

## Weekly Report

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Topic: Robot Guided Surface Scanning with Ultrasound

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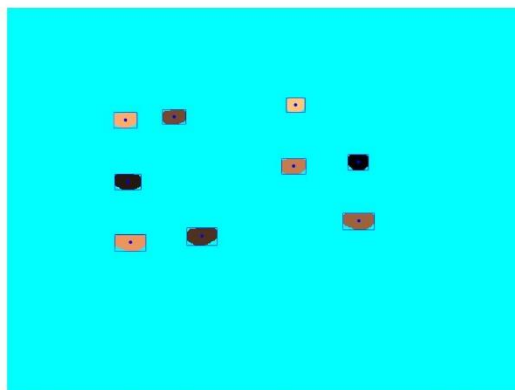
Tasks Done:

- Extraction of centroid points of the blob from the images.
- Study of how to solve PnP problem.
- Study of solution to  $AX = XB$  problem.

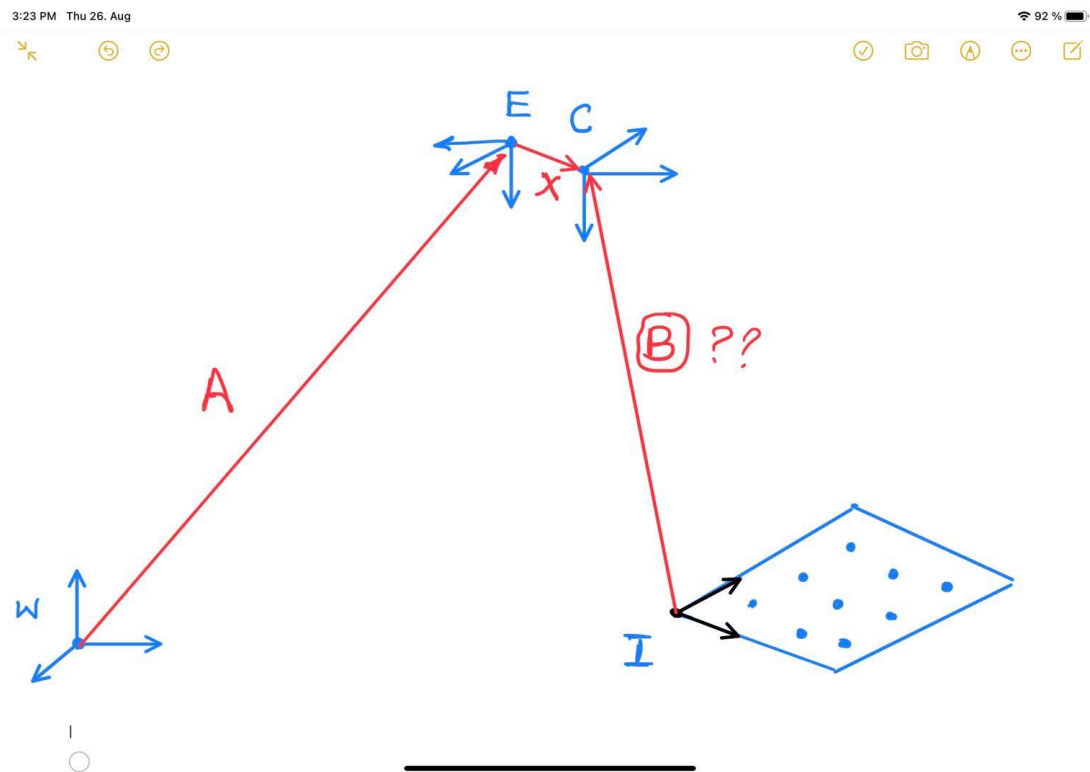
Question Description:

1. I was also able to extract all the centroids of the blobs in the images precisely. I have attached the image to show it. Centroids are available in Image coordinate frame in pixels or in mms.
2. Now ultimately, I have to solve the problem of eye in hand calibration i.e.,  $AX = XB$ .
3. Assuming  $A$  = poses of the robot end effector registered while taking the images.
4.  $X$  is transformation between end effector frame and camera coordinate frame which is to be evaluated.
5.  $B$  is the pose of the phantom in camera coordinates. I don't understand how to I get this pose using the centroid information which is in Image coordinate frame.

Image of centriods found:



## Visual Description of my Question:



## Solutions:

1. Since I have the centroids, I can solve Pnp problem. (Perspective n point problem).
2. I found built in command in Image processing tool box to do it. But I am confused with the inputs of the function

```
[worldOrientation, worldLocation, inlierIdx] =  
estimateWorldCameraPose(imagePoints, worldPoints, cameraParams)
```

imagePoints = centroids of the image extracted

cameraParams = intrinsic parameters. ( Not sure how to find these these)

worldPoints = points of the phantom in phantom coordinate frame.

## Questions:

1. Where is the phantom coordinate frame origin? How the points are extracted?
2. For intrinsic parameters do I have to perform intrinsic calibration?
3. What is the Ultra Sound index for the probe that we are using?

Most of the papers that I read either use an optical tracking system. Or have some kind of 3D registration methods for which I am able to get any documentation. I have attached the papers that I have read.

Question from Existing solutions of the problem:

$$z_{\text{MidCamera}} = (c_2 c_3 / c_1 c_3) * (P_3 - P_2) + \text{ones}([\text{numImages}, 1]) * P_2;$$

I don't understand clearly what are we calculating here.