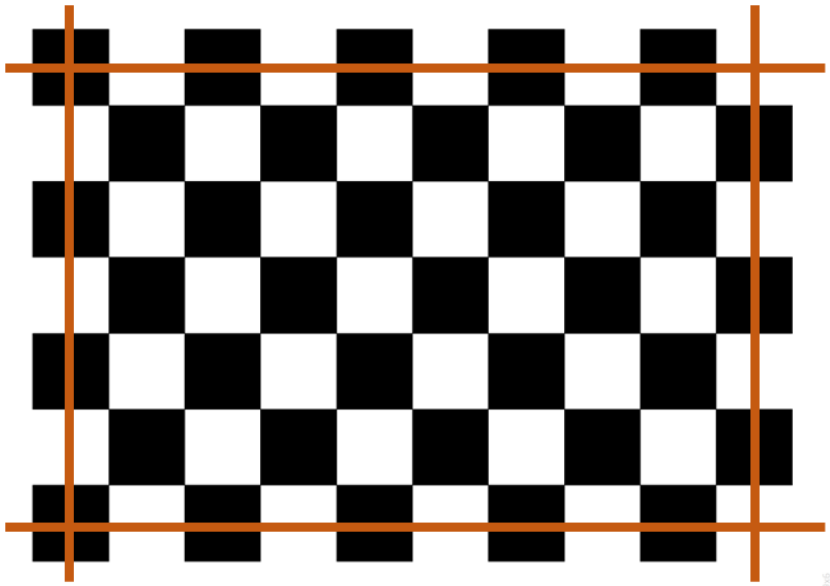
How to Capture Camera-Lens-Calibration Images

1. Download the *calibration_pattern.png* file from our GitHub repository and print it on waterproof paper.

2. Affix the calibration pattern to a clipboard using four rubber bands placed as follows:



= Rubber band placements

   Placing the rubber bands in this fashion prevents water from flowing between the calibration pattern and the clipboard to ensure that the pattern does not move during the imaging process. Ensure nothing occludes the region inside these four rubber bands (the 9 x 6 interior corners of the squares need to be detected) and that the pattern is lying perfectly flat on the clipboard.

3. Affix weights to the backside of the clipboard and place the clipboard in a shallow, low flow, moderate light, and high visibility reef environment. Alternatively, calibration imaging can also be done in an aquarium tank or a pool.

4. Capture 50< images (more is better) of the static calibration pattern from different angles and with the pattern composed in different areas of the image frame. That is, do not capture every image with the pattern in the center of the image frame. Ensure to also capture images with the pattern in the corners of the image and along the borders of the image. Avoid extreme angles (0-20°, where a top-down view is 90°). Equivalently, you can fix the position and orientation of the camera and move the calibration pattern around instead.

Examples of what these images should look like are included in the *Tutorial* folder. We learned that (1) our number of rubber bands and their placements could be improved and (2) images with extreme angles did not perform well, hence the development of the above instructions.

If the clipboard moves at all during the imaging process, you must discard the images and start over. The same applies if the camera moves if it was chosen to be fixed instead of the clipboard. If you have issues printing on the waterproof paper (i.e., melting or warping), you can laminate regular paper instead. In either case, avoid solar glare in the region inside of the 4 rubber bands.

The calibration-imaging process must be repeated for each camera-lens model. For example, do not transform images captured with camera model ‘A’ using calibration parameters from camera model ‘B’ unless both camera models have (1) the same or similar lens specifications and (2) the same image dimensions.

If you are using multiple cameras for your surveys that are the same model, consider calibrating each camera to account for manufacturing tolerances, although this difference would be trivial to most users.