Topic 5 – Installing gVirtualXRay

IBSim-4i 2020

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How to compile and install gVirtualXRay Suite

Requirements

Make sure you have:

- CMake 3.12 or newer (see `http://www.cmake.org/`);
- A C++ compiler; and
- A GPU that supports OpenGL (integrated GPUs are fine).

For GNU/Linux

The examples below are for openSUSE Leap but you can adapt them for your own distro.

1. You need cmake and a compiler:

```
$ sudo zypper in cmake-full gcc-c++
```

2. You need some system libraires:

```
$ sudo zypper in libX11-devel \
                 libXi-devel \
                 libXcursor-devel \
                 libXinerama-devel \
                 libXrandr-devel \
                 libXxf86vm-devel \
                 glu-devel
```

3. For unit testing, SimpleGVXR and wrappers (optional):

```
$ sudo zypper in Mesa-libEGL1 Mesa-libEGL-devel libgbm1 libgbm-devel
```

4. For unit wrappers (optional):

```
$ sudo zypper in swig \
    ruby-devel \
    tcl-devel \
    python3 python3-devel \
    java-11-openjdk \
    octave-devel \
    R-core R-base  R-core-devel R-base-devel
```

Mac OS X:

1. Install XCode from the Mac App Store.
2. Install the Command Line Tools package via the Terminal application using

```
$ xcode-select --install command.
```

3. Install CMake from `https://cmake.org/download/`
4. For Wrappers, you may want to install SWIG and Python 3. I use homebrew for that purpose, see `https://brew.sh/`

Microsoft Windows

1. Install Visual Studio from `https://visualstudio.microsoft.com/vs/`
   - **Make sure to select the C++ language**
2. Install CMake from `https://cmake.org/download/`
3. You may want to install a git client, e.g. `https://git-scm.com/download/win`
4. You may want to install a SVN client, e.g. TortoiseSVN from `https://tortoisesvn.net/downloads.html`
5. For Wrappers, you may want to install Python 3 from `https://www.python.org/downloads/` Make sure to install the development libraries.

Download the latest version of the source code

- The latest release (gVirtualXRay-1.1.3-Source.zip) available at `https://sourceforge.net/projects/gvirtualxray/files/1.1/gVirtualXRay-1.1.3-Source.zip/download` or
- The latest version from SVN at `https://svn.code.sf.net/p/gvirtualxray/code/trunk`

Installation from the source code

GNU/Linux and Mac OS X

Assuming the system is ready.

1. Open a terminal and choose where the binaries should be installed. **It must be a directory where you can write.** If you can't, make sure you use `sudo make` rather than `make` in Steps 5 and 6. In the example below, I install it in my home directory in `gvxr-install`.

```
$ export GVXR_INSTALL_DIR=$HOME/gvirtualxray-install
```

2. go in the directory where you want to build the gVirtualXRay, e.g.

```
$ mkdir ~/gvxr
$ cd ~/gvxr
```

3. Download the latest release:

```
$ wget https://sourceforge.net/projects/gvirtualxray/files/1.1/gVirtualXRay-
1.1.3-Source.zip/download
$ mv download gVirtualXRay-1.1.3-Source.zip
$ unzip gVirtualXRay-1.1.3-Source.zip
```

4. Create a directory where the binaries will be created and go in this directory.

```
$ mkdir gvxr-bin
$ cd gvxr-bin
```

5. Configure the project using CMake. Use `cmake`, `ccmake` or `cmake-gui` depending on you preferences. `ccmake` and `cmake-gui` are interactive.
   — `cmake`:

```
$ cmake \
    -DCMAKE_BUILD_TYPE:STRING=Release \
    -DCMAKE_INSTALL_PREFIX:STRING=$GVXR_INSTALL_DIR \
    -DBUILD_TESTING:BOOL=ON \
    -DBUILD_WRAPPER_CSHARP:BOOL=ON \
    -DBUILD_WRAPPER_JAVA:BOOL=ON \
    -DBUILD_WRAPPER_OCTAVE:BOOL=ON \
    -DBUILD_WRAPPER_PERL:BOOL=ON \
    -DBUILD_WRAPPER_PYTHON3:BOOL=ON \
    -DBUILD_WRAPPER_R:BOOL=ON \
    -DBUILD_WRAPPER_RUBY:BOOL=ON \
    -DBUILD_WRAPPER_TCL:BOOL=ON \
    -S .. \
    -B $PWD
```

– `ccmake`:

```
$ ccmake \
    -DCMAKE_BUILD_TYPE:STRING=Release \
    -DCMAKE_INSTALL_PREFIX:STRING=$GVXR_INSTALL_DIR \
    -S .. \
    -B $PWD
```

– `cmake-gui`:

```
$ ccmake \
    -DCMAKE_BUILD_TYPE:STRING=Release \
    -DCMAKE_INSTALL_PREFIX:STRING=$GVXR_INSTALL_DIR \
    -S .. \
    -B $PWD
```

6. Compile the project.

```
$ make -j16
```

I used a parallel build with 16 jobs as I got 16 cores in my CPU. Adjust `-j` depending on your computer. Once the project is made, it is also installed. 7. Run the unit tests (optional)

```
$ make test
```

8. Install

```
$ make install
```

or at your own risk as `root` using:

```
$ sudo make install
```

If you built the python wrapper, add its path to `PYTHONPATH`:

```
$ PYTHONPATH=$GVXR_INSTALL_DIR/gvxrWrapper-1.0.1/python3:$PYTHONPATH
```

And to make it permanent:

```
$ echo "" >> $HOME/.bashrc
$ echo "###########################################################################
>> $HOME/.bashrc
$ echo "# Install gvxrPython3 in PYTHONPATH" >> $HOME/.bashrc
$ echo export PYTHONPATH=$GVXR_INSTALL_DIR/gvxrWrapper-1.0.1/python3:\$PYTHONPATH
>> $HOME/.bashrc
$ echo "###########################################################################
>> $HOME/.bashrc
```

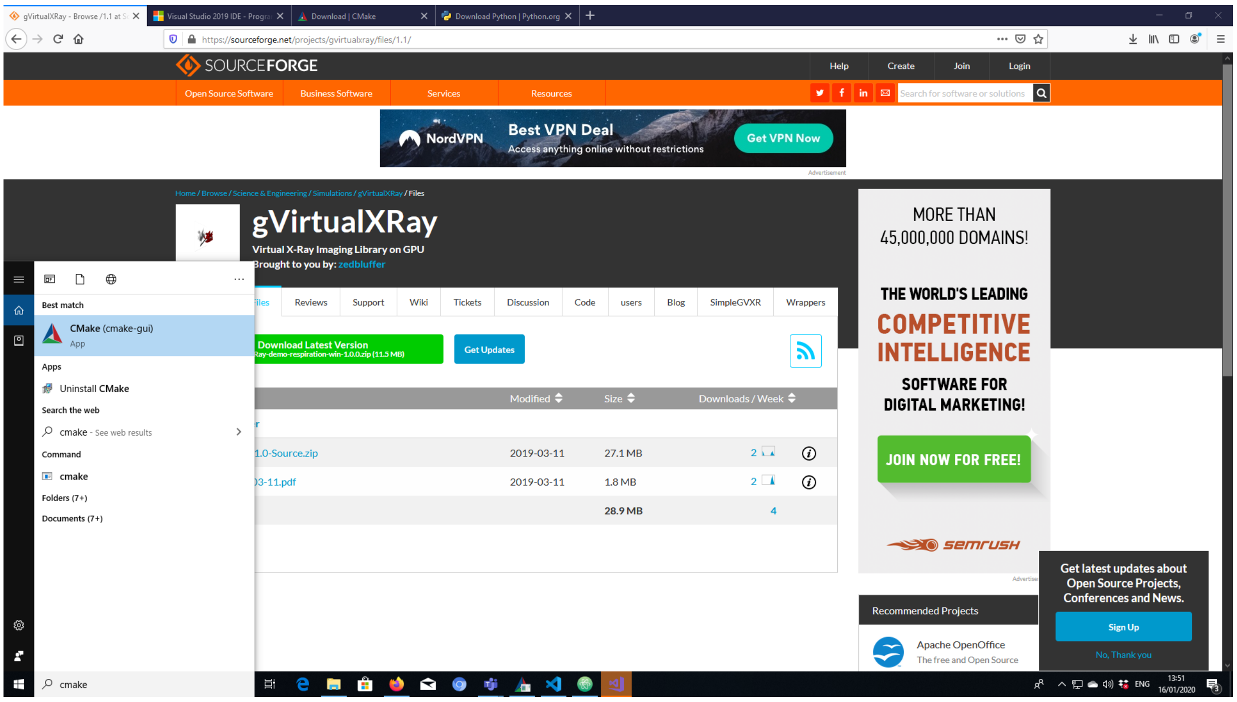
Summary of all the commands:

```
export GVXR_INSTALL_DIR=$HOME/gvirtualxray-install

mkdir ~/gvxr
cd ~/gvxr

wget https://sourceforge.net/projects/gvirtualxray/files/1.1/gVirtualXRay-
1.1.3-Source.zip/download
mv download gVirtualXRay-1.1.3-Source.zip
unzip gVirtualXRay-1.1.3-Source.zip

mkdir gvxr-bin
cd gvxr-bin

cmake \
    -DCMAKE_BUILD_TYPE:STRING=Release \
    -DCMAKE_INSTALL_PREFIX:STRING=$GVXR_INSTALL_DIR \
    -DBUILD_TESTING:BOOL=ON \
    -DBUILD_WRAPPER_CSHARP:BOOL=OFF \
    -DBUILD_WRAPPER_JAVA:BOOL=OFF \
    -DBUILD_WRAPPER_OCTAVE:BOOL=OFF \
    -DBUILD_WRAPPER_PERL:BOOL=OFF \
    -DBUILD_WRAPPER_PYTHON3:BOOL=ON \
    -DBUILD_WRAPPER_R:BOOL=OFF \
    -DBUILD_WRAPPER_RUBY:BOOL=OFF \
    -DBUILD_WRAPPER_TCL:BOOL=OFF \
    -S .. \
    -B $PWD

make -j16
make test

make install

export PYTHONPATH=$GVXR_INSTALL_DIR/gvxrWrapper-1.0.1/python3:PYTHONPATH

echo "" >> $HOME/.bashrc
echo "################################################################################
>> $HOME/.bashrc
echo "# Install gvxrPython3 in PYTHONPATH" >> $HOME/.bashrc
echo "PYTHONPATH=$GVXR_INSTALL_DIR/gvxrWrapper-1.0.1/python3:\$PYTHONPATH"
>> $HOME/.bashrc
echo "################################################################################
>> $HOME/.bashrc
```

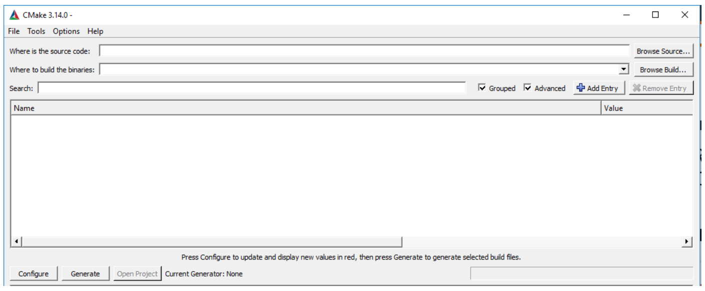
For Windows

I recommand to use **64 bits** for all the components, including for **Python 3**.

1. Download and extract gVirtualXRay's code from `https://sourceforge.net/projects/gvirtualxray/files/1.1/gVirtualXRay-1.1.3-Source.zip/download`.
2. Open CMake's gui.
3. Select where the source code is. This is the top directory of the repository that contains CMakeLists.txt.
4. Select where the binaries are going to be compiled. It CANNOT be a subdirectory of the source directory chosen in the previous step.
5. Press configure, then choose which compiler you want to use and which architecture. I used Visual Studio 15 2017's native compilers, and x64 (for 64 bits).
6. Click on `Configure`. There'll be an error, but don't worry about it.
7. Search for `install`.
8. Change the variable `CMAKE_INSTALL_PREFIX` into a path where you are allowed to write. Click on configure. If it does not work, change the path and make sure you have write privilege for that path.



Illustration



Illustration

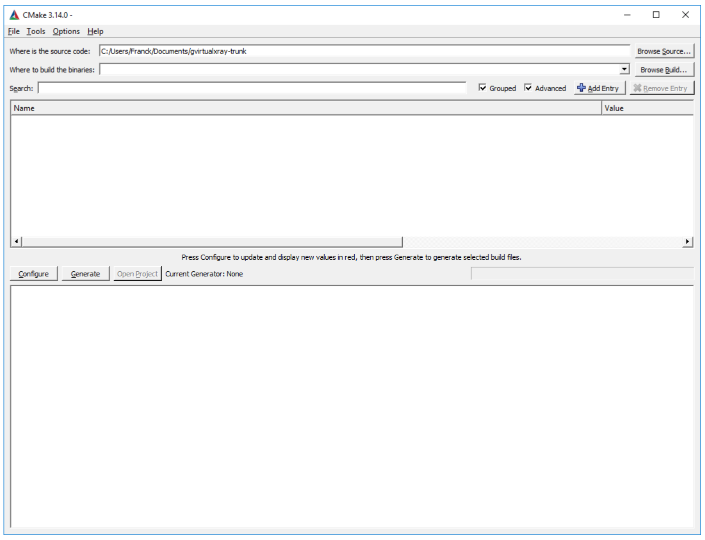
9. If you want to build a wrapper, e.g. for Python 3, go to `BUILD` and tick the right option(s) (in my case `BUILD_PYTHON£_WRAPPER`). Now you can click on `Configure`, then `Generate`, then `Open Project`.

10. It will open Visual Studio. Change Debug into Release.

11. Do a right click on `BUILD_ALL` or press the `F7` key to build the project.

12. Go and make some coffee, it's gonna take a bit of time... At the end, in the output, you should see something like

```
========== Build: 4 succeeded, ...
```



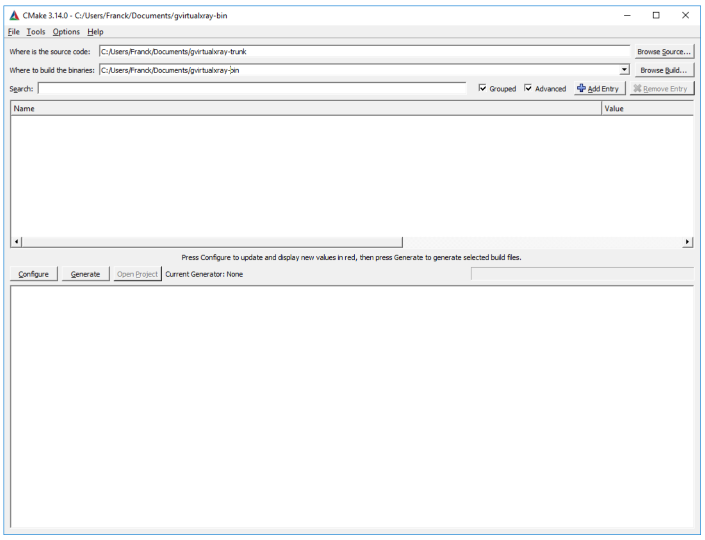
Where is the source code: C:/Users/Franck/Documents/gvirtualxray-trunk

Where to build the binaries:

Press Configure to update and display new values in red, then press Generate to generate selected build files.

Current Generator: None

Illustration



Where is the source code: C:/Users/Franck/Documents/gvirtualxray-trunk

Where to build the binaries: C:/Users/Franck/Documents/gvirtualxray-bin

Press Configure to update and display new values in red, then press Generate to generate selected build files.

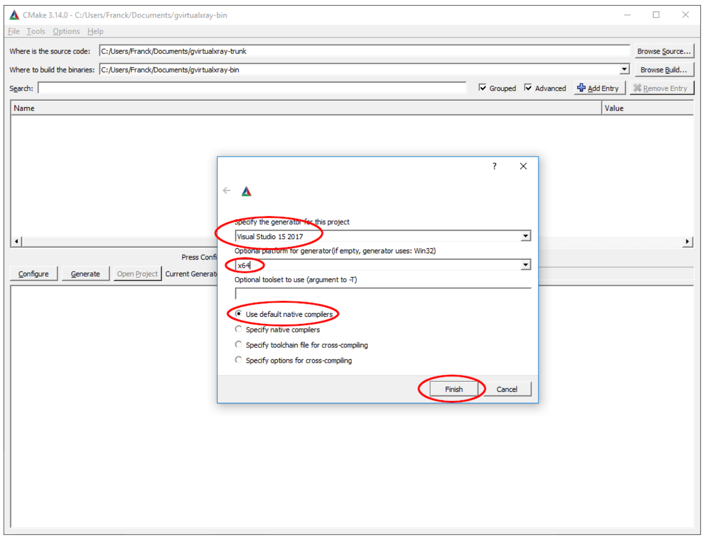
Current Generator: None

Illustration

Installation directory content in Windows

On Windows, you Should see 4 or 5 directories in the installation directory depending on wrappers:

- bin
- third_party
  - include
  - lib (Windows) or lib64 (GNU/Linux and Mac OS X???)



CMake 3.14.0 - C:/Users/Franck/Documents/gvirtualxray-bin

Where is the source code: C:/Users/Franck/Documents/gvirtualxray-trunk

Where to build the binaries: C:/Users/Franck/Documents/gvirtualxray-bin

Grouped ✓ Advanced ✓

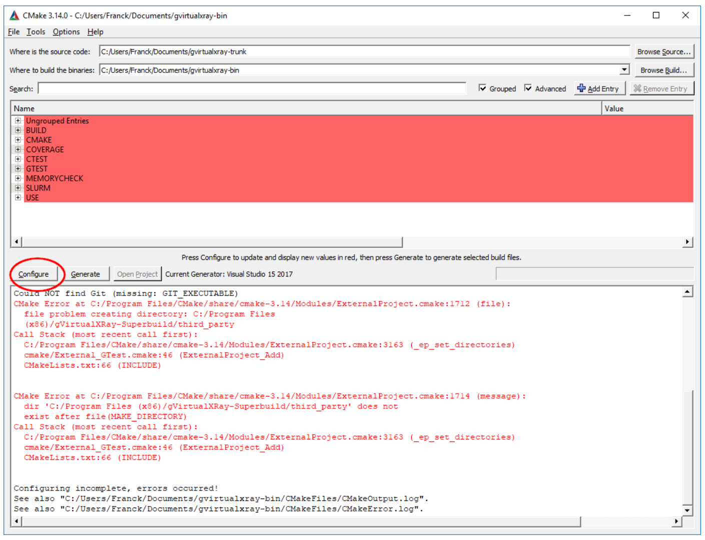
Specify the generator for this project: Visual Studio 15 2017

Optional platform for generator(if empty, generator uses: Win32): x64

Optional toolset to use (argument to -T):

[✓ Use default native compilers] Specify native compilers / Specify toolchain file for cross-compiling / Specify options for cross-compiling

Illustration



CMake 3.14.0 - C:/Users/Franck/Documents/gvirtualxray-bin

Where is the source code: C:/Users/Franck/Documents/gvirtualxray-trunk

Where to build the binaries: C:/Users/Franck/Documents/gvirtualxray-bin

Grouped ✓ Advanced ✓

Ungrouped Entries
BUILD
CMAKE
COVERAGE
CTEST
GTEST
MEMORYCHECK
SLURM
USE

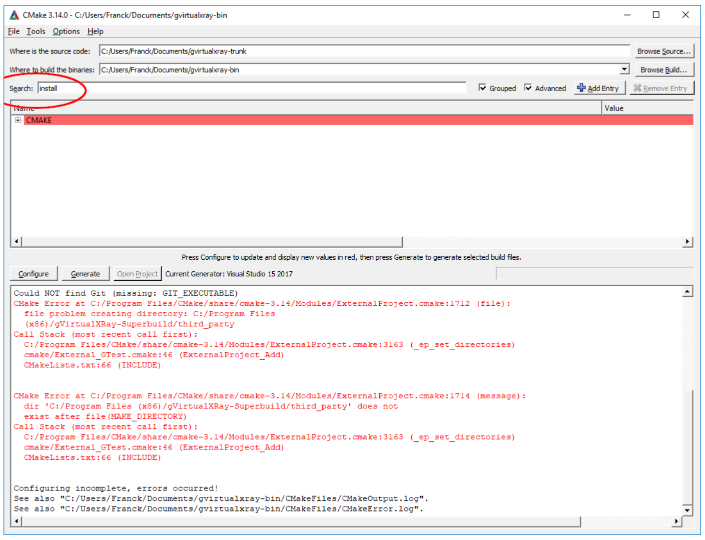
Press Configure to update and display new values in red, then press Generate to generate selected build files.

Current Generator: Visual Studio 15 2017

```
Could NOT find Git (missing: GIT_EXECUTABLE)
CMake Error at C:/Program Files/CMake/share/cmake-3.14/Modules/ExternalProject.cmake:1712 (file):
  file problem creating directory: C:/Program Files
  (x86)/gVirtualXRay-Superbuild/third_party
Call Stack (most recent call first):
  C:/Program Files/CMake/share/cmake-3.14/Modules/ExternalProject.cmake:3163 (_ep_set_directories)
  cmake/External_GTest.cmake:46 (ExternalProject_Add)
  CMakeLists.txt:66 (INCLUDE)


CMake Error at C:/Program Files/CMake/share/cmake-3.14/Modules/ExternalProject.cmake:1714 (message):
  dir 'C:/Program Files (x86)/gVirtualXRay-Superbuild/third_party' does not
  exist after file(MAKE_DIRECTORY)
Call Stack (most recent call first):
  C:/Program Files/CMake/share/cmake-3.14/Modules/ExternalProject.cmake:3163 (_ep_set_directories)
  cmake/External_GTest.cmake:46 (ExternalProject_Add)
  CMakeLists.txt:66 (INCLUDE)


Configuring incomplete, errors occurred!
See also "C:/Users/Franck/Documents/gvirtualxray-bin/CMakeFiles/CMakeOutput.log".
See also "C:/Users/Franck/Documents/gvirtualxray-bin/CMakeFiles/CMakeError.log".
```

Illustration

- gVirtualXRay-1.1.3
  - Bin2C.cmake
  - CreateHeaderFiles.cmake
  - gVirtualXRayConfig.cmake
  - include
  - lib
  - LICENSE.txt
  - test
  - third_party



Where is the source code: C:/Users/Franck/Documents/gvirtualxray-trunk

Where to build the binaries: C:/Users/Franck/Documents/gvirtualxray-bin

Search: install ✓ Grouped ✓ Advanced

Name	Value
CMAKE	

Press Configure to update and display new values in red, then press Generate to generate selected build files.

Current Generator: Visual Studio 15 2017

```
Could NOT find Git (missing: GIT_EXECUTABLE)
CMake Error at C:/Program Files/CMake/share/cmake-3.14/Modules/ExternalProject.cmake:1712 (file):
  file problem creating directory: C:/Program Files
  (x86)/gVirtualXRay-Superbuild/third_party
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CMake Error at C:/Program Files/CMake/share/cmake-3.14/Modules/ExternalProject.cmake:1714 (message):
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Call Stack (most recent call first):
  C:/Program Files/CMake/share/cmake-3.14/Modules/ExternalProject.cmake:3163 (_ep_set_directories)
  cmake/External_GTest.cmake:46 (ExternalProject_Add)
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Configuring incomplete, errors occurred!
See also "C:/Users/Franck/Documents/gvirtualxray-bin/CMakeFiles/CMakeOutput.log".
See also "C:/Users/Franck/Documents/gvirtualxray-bin/CMakeFiles/CMakeError.log".
```
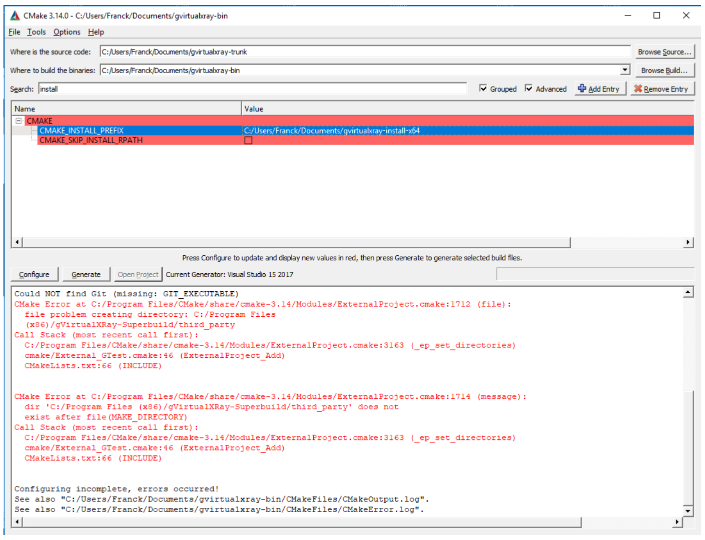

Illustration



Where is the source code: C:/Users/Franck/Documents/gvirtualxray-trunk

Where to build the binaries: C:/Users/Franck/Documents/gvirtualxray-bin

Search: install ✓ Grouped ✓ Advanced

Name	Value
CMAKE	
CMAKE_INSTALL_PREFIX	C:/Users/Franck/Documents/gvirtualxray-install-x64
CMAKE_SKIP_INSTALL_RPATH	☐

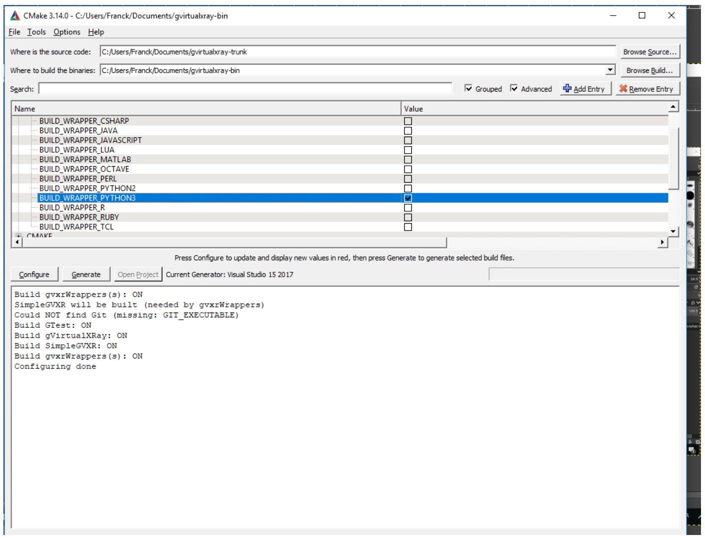
Press Configure to update and display new values in red, then press Generate to generate selected build files.

Current Generator: Visual Studio 15 2017

```
Could NOT find Git (missing: GIT_EXECUTABLE)
CMake Error at C:/Program Files/CMake/share/cmake-3.14/Modules/ExternalProject.cmake:1712 (file):
  file problem creating directory: C:/Program Files
  (x86)/gVirtualXRay-Superbuild/third_party
Call Stack (most recent call first):
  C:/Program Files/CMake/share/cmake-3.14/Modules/ExternalProject.cmake:3163 (_ep_set_directories)
  cmake/External_GTest.cmake:46 (ExternalProject_Add)
  CMakeLists.txt:66 (INCLUDE)


CMake Error at C:/Program Files/CMake/share/cmake-3.14/Modules/ExternalProject.cmake:1714 (message):
  dir 'C:/Program Files (x86)/gVirtualXRay-Superbuild/third_party' does not
  exist after file(MAKE_DIRECTORY)
Call Stack (most recent call first):
  C:/Program Files/CMake/share/cmake-3.14/Modules/ExternalProject.cmake:3163 (_ep_set_directories)
  cmake/External_GTest.cmake:46 (ExternalProject_Add)
  CMakeLists.txt:66 (INCLUDE)


Configuring incomplete, errors occurred!
See also "C:/Users/Franck/Documents/gvirtualxray-bin/CMakeFiles/CMakeOutput.log".
See also "C:/Users/Franck/Documents/gvirtualxray-bin/CMakeFiles/CMakeError.log".
```

Illustration

  - UsegVirtualXRay.cmake
- SimpleGVXR-1.0.1
  - include
  - lib
  - SimpleGVXR-doc.i
  - SimpleGVXRConfig.cmake
  - test
  - UseSimpleGVXR.cmake
- gvxrWrapper-1.0.1


CMake 3.14.0 - C:/Users/Franck/Documents/gvirtualxray-bin

Where is the source code: C:/Users/Franck/Documents/gvirtualxray-trunk

Where to build the binaries: C:/Users/Franck/Documents/gvirtualxray-bin

[✓ Grouped] [✓ Advanced]

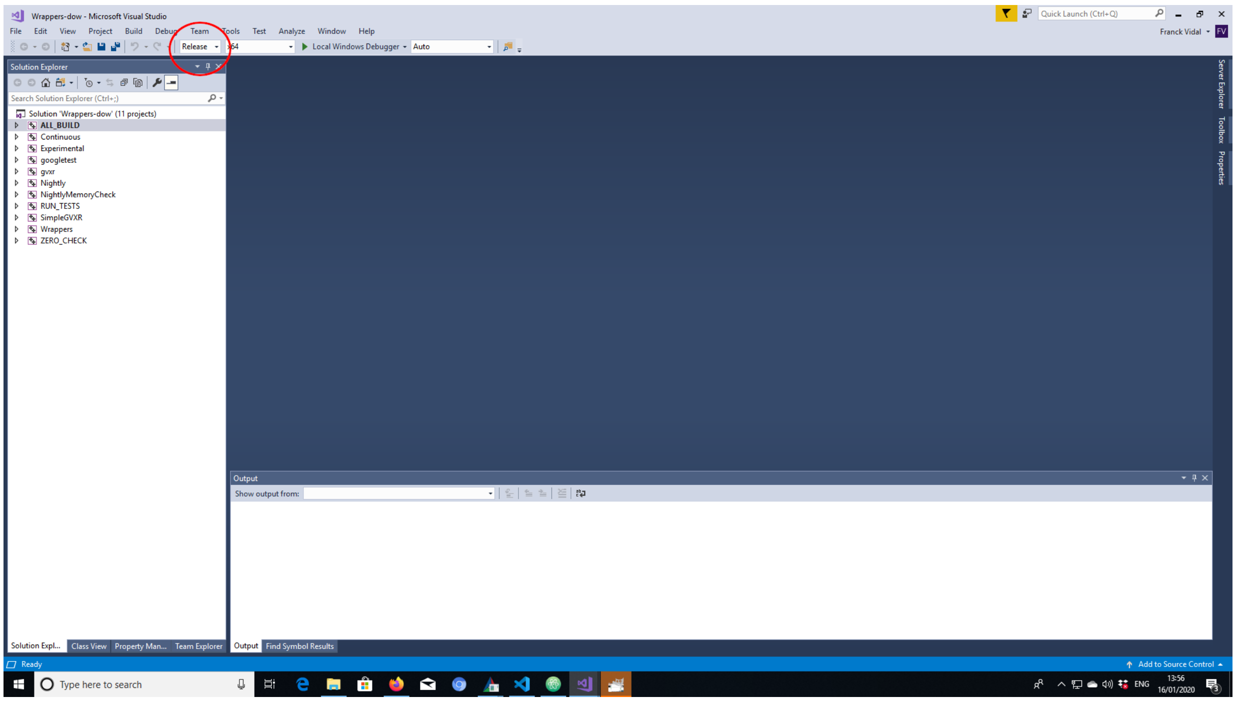
Name	Value
BUILD_WRAPPER_CSHARP	☐
BUILD_WRAPPER_JAVA	☐
BUILD_WRAPPER_JAVASCRIPT	☐
BUILD_WRAPPER_LUA	☐
BUILD_WRAPPER_MATLAB	☐
BUILD_WRAPPER_OCTAVE	☐
BUILD_WRAPPER_PERL	☐
BUILD_WRAPPER_PYTHON2	☐
BUILD_WRAPPER_PYTHON3	✓
BUILD_WRAPPER_R	☐
BUILD_WRAPPER_RUBY	☐
BUILD_WRAPPER_TCL	☐

Press Configure to update and display new values in red, then press Generate to generate selected build files.

Current Generator: Visual Studio 15 2017

```
Build gvxrWrappers(s): ON
SimpleGVXR will be built (needed by gvxrWrappers)
Could NOT find Git (missing: GIT_EXECUTABLE)
Build GTest: ON
Build gVirtualXRay: ON
Build SimpleGVXR: ON
Build gvxrWrappers(s): ON
Configuring done
```

Illustration

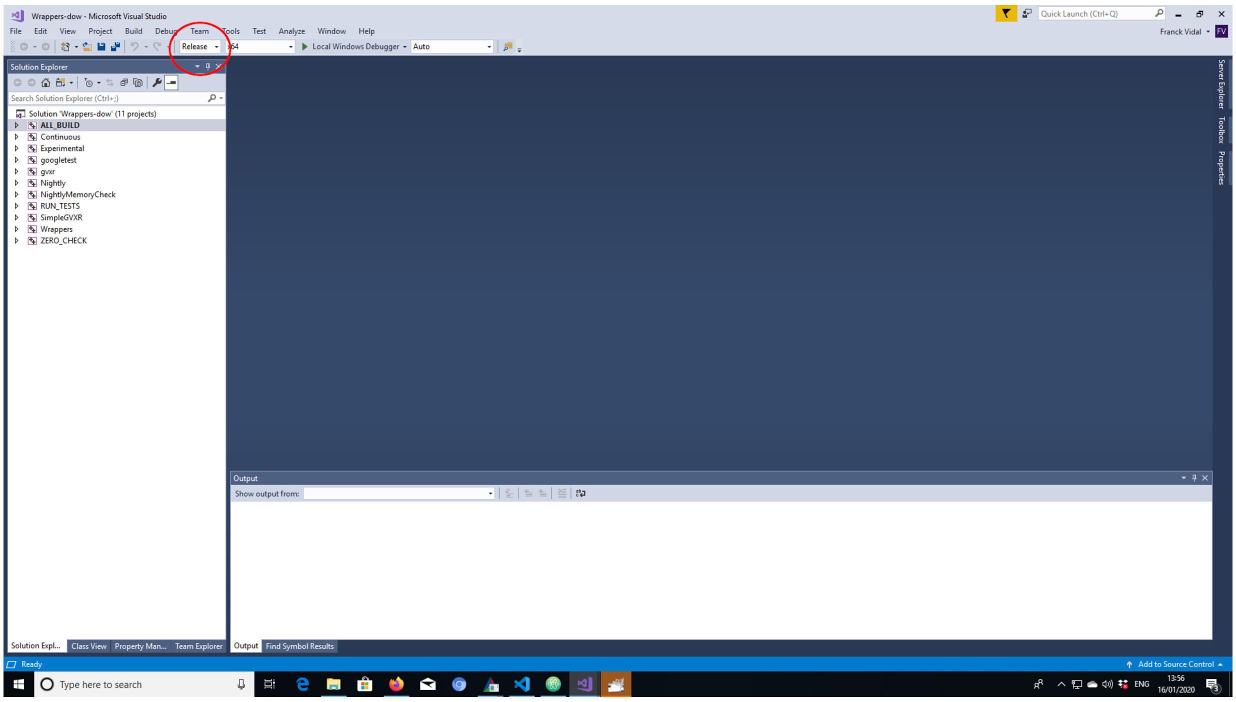

Wrappers-dow - Microsoft Visual Studio

Release | x64 | Local Windows Debugger | Auto

Solution 'Wrappers-dow' (11 projects)
- ALL_BUILD
- Continuous
- Experimental
- googletest
- gvxr
- Nightly
- NightlyMemoryCheck
- RUN_TESTS
- SimpleGVXR
- Wrappers
- ZERO_CHECK
File Edit View Project Build Debug Team Tools Test Analyze Window Help
Quick Launch (Ctrl+Q)
Franck Vidal
Solution Explorer
Search Solution Explorer (Ctrl+;)
Output
Show output from:
Solution Expl... Class View Property Man... Team Explorer
Output Find Symbol Results
Server Explorer Toolbox Properties
Ready
Add to Source Control
Type here to search
ENG
13:56
16/01/2020

Illustration

- data
- python3



Illustration

Installation directory content in GNU/Linux and Mac OS X

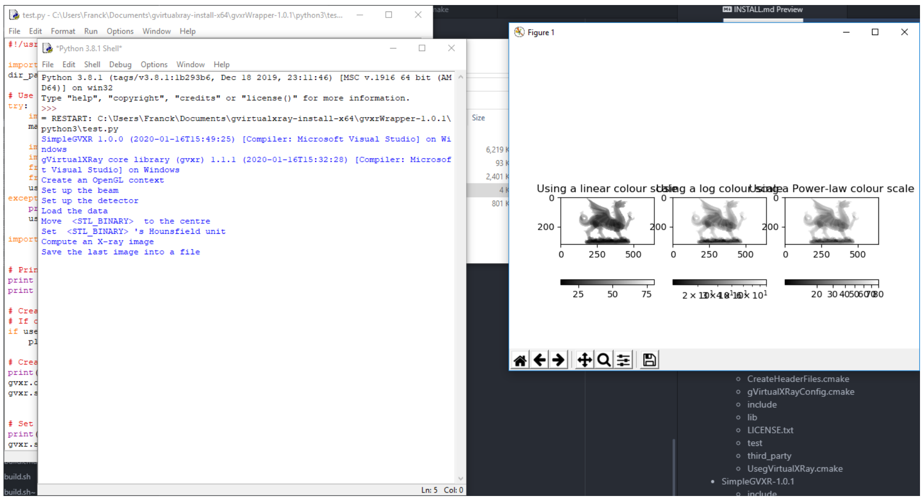
On Unixes, you Should see 3 or 4 directories in the installation directory depending on wrappers:

- third_party
  - include
  - lib (Windows and Mac OS X) or lib64 (GNU/Linux)
- gVirtualXRay-1.1.3
  - Bin2C.cmake
  - CreateHeaderFiles.cmake
  - gVirtualXRayConfig.cmake
  - include
  - lib
  - LICENSE.txt
  - test
  - third_party
  - UsegVirtualXRay.cmake
- SimpleGVXR-1.0.1
  - include
  - lib

  - SimpleGVXR-doc.i
  - SimpleGVXRConfig.cmake
  - test
  - UseSimpleGVXR.cmake
- gvxrWrapper-1.0.1
  - data
  - python3

Test the Python wrapper

1. Go to `gvxrWrapper-1.0.1/python3`,
2. Execute the test script. You should see something like:



```
Python 3.8.1 (tags/v3.8.1:1b293b6, Dec 18 2019, 23:11:46) [MSC v.1916 64 bit (AM
D64)] on win32
Type "help", "copyright", "credits" or "license()" for more information.
>>>
= RESTART: C:\Users\Franck\Documents\gvirtualxray-install-x64\gvxrWrapper-1.0.1\
python3\test.py
SimpleGVXR 1.0.0 (2020-01-16T15:49:25) [Compiler: Microsoft Visual Studio] on Wi
ndows
gVirtualXRay core library (gvxr) 1.1.1 (2020-01-16T15:32:28) [Compiler: Microsof
t Visual Studio] on Windows
Create an OpenGL context
Set up the beam
Set up the detector
Load the data
Move  <STL_BINARY>  to the centre
Set  <STL_BINARY> 's Hounsfield unit
Compute an X-ray image
Save the last image into a file
```

test.py - C:\Users\Franck\Documents\gvirtualxray-install-x64\gvxrWrapper-1.0.1\python3\tes...
Python 3.8.1 Shell
Figure 1
Using a linear colour scale
Using a log colour scale
Using a Power-law colour scale
INSTALL.md Preview

The X-ray image is displayed using linear, log and power law colour scales using Matplotlib.

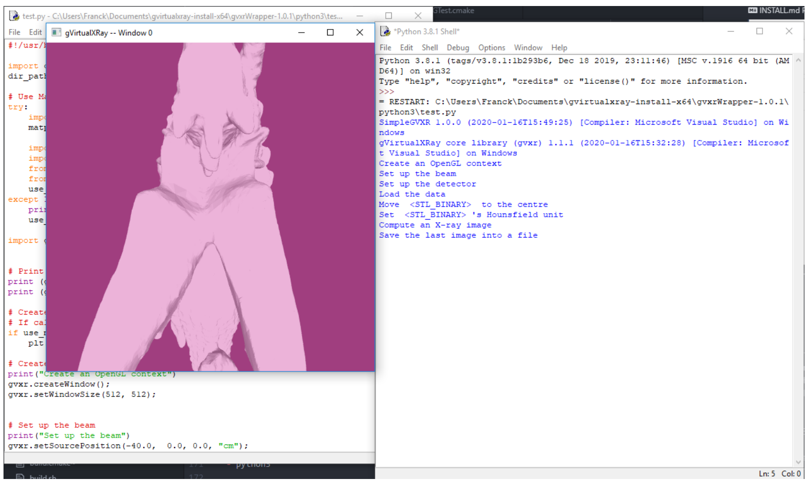
3. Press `<Q>` to close this window and the real-time viewer will open:

4. Use the mouse wheel to zoom-out:

5. Use the mouse left button and move the mouse around to adjust the view:

6. Press `<B>` to hide/show the X-ray beam:

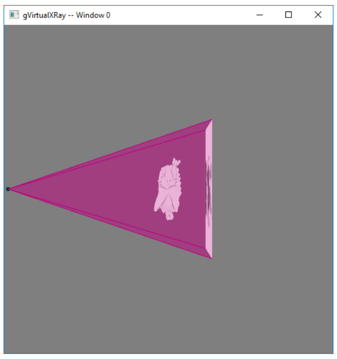
7. Press `<W>` to view the 3-D object in solid/wireframe mode:


test.py - C:\Users\Franck\Documents\gvirtualxray-install-x64\gvxrWrapper-1.0.1\python3\tes...
gVirtualXRay -- Window 0
Python 3.8.1 Shell
File Edit Shell Debug Options Window Help

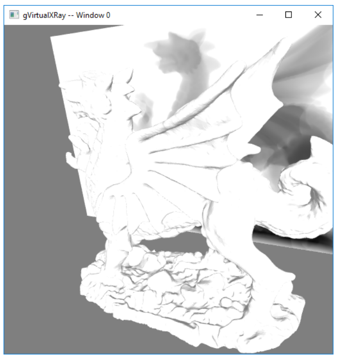
```
print("Create an OpenGL context")
gvxr.createWindow();
gvxr.setWindowSize(512, 512);


# Set up the beam
print("Set up the beam")
gvxr.setSourcePosition(-40.0,  0.0, 0.0, "cm");
```

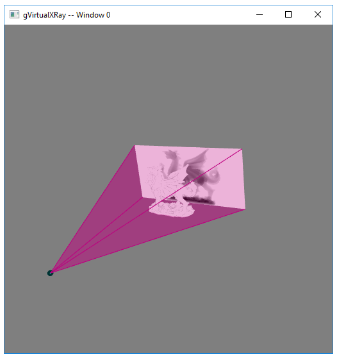
```
Python 3.8.1 (tags/v3.8.1:1b293b6, Dec 18 2019, 23:11:46) [MSC v.1916 64 bit (AM
D64)] on win32
Type "help", "copyright", "credits" or "license()" for more information.
>>>
= RESTART: C:\Users\Franck\Documents\gvirtualxray-install-x64\gvxrWrapper-1.0.1\
python3\test.py
SimpleGVXR 1.0.0 (2020-01-16T15:49:25) [Compiler: Microsoft Visual Studio] on Wi
ndows
gVirtualXRay core library (gvxr) 1.1.1 (2020-01-16T15:32:28) [Compiler: Microsof
t Visual Studio] on Windows
Create an OpenGL context
Set up the beam
Set up the detector
Load the data
Move  <STL_BINARY>  to the centre
Set  <STL_BINARY> 's Hounsfield unit
Compute an X-ray image
Save the last image into a file
```

Illustration

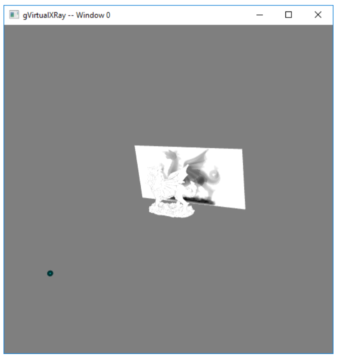


Illustration

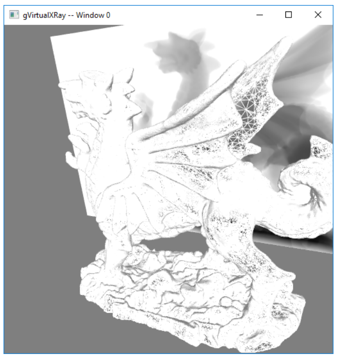




Illustration



Illustration



8. You can also press `<N>` to display the X-ray image in negative or positive and `<H>` to hide/show the X-ray detector.
9. Press `<Q>` or `<ESC>` to exit. When the script ends, there'll be two new files:

- `xray_image-0.mha`: contains the X-ray image. MHA fies can be viewed with the popular scientific image viewer tool ImageJ/Fiji.

- `lbuffer-0.mha`: contains the length of X-rays crossed in the 3-D object.

10. If you want to create your own simulations, have a look at the script. You can find it at `https://sourceforge.net/p/gvirtualxray/code/HEAD/tree/trunk/Wrappers/python3/test.py`.

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