Mobile Robotics

Assignment 3

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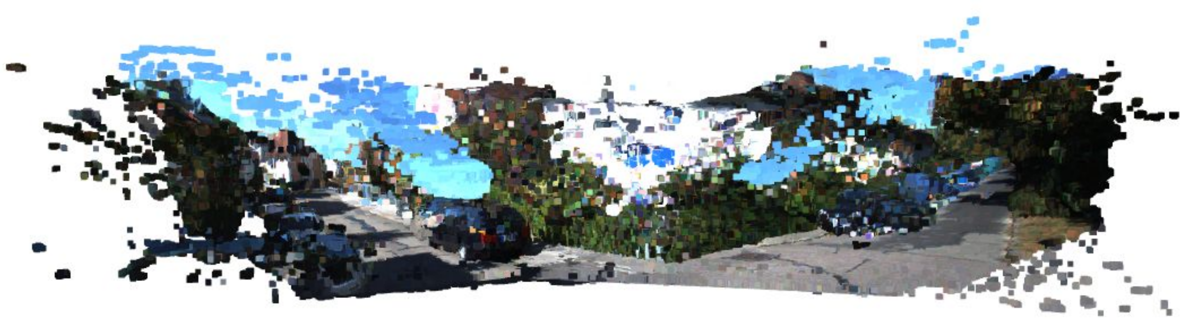
We have 21 images for each left and right stereo vision, we now generate the disparity map between each stereo image pair. For generating the disparity map we use an inbuilt command, ‘StereoSGBM’ as it was suggested in the document. It calculates the disparity by finding the intersection point P of the two rays from two stereo points x1 and x2. The Z coordinate of P represents the depth and is used to find the disparity of the corresponding points of the two images.

$$\text{Disparity} = bf/Z_{Pi}$$

After generating the disparity map we make the point cloud using the perspective matrix we also store the colors of corresponding points only when the disparity of that point is greater than a specific value, ultimately creating a mask ensuring that points with invalid disparity values doesn’t show up in our point cloud. Now we transform all the generated point clouds in the ground frame using the projection matrix that we got from the given ground truth poses and we visualize the result using Open3D.



We take a projection matrix and we generate the 2D points for the corresponding 3D points. Now we calculate the total reprojection error for these correspondences and different poses for which we want to minimise the error. We use Gauss Newton approach to minimise the error as it can start for any random and ultimately gives error less estimate. It proceeds iteratively and refines our estimate as:

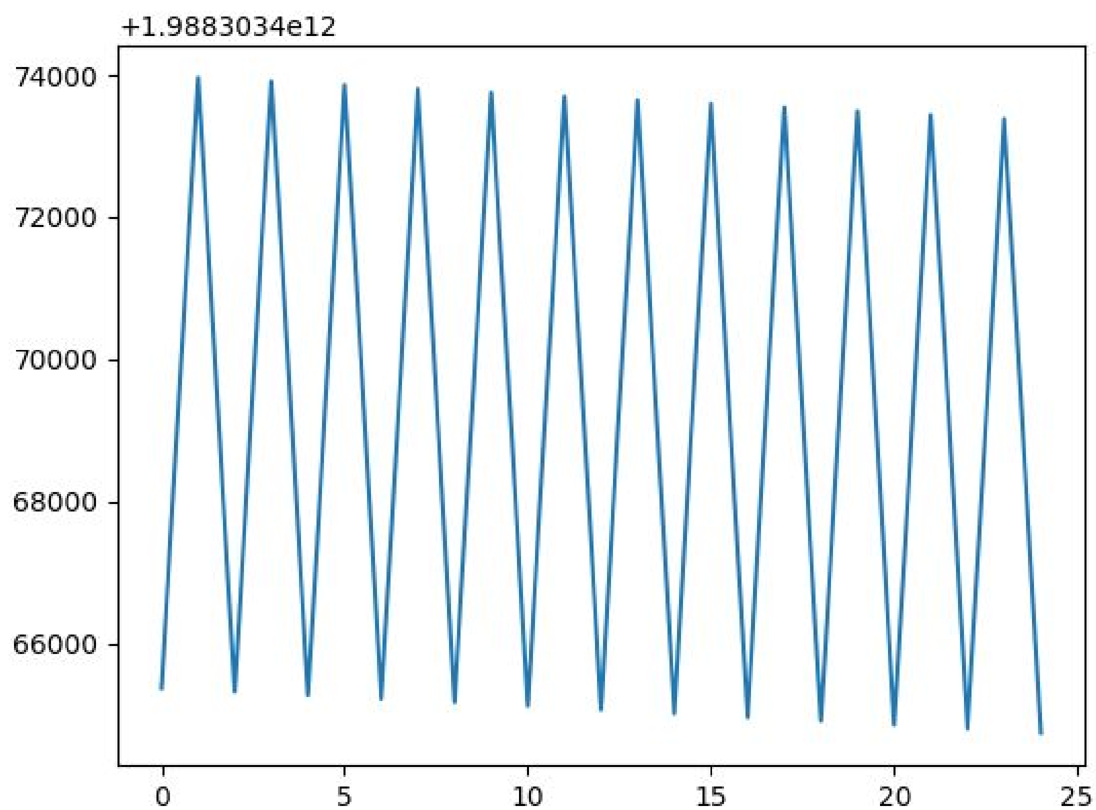
$$x_1 = \Delta_x + x_0$$

and Δ_x is calculated the Jacobian function and the residual as:

$$\Delta_x = (J^T J)^{-1} J^T e$$

Since our poses are of dimension 3x4 suggesting that we have 12 terms and after applying the Jacobian we get a matrix with 2nx12 entries. The main step here is to obtain the correct Jacobian and update the estimate correctly.

Here x_1 is the new pose for every iteration. The stopping criteria for this algorithm either it completes 25 iterations or when the reprojection error is less than a fixed threshold (0.001) in our case.



From the first iteration itself we are getting an error which is close to the minimum error that is possible for this kind of process. For the remaining iterations the error just fluctuates by relatively small amount and more or less stays the same. The figure above suggests that when the sketch is viewed on larger scale these relatively small variations appear to be constant .