

COMP0130: ROBOT VISION AND NAVIGATION

Workshop 1: Mobile GNSS Positioning using Least-Squares Estimation

ANSWERS

Task 1: First-epoch Positioning

- a) The mobile phone cell ID Cartesian ECEF position is $-46\ 47\ 794.6, 2\ 556\ 362.1, -3530042.6$ m.
- b) The Cartesian ECEF satellite positions are

| Satellite | x (m) | y (m) | z (m) |
|-----------|-------------|-------------|-------------|
| 2 | -15733856.4 | 20916688.8 | 4523765.8 |
| 17 | -15733856.4 | 20916688.8 | -4523765.8 |
| 18 | -24265366.1 | -6196711.6 | -8849821.4 |
| 22 | -8444285.4 | 14353129.6 | -20693194.0 |
| 23 | -14510015.9 | -5171383.0 | -21638918.6 |
| 26 | 4785957.9 | 18098607.6 | -18843077.6 |
| 27 | -17773279.9 | 11321955.5 | -16169428.2 |
| 28 | -18499730.4 | -14132428.3 | -12789097.2 |

- c) The predicted ranges are

| Satellite | (m) |
|-----------|-------------|
| 2 | 22909972.3 |
| 17 | 21470688.1 |
| 18 | 22130623.1 |
| 22 | 21169584.3 |
| 23 | 22020721.9 |
| 26 | 23770722.3 |
| 27 | 20220188.0 |
| 28 | 23582210.42 |

- d) The line-of-sight unit vectors are

| Satellite | x (m) | y (m) | z (m) |
|-----------|-----------|-----------|-----------|
| 2 | -0.483892 | 0.801416 | 0.351542 |
| 17 | -0.516330 | 0.855138 | -0.046283 |
| 18 | -0.886446 | -0.395513 | -0.240381 |
| 22 | -0.179334 | 0.557253 | -0.810746 |
| 23 | -0.447862 | -0.350927 | -0.822356 |
| 26 | 0.396869 | 0.653839 | -0.644197 |
| 27 | -0.649115 | 0.433505 | -0.625078 |
| 28 | -0.587393 | -0.707681 | -0.392629 |

- f) The ECEF position solution is $-4\ 648\ 608.3, 2\ 555\ 877.8, -3\ 529\ 219.8$ m. The receiver clock offset solution is 10 000.2m.
- g) The latitude is -33.812506° , the longitude is 151.197315° and the height is 60.66 m.

Task 2: All-epoch Positioning

The position solution is as follows:

| Time (s) | Latitude (°) | Longitude (°) | Height (m) |
|----------|--------------|---------------|------------|
| 0 | -33.812506 | 151.197315 | 60.66 |
| 60 | -33.818981 | 151.203052 | 75.54 |
| 120 | -33.824311 | 151.211323 | 79.69 |
| 180 | -33.832773 | 151.212105 | 86.00 |
| 240 | -33.842909 | 151.211400 | 37.11 |
| 300 | -33.852106 | 151.210752 | 67.38 |
| 360 | -33.859548 | 151.206084 | 28.33 |
| 420 | -33.861464 | 151.213089 | 23.63 |
| 480 | -33.858764 | 151.213666 | 14.20 |
| 540 | -33.857782 | 151.214299 | 12.00 |
| 600 | -33.856750 | 151.214538 | 12.18 |

Task 3: Outlier Detection

An outlier is present on the measurement from satellite 18 at 360s. You may detect outliers on some of the other measurements at the same time because the outlier has contaminated the position solution. However, the satellite 18 measurement will have the largest residual. Removing the measurement from satellite 18 changes the position solution to:

| Time (s) | Latitude (°) | Longitude (°) | Height (m) |
|----------|--------------|---------------|------------|
| 360 | -33.859416 | 151.206359 | 38.53 |

If you then repeat the outlier detection test with satellite 18 removed you should then find that all measurements now pass the test.

Task 4: Velocity determination

The velocity solution is as follows:

| Time (s) | North (m/s) | East (m/s) | Down (m/s) |
|----------|-------------|------------|------------|
| 0 | -8.49 | 18.10 | 0.04 |
| 60 | -12.92 | 15.29 | -0.01 |
| 120 | -10.00 | 17.33 | -0.01 |
| 180 | -19.67 | -3.50 | 0.01 |
| 240 | -19.30 | 5.21 | -0.03 |
| 300 | -13.59 | -6.29 | 0.03 |
| 360 | -14.50 | -3.88 | -0.01 |
| 420 | 14.79 | 2.58 | -0.01 |
| 480 | 1.08 | 1.09 | -0.02 |
| 540 | 1.50 | 0.40 | -0.03 |
| 600 | -0.01 | -0.00 | -0.01 |