Satellite Navigation (AE4E08)

Visualization of GNSS-related design parameters using the VISUAL s/w

Design computations are useful for studying the performance of a positioning system. There are several parameters which can be computed without the need for actual observations and which are good predictors of the performance.

Both users of GNSSs as well as researchers need the information provided by these design computations. Users of a GNSS need to know how they can meet the accuracy requirements for a specific application at hand. Researchers may be interested in the performance of different GNSSs, so that they can make comparisons or study the improvements that future modernizations or systems may bring.

A Matlab user interface was developed at our department that allows one to easily choose the system parameters and then carry out the computation of a certain parameter. The results are visualized for the specified time span and location/area. Later during this course, another assignment will be given where you are going to look at the different performance parameters. In this assignment we will restrict ourselves to an analysis of the satellite tracks, number of visible satellites and skyplots.

VISUAL User interface

The VISUAL user interface makes it possible to compare the performance of GNSSs under different scenarios. For that purpose, it is necessary to specify the system and observation scenario.

The relevant input parameters for this assignment are (other ones can be left unchanged):
- system : GPS, GLONASS, Galileo, integrated GPS-Galileo;
- almanac file : may be a Yuma-type almanac or a RINEX navigation file;
- date and time : both for the first and last observation epochs;
- cutoff angle : satellites with elevation angles below the cutoff angle are not considered;
- location : coordinates which specify the receiver location / area.

The user interface can be used to study either the spatial or temporal variation of a specific design parameter. A user who wants to look at the spatial variation must specify the area of interest. Also, the entire world may be considered. The output parameter will then be visualized on a map of the area for the given start time and number of epochs. If the computations are to be carried out at one specific location, the output parameter will be shown as a function of start time, so that the temporal variation can be studied. The output will always be plotted in a separate window.

1.
Download the file visual.zip from blackboard, unzip the files in the directory of your choice. Start Matlab and cd to that directory.

Start up the VISUAL software, simply by issueing the command

>> visual

at the Matlab prompt.

Before you continue, check all options and play around a little. Always take care to check all settings after you have changed something.

In this assignment only GPS and Galileo will be considered. A GPS Yuma almanac is provided with the software (yumaGPS.txt), as well as the corresponding Galileo Yuma almanac (yumaGAL.txt), which is generated under the assumption that the system is fully operational according to its nominal settings.

2.
Plot the *number of satellites* for the entire world, both for GPS and Galileo. Choose the same date and time.

Keep the figure windows open. Make the same plots, but for **12h** and **23h56m** later (again both for GPS and Galileo).

Look at the plots and try to answer the following questions:
- Why is the number of visible satellites not the same everywhere?
- In which region is the highest number of satellites visible? Why?
- In which region is the lowest number of satellites visible? Why?
- What is different if you compare the plots for different times? Why? (look at GPS and Galileo separately)

Close all figure windows.

3.
Plot the *number of satellites* for four different locations for GPS; use a fixed longitude (e.g. 4 degrees) and change the latitude:
- 0 degrees
- 30 degrees
- 60 degrees
- 90 degrees

Select a full day (24h), choose the same date for all cases.

It is not (yet) possible to make skyplots with VISUAL, but there is a separate routine available in the visual folder, called skyplot.m. Open this file in the Matlab-editor and edit the file to make skyplots for the same locations and day as above.

Look at the plots and try to answer the following questions:
- Why is the number of visible satellites not the same all the time?
- For which latitude is (on average) the highest number of satellites visible? Why?
- For which latitude is (on average) the lowest number of satellites visible? Why?
- [Optional] Repeat all of the above for Galileo. Are your conclusions different?

Done!

Feel free to play around with this tool later on during this course. We will use it for a graded assignment later on.