

3DUNDERWORLD-SLS v.3.0

“Rapid Scanning and Automatic 3D Reconstruction of Underwater Sites”

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3DUNDERWORLD

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Q&A to use 3DUNDERWORLD-SLS2012 version 3.0 with Canon EOS Cameras

Q1. What you will need?

At least 2 Canon EOS cameras, a projector, a calibration board and an object to scan.

Q2. How to scan and reconstruct?

Step1. Set up the cameras and the projector in a dark room and connect with computer.

Step2. Take a set of Calibration Images and initiate the scanning process (Q3)

Step3. Calibrate the Cameras (Q4,Q5)

Step4. Reconstruct (Q6)

Q3. How do I perform calibration and scan an object?

Step1. Run 3DUNDERWORLD-SLS2012 and select option 3 (option 4 performs just the scan without capturing calibration images).

Step2. Press 'Enter', each time taking a photo of the calibration board in different positions and orientations for the first camera.

Step3. Then press 'Space'; to capture calibration images with the second camera.

Step4. Repeat Step 2 and 3 as many times as required based on the number of connected cameras.

Step5. When you finish, press 'Space'. Then setup the calibration board in such a position that both cameras can see the same area. Press 'Enter' and all connected cameras will capture an image of the scene (those images will be used in order to calculate the extrinsic parameters of the cameras.)

Step6. Set the object to be scanned, at the preferred position, and press 'Enter'. The projector will start projecting patterns of stripes and the cameras automatically will take photos of each projection.

Q4. How do I calibrate the cameras with MatLab?

Download the photos of the calibration board, from the camera, using Canons's provided software, to calibrate the camera using "Camera Calibration Toolbox for MatLab".

Copy the following parameters to files in the folder 'reconstruction/dataset/camX/input/' (where *X* is the number of each camera):

1. Camera Matrix (3x3) to file 'cam_Matrix.txt' file.
2. Distortion Coefficients (3x1) to file 'cam_distortion.txt' file.
3. Rotation Matrix (3X3) to file 'cam_rotation_matrix.txt'.
4. Translation Vector (3x1) to file 'cam_trans_vectror.txt'.

Note: The format of the Camera Matrix used in 3DUNDERWORLD-SLS2012 is:

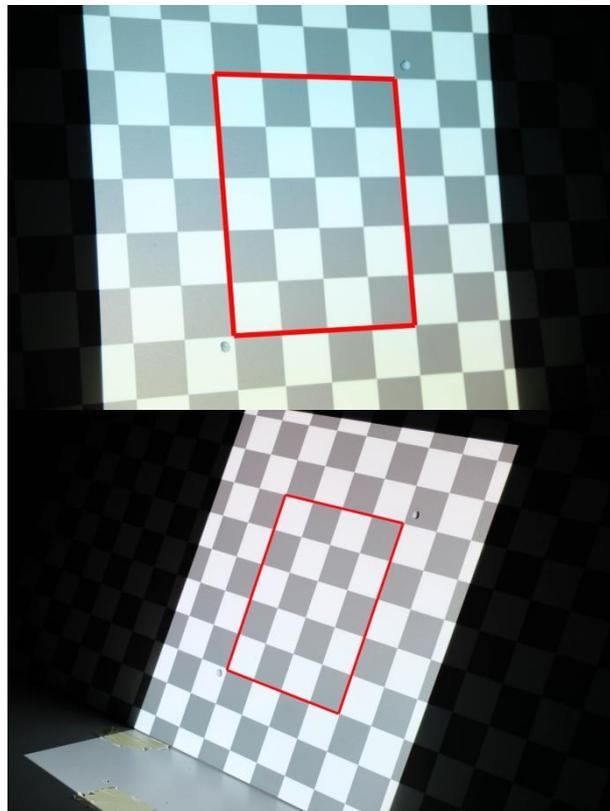
$$\begin{bmatrix} fc.X & 0 & cc.X \\ 0 & fc.Y & cc.Y \\ 0 & 0 & 1 \end{bmatrix}$$

Where *fc* is the focal length and *cc* the principal point.

“Camera Calibration Toolbox for MatLab” Link:

http://www.vision.caltech.edu/bouguetj/calib_doc/

Note: To calculate the extrinsic parameters of the camera use the same area of the calibration board for all the cameras, as can be seen in the following example:



Q5. How do I calibrate the cameras using 3DUNDERWORLD-SLS2012?

You can use 3DUNDERWORLD-SLS2012 to calibrate the cameras. Copy the calibration images in the folder 'calibration\cameraX\' (where **X** is the number of the camera). All calibration images have to be named with a single number starting from 1 (e.g. 1.jpg), except of the one that will be used to calculate the extrinsic parameters which will be named as 'extr' (e.g. extr.jpg).

Run 3DUNDERWORLD-SLS2012 and select option '7', then follow the instructions. When you finish you can find the calibration parameters in the output folder of each camera, and copy them in the folder 'reconstruction/dataset/camX/input/' (where **X** is the number of each camera):

1. Camera Matrix (3x3) to file 'cam_Matrix.txt' file.
2. Distortion Coefficients (3x1) to file 'cam_distortion.txt' file.
3. Rotation Matrix (3X3) to file 'cam_rotation_matrix.txt'.
4. Translation Vector (3x1) to file 'cam_trans_vector.txt'.

Q6. How do I reconstruct the 3D geometry?

Download the photos of the scanned object with the gray code patterns projected on it, to the cameras' folders under 'reconstruction/dataset/'. Copy text files with the calibration parameters in the 'input' folder as specified in Q4 and Q5.

Then run 3DUNDERWORLD-SLS2012 and select option 2.

The application will create a 3D mesh of the object. This mesh (*.obj) cloud can be found in 'reconstruction/output/' folder.

Note: In order for 3DUNDERWORLD-SLS2012 to be able to load the photos, they need to have a specific name format: XX.FFF where XX is the number and FFF the format. For example, if you use JPG format, the first photo must be 01.jpg. Supported formats for the current version are JPG, PNG and TIF.

Q7. How can I view the 3D mesh?

The 3D mesh is exported in a generic format *.obj that is supported by many applications dealing with 3D geometry.

Suggested free application:

MeshLab

Link: <http://meshlab.sourceforge.net>

Q8. Can I project scan patterns without actually scanning the object?

Yes. Run 3DUNDERWORLD-SLS2012 and choose 5. This option lets you project the patterns without the need of a camera to be connected on the PC. You can manually project the next pattern by pressing 'Enter'.

Q9. Can I save the gray-code patterns that 3DUNDERWORLD-SLS2012 uses?

Yes. Run 3DUNDERWORLD-SLS2012 and choose 6. This option will save the gray codes in the folder 'gray'.

Q10. Can I customize 3DUNDERWORLD-SLS2012?

3DUNDERWORLD-SLS2012 let you make some customizations through the file 'slsConfig.xml'.

slsConfig.xml parameters:

Projector: Width and height of the projector image in pixels.

Camera: Width and height of the images that the camera will capture in pixels. The ID of the USB camera. If the camera recognized from 3DUNDERWORLD-SLS2012 is not the one you want to use for scanning (i.e. built-in camera/web camera), you should try changing the ID to 1 or 2.

Projector Window: Position of the left top corner of the projector window. The projector window is actually shown in full screen mode, and this setting is used to specify the screen that projector uses.

Reconstruction: Black threshold is a number between 0-255 that represents the minimum brightness difference required for valid pixels, between the fully illuminated (white) and the non - illuminated images (black) - the first two images of the sequence. White threshold is a number between 0-255 that represents the minimum brightness difference required for valid pixels, between the gray-code pattern and its inverse images.