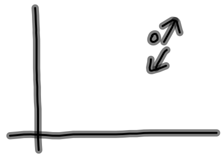
Inversion of Lens Distortion 20-1

if magnitude small:



if magnitude is large then you can invert by iteration

Mar 21-4:25 PM

meas $\xrightarrow[\text{now}]{}$ refined (pba_sc.m) 20-2

$\longleftarrow$

start with $x_i y_i$ i: ideal, refined

$\mathrm{corr}(x_i, y_i) \rightarrow c_x, c_y$ (deltas)

$x_m = x_i - c_x$

$y_m = y_i - c_y$

iteration loop

$\mathrm{corr}(x_m, y_m) \rightarrow$ comp x_i, comp y_i, $dx = x_i -$ comp x_i, $dy = y_i -$ comp y_i

$x_m = x_m + dx$

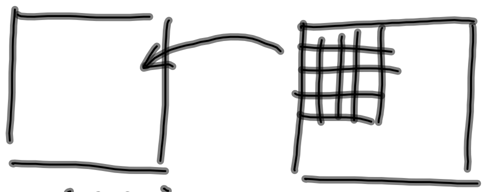
$y_m = y_m + dy$

if dx, dy large

done

Mar 21-4:26 PM

20-3



$x_m y_m$ original image (distortion)

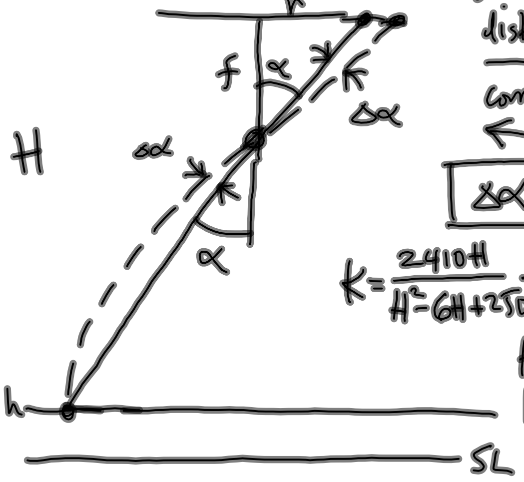
ideal refined $x_i y_i$

true perspective pinhole geometry

another systematic error correction

Atmospheric Refraction

20-4



distortion outward

$\longrightarrow$

correction

$\longleftarrow$

$$\boxed{\Delta\alpha = K \cdot \tan\alpha}$$

$$K = \frac{2410H}{H^2-6H+250} - \frac{2410h}{h^2-6h+250}\left(\frac{h}{H}\right) \mu Rad$$

H: height camera <u>km</u>

h: height terrain <u>km</u>

20-5

x'', y'' already corrected for LD

$r = \sqrt{(x'')^2 + (y'')^2}$

$\alpha = \operatorname{atan}\left(\frac{r}{f}\right)$

$\Delta\alpha = K \cdot \tan\alpha = K\frac{r}{f}$

$r' = f\tan(\alpha - \Delta\alpha)$

example 5-1 text + (wrong)

$x''' = \frac{r'}{r} \cdot x''$

$y''' = \frac{r'}{r} y''$

Mar 21-4:26 PM

20-6

Redo Ex. 5-1

$f = 152.000$ mm

$x'' = 59.043$, $y'' = 72.392$

$\boxed{\begin{array}{l} x''' = \frac{r'}{r}x'' = 59.040 \\ y''' = \frac{r'}{r}y'' = 72.389 \end{array}}$

$r = 93.417$

$H = 3000$ m, $\underline{3\text{ km}}$

$h = 300$ m, $\underline{0.3\text{ km}}$

$\rightarrow K = 29.7088\ \mu R$

$\alpha = \operatorname{atan}\left(\frac{r}{f}\right) = 31.^\circ 574281$

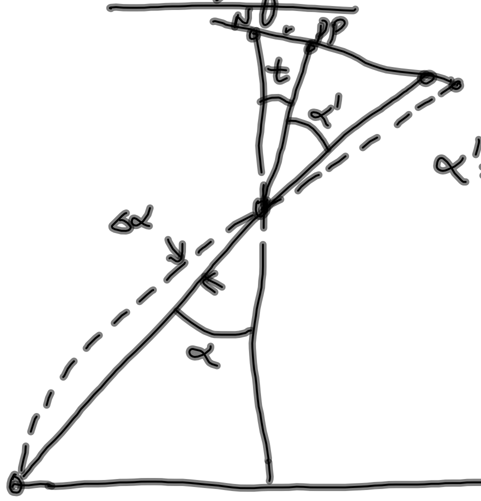
$\Delta\alpha = K\tan\alpha = 18.258\ \mu R = 0.001046$ deg

$r' = f \cdot \tan(\alpha - \Delta\alpha) = 93.413$

Mar 21-4:26 PM

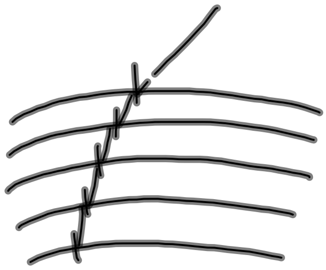
If oblique:

20-7



$\delta\alpha = k \tan\alpha$

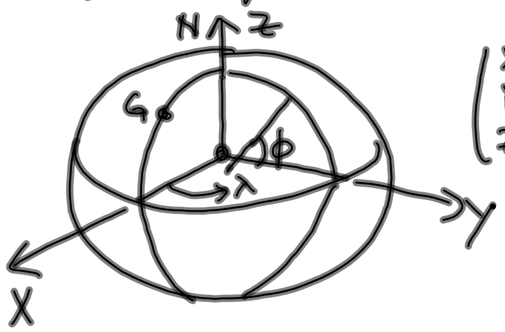
$\alpha' = \alpha - t$



Mar 21-4:26 PM

Object space coordinate system

20-8



$$\begin{pmatrix} X \\ Y \\ Z \end{pmatrix} \leftrightarrow \begin{pmatrix} \varphi \\ \lambda \\ h \end{pmatrix}$$

φ: latitude

λ: longitude

h: height (ellipsoid)

Earth Centered Earth Fixed

ECF

a: 6378137m, $f = \frac{1}{298.257222101}$

NAD83, GRS80 ellipsoid

Mar 21-4:26 PM

20.9

b: $f = \frac{(a-b)}{a}$

$e = \sqrt{2f - f^2}$

$$\begin{pmatrix} X \\ Y \\ Z \end{pmatrix} = \begin{bmatrix} (N+h)\cos\varphi\cos\lambda \\ (N+h)\cos\varphi\sin\lambda \\ ((1-e^2)N+h)\sin\varphi \end{bmatrix}$$

N: radius of curvature in prime vert.

$$N = \frac{a}{(1-e^2\sin^2\varphi)^{1/2}}$$

Mar 21-4:26 PM

20-10

$$\varphi = \tan^{-1}\left[\frac{z}{(X^2+Y^2)^{1/2}}\left(1-e^2\left(\frac{N}{N+h}\right)\right)^{-1}\right]$$

*

$$h = \frac{(X^2+Y^2)^{1/2}}{\cos\varphi} - N$$

* recompute N

$$\lambda = \tan^{-1}(Y/X)$$

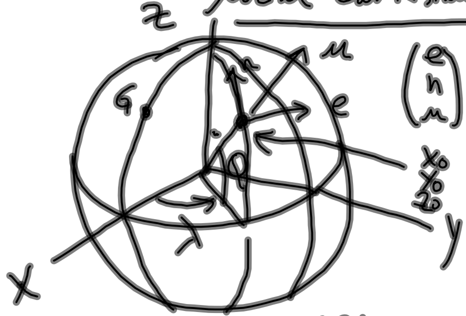
** 2 arg atan for correct quadrant

Mar 21-4:26 PM

Object space coord. system:

local cartesian system

20-11



$\begin{pmatrix} e \\ n \\ u \end{pmatrix}$ 1st $M_z(\lambda + 90^\circ)$

2nd $M_x(90^\circ - \phi)$

convert

$$\begin{pmatrix} e \\ n \\ u \end{pmatrix} = \underset{(R_1)}{M_x(90^\circ - \phi)} \; \underset{(R_3)}{M_z(\lambda + 90^\circ)} \underbrace{\left[\begin{bmatrix} X \\ Y \\ Z \end{bmatrix} - \begin{bmatrix} X_0 \\ Y_0 \\ Z_0 \end{bmatrix} \right]}$$

Mar 21-4:26 PM

20-12

$$\left[\begin{pmatrix} x \\ y \\ z \end{pmatrix} - \begin{bmatrix} (N+h)\cos\varphi\cos\lambda \\ (N+h)\cos\varphi\sin\lambda \\ ((1-e^2)N+h)\sin\varphi \end{bmatrix} \right]$$

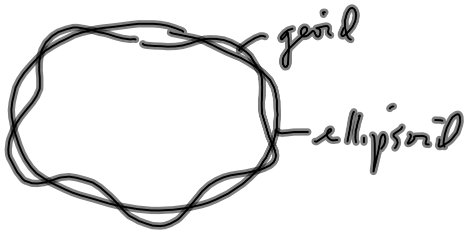
$$\begin{pmatrix} X_0 \\ Y_0 \\ Z_0 \end{pmatrix}$$

h: ellipsoid height

H: orthometric height
with resp. to geoid

Mar 21-4:26 PM

20-13



$h = H + N$

N : geoid undulation

Ind $N: \approx -33$m

Mar 21-4:26 PM

20-14

N: G w.r.t. E

H : elev. of terrain w.r.t. G

h : elev. " " w.r.t. E

Mar 21-4:26 PM