Instructions of Kinect Acquisition Analogue Models (KAM) Software for Kinect v2
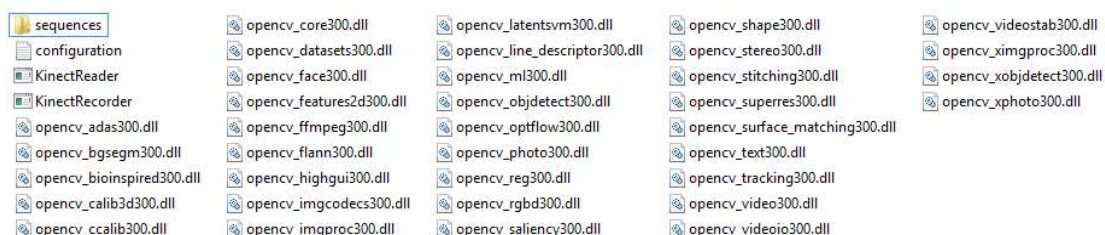
1. Kinect installation.

- 1.1. SDK installation on the computer: SDK v2.0 can be downloaded from the Microsoft website https://www.microsoft.com/en-us/download/details.aspx?id=44561 (follow the instructions for installation). It is advisable to read the system requirements for appropriate installation and operation.

- 1. 2. Connect sensor Kinect v2 to USB 3.0 port. To verify that Sensor Kinect v2 is installed correctly, you can open Microsoft Kinect Studio (this software is downloaded together with the SDK).

  (Be sure that you have downloaded all the Windows updates. If Kinect is not working at first time, reboot your computer).

2. KAM software installation.

- 2.1. Download KAM.zip from https://github.com/capo-urjc
- 2.2. Open Zip file and extract all files in a folder.
- 2.3. Open KAM folder. Inside the folder where you have unzipped the file, you will find the following folders and files.

📁 sequences	opencv_core300.dll	opencv_latentsvm300.dll	opencv_shape300.dll	opencv_videostab300.dll
configuration	opencv_datasets300.dll	opencv_line_descriptor300.dll	opencv_stereo300.dll	opencv_ximgproc300.dll
KinectReader	opencv_face300.dll	opencv_ml300.dll	opencv_stitching300.dll	opencv_xobjdetect300.dll
KinectRecorder	opencv_features2d300.dll	opencv_objdetect300.dll	opencv_superres300.dll	opencv_xphoto300.dll
opencv_adas300.dll	opencv_ffmpeg300.dll	opencv_optflow300.dll	opencv_surface_matching300.dll	
opencv_bgsegm300.dll	opencv_flann300.dll	opencv_photo300.dll	opencv_text300.dll	
opencv_bioinspired300.dll	opencv_highgui300.dll	opencv_reg300.dll	opencv_tracking300.dll	
opencv_calib3d300.dll	opencv_imgcodecs300.dll	opencv_rgbd300.dll	opencv_video300.dll	
opencv_ccalib300.dll	opencv_imgproc300.dll	opencv_saliency300.dll	opencv_videoio300.dll	

3. Kinect v2 data acquisition using KAM.

KAM software allows the simultaneous acquisition of RGB images and Depth information of the monitored models. Those data are stored in image files where the value of each pixel is the distance from the Kinect device to the experiment surface in millimetres.

- 3.1. Double-Click on "KinectRecorder" file.
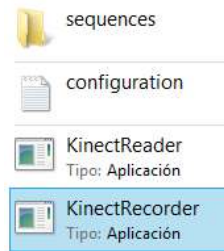
- 3.2. A window will appear with the message: *"insert frame rate for RGB image"*. You must introduce here the number of RGB-images per second that you want to obtain. Example: If you want 1 RGB img/sec, you should enter 1.
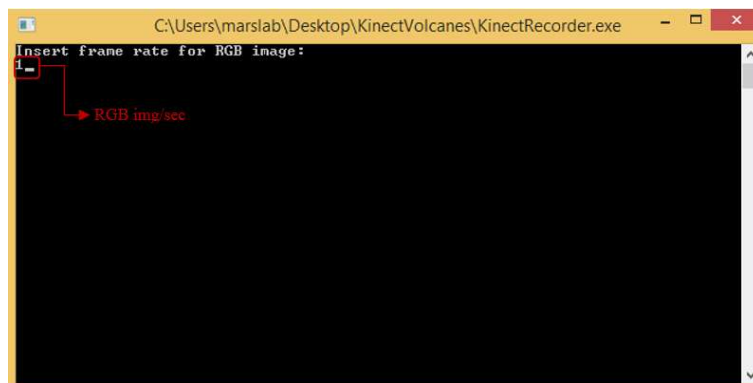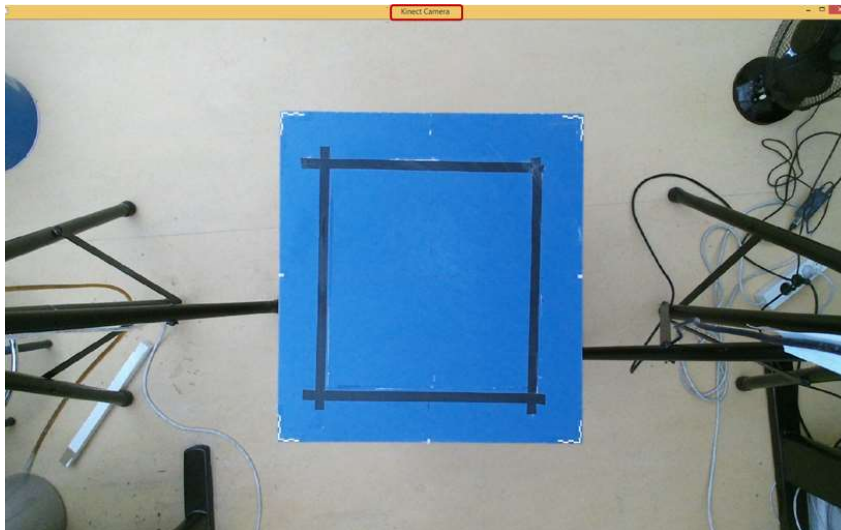

- 3.3. Press Enter key.
- 3.4. Then, the message "*insert frame rate for depth image*" will appear. Once again, you must introduce the number of Depth-images per second that you want to obtain. Example: 2 img/sec.

  (Different images per second for RGB and Depth data can be recorded).
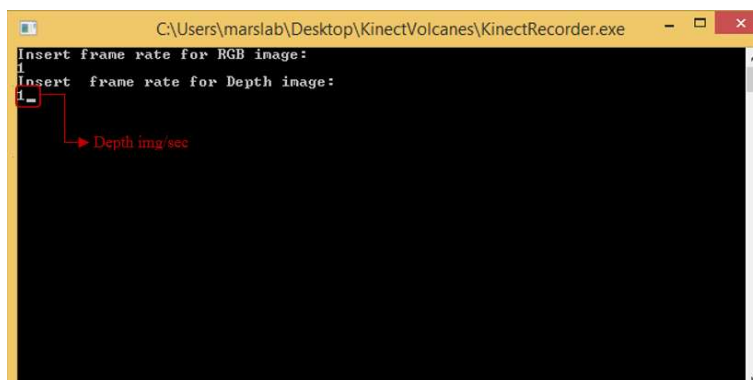
- 3.5. Press Enter key.
- 3.6. A new window will appear where you can choose the RGB camera for capturing images (any external camera, the computer Cam or the Kinect Cam). Click with the mouse over "Kinect Camera" window bar and then press the space key to see the different cameras available.


- 3.7. Press Enter key to select the RGB camera to be used. The Kinect Camera window is called now "Select Region of interest" (Region-Of-Interest to be recorded). Then, you have the option to crop a region of interest for the RGB image (Click and drag with left mouse button). This is useful in order to obtain a higher frame-rate.
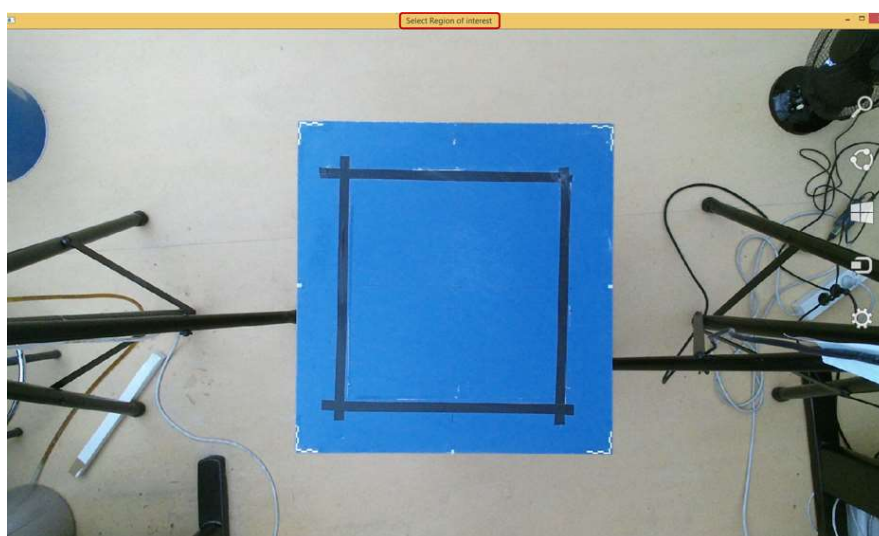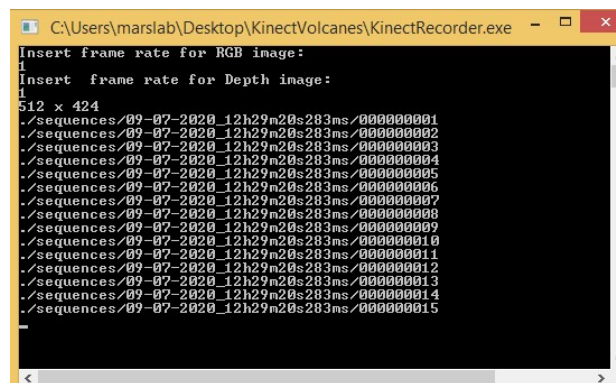

- 3.8. Press Enter key.

- 3.9. Wait for a few seconds and two additional windows will appear: the RGB-image and the Depth image.
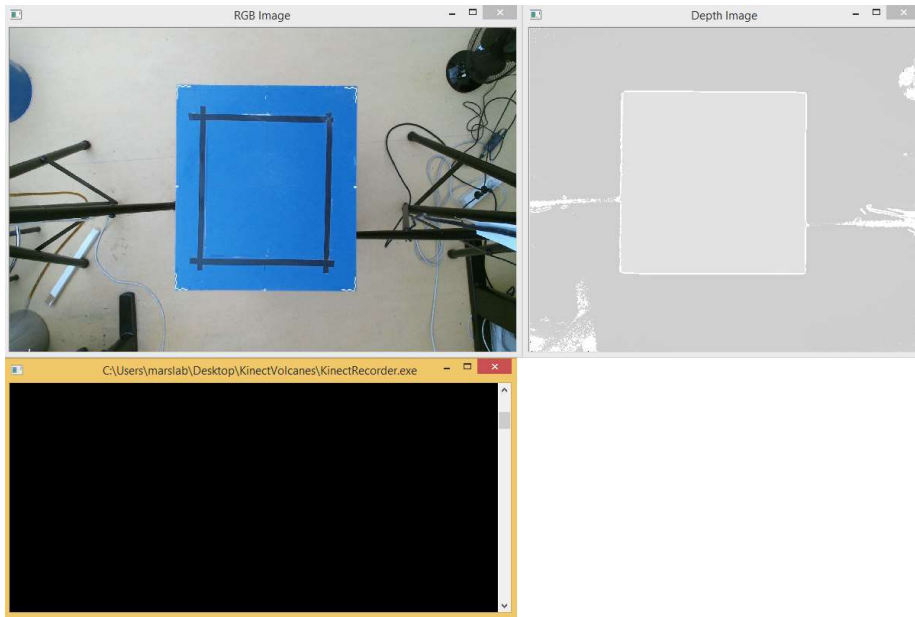
Suggestion: the RGB-image and Depth-image windows are not full screens: locate the centre of the experiment in the vertical of the centre of the Kinect sensor, to reduce possible distortion.

- 3.10. Locate the mouse over *"RGB Image Window"* or *"Depth Window"*, click with mouse left button and press Enter key. In that moment KAM will start the data acquisition. You will see in the screen the different images captured at real-time when they are obtained.

- 3.11. To stop data acquisition, click with the mouse over *"RGB Image Window"* or *"Depth Window"* and press Enter Key.

4. Format of KAM data storage.

All the data are stored in the *"sequences"* folder. Inside this folder another folder has been created with a name *DD-MM-YY_AAhBBmCCsXXXms where DD, MM, YY are day month and year of recording, AA, BB, CC, XXX are hour, minutes, seconds and miliseconds, "h", "m","s" and "ms" are separators*.
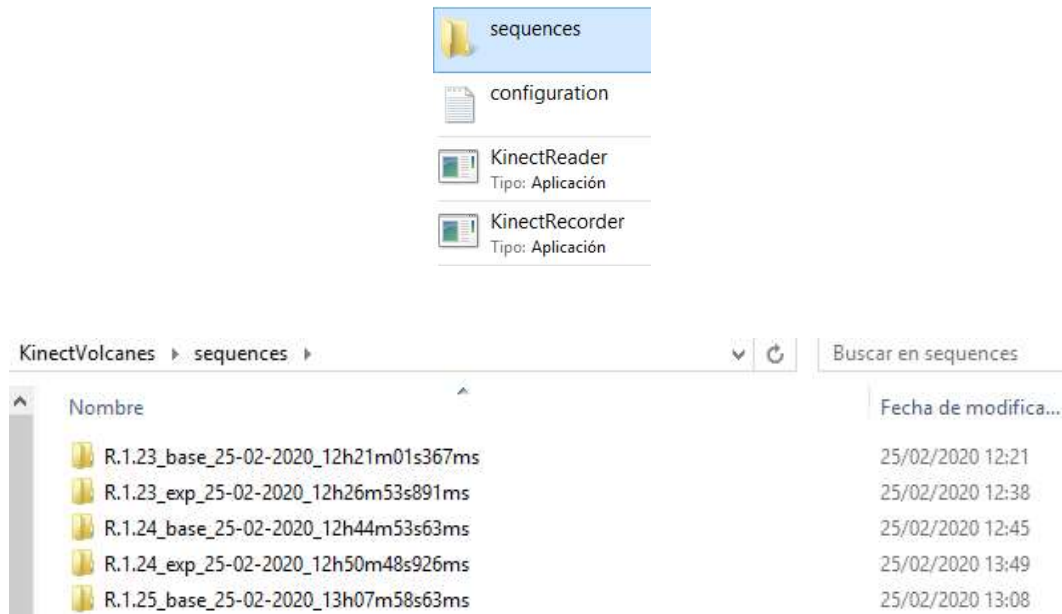

In the folder you will find RGB-images in files with ".png" format and Depth-data in files without extension (512 x 424 images stored in binary format with no header). The names of both types of files are related to their acquisition order (00001, 00002…); i.e., you will find both a 00001.png and a 00001 files corresponding respectively to the RGB-image and the depth data obtained in time 1 of the monitoring. In addition, two text files called *"Colour Info"* and *"Depth Info"* included in the same folder contain information about the precise time when each image was acquired.

5. KAM tool for averaging Depth-data to reduce the noise.

This step is optional: you only need to apply it if you want to reduce the noise of the Kinect v2 Depth-data obtained by the averaging several consecutive acquisitions.

- 5.1. In the folder, open *"configuration"* file with a text editor: at the first line copy-and-paste the directory where RGB-images and Depth-files that you want to process are located, and in the second line type the number of distance-images that you want to average. Example: If you recorded 90 depth data and want to make the means of each 3 images, you will get 30 depth data.
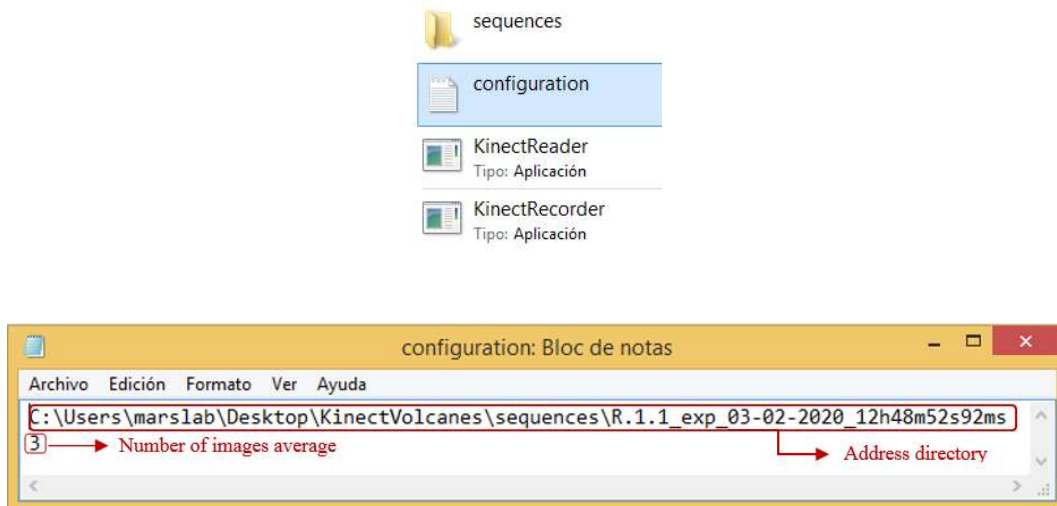
- 5.2. Save changes and close this window.
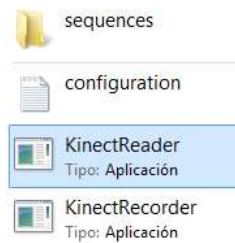
- 5.3. Double-Click on *"KinectReader"* file and the averages are calculated automatically.
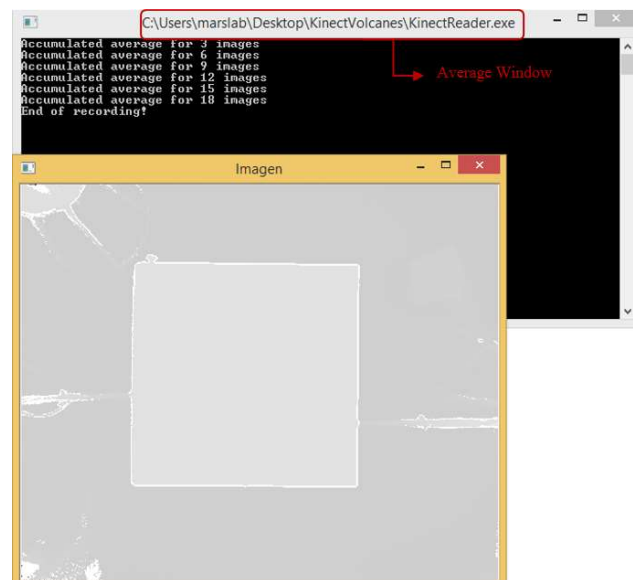
- 5.4. Close "*Average Window"*, when you see the message *"End of recording"*. The files resulting from the averages are stored in a folder called "*average*" located inside the folder where your data are located. Those averaged-depth are also named sequentially (00001,

00002) with no extension and their format is the same that the original depth-data files (512 x 424 binary images).
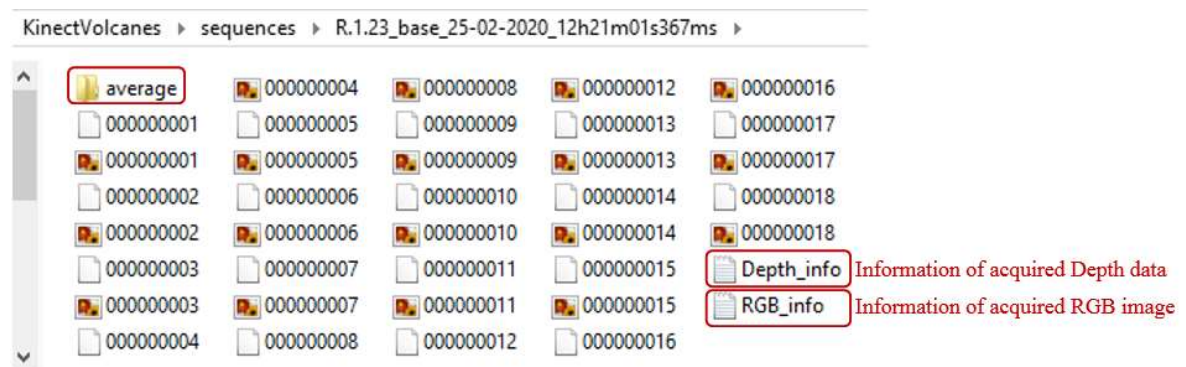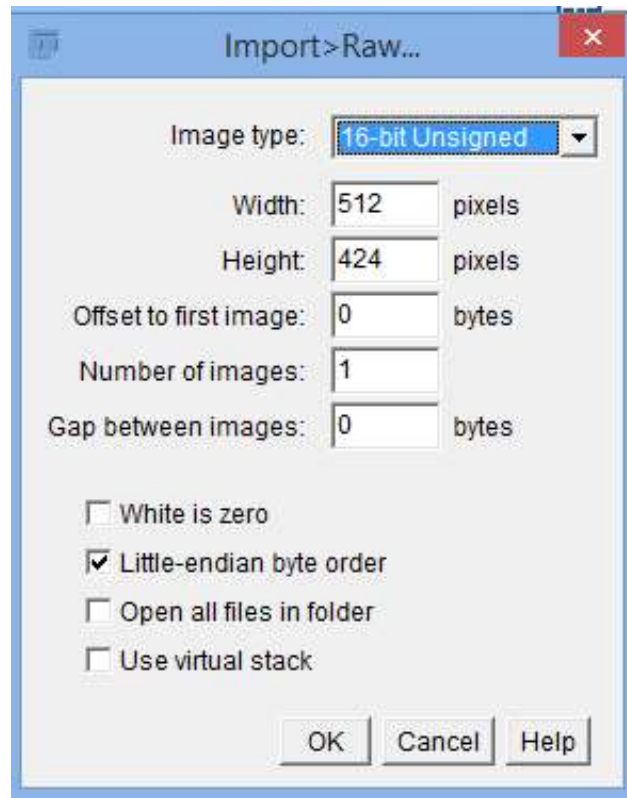

6. Obtaining DEMs of the models from Kinect v2 Depth-data of KAM software.

- Importing KAM-derived Kinect v2 depth-data as an image.

Kinect v2 depth-data obtained with KAM are binary files of 512 samples and 424 lines, with no extension. Pixel values are the distance from the Kinect device to the experiment surface expressed in millimetres, stored in 16-bit format. No header is stored either in additional file or in the data file. With this basic information, depth-data can be easily imported in any common image software.

We have used in the case study show in this work the free software Fiji distribution of ImageJ (https://fiji.sc/). This software is very easy to use and contains a lot of tools for image processing. To open depth-data and visualize it as an image, you can just import it as a "raw" file with its dimensions:

- 6.2. Digital Elevation Models (DEM) from Kinect v2 distance images.

The pixel values of the image imported from Kinect v2 depth-data are the distance (in millimetres) between the device and the model surface. In order to obtain a Digital Elevation Model (i.e., an image where the pixel value will be the height of the model above its base) from each of those images, we propose to make a subtraction of each distance image of the experiment and a distance image of the table obtained before the experiment was performed; i.e., we first make all the previous mentioned steps on the clean base table without the volcano. That image subtraction can be easily done in any image processing software, obtaining an image where the pixel value is the altitude of the experiment surface over the basal table.

This simple approach for building DEM experiments is useful also to remove the common problems of non-parallel setting of the Kinect sensor with respect to the experiment base; we have found in some cases that it is not easy to locate the Kinect sensor perfectly horizontal at the rail over the experiment.