Gaia Sandbox user manual

http://www.zah.uni-heidelberg.de/gaia2/outreach/gaiasandbox

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1. Introduction

The Gaia Sandbox is a visualisation application developed in the Gaia group of Astronomisches Rechen-Institut with the purpose of serving as outreach software so that the general public can inspect various aspects of the Gaia mission in an interactive manner. With this software one can discover where Gaia is in its orbit at any time, inspect its movement and attitude patterns and behold the satellite model and its parts. Additionally, the HYG catalog loaded into the application allows for the real time visualisation and exploration of more than 100.000 stars in the vicinity of the Sun. The application is packed with features and details, some of which are covered in this user manual document.

2. System requirements and installation

2.1 System requirements

This section describes the system requirements you have to meet in order to run the Gaia Sandbox.

Operating systems

The Gaia Sandbox application runs on Windows, MacOS and Linux. So far it has only been tested to work on Ubuntu 13.4, Ubuntu 13.10, Linux Mint 16 and Windows 7 Ultimate.

Java

In order to run this software you will need the Java Runtime Environment (JRE) 7+ installed in your system. We recommend using the Oracle HotSpot JVM (http://www.oracle.com/java), as it is the only one we test, but it may also run in IBM's JVM or in the OpenJDK JVM. It may also run in Java 6, but it has not been tested.

OpenGL

You will need an operating system that supports at least OpenGL 2.0.

Hardware requirements

We have not tested the application on many different machines, but for sure you weed a decent GPU and an average CPU to get good frame rates. Specific system requirements are yet to be determined.

2.2 Installation

The Gaia Sandbox application does not require a 'formal' installation, as it is ready to be executed out of the box. Just unzip it anywhere in your desired drive and that's about it.

3. Configuration options

The configuration file is `conf/global.properties`. This file contains some useful configuration parameters to tweak the application:

3.1 Resolution

You may change the resolution of the application. By default it is configured to execute at 1280x720 (16:9 aspect ratio). To change the running resolution you need to modify the following properties in the configuration file.

```
graphics.screen.width=1280
graphics.screen.height=720
```

3.2 Mode

By default the application will execute in windowed mode. You can switch it to full screen by setting the following property to true:

```
graphics.screen.fullscreen=false
```

However, not all resolutions can be used with the full-screen mode. The list of native resolutions is outputted in the console when the application is started, just under the "Available full screen display modes" text. The output is something like this:

```
1600x1200, bpp: -1, hz: 50
1280x1024, bpp: -1, hz: 51
1024x768, bpp: -1, hz: 53
800x600, bpp: -1, hz: 55
```

These are the resolutions you can use in full-screen. If you use any other resolution the program will crash.

3.3 Anti-aliasing

MSAA (multi-sample anti-aliasing) is deactivated by default. However, if you have a fast enough graphics card you can activate it by specifying the number of samples to 2, 4, 8 or 16. The more samples the better the quality of MSAA.

```
graphics.screen.antialiasing=0
```

3.4 Rendering to images

The application can also render to image files. In order to configure the rendering to images one must modify the properties that start with `graphics.render`. One may modify the resolution, the target FPS, the output folder, the image name prefix and the anti-aliasing.

```
graphics.render.renderoutput=false
graphics.render.width=1600
graphics.render.height=900
graphics.render.targetfps=24
graphics.render.folder=/home/tsagrista/tmp/OrbitVideo/5/
graphics.render.filename=OrbitVideo
graphics.render.antialiasing=false
```

3.5 Orbit data configuration

The orbit data file can be configured as well. Usually you'll never need to touch this as we will bundle newer data with subsequent versions of this application. One can also deactivate the heliotropic correction.

```
data.orbit.file=data/ORB1_20131127_000001.topcat
data.orbit.referenceframe=RF_HELIOTROPIC
```

The data orbit file is an ASCII file with the following columns:

```
DATE X Y Z X_dot Y_dot Z_dot X_dotdot Y_dotdot Z_dotdot
```

Where the date is in the format `yyyy-MM-ddThh:mm:ss.ss`, the positions `X`, `Y` and `Z` are in km, the velocities `X_dot`, `Y_dot`, `Z_dot` are in km/s and the accelerations are in km/s^2.

3.6 Catalog file

The application is shipped with the HYG catalog (http://www.astronexus.com/hyg) in an own binary form. However, it is possible to use other catalogs by either using the provided loaders (described in the config file) or by adding your own. You just need to implement the

ICatalogLoader interface with its `loadStars()` method that returns a list of Star objects. Then, you need to point the program to the file you want to load.

```
data.catalog.loader=gaia.cu9.ari.gaiaorbit.catalog.HYGBinaryLoader
data.catalog.file=data/hygxyz.bin
```

3.7 Scene properties

You can change some properties of the scene itself such as the camera field of view, the velocity in focus mode and the entities to be loaded at boot.
This property sets the field of view angle of the camera. The bigger the angle the wider the camera view.

```
scene.camera.fov=60
```

This property is a multiplier for the velocity of the camera in `FOCUS` mode.

```
scene.camera.focus.vel=1
```

This is a list of entities to be loaded at startup. If you remove any of these you won't have the option to toggle its visibility from the application GUI.

```
scene.entities=earth gaia moon mw
```

3.8 Program options

Finally, you can disable the tutorial windows being shown every time the application is started with the following property.

```
program.tutorial=true
```

4. Running and operating instructions

4.1 Running the program

In order to run the program follow the instructions of your operating system.

Linux

In order to run the application on Linux, open the terminal, give execution permissions to the run.sh file and then run it.

```
> cd path_to_gaiasandbox_folder/
> chmod +x run.sh
> run.sh
```

Alternatively you can run the jar file directly, specifying the configuration file.

```
> java -Dproperties.file=conf/global.properties -jar gaiasandbox.jar
```

Windows

In order to run the application on Windows, open a terminal window (write 'cmd' in the start menu search box) and run the run.bat file.

```
> cd path_to_gaiasandbox_folder\
> run.bat
```

Alternatively you can run the jar file directly, specifying the configuration file.

```
> java -Dproperties.file=conf/global.properties -jar gaiasandbox.jar
```

MacOS

To run the application on MacOS systems, run the jar file specifying the configuration file.

```
> java -Dproperties.file=conf/global.properties -jar gaiasandbox.jar
```

4.2 Operating instructions

User interface

The Gaia Sandbox application has an on-screen user interface designed to be easy to use. It is divided into three sections, Time, Camera and Object visibility.

Time

You can play and pause the simulation using the `PLAY/PAUSE` button in the `OPTIONS` window to the left. You can also change the pace, which is the simulation time to real time ratio, expressed in h/sec. If the pace is 2.1, then one second of real time translates to two hours of simulation time. Finally, the current simulation date is given in the bottom box of the Time group.

Camera

In the camera options pane on the left you can select the type of camera. This can also be done by using the Numpad 0-8 keys. There is also a list of focus objects that can be selected from the interface. When an object is selected the camera automatically centers it in the view and you can rotate around it or zoom in and out. Objects can also be selected by clicking on them directly in the view.
** Hint: Try focusing on Gaia and zoom in to inspect its movement and orbit.

Object visibility

Most graphical elements can be turned off and on using the visibility toggles at the bottom of the `OPTIONS` window. For example you can remove the stars from the display by clicking on the 'stars' toggle. Some graphical elements are a bit costly to display, such as the 'star names' or the 'Milky Way'. If you experience poor frame rates (below 30 FPS), try disabling some of the graphical elements and see if this fixes the issue.

Controls

This section describes the controls of the Gaia Sandbox.

Keyboard controls

Control	Action
Numpad 0-8	Change camera mode
Numpad 0	Sets camera mode to `FREE`
Numpad 1	Sets camera mode to `FOLLOW_ORBIT`
Numpad 2	Sets camera mode to `FOLLOW_GAIA`
Numpad 3	Sets camera mode to `GAIA_INTERTIAL_RF`, where the camera is fixed with respect to Gaia
Numpad 4	Sets camera mode to `ROTATE_GAIA`, where the camera rotates with Gaia
Numpad 5	Sets camera mode to `ROTATE_PRECESS_GAIA`, where the camera rotates and precesses with Gaia
Numpad 6	Sets camera mode to `INSIDE_GAIA`
Numpad 7	Sets camera mode to `SCENE`, where the camera tries to get Gaia and the Earth in its field of view
Numpad 8	Sets camera mode to `FOCUS`, where the camera focuses the selected object
P	Toggle simulation play/pause
I	Toggle reference axes visibility

Mouse controls

Control	Action
Left click on object	Select object as focus
Left click + drag	Pitch and yaw (`FREE` mode) or rotate around foucs (`FOCUS` mode)
Middle click + drag or wheel	Forward/backward movement
Right click + drag	Move sideways (only in `FREE` mode)
Shift + left click + drag	Camera roll

5. Copyright and licensing information

This software is published and distributed under the `LGPL` (Lesser General Public License) license. You can find the full license text in the `LICENSE.txt` file or visiting www.gnu.org/licenses/lgpl-3.0-standalone.html.

6. Contact information

The main webpage of the project is www.zah.uni-heidelberg.de/gaia2/outreach/gaiasandbox. There you can find the latest versions and the latest information on the Gaia Sandbox.

6.1 Main designer and developer

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6.2 Contributors

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7. Known bugs, issues and TODOs

- Distances are not unified amongst all the entities.
- The program crashes if Gaia reaches the end or the beginning of the orbit line.
- Clipping problems when rendering to files in models with very near surfaces (i.e. bottom of Gaia). Possible depth buffer problem.
- If the camera is far from the orbit line and FOLLOW_ORBIT or FOLLOW_GAIA camera modes are selected, the camera should quickly move to the orbit position.
- Possible problems with the Mac and Windows versions.
- OwnTextButton cursor image (pointing hand) disappears when button is pressed.
- Accented and greek letters must be added to the character set.
- Some missing symbols (such as the degree symbol) must be added to the character set.

8. Credits and acknowledgements

The author would like to acknowledge the following people, or the people behind the following technologies/resources:

- The DLR (http://www.dlr.de/) for financing this project.
- Dr. Martin Altmann for providing the orbit data.
- Libgdx - http://libgdx.badlogicgames.com
- HYG catalog - http://www.astronexus.com/hyg

9. Change log

[version 0.504b] - 16/04/2014

- Fixed Sun distance in FOCUS mode.
- Log messages hidden by default.
- Smooth shading for all models except mw.
- Normals removed from mw model. Transparency tweaked.
- Initial camera position moved to Gaia.

[version 0.503b] - 15/04/2014

- Added distance to focus.
- Fixed Java8 library issue.
- Fixed font shader for MacOS.

[version 0.502b] - 14/04/2014

- First public version.