LOsim Manual

Description: LOsim generates pristine uv data of N x N square pixels (where N=2^n), which is FFT'd by visgen to generate a "visibility sky" of the same dimensions, i.e. a sky populated with brightness for every pixel. Information such as size and resolution of the "uv sky," source parameters and their distribution, etc. are specified through a set of ascii text input files.

Installation:

1. Prerequisites:

   - Like most other simulator modules, LOsim was also developed on a Linux platform. It is a self-contained package by itself, with its own include and header files. The code is written in ANSI C, and makes use of standard X11 and mathematical libraries provided by the system.
   - A makefile is provided in the source directory of your LOsim installation, and it makes use of the standard Gnu'c C compiler *gcc*. Note that the current version of LOsim is designed to run on a single machine only, and thus does not require MPI libraries.

2. Download and unpacking:

   A tarball of the LOsim code, along with the relevant directory structure and a full set of input files required for the test run, is available. Please contact Ramesh Bhat (rbhat@haystack.mit.edu) to request a copy. Place the tarball into LOsim directory of your visgen installation, i.e., */data/simulator/LOsim*. The tarball can be unzipped and expanded by typing:

   ```
   tar zxvf LOsim.tgz
   ```

   The above command will result in tarball unfolding into the following directories:

   ```
   source      :  source code and makefile
   include     :  relevant header files
   bin         :  bin directory for executable
   txt         :  example input (*.txt) files
   ```

   Included with the tarball is an executable version of LOsim compiled on a Linux machine, running RedHat8.0 and kernel 2.4.18-18.8.0.

3. Setting up the environment:

   No additional setup is needed. You should be able to compile and run LOsim under standard C shell or a bourne-type shell.

4. Compilation:

   LOsim is a self-contained package, and consequently the compilation procedure is fairly simple. Locate makefile in the source directory of your LOsim installation. Make appropriate modifications to the PATHs for *include* and *bin* directories (i.e., *LOSIM_INC* and *LOSIM_BIN* environments, respectively), and then proceed to building up the dependencies before attempting the compilation. For example, if */data/simulator* is your visgen installation directory,

   ```
   cd /data/simulator/LOsim/source
   make depend
   make
   ```

This will create the executable and place it in the *bin* directory of your LOsim installation. Once you have successfully compiled LOsim, you may either incorporate *LOsim/bin* directory into your PATH, or more preferably, make a link to the executable inside your simulator bin directory. For example,

```
cd /data/simulator/bin
ln -s /data/simulator/LOsim/bin/LOsim LOsim
```

Alternatively, you can move the executable itself to the desired bin directory.

Running LOsim:

You will need to be provide LOsim with the necessary information pertaining to the sky, specifically, its size and resolution, the parameters and the distribution of sources in the field of view. These are specified using a set of *.txt files. The tarball includes an example set (see */data/simulator/LOsim/txt*), which includes the files listed below:

```
1. test_Description.txt
2. SourceList_test.txt
3. Observation_test.txt
4. Images_test.txt
```

Below is a brief description of each *.txt file, with the emphasis being on those parameters that are relevant for the test run.

(1) test_Description.txt (description of the sky)

```
// This is a test file
// Lines beginning with "//" are comments and are ignored

Simulation name = test
Title = Test the LOFAR simulator (LOsim)

Brightness grid x-N = 1024
Brightness grid y-N = 1024

Visibility grid x-log2N = 10
Visibility grid y-log2N = 10

Source list name = 1sourceOffset
Observation name = test
// Image name = test
Out-of-beam source list name = ???1
Station list name = ShepTest
Ionosphere parameters name = ???3
```

Below are some guidelines on how to specify the above-listed parameters:

- Note that the simulation name should match the prefix of the description file, i.e., if "Simulation name = **test**," then the file should be named "**test**_Description.txt."

- You will also need to specify the dimensions of a brightness grid (N x N) and a visibility grid (M x M), where N=2^n and M=2^m. Also note that while the size of the brightness grid is specified by "N," the visibility grid needs to be specified by "m."
- Use of a much larger dimension for the visibility grid (say, M=4N) is recommended, as this will result in oversampling of the uv data, which will in turn result in a better interpolation (and higher accuracies) by visgen.
- In addition, the name of the source list should match the suffix of the text file, i.e., if Source list name = **test**, then the source list file should be named "SourceList_**test**.txt."

(2) SourceList_test.txt (the source list and their parameters)

```
//source  flux     Q U V nu  x_off   y_off  major_axis    minor_axis    ecc
Circular  0.0109   0 0 0  0  240.00   58.00 0.04246609    0.04246609    0.0
Circular  0.0131   0 0 0  0  -71.00  -62.00 0.04246609    0.04246609    0.0
Circular  0.0101   0 0 0  0 -134.00  136.00 0.04246609    0.04246609    0.0
Circular  0.0128   0 0 0  0 -191.00  133.00 0.04246609    0.04246609    0.0
Circular  0.0094   0 0 0  0   18.00 -115.00 0.04246609    0.04246609    0.0
```

LOsim accepts a source list in the above format. The sources are modeled as circular or elliptical Gaussians, and can be placed at any arbitrary location within the field of view, and can be of arbitrary strength, spectral index, and polarization. The entries in this file are: (1) source ID or tag (say, a geometrical description of the source), (2) scaled flux value ($\approx S(Jy)/88.xx$), (3) stokes parameters Q, U and V, (4) spectral index, (5) offset (in arc secs) of the source (along x and y axes) from the center of the image, (6) major and minor axes (in arc secs), and (7) eccentricity. Note that the current version of LOsim does not handle the information such as (3) and (4), and thus they can be ignored for the time being.

(3) Observation_test.txt (the observing parameters)

```
Field of view center right ascension = 19:57:44
Field of view center declination = 40d 35' 46"
Field of view x-size = 1023.0 arc-seconds
Field of view y-size = 1023.0 arc-seconds
Start time = 2001-8-22 13:17:01.00
End time = 2001-8-23 00:30:00.00
Observation frequency = 1400.0
Bandwidth = 1
Spectral points = 1
Integration time = 10
```

The only relevant parameter in this file is the size of the field of view (along x and y axes). Use of the remainder has never been implemented or tested out, and thus can be ignored for the time being. For a brightness grid of size N x N, specify the field of view as N-1 x N-1 (arc secs).

(4) Images_test.txt (the image parameter file)

```
// this is a test image parameter file
File containing image = bobby.fits
//File containing image = /data2/CYG_PERLEY.FITS
FITS file = 1
```

In addition to accepting a list of individual sources as described above, LOsim also allows the import of FITS images. The option can be exploited for the generation of sky of arbitrary complexity, or to incorporate high-level details in a source image (e.g. radio image of Cygnus A). One or more FITS files can be imported by specifying their locations in the image parameter file. Details on testing out this option is deferred to a supplementary manual. For the purpose of the test run, you are advised to ignore this option (simply comment out "Image name" option in the description file (see test_Description.txt).

Once you have set up the above input *.txt files, run LOsim by simply typing

```
LOsim
```

in your working directory. No command-line options need to specified, instead LOsim runs interactively. Several functions are available, however only a few are relevant for the test run. Follow the instruction sequence below:

- LOsim will first prompt for a simulation name. Enter the simulation name as in your description file (e.g. test).
- Type "?" for a listing of the available functions.
- Read in-beam source list, sum in-beam sources, and FFT sources. I.e., use the options "R," "S" and "F" in sequence (they are not case-sensitive, both lower and upper case letters will work).
- Exit the program by typing "X" or "x."

This will result in the generation of 3 output files, viz. (1) test_Brightness.fts, (2) test_BrFFT.dat_00, and (3) test_Visibility.dat_00; (1) is a standard FITS file which can be read in by AIPS, and (3) is the uv data for input to visgen program.

Testing LOsim:

Included in the tarball are a full set of output files "test_Brightness-haystack.fts", "test_BrFFT-haystack.dat_00" and "test_Visibility-haystack.dat_00" generated by running LOsim at one of our Haystack machines (Linux PC, running RedHat8.0). A simple check would be a comparison of the file sizes (rigorous tests such as byte-to-byte comparison is not meaningful unless the hardware in your system is identical). Another useful test would be to use the generated LOsim output to do a test run of visgen.