Homework 1 Extra Credit

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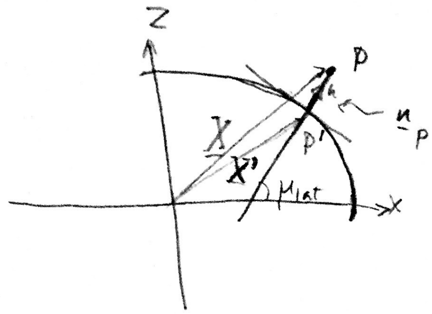

P(x, y, z)
P'(x', y', z')

$$\begin{bmatrix} x \\ y \\ z \end{bmatrix} = f\begin{bmatrix} \varphi \\ \lambda \\ h \end{bmatrix}$$

from ellipsoidal geometry

$$\frac{x^2+y^2}{a^2} + \frac{z^2}{b^2} = 1 \qquad (1)$$

$$\underline{X}' = \begin{bmatrix} N\cos\varphi\cos\lambda \\ N\cos\varphi\sin\lambda \\ \frac{b^2}{a^2}N\sin\varphi \end{bmatrix} \qquad \begin{matrix}(2)\\(3)\\(4)\end{matrix}$$

where $N = a^2 \cdot (a^2\cos^2\varphi + b^2\sin^2\varphi)^{-0.5}$ (5)

normal radius of curvature

$$\underline{n}_{p'} = \begin{bmatrix} \cos\varphi\cos\lambda \\ \cos\varphi\sin\lambda \\ \sin\varphi \end{bmatrix} \qquad (6)$$

Unit vector normal to the ellipsoid surface at p'.

vector chain

$$\underline{X} = \underline{X}' + h\,\underline{n}_{p'} \qquad (7)$$

Substitute (3), (6)

$$\underline{X} = \begin{bmatrix} (N+h)\cos\varphi\cos\lambda \\ (N+h)\cos\varphi\sin\lambda \\ (\frac{b^2}{a^2}N+h)\sin\varphi \end{bmatrix}$$

Reference: Hofmann-Wellenhof, Bernhard, and Helmut Moritz. Physical geodesy. Springer Science & Business Media, 2006.

```
clear variables; close all; clc;

% WGS84
% http://earth-info.nga.mil/GandG/publications/tr8350.2/wgs84fin.pdf
a = 6378137.0; % m
inv_f = 298.257223563;
b = a*(1-1/inv_f); % m

N = @(phi) a^2 * (a^2*cos(phi)^2 + b^2*sin(phi)^2)^(-0.5);

% input in radians and m, output in m
geodesic2ctrs = @(lat, long, h) [(N(lat)+h)*cos(lat)*cos(long);
                                (N(lat)+h)*cos(lat)*sin(long);
                                (b^2*N(lat)/a^2+h)*sin(lat)];

sole_ctrs = geodesic2ctrs(deg2rad(42.271167),deg2rad(-71.807627),0) %
 m
```

```
sole_ctrs =

   1.0e+06 *

    1.4757
   -4.4905
    4.2679
```

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