ASE 389P.4 Methods of Orbit Determination
Homework 5: Setting Up the Term Project

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The theory and algorithms are derived and computer program to establish the trajectory of an Earth-orbiting satellite is developed. The assumptions for the study are:

- **Three tracking stations taking apparent range and range-rate data are available for tracking the satellite. Apparent quantities imply that the one-way light time between signal transmission and reception were modeled into the measurement (i.e. the effect is dealt with).**
- **The force model used to generate the truth is the EGM96 gravity field of degree and order 20, attitude-dependent solar radiation pressure, and atmospheric drag.**
- **The satellite is a box-wing shaped with one Sun-pointed solar panel with known component sizes, material properties, and orientation. The spacecraft -Z axis (in the spacecraft body reference frame) is always Nadir-pointed and has the antenna.**

Problem

For the state vector containing

$$\boldsymbol{X} = \begin{bmatrix} \underline{r} \\ \underline{\dot{r}} \\ C_D \\ C_{solar} \\ \cdots \\ \underline{b}_{Range_i} \end{bmatrix} \tag{1}$$

where $\underline{b}_{Range_i}$ are the Range biases for each tracking station, $i = 1, ..., n$.

Problem 1

Derive the $\underline{\underline{A}}_{n\times n}$ and $\underline{\underline{\tilde{H}}}_{m\times n}$ matrices for the linearized system and implement the partials in your computer language of choice. We recommend using a symbolic solver, e.g., MATLAB's symbolic toolbox, due to the large number of partial derivatives required. Compare to the numeric solutions online (found on canvas) at t_0. Compute the relative difference for each non-zero element, for example (in MATLAB)

```
>> relDiff = abs((yourHtilde-solutionHtilde)./solutionHtilde)
```

For the $\underline{\underline{\tilde{H}}}$ solution, provide the numeric values for the relative difference in your write-up. For the $\underline{\underline{A}}$ matrix, include a histogram of the exponents, e.g., (in MATLAB)

```
>> hist(reshape(log10(abs(relDiff)),n*m,1))
```

Solution

Appendix

HW4 MATLAB code

```
% HW 5
```

References

[1] Bob Schutz, G. H. B., Byron Tapley, *Statistical Orbit Determination*, Academic Press, 2004.

[2] Vallado, D. A., and McClain, W. D., *Fundamentals of Astrodynamics and Applications*, 4th ed., Microcosm Press, 2013.

[3] Vallado, D. A., "Fundamentals of Astrodynamics and Applications 4th Ed Consolidated Errata," `https://celestrak.com/software/vallado/ErrataVer4.pdf`, 2019.

[4] Montenbruck, O., and Gill, E., *Satellite Orbits: Models, Methods and Applications*, Springer, Berlin, Heidelberg, 2000.

[5] "Standard Rapid EOP Data since 02. January 1973 (IAU1980)," `https://datacenter.iers.org/data/7/finals.all`, 2021.