Assignment 2

Q. Explain how SURF is different from SIFT (10 sentences).

Ans:

Scale Invariant Feature Transform (SIFT), which extract keypoints and compute its descriptors. It is both scale and rotation invariant. SIFT olves the image rotation, affine transformations, intensity, and viewpoint change in matching features. The SIFT algorithm has 4 basic steps. First is to estimate a scale space extrema using the Difference of Gaussian (DoG). Secondly, a key point localization where the key point candidates are localized and refined by eliminating the low contrast points. Thirdly, a key point orientation assignment based on local image gradient and lastly a descriptor generator to compute the local image descriptor for each key point based on image gradient magnitude and orientation.

SURF approximates the DoG with box filters. Instead of Gaussian averaging the image, squares are used for approximation since the convolution with square is much faster if the integral image is used. Also this can be done in parallel for different scales. The SURF uses a BLOB detector which is based on the Hessian matrix to find the points of interest. For orientation assignment, it uses wavelet responses in both horizontal and vertical directions by applying adequate Gaussian weights. For feature description also SURF uses the wavelet responses. A neighborhood around the key point is selected and divided into subregions and then for each subregion the wavelet responses are taken and represented to get SURF feature descriptor. The sign of Laplacian which is already computed in the detection is used for underlying interest points. The sign of the Laplacian distinguishes bright blobs on dark backgrounds from the reverse case. In case of matching the features are compared only if they have same type of contrast (based on sign) which allows faster matching.

Q. Briefly explain the main principles of FLANN matching and RANSAC (5 sentences).

Ans: FLANN stands for Fast Library for Approximate Nearest Neighbors. It contains a collection of algorithms optimized for fast nearest neighbor search in large datasets and for high dimensional features. It works faster than BFMatcher for large datasets. We will see the second example with FLANN based matcher.

For FLANN based matcher, we need to pass two dictionaries which specifies the algorithm to be used, its related parameters etc. First one is IndexParams. For various algorithms, the information to be passed is explained in FLANN docs. As a summary, for algorithms like SIFT, SURF etc.

While using ORB, you can pass the following. The commented values are recommended as per the docs, but it didn't provide required results in some cases. Other values worked fine

Second dictionary is the SearchParams. It specifies the number of times the trees in the index should be recursively traversed..

- To detect our outliers correctly and to build a model that ignores them in computation, we use the RANSAC algorithm. **It works by taking a random subset of our given data and creating a model from it.** Then we check how well the whole dataset fits the model. We repeat these steps until we have found a model that fits our data well. In this process, we mark all points that are not close to it as outliers.

he RANSAC algorithm is essentially composed of two steps that are iteratively repeated:

1. In the first step, a sample subset containing minimal data items is randomly selected from the input dataset. A fitting model with model parameters are computed using only the elements of this sample subset. The cardinality of the sample subset (e.g., the amount of data in this subset) is sufficient to determine the model parameters.
2. In the second step, the algorithm checks which elements of the entire dataset are consistent with the model instantiated by the estimated model parameters obtained from the first step. A data element will be considered as an outlier if it does not fit the model within some error threshold defining the maximum data deviation of inliers. (Data elements beyond this deviation are outliers.