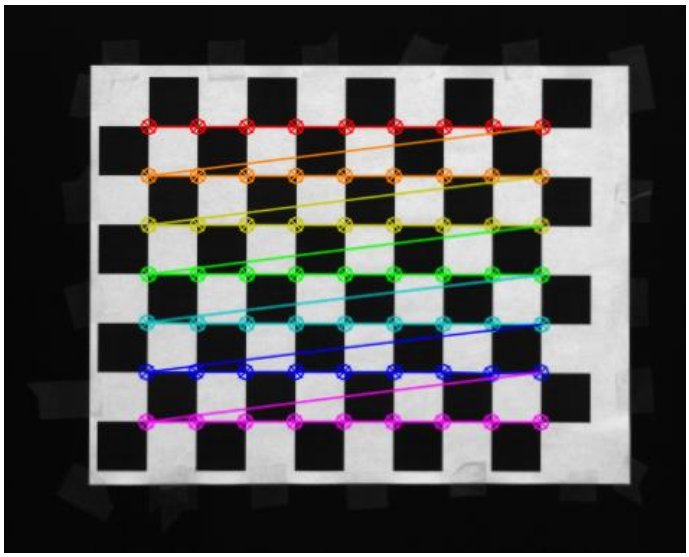
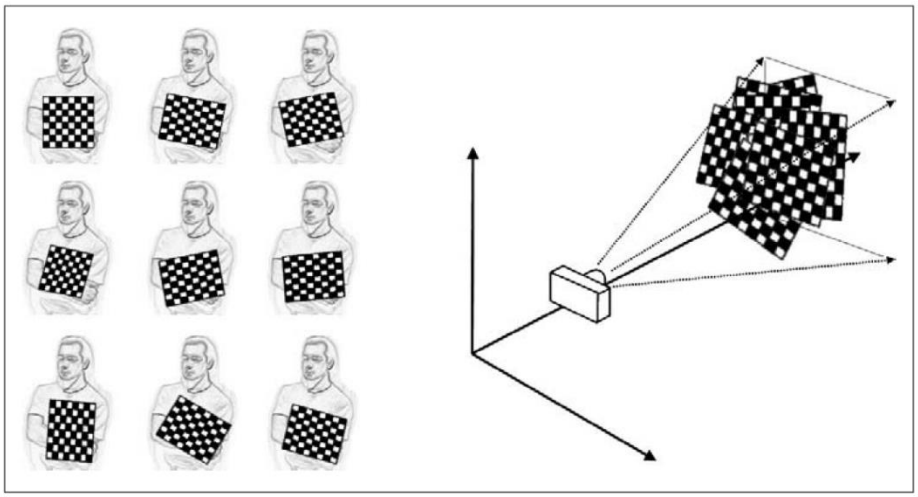
Calibration

- All 3D sensors require some level of calibration
- Data accuracy is only as good as the calibration
- Instrinsic: Calibration specific to individual sensor (only has to be done one time)
- Extrinsic: Calibration specific to lens, camera position, FOV, working distance, etc.
- Many types of calibration methods for varying cameras are available via open source code

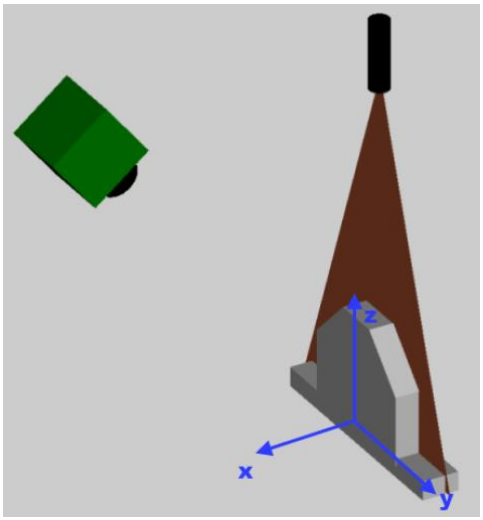


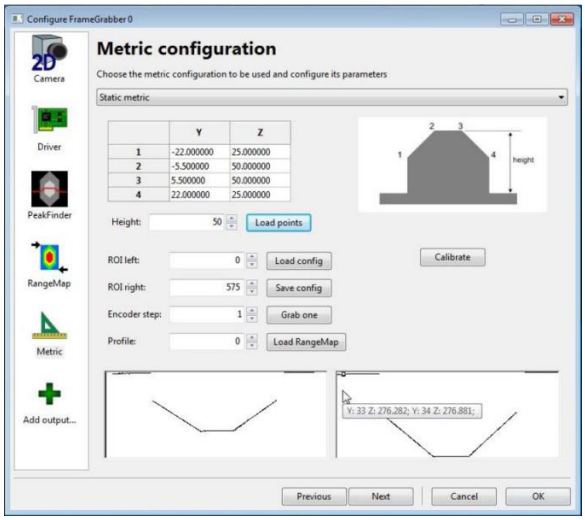
The most popular method of calibration is with the use of a chess board where the size of each square in the chessboard is known. In the image above, a software routine was used to determine the location of each inside corner of the chessboard. For a high quality of calibration, a series of images with varying positions of the chessboard are required.



For 3D calibration, each sensor must be calibrated individually and then together for improved depth information.

Some software packages include sensor calibration in their toolbox. AQSENSE has a calibration procedure, as shown below.

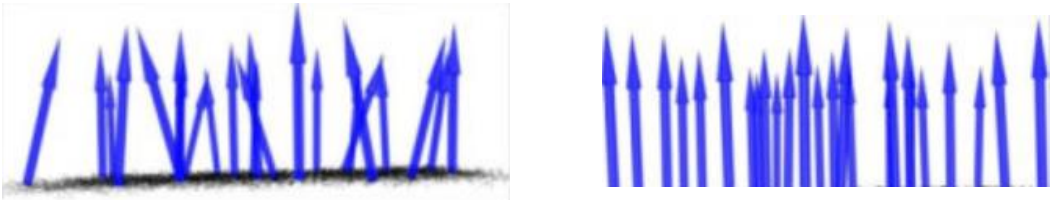




As long as the calibration object has known dimensions, the software can utilize those dimensions to create a camera to world coordinate conversion.

Noise Reduction

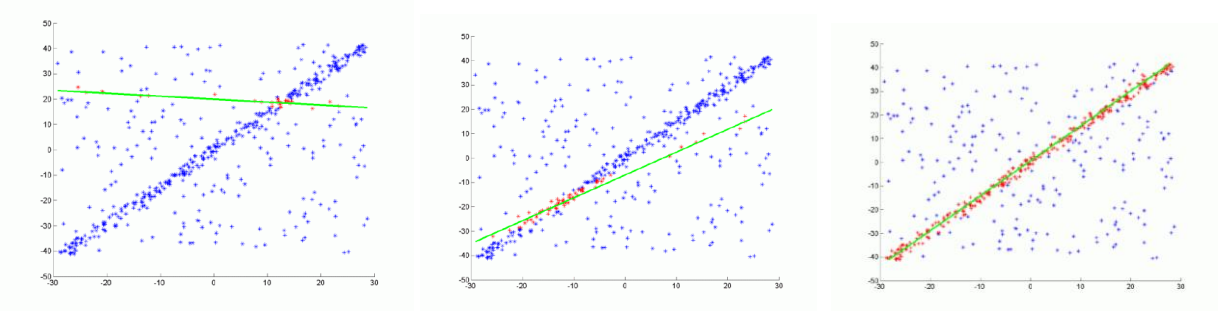
Even after a successful calibration, sometimes cameras continue to have a significant noise floor. To illustrate "noise," we may use the following examples of arrows that should be normal to the surface:



The image on the left should have only arrows pointing straight up. All of the arrows that aren't pointing straight up are "noise." There are several ways to handle filtering out most of the noise to end up with the image on the right. Depending on the sensor and application, some of

these filtering methods can “make” or “break” the success of an application, so noise reduction should not be overlooked when planning a project.

An example of one method includes removal of outliers:



All blue data points that are not within a tolerance to the linear fit will be removed to reduce noise and improve performance.

Correction for Lens Distortion

One specific problem that exists for applications can come from the imperfections of the camera lens. Some lenses are better than others, but as the quality increases, so does the cost. One way to achieve a balance is to adjust for lens distortions through your calibration process. The left view shows a rectangular perforated board without correction, the right view shows with correction.