**SHARAD3d plug-in for QGIS**

***Release 1.0***

***Si-Ting Xiong (UCL)***

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CONTENTS

1 1 About the plug-in 3

2 2 Installation 4

2.1 Install dependencies 4

2.2 Install SHARAD3d plug-in 4

3 3 Using the plug-in 6

3.1 Running the plug-in 6

3.2 Select folder as workspace 6

3.3 ROI and Downloading 6

3.4 2-D Processing 7

3.5 3-D Processing 8

**CHAPTER**

**ONE**

1. ABOUT THE PLUG-IN

*SHARAD3d* isa plug-in for the QGIS software (http://www.qgis.org/). It aims to provide an easy way to download and clip the SHARAD data (http://mars.nasa.gov/mro/mission/instruments/sharad/) to a ROI and further to extract subsurface reflections from these data to reconstruct the subsurface topography.

It is written in Python and uses the PyQtGraph (http://www.pyqtgraph.org/) library for 2D and 3D plots rendering. The plug-in is made to work together with SHARAD coverage shapefiles which can be downloaded from the following link.

http://ode.rsl.wustl.edu/mars/coverage/ODE\_Mars\_shapefile.html

The development work leading to these results has received funding from the Chinese Scholarship Council and University College London.

**CHAPTER**

**TWO**

1. INSTALLATION
   1. Install dependencies
      1. GNU/Linux

**Debian 8 (Jessie)**

**Ubuntu 16 LTS (Xenial Xerus)**

**CentOS 7**

* + 1. Apple OSX

Download and install QGIS

Download and install *QGIS* from https://www.qgis.org/en/site/forusers/download.html#mac or directly from http://www.kyngchaos.com/software/qgis

**Download and install dependencies**

The following packages are needed for this plug-in and can be downloaded with *pip install*:

* NumPy
* SciPy
* Scikit-learn
* Gdal
* Skimage
* pyqtgraph
  + 1. Microsoft Windows
  1. Install SHARAD3d plug-in
     1. Download the plug-in

You can download the latest release version (or any other version at your choice) from

https://github.com/xiongsiting/SHARAD3D and uncompress the archive.

* + 1. Installing the plug-in

Copy the folder *SHARAD3d* containing the plug-in files in the QGIS plug-ins folder.

The folder may be named *SHARAD3d-<branch\_name>*. Rename it to *SHARAD3d*.

Location of the QGIS plug-ins folder

|  |  |
| --- | --- |
| Operating system | Folder location |
| GNU/Linux | /home/*{username}*/.qgis2/python/plugins |
| OSX | /Users/*{username}*/.qgis2/python/plugins |
| Windows | C:\users\{*username*}\.qgis2\python\plugins |

Launch QGIS, the *‘SHARAD3d’* menu should appear in the menu bar under *Plugins->SHARAD3d -> SHARAD3d* as shown in the figure below. If not, open the plug-ins manager from the menu bar using *Plugins-> Manage and install plugins...* and activate *SHARAD3d.*

**CHAPTER**

**THREE**

1. USING THE PLUG-IN
   1. Running the plug-in

Once the features of interest are selected, the plug-in can be started using either the *Plugins ->SHARAD3d -> SHARAD3d* menu or by pressing the plug-in launch button (see figure below).

The plug-in shows as the figure below. It has four sections: I Select folder as workspace; II ROI and Downloading; III 2D processing; IV 3D processing and a textBrowser for showing guidance and message.

* 1. Select folder as workspace

Choosing a folder in the disk as the work space where data will be downloaded and processed.

Two folders which are named *Radargrams* and *Results* will be created automatically for storing the downloaded SHARAD data and processed result.

|  |
| --- |
| ~/<*workspace>/Radargrams*  *~/<workspace>/Results* |

* 1. ROI and Downloading

The Region of Interest (ROI) and the SHARAD footprint can be chosen from the QGIS layers in the comboBox.

Click the button ‘*Create data list*’, a TXT file named *datalist.txt* will be generated in the working folder, which contains all the SHARAD product ID covering the chosen ROI.

Click the button ‘*Download data’*, all the SHARAD radargrams listed in the *datalist.txt* will be downloaded in the folder named *workspace/Radargrams.*

|  |
| --- |
| ~/<*workspace>/datalist.txt* |

Click the button ‘*Project’* to project the SHARAD latitude and longitude into the same projection with MOLA DTM.

* 1. 2-D Processing

In this step, the subsurface reflections are extracted from radargrams in the folder of *workspace/Radargrams.* Processing all radargrams may take a long time (hours) depending on the number of radargrams.

* + 1. Set up parameters

*Path to DTM [geotif]:*

Choose the DTM from the QGIS layers as the external DTM for simulating cluttergram.

*DTM width*:

The half width of the DTM patch around the SHARAD footprints used for simulating the cluttergram.

*wavelet scales:*

Wavelet scales used for CWT-based peak detection. The higher value, the fewer number of detected peaks.

*log-Gabor filters (optional):*

Parameters related to log-Gabor filtering. If this is left blank, no filtering before peak detection is carried out. Otherwise, indicate the number of frequency, the multiple factor and the number of orientation angles for inputting to log-Gabor filtering.

*min trace:*

Limit the number of footprints after clipping the radargram with ROI, which means if the radargram after clipping having trace less this threshold is not processed.

*min points:*

Limit the number of points after peak detection. This parameter is to remove isolated points or point cluster less than this threshold.

* + 1. Processing radargrams

*Button ‘Extract’*

Extract subsurface reflections from one chosen radargram in the viewing box with optional log-Gabor filtering to the original radargram, CWT-based peak detection, removal of clutter reflections and output of the final subsurface reflections.

*Button ‘Extract all’*

The function is the same with the button ‘*Extract’,* but the 2-D processing is applied to all radargrams in the *datalist.txt*

* + 1. Examine the results

*Button ‘Load list’:*

Load the product ID in *workspace/datalist.txt* into the list viewing box.

Users can view the results of the chosen radargrams by double clicking the product Id in the viewing box. If this radargram has been processed, then a browse figure will be shown in the right panel.

*Button ‘Save list’*:

Save the list in the viewing box into a new file which overwrite the *workspace/datalist.txt*.

* 1. 3-D Processing
     1. Generate point cloud

*Button ‘PtCloud’:*

Generate the point cloud file by combining all *workspace/\*subpt.txt* files relating to the product id which is listed in *workspace/datalist.txt*.

* + 1. Classify points forming 3D layers

*Button ‘Generate 3D layers’:*

Using the DBSCAN and Hierarchical clustering to divide the point cloud into subsurface layers. Several parameters need to be set up.

*DBSCAN eps*

*DBSCAN dist*

*layer numbers:*

* + 1. Interpolate to raster subsurface

*Button ‘Interpolation to raster’:*

Interpolate the classified points into subsurface DTMs. Several parameters need to be set up….