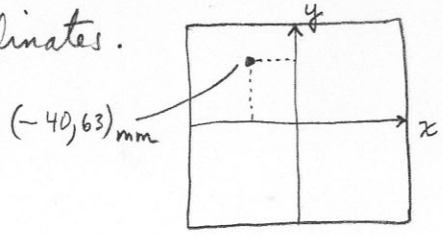
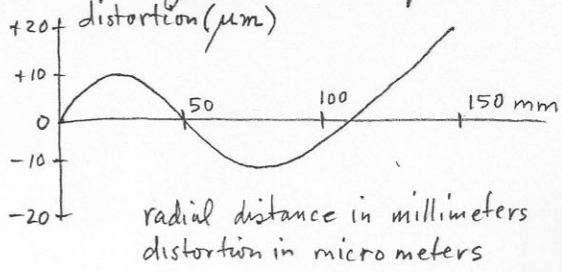
CE 503 Exam 3 Name _____

15 December 2003

1 page of Notes allowed

1. A photograph measurment is made with $(x,y) = (-40.000, 63.000)$ mm as shown. The lens distortion curve is also given. Compute the refined coordinates.



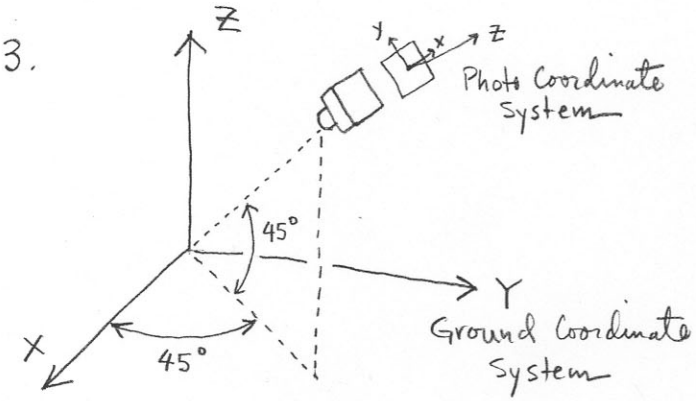


2. For the given rotation matrix, what are ω, ϕ, κ ?

$$\begin{bmatrix} .9513 & .2432 & .1897 \\ -.2549 & .9662 & .0394 \\ -.1736 & -.0858 & .9811 \end{bmatrix}$$

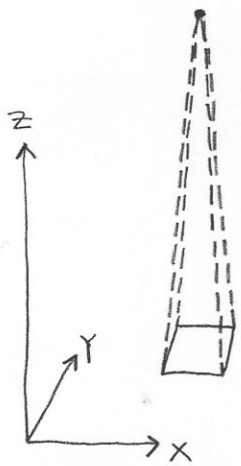
$$M = \begin{bmatrix} \cos\phi\cos\kappa & \cos\omega\sin\kappa + \sin\omega\sin\phi\cos\kappa & \sin\omega\sin\kappa - \cos\omega\sin\phi\cos\kappa \\ -\cos\phi\sin\kappa & \cos\omega\cos\kappa - \sin\omega\sin\phi\sin\kappa & \sin\omega\cos\kappa + \cos\omega\sin\phi\sin\kappa \\ \sin\phi & -\sin\omega\cos\phi & \cos\omega\cos\phi \end{bmatrix}$$

3.



Give a set of sequential Rotations to generate the rotation matrix for the camera in the sketch.

4.



A downward looking camera has a narrow field of view as shown in the sketch. List 2 pairs of the resection parameters $(X_L, Y_L, Z_L, \omega, \phi, \kappa)$ which are strongly coupled or correlated (that is, a small change in one looks like a small change in the other one).

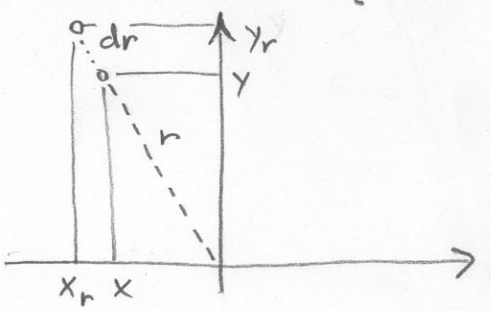
4 problems ; choose 3 ! CE503 Exam 3 solution 17-Dec-03

1. $(x,y) = (-40, 63)$ mm , $r = 74.6$ mm , interpolate visually $d = \begin{cases} -10\ \mu m \\ -0.010\ mm \end{cases}$ $(1\ \mu m = .001\ mm)$

$$d_x = \frac{-40}{74.6}(-.010) = .005$$
$$d_y = \frac{63}{74.6}(-.010) = -.008$$
} distortion components

we want to make correction so we subtract

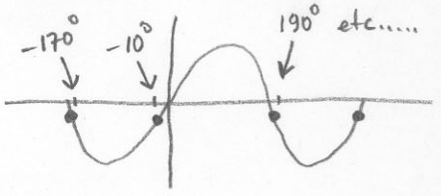
$$x_{refined} = -40 - .005 = \boxed{-40.005}$$
$$y_{refined} = 63 - (-.008) = \boxed{63.008}$$



2. $$M = \begin{bmatrix} .9513 & .2432 & .1897 \\ -.2549 & .9662 & .0394 \\ -.1736 & -.0858 & .9811 \end{bmatrix}$$

$\sin\varphi = m_{31} = -.1736$

$\Rightarrow \varphi = -10°$, or $-170°$



assume $\varphi = \boxed{-10°}$

$$\tan K = \frac{-m_{21}/\cos\varphi}{m_{11}/\cos\varphi} = \frac{.258832}{.965975}$$

$K = \boxed{15°}$ +,+ quadrant

$$\tan\omega = \frac{-m_{32}/\cos\varphi}{m_{33}/\cos\varphi} = \frac{.087123}{.996235}$$

$\omega = \boxed{5°}$ +,+ quadrant

assume $\varphi = \boxed{-170°}$

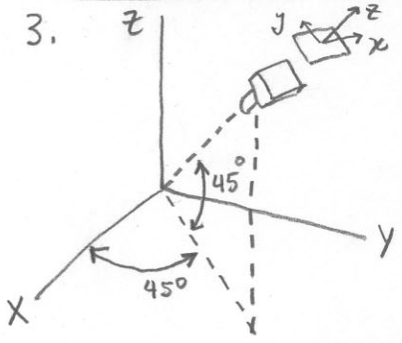
$$\tan K = \frac{-.258832}{-.965975}$$

$K = \boxed{-165°}$ -,- quadrant

$$\tan\omega = \frac{-.087123}{-.996235}$$

$\omega = \boxed{-175°}$ -,- quadrant

3.



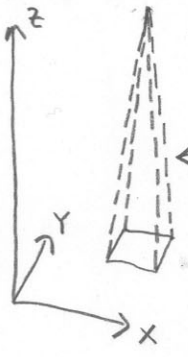
rotate ground → image with sequential rotations

1. $M_z\ (45° + 90°) = M_z\ (135°)$
2. $M_x\ (45)$

$$\underset{M}{\begin{bmatrix} -.707 & .707 & 0 \\ -.5 & -.5 & .707 \\ .5 & .5 & .707 \end{bmatrix}} = \underset{M_x(45°)}{\begin{bmatrix} 1 & 0 & 0 \\ 0 & .707 & .707 \\ 0 & -.707 & .707 \end{bmatrix}} \underset{M_z(135°)}{\begin{bmatrix} -.707 & .707 & 0 \\ -.707 & -.707 & 0 \\ 0 & 0 & 1 \end{bmatrix}}$$

you could also write $R = R_1(45°) \cdot R_3(135°)$

4.

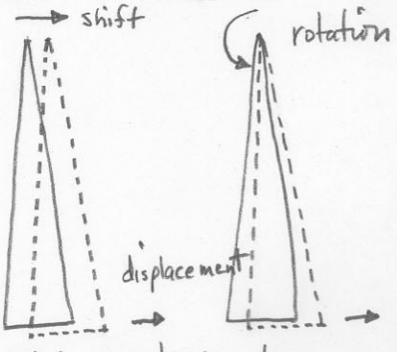


narrow field of view camera

Resection parameters $(X_L, Y_L, Z_L, \omega, \varphi, K)$

correlated pairs :

1. (X_L, φ)
2. (Y_L, ω)



The same displacement can be produced by either shift or rotation. Given only the image, we don't know what caused the displacement