Statistical Orbit Determination

Lecture 7 – Ideal and Conceptual Measurements

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Recap

- Lecture 6 – Notes posted here
  – Coordinate Systems and Time
- Questions
  – Post them to YouTube page

Agenda

- Ideal Observations
  - Ideal range
  - Ideal range rate
  - Simulating observations
- Conceptual Measurement Systems
  - Range
  - Range Rate

Ideal Observations – Range

- Ideal Range
  - Ideal means ignore propagation
  - Instantaneous range or geometric range
    - Propagation and other errors captured in the observed range
  - Difference between instrument and satellite position vector

$$\rho = [(\bar{r} - \bar{r}_I) \cdot (\bar{r} - \bar{r}_I)]^{1/2}$$

  - Observed range,

$$\rho_{obs} = \rho + \epsilon$$

- Geometric range is invariant between different frames
  - ρ will be identical between both ECF and J2000
    - Magnitude of difference in position vectors

$$\rho = [(X - X_I)^2 + (Y - Y_I)^2 + (Z - Z_I)^2]^{1/2}$$

$$\rho = [(x - x_I)^2 + (y - y_I)^2 + (z - z_I)^2]^{1/2}$$

Ideal Observations – Range rate

- Ideal range rate
  - Differentiating the range with respect to time

$$\dot{\rho} = \frac{\bar{\rho} \cdot \dot{\bar{\rho}}}{\rho}$$

$$\rho = \left[(X - X_I)(\dot{X} - \dot{X}_I) + (Y - Y_I)(\dot{Y} - \dot{Y}_I) + (Z - Z_I)(\dot{Z} - \dot{Z}_I)\right] \ /\rho$$

  - Relative velocity in direction defined by ρ
    - Range-rate is the component of the relative velocity between the observing instrument and the satellite in the line-of-sight direction

$$\dot{\rho}_{obs} = \dot{\rho} + \epsilon$$

- Azimuth and elevation

$$\sin(El) = \frac{z_t}{r_t} \quad -90° \le El \le 90°$$

$$\sin(Az) = \frac{x_t}{r_{xy}} \quad 0 \le Az \le 360°$$

$$\cos(Az) = \frac{y_t}{r_{xy}}$$