Satellite Photogrammetry HW 4

Build a suite of <u>matlab functions</u> + a "main" calling program as follows:

(0) main program reads .att and .eph files into a <u>global</u> variable which is then accessed by the FI2G function.

(1) function $\begin{bmatrix} X \\ Y \\ Z \end{bmatrix} = FI2G(l, s, h)$ This implements the projection done in HW3.

(2) function $\begin{bmatrix} \phi \\ \lambda \end{bmatrix} = FI2G\_PL(l, s, h)$ this is just a wrapper of FI2G(1) + a conversion from cartesian to geographic coordinates

(3) function $\begin{bmatrix} d\phi \\ d\lambda \end{bmatrix} = FI2G\_PL\_\phi(l, s, h, \phi, \lambda)$

This is just a wrapper of FI2G_PL (2) + a subtraction. The output vector is just a misclosure between input ϕ, λ and the ϕ, λ produced by l, s, h. In other words it is just:

$$\begin{bmatrix} d\phi \\ d\lambda \end{bmatrix} = \underbrace{\begin{bmatrix} \phi \\ \lambda \end{bmatrix}}_{\text{input}} - \underbrace{FI2G\_PL(l, s, h)}_{\text{computed from } (l, s, h)}$$

in other words l, s, h and ϕ, λ are <u>not</u> <u>consistent</u> necessarily.

(4) using the output of FI2G_PL_ϕ (3) : $\begin{bmatrix} F_\phi \\ F_\lambda \end{bmatrix} = \begin{bmatrix} d\phi \\ d\lambda \end{bmatrix}$

make function $\begin{bmatrix} l \\ s \end{bmatrix} = FG2I(\phi, \lambda, h)$ as follows

start with $l^0, s^0 = (0,0)$ & input ϕ, λ, h

ITERATE 3 TIMES (confirm Δs small)

(a) compute $\begin{bmatrix} F_\phi \\ F_\lambda \end{bmatrix}$ using FI2G_PL_ϕ *

(b) compute partials $\frac{\partial F_\phi}{\partial l}, \frac{\partial F_\phi}{\partial s}, \frac{\partial F_\lambda}{\partial l}, \frac{\partial F_\lambda}{\partial s}$ by :

all same do not have to compute again.

$$\begin{bmatrix} \frac{\partial F_\phi}{\partial l} \\ \frac{\partial F_\lambda}{\partial l} \end{bmatrix} = \frac{\text{FI2G\_PL\_}\phi(l^0+\Delta l, s^0, h, \phi, \lambda) - \text{FI2G\_PL\_}\phi(l^0, s^0, h, \phi, \lambda)^{*}}{\Delta l}$$

$$\begin{bmatrix} \frac{\partial F_\phi}{\partial s} \\ \frac{\partial F_\lambda}{\partial s} \end{bmatrix} = \frac{\text{FI2G\_PL\_}\phi(l^0, s^0+\Delta s, h, \phi, \lambda) - \text{FI2G\_PL\_}\phi(l^0, s^0, h, \phi, \lambda)^{*}}{\Delta s}$$

(c) solve for corrections to l^0, s^0 :

$$\begin{bmatrix} \frac{\partial F_\phi}{\partial l} & \frac{\partial F_\phi}{\partial s} \\ \frac{\partial F_\lambda}{\partial l} & \frac{\partial F_\lambda}{\partial s} \end{bmatrix} \begin{bmatrix} \Delta l \\ \Delta s \end{bmatrix} = \begin{bmatrix} -F_\phi \\ -F_\lambda \end{bmatrix}$$

$$J \quad \Delta \quad = \quad -F$$

$$\Delta = -J^{-1}F$$

(d) update l^0, s^0 : $\begin{pmatrix} l^0_{new} \\ s^0_{new} \end{pmatrix} = \begin{pmatrix} l^0_{old} + \Delta l \\ s^0_{old} + \Delta s \end{pmatrix}$

after you are done iterating, the refined l, s are consistent with input ϕ, λ, h and you have solved the ground to image projection problem:

$$\begin{pmatrix} l \\ s \end{pmatrix} = FG2I(\phi, \lambda, h) \quad \checkmark$$

equations in (c) are from Taylor Series Linearization

$$F_\phi(l, s) = 0 \; , \quad F_\phi \approx F_\phi(l^0, s^0) + \frac{\partial F_\phi}{\partial l}\Delta l + \frac{\partial F_\phi}{\partial s}\Delta s = 0$$

$$F_\lambda(l, s) = 0 \; , \quad F_\lambda \approx \underbrace{F_\lambda(l^0, s^0) + \frac{\partial F_\lambda}{\partial l}\Delta l + \frac{\partial F_\lambda}{\partial s}\Delta s = 0}$$

put this in matrix form and you have the $J\Delta = -F$ equation

(5) verify equation (4) by inputting the computed (ϕ, λ, h), not GCP values, from $\begin{pmatrix} l \\ s \end{pmatrix} = \begin{pmatrix} 14256 \\ 13398 \end{pmatrix}$. Then you should get back exactly the (l, s) you started with. Our G2I is just inverting our I2G.