# Assignment 2: Question 5

October 29, 2023 3:39 PM

## Target Registration

- Module to register tumour target point from CT → Ch frame

Input: $TP_{CT}$, $M1_{CT}, M2_{CT}, M3_{CT}$, $M1_{Ch}, M2_{Ch}, M3_{Ch}$

Output: $TP_{Ch}$

Testing: Stretch $F_{Ch \leftarrow CT}$, Prove $M_{1,2,3\,CT} \rightarrow M_{1,2,3\,Ch}$

Strategy:

- Make Frames of $M_{1,2,3,\,CT}$ using generate Ortho Frame Function with $M_{1,2,3}$ as A, B, C
- Make Frame of $M_{1,2,3\,Ch}$ " "
- Find the Transformation Matrix using Frame Transform to Home with $O_2, e_1, e_2, e_3$ from new ortho frames
- Take the Transformation matrices and Multiply to find $F_{CT \rightarrow Ch}$

Solution: We can see that a trivial linear transformation exists:

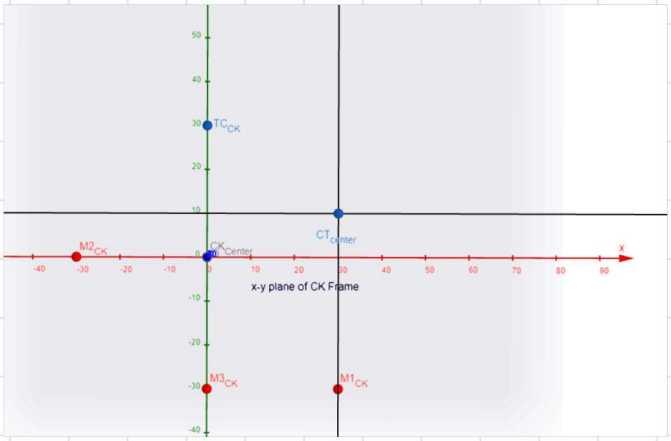
From markers it is clear that the transformation is

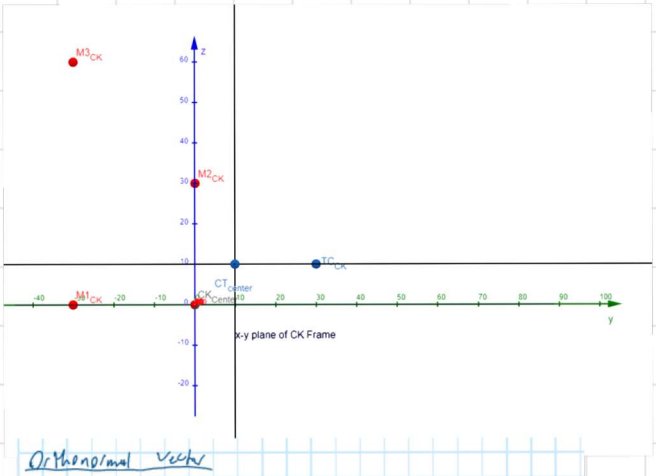
$M_{1Ch} - M_{1CT} = (30-0, -30+40, 0+10) = (30, 10, 10)$ (x, y, z)

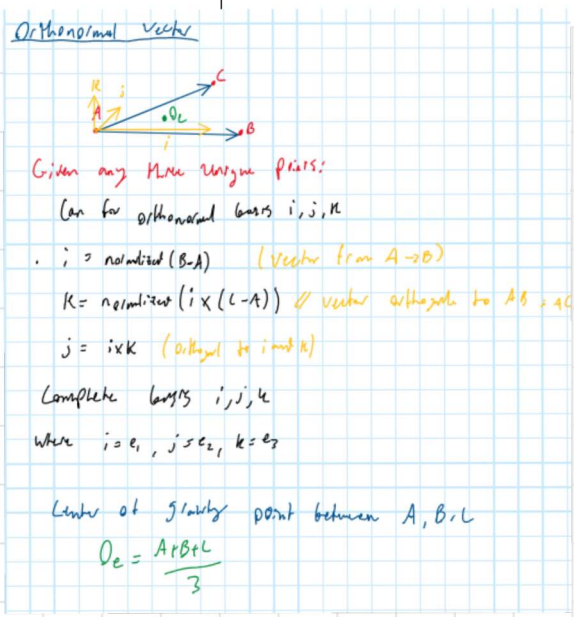
$$\begin{bmatrix} 1 & 0 & 0 & 30 \\ 0 & 1 & 0 & 10 \\ 0 & 0 & 1 & 10 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} -30 \\ 20 \\ 20 \\ 1 \end{bmatrix} = \begin{bmatrix} -30+30 \\ 20+10 \\ 20+10 \\ 1 \end{bmatrix} = \begin{bmatrix} 0 \\ 30 \\ 30 \\ 1 \end{bmatrix}$$

$F_{CT \rightarrow Ch}$ $TP_{CT}$ $TP_{Ch}$

If we did not jump to a tranformation matrix from the observation that each points is linearly transformed (30, 10, 10) in x,y,z then we could generate planes using the markers as input :




We can see how to generate an orthonormal frame given any 3 points on the left:

We can then use the orthonormal frames from the MCK and MCT points to populate a transformation matrix

For $M_{CK}$

$O_c = [-30, -30, 20]$

$e_1 = [-0.4165, 0.4082, 0.812]$

$e_2 = [0.242, -0.4364, 0.8729]$

$e_3 = [0.5345, 0.8018, 0.2673]$

For $M_{CT}$

$O_c = [0, -20, 30]$

$e_1 = [-0.8165, 0.4082, 0.4082]$

$e_2 = [0.2182, -0.44, 0.87]$

$e_3 = [0.53, 0.80, 0.27]$