecolor='none', alpha=0.5)
            plots[y][x].add_patch(ellipse)
            if i == i2:
                break
            else:
                i += 1
        if i == i2:
            break
    plt.show()
```

In [223]:
```
plotRegionDetection(13, 63, "bl", bottom_left, 0.9)
```

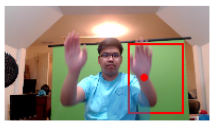
Frame 65.
x:23.452637
y:73.61252
Angle:72
Distance:77.25819711255409
Inside BL:False



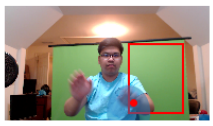
Frame 70.
x:26.626099
y:226.60602
Angle:83
Distance:228.1649327839769
Inside BL:False



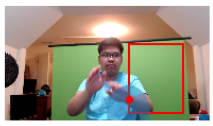
Frame 75.
x:-94.29785
y:238.45923
Angle:111
Distance:256.42716017140293
Inside BL:False



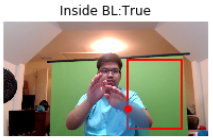
Frame 80.
x:-44.10913
y:-23.627075
Angle:-151
Distance:50.038526231838794
Inside BL:True



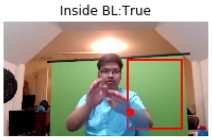
Frame 85.
x:-0.107543945
y:-64.79486
Angle:-90
Distance:64.7949500883741
Inside BL:True



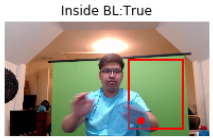
Frame 90.
x:17.69934
y:35.36017
Angle:63
Distance:39.54248574360504
Inside BL:True



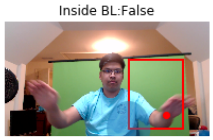
Frame 95.
x:91.30322
y:73.56232
Angle:38
Distance:117.25055622174337
Inside BL:True



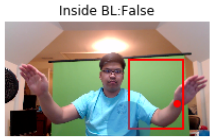
Frame 100.
x:241.34021
y:-44.1474
Angle:-10
Distance:245.34483867024156
Inside BL:True



Frame 105.
x:102.9646
y:-111.85864
Angle:-47
Distance:152.03310393509574
Inside BL:False



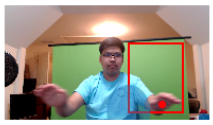
Frame 110.
x:-5.8476562
y:23.534302
Angle:103
Distance:24.2499163471947
Inside BL:False



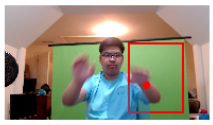
Frame 115.
x:-50.022705
y:106.01996
Angle:115
Distance:117.22842071292487
Inside BL:False

Frame 120.
x:-85.38281
y:26.412292
Angle:162
Distance:89.37468245808755
Inside BL:False

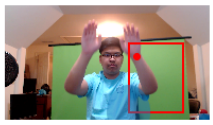
Frame 125.
x:-153.00854
y:-179.51996
Angle:-130
Distance:235.87927063976747
Inside BL:False



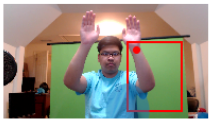
Frame 130.
x:-88.201416
y:-264.78894
Angle:-108
Distance:279.09258815138384
Inside BL:False



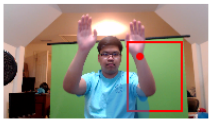
Frame 135.
x:8.707886
y:-53.060333
Angle:-80
Distance:53.770124036562486
Inside BL:False



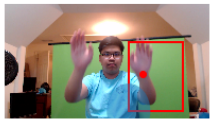
Frame 140.
x:29.404663
y:56.00244
Angle:62
Distance:63.2527284364711
Inside BL:False



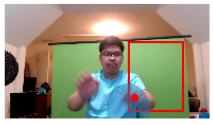
Frame 145.
x:26.531128
y:176.55765
Angle:81
Distance:178.53992190087885
Inside BL:False



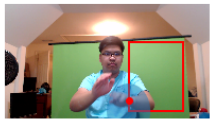
Frame 150.
x:-88.35022
y:217.82672
Angle:112
Distance:235.0622083422397
Inside BL:False



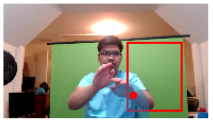
Frame 155.
x:-44.099487
y:32.312073
Angle:143
Distance:54.67023711481435
Inside BL:True



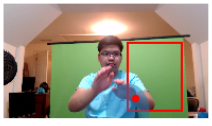
Frame 160.
x:47.099
y:-49.93396
Angle:-46
Distance:68.6419410156085
Inside BL:True



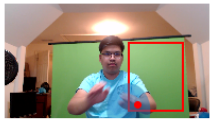
Frame 165.
x:17.618286
y:20.565552
Angle:49
Distance:27.080360510172646
Inside BL:True



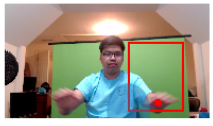
Frame 170.
x:8.843384
y:61.72052
Angle:81
Distance:62.350846251851394
Inside BL:True



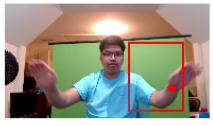
Frame 175.
x:191.3147
y:-14.648132
Angle:-4
Distance:191.87464962945356
Inside BL:True



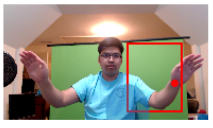
Frame 180.
x:135.43457
y:-138.28363
Angle:-45
Distance:193.55848021810047
Inside BL:False



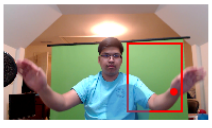
Frame 185.
x:38.171875
y:-50.05902
Angle:-52
Distance:62.9523440715513
Inside BL:False



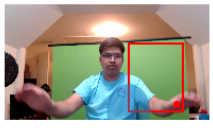
Frame 190.
x:-14.616333
y:79.456604
Angle:100
Distance:80.78978345328598
Inside BL:False



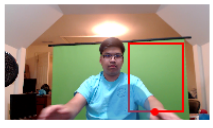
Frame 195.
x:20.563232
y:111.84259
Angle:79
Distance:113.71724381031498
Inside BL:False



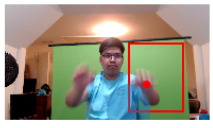
Frame 200.
x:-209.01892
y:73.57941
Angle:160
Distance:221.59160270530268
Inside BL:False



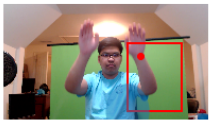
Frame 205.
x:-76.5354
y:-256.0926
Angle:-106
Distance:267.2846466520718
Inside BL:False



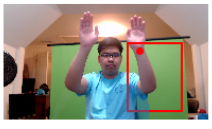
Frame 210.
x:-47.07898
y:-261.95047
Angle:-100
Distance:266.1474760877849
Inside BL:False



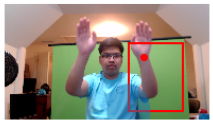
Frame 215.
x:-2.8763428
y:-55.947174
Angle:-92
Distance:56.021064202875486
Inside BL:False



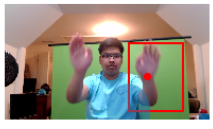
Frame 220.
x:26.484741
y:67.694824
Angle:68
Distance:72.69133884458171
Inside BL:False



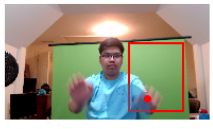
Frame 225.
x:29.472778
y:176.65167
Angle:80
Distance:179.09343374524468
Inside BL:False



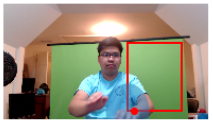
Frame 230.
x:8.77124
y:211.8982
Angle:87
Distance:212.07965249928196
Inside BL:False



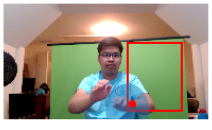
Frame 235.
x:-117.71582
y:117.732056
Angle:134
Distance:166.4867901148037
Inside BL:True



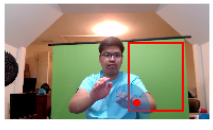
Frame 240.
x:-14.67688
y:-70.57434
Angle:-101
Distance:72.08431441940843
Inside BL:True



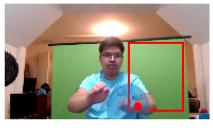
Frame 245.
x:26.437988
y:-11.864624
Angle:-24
Distance:28.978207804780517
Inside BL:True



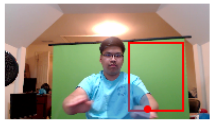
Frame 250.
x:14.739746
y:29.397034
Angle:63
Distance:32.885341791775446
Inside BL:True



Frame 255.
x:82.41931
y:32.42566
Angle:21
Distance:88.56842713537759
Inside BL:True



Frame 260.
x:229.56226
y:-88.34216
Angle:-21
Distance:245.9739154746851
Inside BL:True



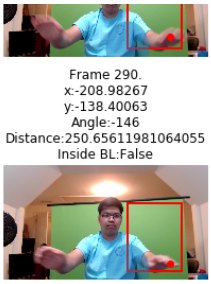
Frame 265.
x:17.60376
y:-147.09003
Angle:-83
Distance:148.1396920417629
Inside BL:False

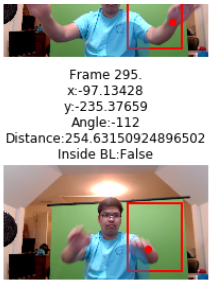
Frame 270.
x:-11.768677
y:-41.267273
Angle:-105
Distance:42.91258054807702
Inside BL:False

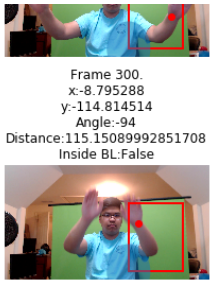
Frame 275.
x:-17.662842
y:61.82434
Angle:105
Distance:64.29794007748299
Inside BL:False

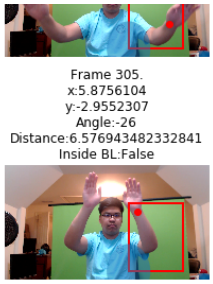
Frame 280.
x:-26.474243
y:111.86145
Angle:103
Distance:114.95159673057303
Inside BL:False

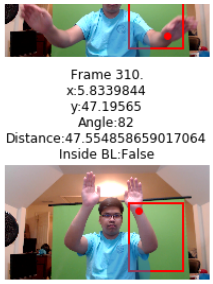
Frame 285.
x:38.294067
y:47.07019
Angle:50
Distance:60.67980243710776
Inside BL:False


Frame 290.
x:-208.98267
y:-138.40063
Angle:-146
Distance:250.65611981064055
Inside BL:False


Frame 295.
x:-97.13428
y:-235.37659
Angle:-112
Distance:254.63150924896502
Inside BL:False

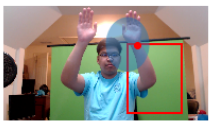

Frame 300.
x:-8.795288
y:-114.814514
Angle:-94
Distance:115.15089992851708
Inside BL:False


Frame 305.
x:5.8756104
y:-2.9552307
Angle:-26
Distance:6.576943482332841
Inside BL:False

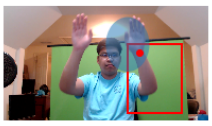

Frame 310.
x:5.8339844
y:47.19565
Angle:82
Distance:47.554858659017064
Inside BL:False

In [224]:
```
plotRegionDetection(13, 63, "tl", top_left, 0.9)
```

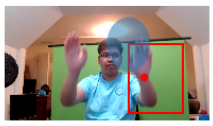
Frame 65.
x:23.452637
y:73.61252
Angle:72
Distance:77.25819711255409
Inside BL:True



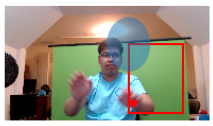
Frame 70.
x:26.626099
y:226.60602
Angle:83
Distance:228.1649327839769
Inside BL:True



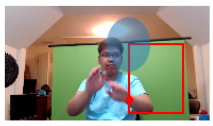
Frame 75.
x:-94.29785
y:238.45923
Angle:111
Distance:256.42716017140293
Inside BL:False



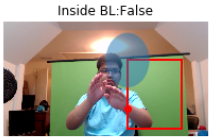
Frame 80.
x:-44.10913
y:-23.627075
Angle:-151
Distance:50.038526231838794
Inside BL:False



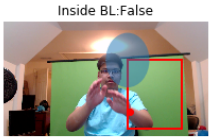
Frame 85.
x:-0.107543945
y:-64.79486
Angle:-90
Distance:64.7949500883741
Inside BL:False



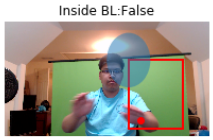
Frame 90.
x:17.69934
y:35.36017
Angle:63
Distance:39.54248574360504
Inside BL:False



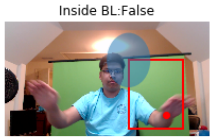
Frame 95.
x:91.30322
y:73.56232
Angle:38
Distance:117.25055622174337
Inside BL:False



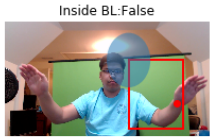
Frame 100.
x:241.34021
y:-44.1474
Angle:-10
Distance:245.34483867024156
Inside BL:False



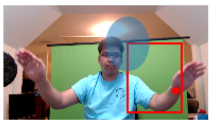
Frame 105.
x:102.9646
y:-111.85864
Angle:-47
Distance:152.03310393509574
Inside BL:False



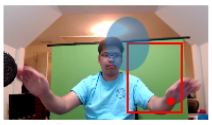
Frame 110.
x:-5.8476562
y:23.534302
Angle:103
Distance:24.2499163471947
Inside BL:False



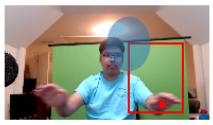
Frame 115.
x:-50.022705
y:106.01996
Angle:115
Distance:117.22842071292487
Inside BL:False



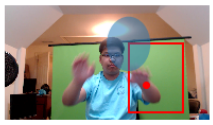
Frame 120.
x:-85.38281
y:26.412292
Angle:162
Distance:89.37468245808755
Inside BL:False



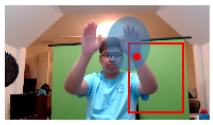
Frame 125.
x:-153.00854
y:-179.51996
Angle:-130
Distance:235.87927063976747
Inside BL:False



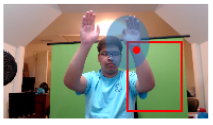
Frame 130.
x:-88.201416
y:-264.78894
Angle:-108
Distance:279.09258815138384
Inside BL:False



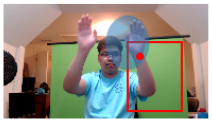
Frame 135.
x:8.707886
y:-53.060333
Angle:-80
Distance:53.770124036562486
Inside BL:True



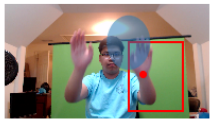
Frame 140.
x:29.404663
y:56.00244
Angle:62
Distance:63.2527284364711
Inside BL:True



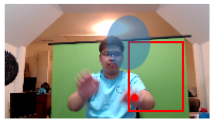
Frame 145.
x:26.531128
y:176.55765
Angle:81
Distance:178.53992190087885
Inside BL:True



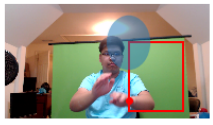
Frame 150.
x:-88.35022
y:217.82672
Angle:112
Distance:235.0622083422397
Inside BL:False



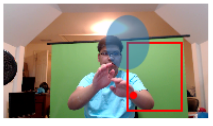
Frame 155.
x:-44.099487
y:32.312073
Angle:143
Distance:54.67023711481435
Inside BL:False



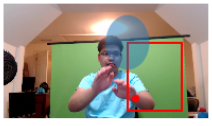
Frame 160.
x:47.099
y:-49.93396
Angle:-46
Distance:68.6419410156085
Inside BL:False



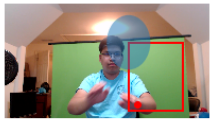
Frame 165.
x:17.618286
y:20.565552
Angle:49
Distance:27.080360510172646
Inside BL:False



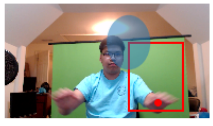
Frame 170.
x:8.843384
y:61.72052
Angle:81
Distance:62.350846251851394
Inside BL:False



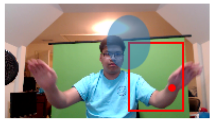
Frame 175.
x:191.3147
y:-14.648132
Angle:-4
Distance:191.87464962945356
Inside BL:False



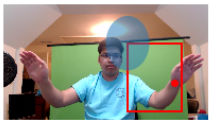
Frame 180.
x:135.43457
y:-138.28363
Angle:-45
Distance:193.55848021810047
Inside BL:False



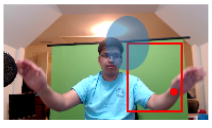
Frame 185.
x:38.171875
y:-50.05902
Angle:-52
Distance:62.9523440715513
Inside BL:False



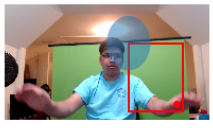
Frame 190.
x:-14.616333
y:79.456604
Angle:100
Distance:80.78978345328598
Inside BL:False



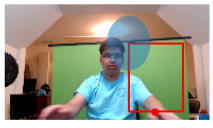
Frame 195.
x:20.563232
y:111.84259
Angle:79
Distance:113.71724381031498
Inside BL:False



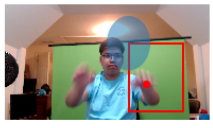
Frame 200.
x:-209.01892
y:73.57941
Angle:160
Distance:221.59160270530268
Inside BL:False



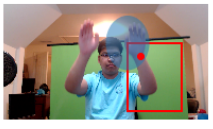
Frame 205.
x:-76.5354
y:-256.0926
Angle:-106
Distance:267.2846466520718
Inside BL:False



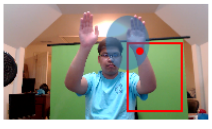
Frame 210.
x:-47.07898
y:-261.95047
Angle:-100
Distance:266.1474760877849
Inside BL:False



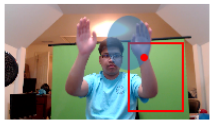
Frame 215.
x:-2.8763428
y:-55.947174
Angle:-92
Distance:56.021064202875486
Inside BL:True



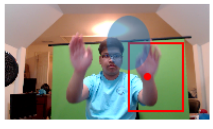
Frame 220.
x:26.484741
y:67.694824
Angle:68
Distance:72.69133884458171
Inside BL:True



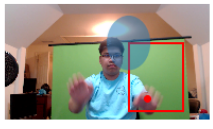
Frame 225.
x:29.472778
y:176.65167
Angle:80
Distance:179.09343374524468
Inside BL:True



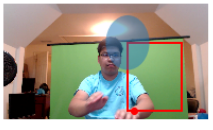
Frame 230.
x:8.77124
y:211.8982
Angle:87
Distance:212.07965249928196
Inside BL:False



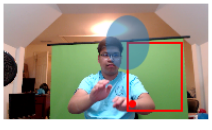
Frame 235.
x:-117.71582
y:117.732056
Angle:134
Distance:166.4867901148037
Inside BL:False



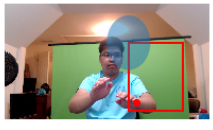
Frame 240.
x:-14.67688
y:-70.57434
Angle:-101
Distance:72.08431441940843
Inside BL:False



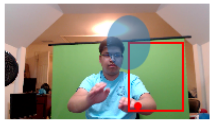
Frame 245.
x:26.437988
y:-11.864624
Angle:-24
Distance:28.978207804780517
Inside BL:False



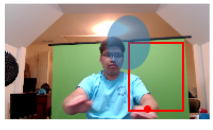
Frame 250.
x:14.739746
y:29.397034
Angle:63
Distance:32.885341791775446
Inside BL:False



Frame 255.
x:82.41931
y:32.42566
Angle:21
Distance:88.56842713537759
Inside BL:False



Frame 260.
x:229.56226
y:-88.34216
Angle:-21
Distance:245.9739154746851
Inside BL:False



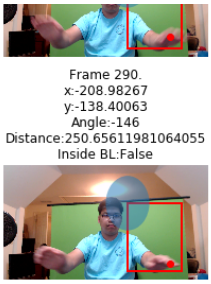
Frame 265.
x:17.60376
y:-147.09003
Angle:-83
Distance:148.1396920417629
Inside BL:False

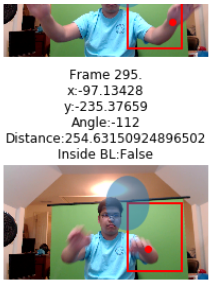
Frame 270.
x:-11.768677
y:-41.267273
Angle:-105
Distance:42.91258054807702
Inside BL:False

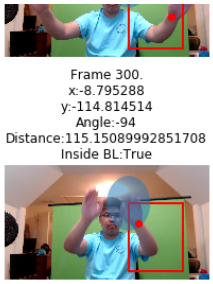
Frame 275.
x:-17.662842
y:61.82434
Angle:105
Distance:64.29794007748299
Inside BL:False

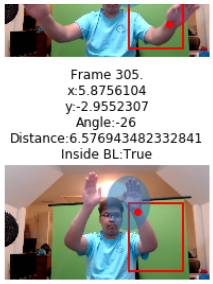
Frame 280.
x:-26.474243
y:111.86145
Angle:103
Distance:114.95159673057303
Inside BL:False

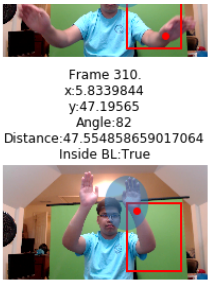
Frame 285.
x:38.294067
y:47.07019
Angle:50
Distance:60.67980243710776
Inside BL:False


Frame 290.
x:-208.98267
y:-138.40063
Angle:-146
Distance:250.65611981064055
Inside BL:False


Frame 295.
x:-97.13428
y:-235.37659
Angle:-112
Distance:254.63150924896502
Inside BL:False

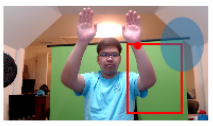

Frame 300.
x:-8.795288
y:-114.814514
Angle:-94
Distance:115.15089992851708
Inside BL:True


Frame 305.
x:5.8756104
y:-2.9552307
Angle:-26
Distance:6.576943482332841
Inside BL:True

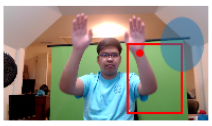

Frame 310.
x:5.8339844
y:47.19565
Angle:82
Distance:47.554858659017064
Inside BL:True

In [225]:
```
plotRegionDetection(13, 63, "tr", top_right, 0.9)
```

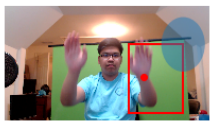
Frame 65.
x:23.452637
y:73.61252
Angle:72
Distance:77.25819711255409
Inside BL:False



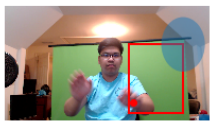
Frame 70.
x:26.626099
y:226.60602
Angle:83
Distance:228.1649327839769
Inside BL:False



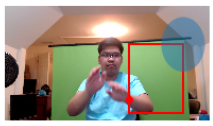
Frame 75.
x:-94.29785
y:238.45923
Angle:111
Distance:256.42716017140293
Inside BL:False



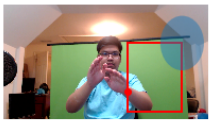
Frame 80.
x:-44.10913
y:-23.627075
Angle:-151
Distance:50.038526231838794
Inside BL:False



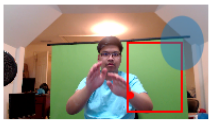
Frame 85.
x:-0.107543945
y:-64.79486
Angle:-90
Distance:64.7949500883741
Inside BL:False



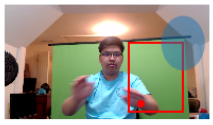
Frame 90.
x:17.69934
y:35.36017
Angle:63
Distance:39.54248574360504
Inside BL:False



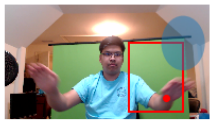
Frame 95.
x:91.30322
y:73.56232
Angle:38
Distance:117.25055622174337
Inside BL:False



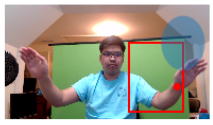
Frame 100.
x:241.34021
y:-44.1474
Angle:-10
Distance:245.34483867024156
Inside BL:False



Frame 105.
x:102.9646
y:-111.85864
Angle:-47
Distance:152.03310393509574
Inside BL:False



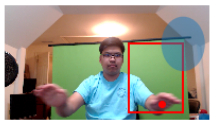
Frame 110.
x:-5.8476562
y:23.534302
Angle:103
Distance:24.2499163471947
Inside BL:False



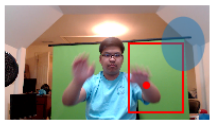
Frame 115.
x:-50.022705
y:106.01996
Angle:115
Distance:117.22842071292487
Inside BL:False

Frame 120.
x:-85.38281
y:26.412292
Angle:162
Distance:89.37468245808755
Inside BL:False

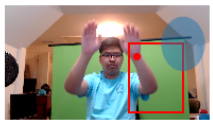
Frame 125.
x:-153.00854
y:-179.51996
Angle:-130
Distance:235.87927063976747
Inside BL:False



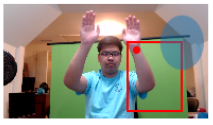
Frame 130.
x:-88.201416
y:-264.78894
Angle:-108
Distance:279.09258815138384
Inside BL:False



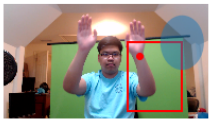
Frame 135.
x:8.707886
y:-53.060333
Angle:-80
Distance:53.770124036562486
Inside BL:False



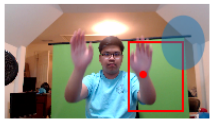
Frame 140.
x:29.404663
y:56.00244
Angle:62
Distance:63.2527284364711
Inside BL:False



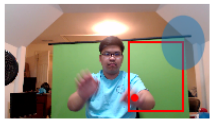
Frame 145.
x:26.531128
y:176.55765
Angle:81
Distance:178.53992190087885
Inside BL:False



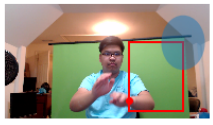
Frame 150.
x:-88.35022
y:217.82672
Angle:112
Distance:235.0622083422397
Inside BL:False



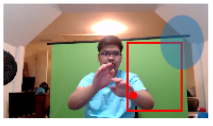
Frame 155.
x:-44.099487
y:32.312073
Angle:143
Distance:54.67023711481435
Inside BL:False



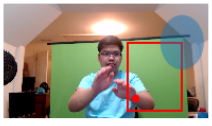
Frame 160.
x:47.099
y:-49.93396
Angle:-46
Distance:68.6419410156085
Inside BL:False



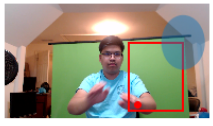
Frame 165.
x:17.618286
y:20.565552
Angle:49
Distance:27.080360510172646
Inside BL:False



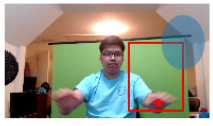
Frame 170.
x:8.843384
y:61.72052
Angle:81
Distance:62.350846251851394
Inside BL:False



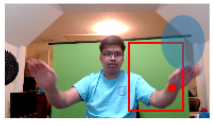
Frame 175.
x:191.3147
y:-14.648132
Angle:-4
Distance:191.87464962945356
Inside BL:False



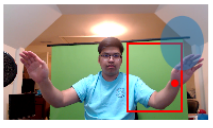
Frame 180.
x:135.43457
y:-138.28363
Angle:-45
Distance:193.55848021810047
Inside BL:False



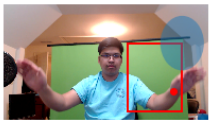
Frame 185.
x:38.171875
y:-50.05902
Angle:-52
Distance:62.9523440715513
Inside BL:False



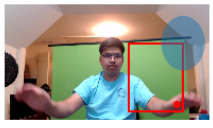
Frame 190.
x:-14.616333
y:79.456604
Angle:100
Distance:80.78978345328598
Inside BL:False



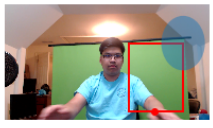
Frame 195.
x:20.563232
y:111.84259
Angle:79
Distance:113.71724381031498
Inside BL:False



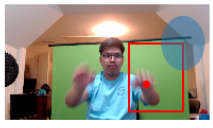
Frame 200.
x:-209.01892
y:73.57941
Angle:160
Distance:221.59160270530268
Inside BL:False



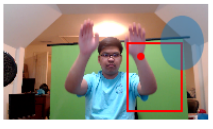
Frame 205.
x:-76.5354
y:-256.0926
Angle:-106
Distance:267.2846466520718
Inside BL:False



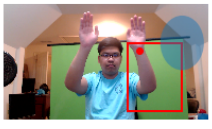
Frame 210.
x:-47.07898
y:-261.95047
Angle:-100
Distance:266.1474760877849
Inside BL:False



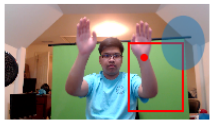
Frame 215.
x:-2.8763428
y:-55.947174
Angle:-92
Distance:56.021064202875486
Inside BL:False



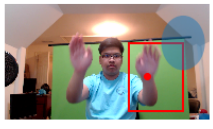
Frame 220.
x:26.484741
y:67.694824
Angle:68
Distance:72.69133884458171
Inside BL:False



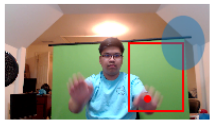
Frame 225.
x:29.472778
y:176.65167
Angle:80
Distance:179.09343374524468
Inside BL:False



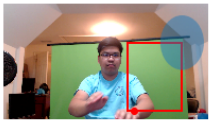
Frame 230.
x:8.77124
y:211.8982
Angle:87
Distance:212.07965249928196
Inside BL:False



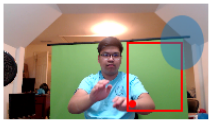
Frame 235.
x:-117.71582
y:117.732056
Angle:134
Distance:166.4867901148037
Inside BL:False



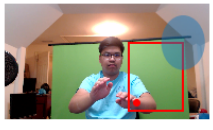
Frame 240.
x:-14.67688
y:-70.57434
Angle:-101
Distance:72.08431441940843
Inside BL:False



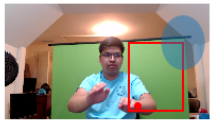
Frame 245.
x:26.437988
y:-11.864624
Angle:-24
Distance:28.978207804780517
Inside BL:False



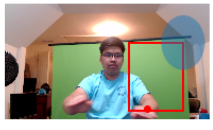
Frame 250.
x:14.739746
y:29.397034
Angle:63
Distance:32.885341791775446
Inside BL:False



Frame 255.
x:82.41931
y:32.42566
Angle:21
Distance:88.56842713537759
Inside BL:False



Frame 260.
x:229.56226
y:-88.34216
Angle:-21
Distance:245.9739154746851
Inside BL:False



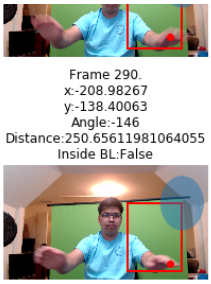
Frame 265.
x:17.60376
y:-147.09003
Angle:-83
Distance:148.1396920417629
Inside BL:False

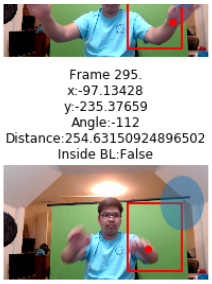
Frame 270.
x:-11.768677
y:-41.267273
Angle:-105
Distance:42.91258054807702
Inside BL:False

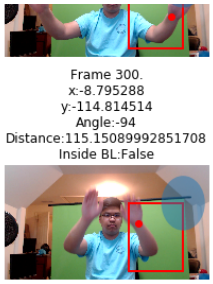
Frame 275.
x:-17.662842
y:61.82434
Angle:105
Distance:64.29794007748299
Inside BL:False

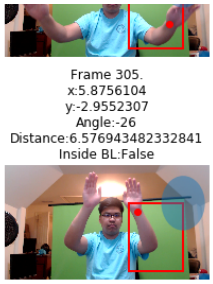
Frame 280.
x:-26.474243
y:111.86145
Angle:103
Distance:114.95159673057303
Inside BL:False

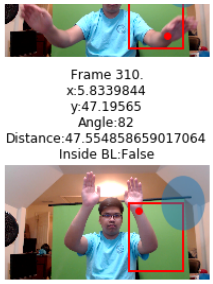
Frame 285.
x:38.294067
y:47.07019
Angle:50
Distance:60.67980243710776
Inside BL:False


Frame 290.
x:-208.98267
y:-138.40063
Angle:-146
Distance:250.65611981064055
Inside BL:False


Frame 295.
x:-97.13428
y:-235.37659
Angle:-112
Distance:254.63150924896502
Inside BL:False

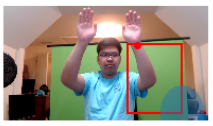

Frame 300.
x:-8.795288
y:-114.814514
Angle:-94
Distance:115.15089992851708
Inside BL:False


Frame 305.
x:5.8756104
y:-2.9552307
Angle:-26
Distance:6.576943482332841
Inside BL:False

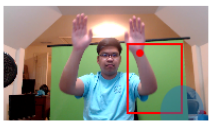

Frame 310.
x:5.8339844
y:47.19565
Angle:82
Distance:47.554858659017064
Inside BL:False

In [226]:
```
plotRegionDetection(13, 63, "br", bottom_right, 0.9)
```

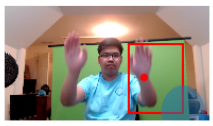
Frame 65.
x:23.452637
y:73.61252
Angle:72
Distance:77.25819711255409
Inside BL:False



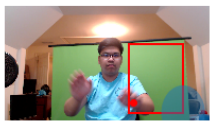
Frame 70.
x:26.626099
y:226.60602
Angle:83
Distance:228.1649327839769
Inside BL:False



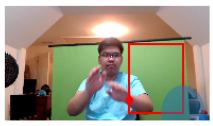
Frame 75.
x:-94.29785
y:238.45923
Angle:111
Distance:256.42716017140293
Inside BL:False



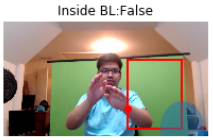
Frame 80.
x:-44.10913
y:-23.627075
Angle:-151
Distance:50.038526231838794
Inside BL:False



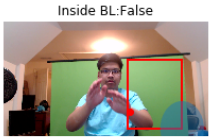
Frame 85.
x:-0.107543945
y:-64.79486
Angle:-90
Distance:64.7949500883741
Inside BL:False



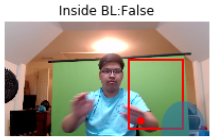
Frame 90.
x:17.69934
y:35.36017
Angle:63
Distance:39.54248574360504
Inside BL:False



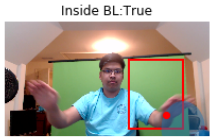
Frame 95.
x:91.30322
y:73.56232
Angle:38
Distance:117.25055622174337
Inside BL:False



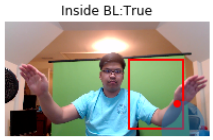
Frame 100.
x:241.34021
y:-44.1474
Angle:-10
Distance:245.34483867024156
Inside BL:False



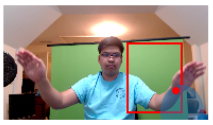
Frame 105.
x:102.9646
y:-111.85864
Angle:-47
Distance:152.03310393509574
Inside BL:True



Frame 110.
x:-5.8476562
y:23.534302
Angle:103
Distance:24.2499163471947
Inside BL:True

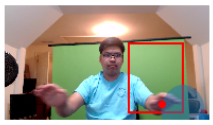


Frame 115.
x:-50.022705
y:106.01996
Angle:115
Distance:117.22842071292487
Inside BL:True

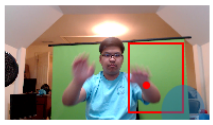


Frame 120.
x:-85.38281
y:26.412292
Angle:162
Distance:89.37468245808755
Inside BL:True

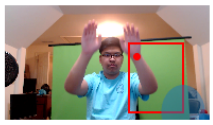
Frame 125.
x:-153.00854
y:-179.51996
Angle:-130
Distance:235.87927063976747
Inside BL:True



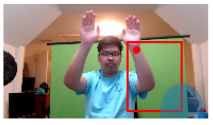
Frame 130.
x:-88.201416
y:-264.78894
Angle:-108
Distance:279.09258815138384
Inside BL:False



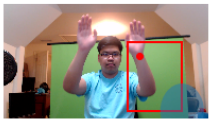
Frame 135.
x:8.707886
y:-53.060333
Angle:-80
Distance:53.770124036562486
Inside BL:False



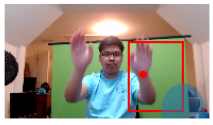
Frame 140.
x:29.404663
y:56.00244
Angle:62
Distance:63.2527284364711
Inside BL:False



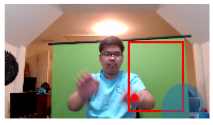
Frame 145.
x:26.531128
y:176.55765
Angle:81
Distance:178.53992190087885
Inside BL:False



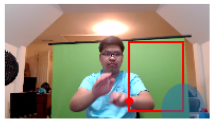
Frame 150.
x:-88.35022
y:217.82672
Angle:112
Distance:235.0622083422397
Inside BL:False



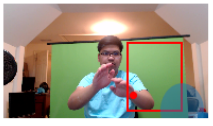
Frame 155.
x:-44.099487
y:32.312073
Angle:143
Distance:54.67023711481435
Inside BL:False



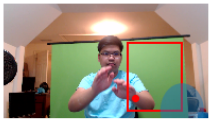
Frame 160.
x:47.099
y:-49.93396
Angle:-46
Distance:68.6419410156085
Inside BL:False



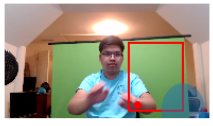
Frame 165.
x:17.618286
y:20.565552
Angle:49
Distance:27.080360510172646
Inside BL:False



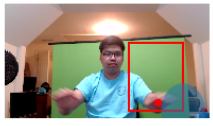
Frame 170.
x:8.843384
y:61.72052
Angle:81
Distance:62.350846251851394
Inside BL:False



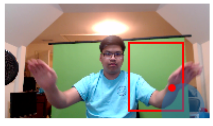
Frame 175.
x:191.3147
y:-14.648132
Angle:-4
Distance:191.87464962945356
Inside BL:False



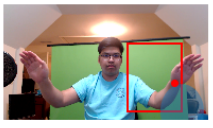
Frame 180.
x:135.43457
y:-138.28363
Angle:-45
Distance:193.55848021810047
Inside BL:False



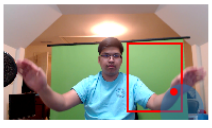
Frame 185.
x:38.171875
y:-50.05902
Angle:-52
Distance:62.9523440715513
Inside BL:True



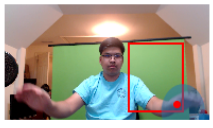
Frame 190.
x:-14.616333
y:79.456604
Angle:100
Distance:80.78978345328598
Inside BL:True



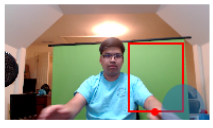
Frame 195.
x:20.563232
y:111.84259
Angle:79
Distance:113.71724381031498
Inside BL:True



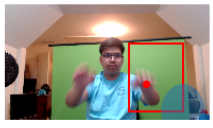
Frame 200.
x:-209.01892
y:73.57941
Angle:160
Distance:221.59160270530268
Inside BL:True



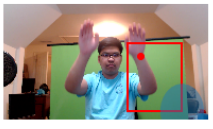
Frame 205.
x:-76.5354
y:-256.0926
Angle:-106
Distance:267.2846466520718
Inside BL:False



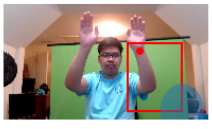
Frame 210.
x:-47.07898
y:-261.95047
Angle:-100
Distance:266.1474760877849
Inside BL:False



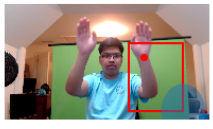
Frame 215.
x:-2.8763428
y:-55.947174
Angle:-92
Distance:56.021064202875486
Inside BL:False



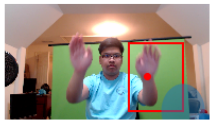
Frame 220.
x:26.484741
y:67.694824
Angle:68
Distance:72.69133884458171
Inside BL:False



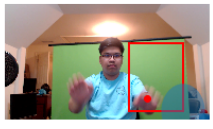
Frame 225.
x:29.472778
y:176.65167
Angle:80
Distance:179.09343374524468
Inside BL:False



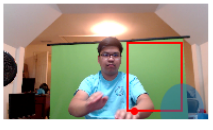
Frame 230.
x:8.77124
y:211.8982
Angle:87
Distance:212.07965249928196
Inside BL:False



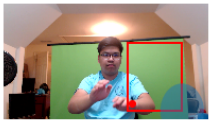
Frame 235.
x:-117.71582
y:117.732056
Angle:134
Distance:166.4867901148037
Inside BL:False



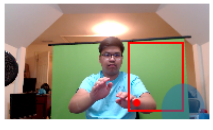
Frame 240.
x:-14.67688
y:-70.57434
Angle:-101
Distance:72.08431441940843
Inside BL:False



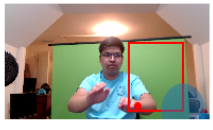
Frame 245.
x:26.437988
y:-11.864624
Angle:-24
Distance:28.978207804780517
Inside BL:False



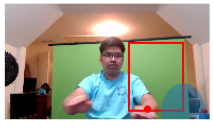
Frame 250.
x:14.739746
y:29.397034
Angle:63
Distance:32.885341791775446
Inside BL:False



Frame 255.
x:82.41931
y:32.42566
Angle:21
Distance:88.56842713537759
Inside BL:False



Frame 260.
x:229.56226
y:-88.34216
Angle:-21
Distance:245.9739154746851
Inside BL:False



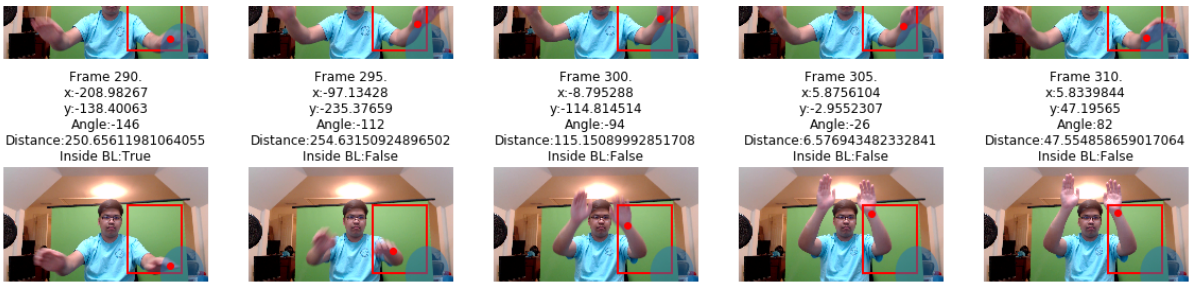
Frame 265.
x:17.60376
y:-147.09003
Angle:-83
Distance:148.1396920417629
Inside BL:True

Frame 270.
x:-11.768677
y:-41.267273
Angle:-105
Distance:42.91258054807702
Inside BL:True

Frame 275.
x:-17.662842
y:61.82434
Angle:105
Distance:64.29794007748299
Inside BL:False

Frame 280.
x:-26.474243
y:111.86145
Angle:103
Distance:114.95159673057303
Inside BL:True

Frame 285.
x:38.294067
y:47.07019
Angle:50
Distance:60.67980243710776
Inside BL:True


Frame 290.
x:-208.98267
y:-138.40063
Angle:-146
Distance:250.65611981064055
Inside BL:True
Frame 295.
x:-97.13428
y:-235.37659
Angle:-112
Distance:254.63150924896502
Inside BL:False
Frame 300.
x:-8.795288
y:-114.814514
Angle:-94
Distance:115.15089992851708
Inside BL:False
Frame 305.
x:5.8756104
y:-2.9552307
Angle:-26
Distance:6.576943482332841
Inside BL:False
Frame 310.
x:5.8339844
y:47.19565
Angle:82
Distance:47.554858659017064
Inside BL:False

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