

We repeated star-field calibration procedure on “mc_motor” dataset captured in July 2016 during cruise. In this report update we briefly list changes in the calibration procedure and show our results.

Changes in the calibration procedure:

1. To filter out outliers, in addition to previously used criterion, we use star brightness.
2. To initialize camera rotations we use SPICE kernel.
3. BA proceed in 2 iterations. After the first iteration, points that have very different residuals when compared to their neighborhood, are rejected and BA is performed second time.

Results:

1. 1227 stars detected and passed false detection filtering procedure in 65 images (see Figure 1).
2. After camera rotation initialization from SPICE kernel average error is 157.42 pix.
3. After camera rotation update using every image independently average error is 3.36 pix
4. After first iteration of bundle adjustment average error is 2.63 pix and focal length is 876.3 mm. 8 points are identified as outliers. (see Figure 2)
5. After second iteration of bundle adjustment average error is 2.50 pix, and focal length is 876.4 mm. 1 point is identified as outlier. (see Figure 3)
6. The obtained focal length 876.4 mm is similar to the one we got with “commissioning2” dataset (875.2 mm) and it is a little bit lower than nominal (880 mm).
7. The residual after bundle adjustment are similar to the one we got with “commissioning2” dataset: they are low in the center of the sensor and high on the borders. This suggests presence of lens distortion.
8. After lens distortion fitting average error is 0.675 pix.
9. The residuals after the lens distortion estimation do not have any visible pattern. This suggests that they come from inaccurate star detection.
10. The distortion field is very similar to the one we got with “commissioning2” dataset.

Conclusion:

1. We got very good consistency across 2 experiments (with “commissioning2” and “mc_motor” dataset), therefore can conclude that camera parameters are well estimated.

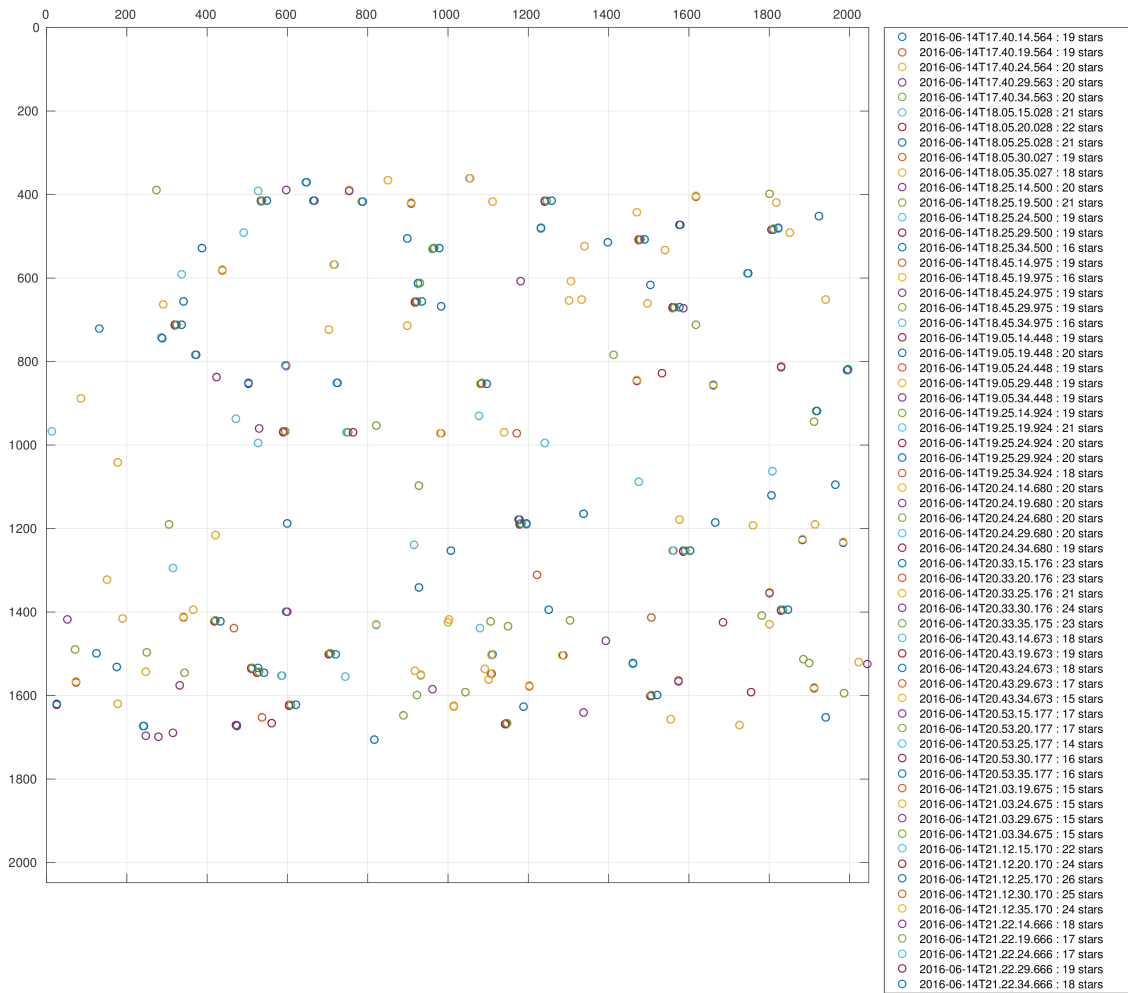


Figure 1: Position of all stars detected in “mc_motor” dataset on the image sensor. Total number of stars is 1227. Note, that the detector is almost uniformly filled.

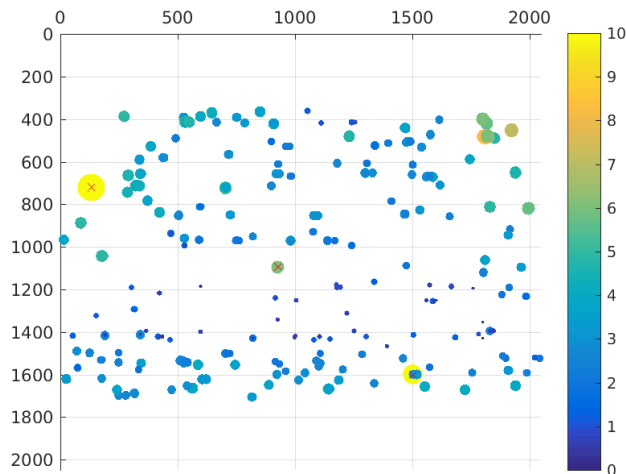


Figure 2: Residual errors in pixels after 1st iteration of bundle adjustment. Average error is 2.63 pixels. Color coding shows actual error scale. 8 crossed out observations correspond to the identified outliers.

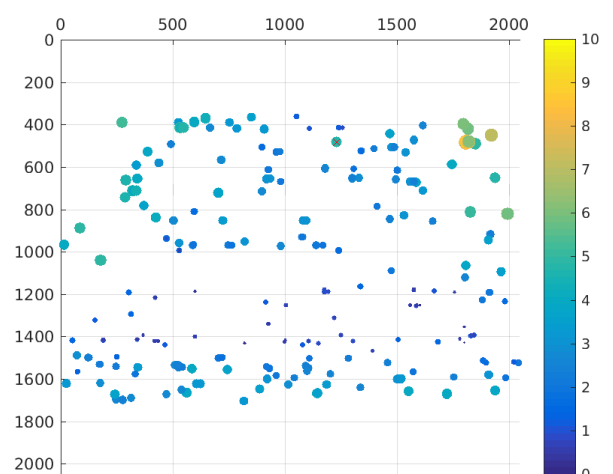


Figure 3: Residual errors in pixels after 2nd iteration of the bundle adjustment. Average error is 2.5 pixels. Color coding shows actual error scale. Note, that the errors have clear pattern: errors are small in the center and large on the borders of the image. This suggests presence of lens distortions.

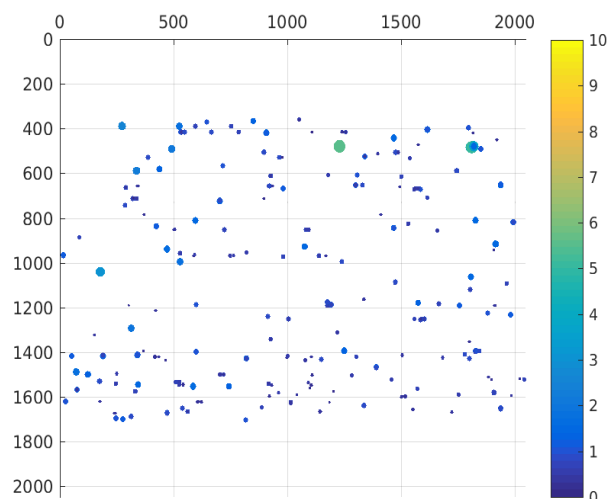


Figure 4: Residual errors in pixels after lens distortion estimation. Average error is 0.675 pixels. Color coding shows actual error scale. Note, that the errors do not have any pattern and they are small than compared to the residual errors after the bundle adjustment. This suggests that they come from inaccurate star detection.

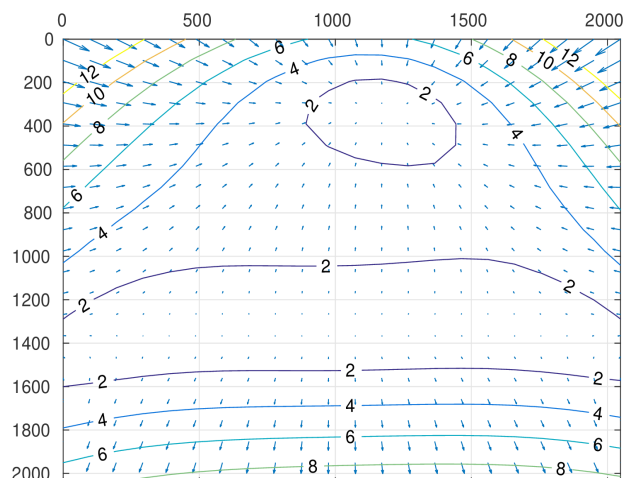


Figure 4: Distortion field estimated using star-field images. Vectors show transformation from distorted pixels to ideal pixels. Note, that it is very similar to the distortion field estimated using data obtained from RUAG