

PCA-SIFT

Computation Steps

1. Scale Space Extrema Detection
2. Key-point Localisation(not implemented)
3. Orientation Assignment
4. Key-point Descriptor

Implementation Details

- Number of octaves : 2 , 2nd octave created by downsampling image by factor of 2
- DOG's per octave : 5 , **Six scale space per octave** leading to 5 DOG's
- Scales per octave : 3 , **Only 3 DOG's** available which have both lower and higher scale neighbours required **for scale space extrema detection.**
- SIGMA = 0.4, of base scale of first octave. Gradually increases by a factor of K after each scale. ($K = 2^{1/s}$, where s is no. of scale space)

Key-point class

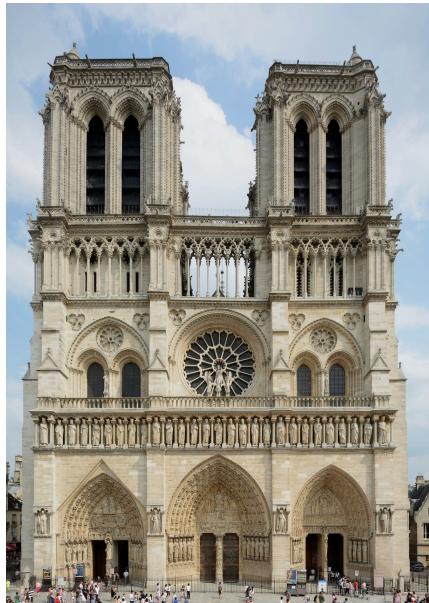
```
→ Keypoint Description:  
location: (350, 237)  
scale: 1  
orientation: 90  
descriptor: [ 0. -6. 12. ... 0. 0. 0.]
```

Sample key point

Key-point : < p, s, o, d >

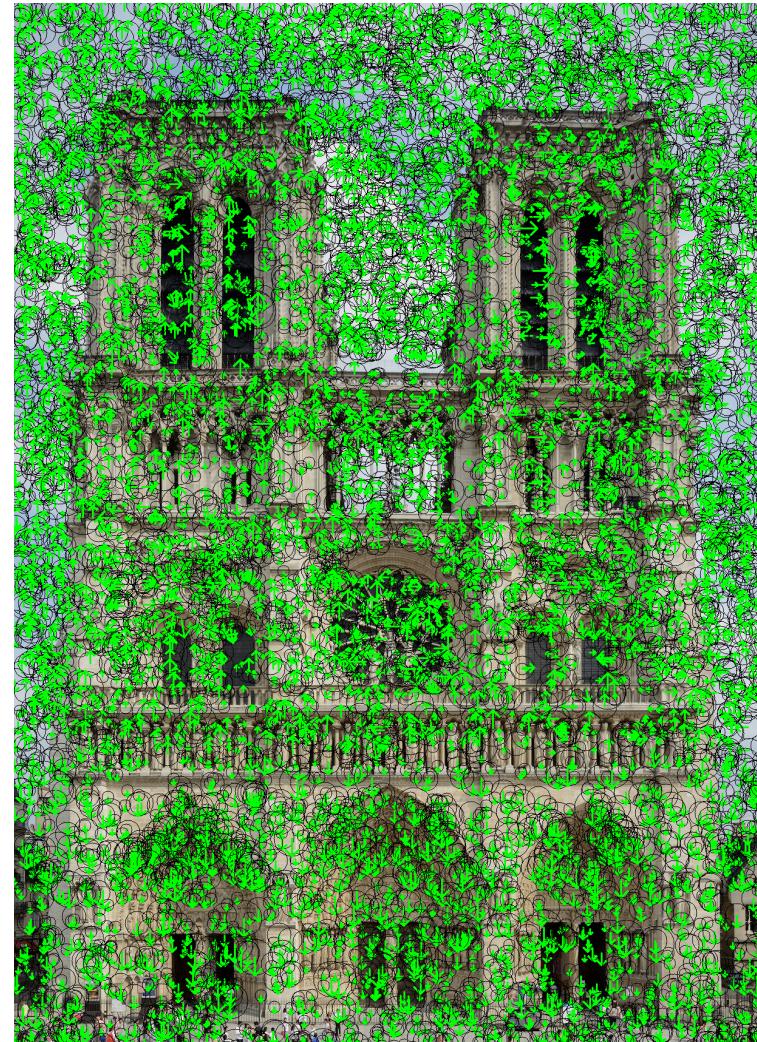
- **p**: Pixel location of the key point in image
- **s** : Scale of the extrema in DOG space
- **o** : orientation of key point. compute image gradients in a local region build a histogram and select peak as the key point orientation.
- **d**: 3042X1 vector descriptor of key point. Generated by concatenating X and Y gradient patches of a 39X39 local region.

Key-points: Image 1

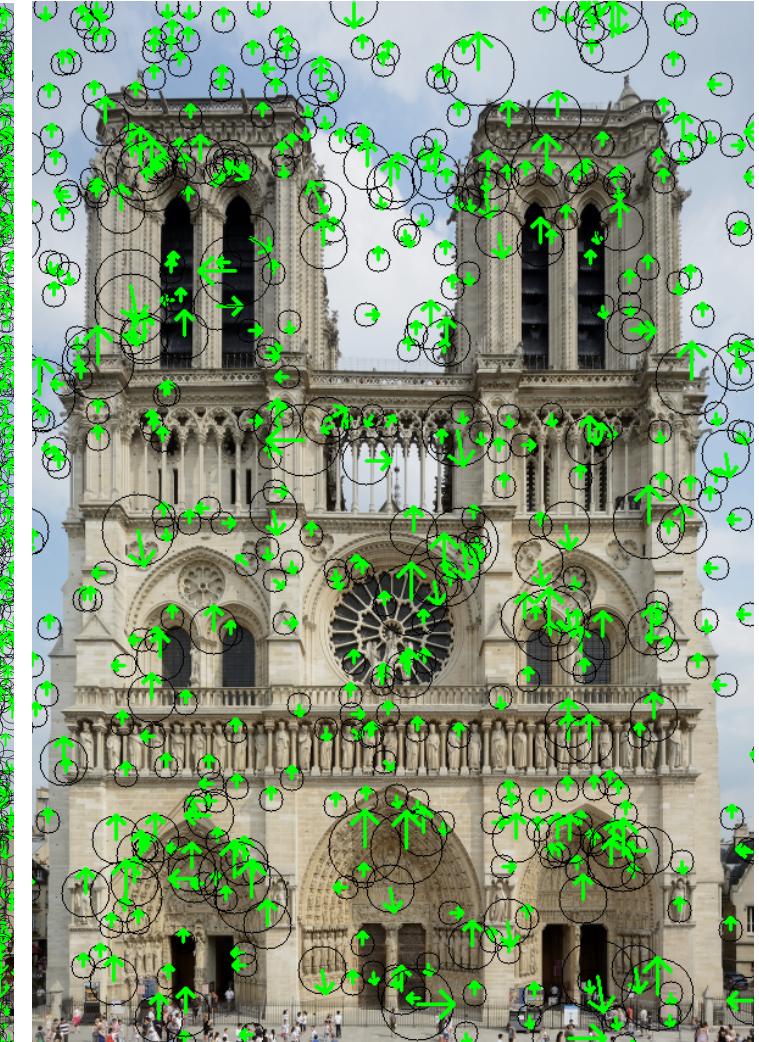


Original Image

1. The size of circle represents scale of the feature
2. The direction of arrow represents principal orientation of the feature

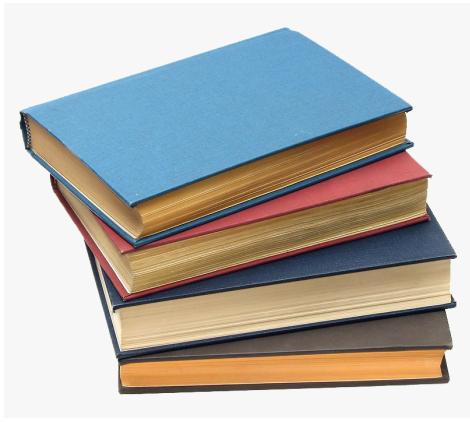


Octave 1: 8196 Key-points



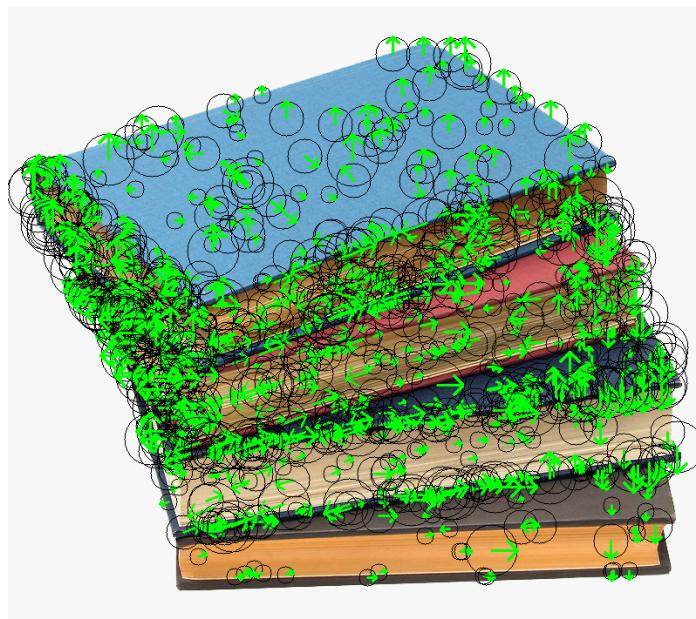
Octave 2 : 501 Key-points

Key-points: Image 2

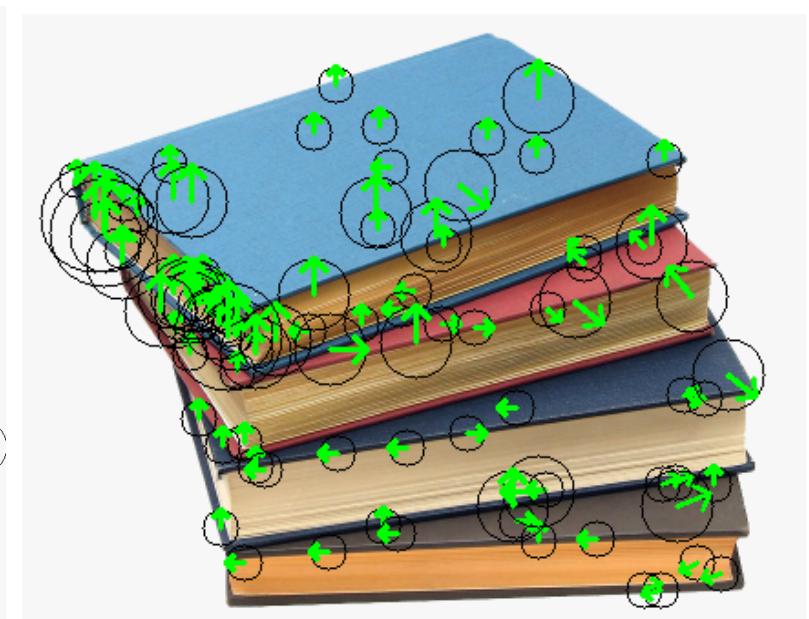


Original Image

1. The size of circle represents scale of the feature
2. The direction of arrow represents principal orientation of the feature



Octave 1: 979 Key-points

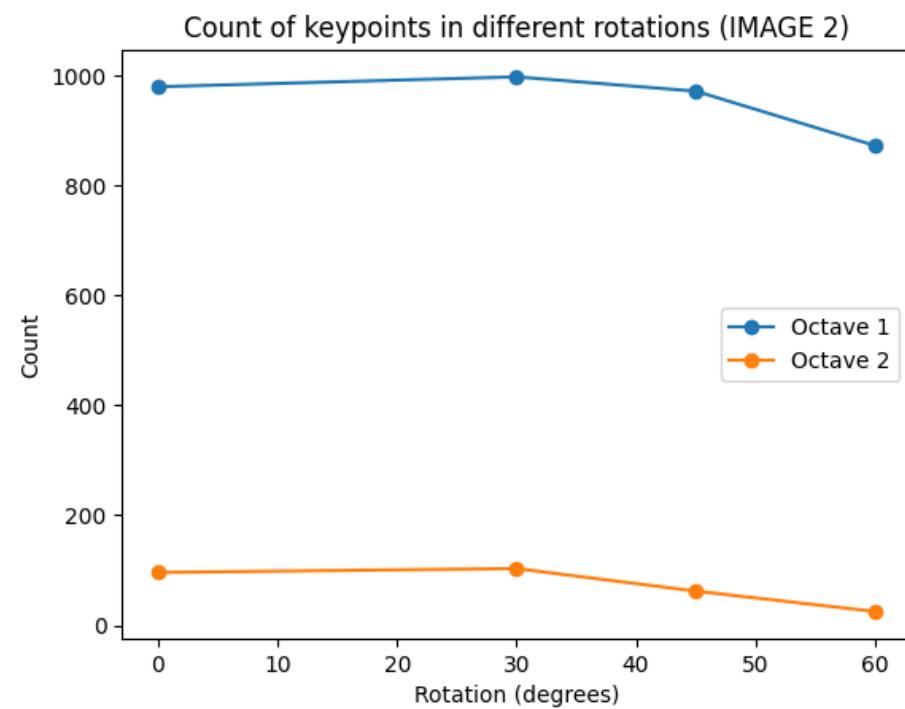
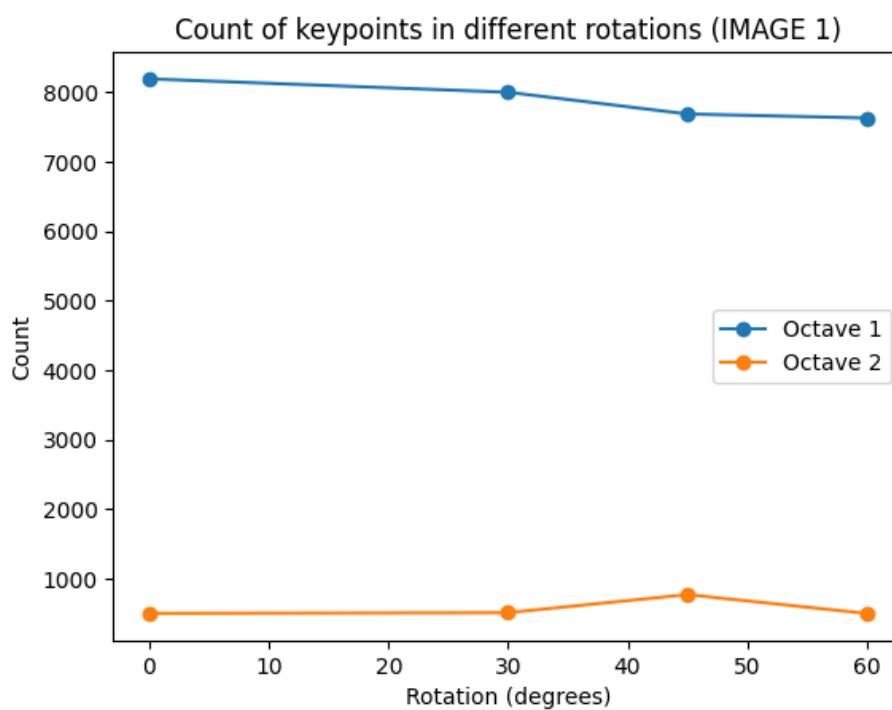


Octave 2: 96 Keypoints

Effect of Rotation

Rotation(degrees)	IMAGE 1	IMAGE 2
Standard	Octave 1 : 8196	Octave 1 : 979
	Octave 2 : 501	Octave 2 : 96
30	Octave 1 : 8003	Octave 1 : 997
	Octave 2 : 511	Octave 2 : 103
45	Octave 1 : 7690	Octave 1 : 971
	Octave 2 : 771	Octave 2 : 62
60	Octave 1 : 7632	Octave 1 : 872
	Octave 2 : 499	Octave 2 : 25

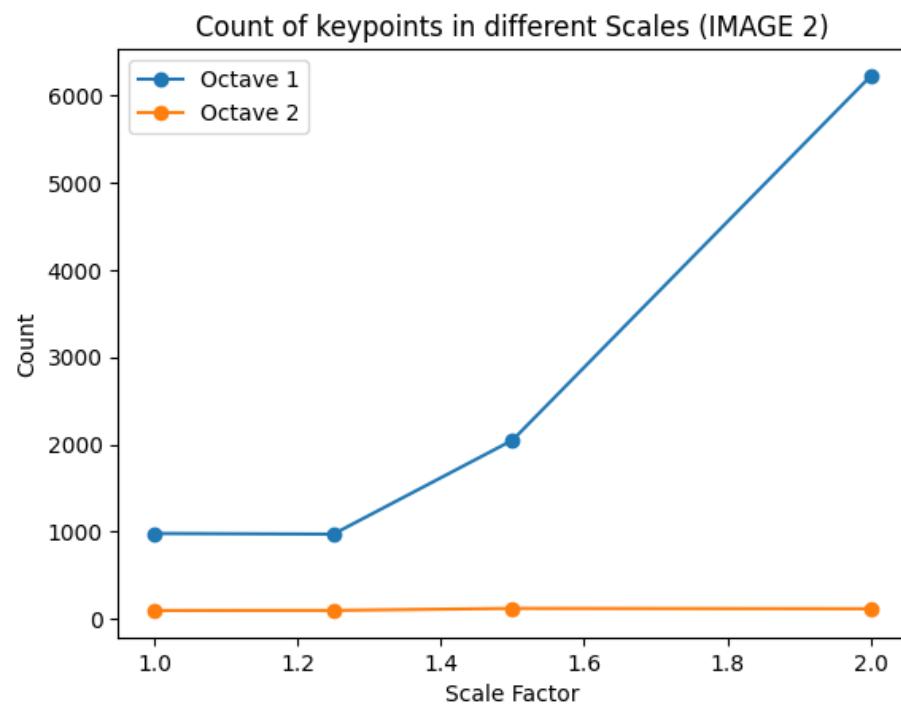
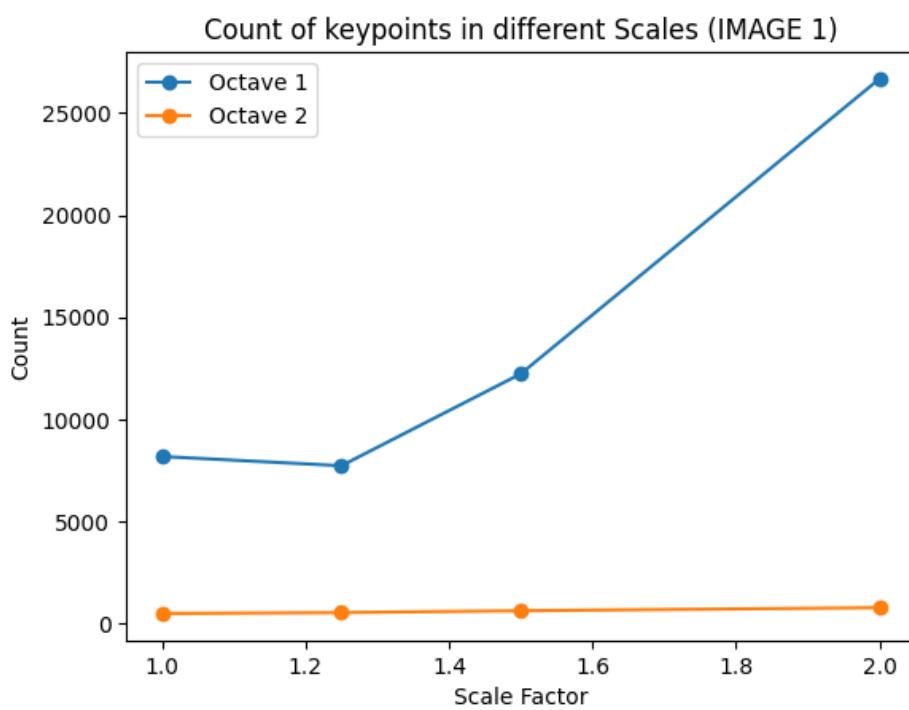
Effect of Rotation



Effect of Scaling

Scale Factor	IMAGE 1	IMAGE 2
Standard	Octave 1 : 8196	Octave 1 : 979
	Octave 2 : 501	Octave 2 : 96
1.25	Octave 1 : 7734	Octave 1 : 971
	Octave 2 : 546	Octave 2 : 97
1.5	Octave 1 : 12233	Octave 1 : 2048
	Octave 2 : 636	Octave 2 : 120
2	Octave 1 : 26671	Octave 1 : 6224
	Octave 2 : 785	Octave 2 : 116

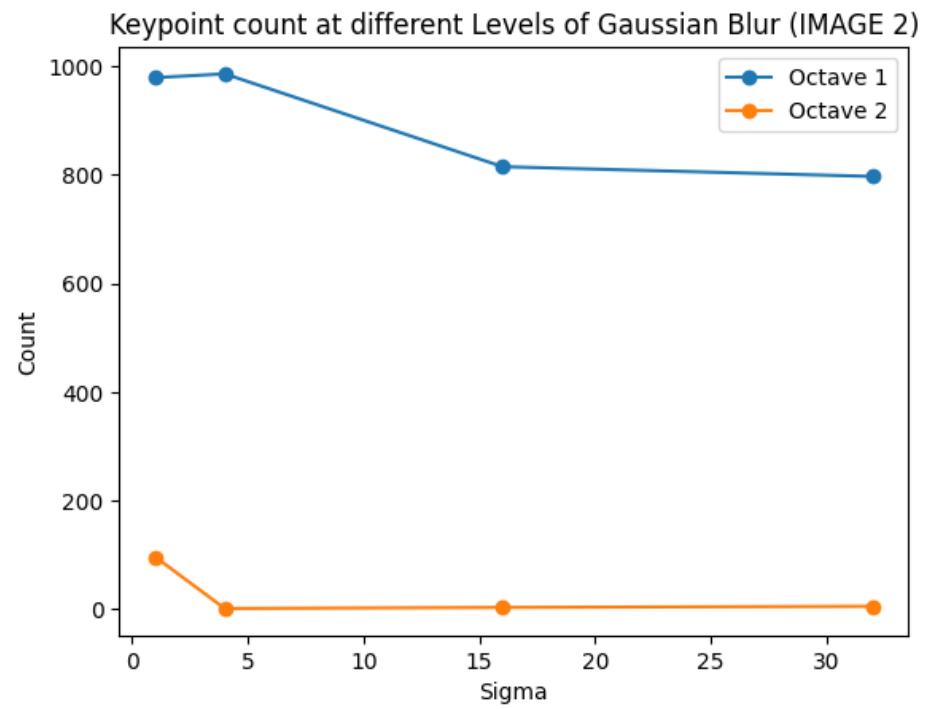
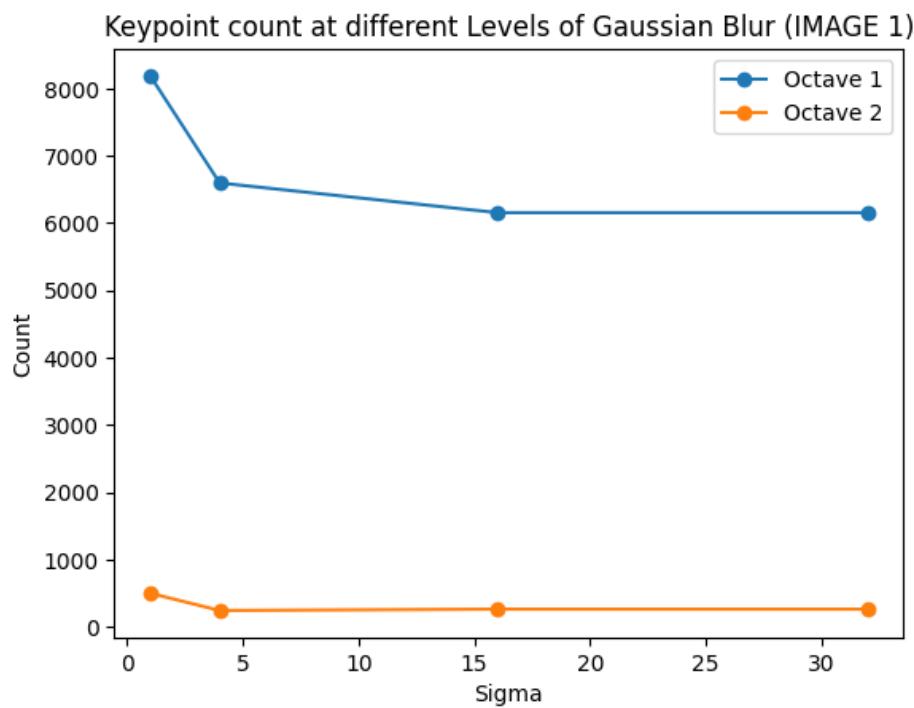
Effect of Scaling



Effect of Gaussian blur

Sigma	IMAGE 1	IMAGE 2
Standard	Octave 1 : 8196	Octave 1 : 979
	Octave 2 : 501	Octave 2 : 96
4	Octave 1 : 6595	Octave 1 : 986
	Octave 2 : 245	Octave 2 : 1
16	Octave 1 : 6154	Octave 1 : 815
	Octave 2 : 265	Octave 2 : 3
32	Octave 1 : 6154	Octave 1 : 797
	Octave 2 : 265	Octave 2 : 5

Effect of Gaussian blur



Takeaways

- * The number of key points do not change significantly upon rotation however a **slight decrease** is observed as the **rotation angle** is **increased**.
- * The number of key points as expected **increases** as the **image** is **scaled**. This is because of capturing finer details which were ignored otherwise.
- * In case of Gaussian blur the key points **drop initially** but then stays relatively same upon higher levels of blur.