

Closest Approach Between a Satellite and Ground Site (Kozai Orbit Propagation Solution)

This *Numerit* application (`rts2sat1`) calculates close approach conditions between a satellite and a ground site on an oblate Earth. The user can specify a minimum range constraint to use during the simulation. This computer program uses a combination of one-dimensional minimization and root-finding to calculate close approach conditions.

The objective function for this application is

$$f(t) = \sqrt{|\mathbf{r}_{sat} - \mathbf{r}_{obs}|^2} = \sqrt{(r_{satx} - r_{obsx})^2 + (r_{saty} - r_{obsy})^2 + (r_{satz} - r_{obsz})^2} \quad (1)$$

where \mathbf{r}_{sat} is the ECI position vector of the satellite and \mathbf{r}_{obs} is the ECI position vector of the ground site.

During the root-finding solution, the objective function is given by

$$f(t) = \sqrt{|\mathbf{r}_{sat} - \mathbf{r}_{obs}|^2} - d_{min} \quad (2)$$

where d_{min} is the minimum ground site-to-satellite separation distance constraint defined by the user. The satellite orbit is propagated using Kozai's method.

The following is a typical draft report created with this program.

```

program rts2sat1

< closest approach between a ground site and Earth satellite >

time and conditions at constraint entry

calendar date           January 1, 1998
universal time          9 h 54 m 59.568 s
Julian date             2450814.913

topocentric slant range 1999.999173 kilometers

time and conditions at closest approach

calendar date           January 1, 1998
universal time          9 h 56 m 52.6426 s
Julian date             2450814.914

topocentric slant range 1884.715944 kilometers

time and conditions at constraint exit

calendar date           January 1, 1998
universal time          9 h 58 m 45.7028 s
Julian date             2450814.916

```

Orbital Mechanics with Numerit

topocentric slant range 1999.999173 kilometers

event duration 00 h 3 m 46.1348 s

time and conditions at constraint entry

calendar date January 1, 1998
universal time 11 h 59 m 44.6953 s
Julian date 2450815

topocentric slant range 2000.001436 kilometers

time and conditions at closest approach

calendar date January 1, 1998
universal time 12 h 3 m 0.995719 s
Julian date 2450815.002

topocentric slant range 1630.360609 kilometers

time and conditions at constraint exit

calendar date January 1, 1998
universal time 12 h 6 m 17.3117 s
Julian date 2450815.004

topocentric slant range 2000.001436 kilometers

event duration 00 h 6 m 32.6164 s

time and conditions at constraint entry

calendar date January 1, 1998
universal time 14 h 6 m 21.1403 s
Julian date 2450815.088

topocentric slant range 2000.001384 kilometers

time and conditions at closest approach

calendar date January 1, 1998
universal time 14 h 9 m 34.5016 s
Julian date 2450815.09

topocentric slant range 1641.729279 kilometers

time and conditions at constraint exit

calendar date January 1, 1998
universal time 14 h 12 m 47.8447 s
Julian date 2450815.092

topocentric slant range 2000.001384 kilometers

event duration 00 h 6 m 26.7044 s