GPS Geodesy - LAB 3

From ECEF to ellipsoidal (and back)

Computations when processing GPS data are typically done in a geocentric, Earth-Centered, Earth-fixed system. The system has three right-handed orthogonal axis X, Y, Z. The Z axis coincides with the Earth's rotation axis. The (O,X,Y) plane coincides with the equatorial plane. The (O,X,Z) plane contains the Earth's rotation axis and the prime meridian. Units are meters.

In most applications, coordinates are however expressed as geodetic longitude, latitude, and height with respect to a datum. The origin and the shape of the associated ellipsoid define the datum. WGS-84 is an example of such a datum.

Assignment:
Using the classical formulas reproduced on the lecture handouts (or any good geodesy book), write matlab functions to convert:

- Convert ECEF coordinates to ellipsoidal [xyz2wgs.m]
- Convert ellipsoidal coordinates to ECEF [wgs2xyz.m]

Deliverables: the 2 matlab functions.

From ECEF to topocentric (and back)

Positions are sometimes expressed in a local topocentric datum. The origin is any point one chooses on the surface of the Earth. The datum has 3 left-handed orthogonal axes: u (for "up") is vertical and points upwards, n (for "north") is in the local horizontal plane and points to the geographic north, e (for "east") is in the local horizontal plane and points to the geographic east. Units are meters.

Assignment:

- Write the 3 matrices that, applied successively to a position vector $\vec{r}_{ECEF}$, convert it from ECEF to topocentric N,E,U datum.
- Combine the 3 matrices into a single transformation matrix R such that $\vec{r}_{NEU} = R\vec{r}_{ECEF}$.
- If the covariance matrix of a position verctor in the ECEF system is C_{ECEF}, what is its covariance matrix C_{NEU} in the NEU system?
- Assuming that the ECEF position vector $\vec{r}_{ECEF}$ is associated with a covariance matrix C_{ECEF}, what is the covariance matrix associated with $\vec{r}_{NEU}$?
- Write matlab functions to convert:
    - ECEF to topocentric NEU coordinates [xyz2neu.m]
    - NEU to topocentric ECEF coordinates [neu2xyz.m]

In addition to transformed coordinates, the functions must return the associated covariance matrix.

Deliverables:

- Derivation of the ECEF to topocentric transformation.
- Two matlab functions.