*Assignment 1*

CS4186 Vision and Image

# **Method 1**

The first method I used for instance search was SIFT. Scale Invariant Feature Transform (SIFT) is a feature detector developed by Lowe in 2004 and has proven to be very efficient in object recognition applications [1]. Speedup Robust Feature (SURF), and Oriented SIFT and Rotated BRIEF (ORB) are other scale- and rotation-invariant interest point detector and descriptors [2-4]. The SIFT feature extraction has four main steps. First is to estimate a scale space extremum 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 [1].

The SIFT algorithm transforms the image into a collection of local feature vectors. These feature vectors are aimed to be distinctive and invariant to any scaling, rotation, or translation of the image.

In the first step, the feature locations are determined as the local extrema of Difference of Gaussians (DOG pyramid) as given by (3). To implement the DOG pyramid the input image is convolved iteratively with a Gaussian kernel (2). This procedure is repeated as long as the down-sampling is possible. Each collection of images of the same size is called an octave. All octaves build together the so-called Gaussian pyramid by (1), which is represented by a 3D function

In the next step, a detailed fit is performed to the nearby data to find the accurate location, scale, and ratio of principal curvatures. This information is useful to the points which have low contrast or For each candidate keypoint, interpolation of the nearby data is used to accurately estimate its position. The interpolation is done using the quadratic Taylor expansion of the Difference-of-Gaussian scale-space function,)y,( σxD with the candidate keypoint as the origin.

In the next step, for each keypoint, one or more orientations are assigned based on local image gradient directions. This isa useful step in achieving invariance to rotation as the keypoint descriptor can be represented relative to this orientation and therefore achieves invariance to image rotation. First, the Gaussian-smoothed image),,( σy xL at the keypoint scaleσ is taken so that all computations are performed in a scale-invariant manner. For an image sample),( yxLat scale σ, the gradient magnitude,),( yxm , and orientation,),( yxθ , are precomputed using pixel difference.

# **Top 10 query results**

Query number: 1258: 2403, 1148, 4342, 1906, 596, 2127, 4002, 3029, 2474, 1701

Query number: 1656: 2003, 934, 1227, 839, 991, 3875, 2490, 1452, 3897, 2950

Query number: 1709: 2857, 79, 3005, 2402, 2683, 1603, 2701, 3628, 2726, 83

Query number: 2032: 770, 3660, 4277, 4346, 426, 1295, 3643, 4986, 2442, 2806

Query number: 2040: 2666, 1127, 1076, 4912, 2226, 4867, 4537, 2860, 1348, 131

Query number: 2176: 4018, 3144, 2604, 126, 4535, 4494, 1390, 977, 3184, 556

Query number: 2461: 1044, 3791, 3362, 2870, 4002, 1452, 2967, 2127, 4313, 4386

Query number: 27: 3457, 2450, 4610, 2604, 1148, 2950, 2798, 596, 42, 3153

Query number: 2714: 4256, 670, 2399, 4967, 3188, 1130, 2966, 3908, 3297, 596

Query number: 316: 3113, 3399, 1169, 1592, 2684, 2489, 184, 584, 4494, 3153

Query number: 35: 86, 3544, 1860, 4249, 2082, 1192, 930, 1238, 630, 4523

Query number: 3502: 3331, 990, 584, 4228, 4576, 739, 3493, 2127, 4002, 1517

Query number: 3557: 4325, 810, 716, 3897, 3166, 4362, 2876, 1970, 750, 2756

Query number: 3833: 1038, 4871, 2450, 1658, 3688, 596, 3897, 943, 2798, 269

Query number: 3906: 456, 3144, 3184, 2584, 3579, 822, 4097, 3643, 3781, 4165

Query number: 4354: 2, 943, 1977, 1687, 3688, 4681, 227, 208, 1964, 2289

Query number: 4445: 1276, 1164, 116, 3956, 623, 649, 862, 1452, 1710, 2477

Query number: 4716: 4286, 4332, 1784, 518, 1884, 4170, 1459, 2807, 4184, 1028

Query number: 4929: 3259, 672, 2389, 1876, 2901, 83, 3643, 803, 4796, 936

Query number: 776: 2575, 1799, 4918, 2473, 173, 1323, 3688, 2967, 1148, 2427

*(1) (PDF) Image Identification Using SIFT Algorithm: Performance Analysis against Different Image Deformations*. Available from: <https://www.researchgate.net/publication/290436456_Image_Identification_Using_SIFT_Algorithm_Performance_Analysis_against_Different_Image_Deformations> [accessed Apr 22 2022].