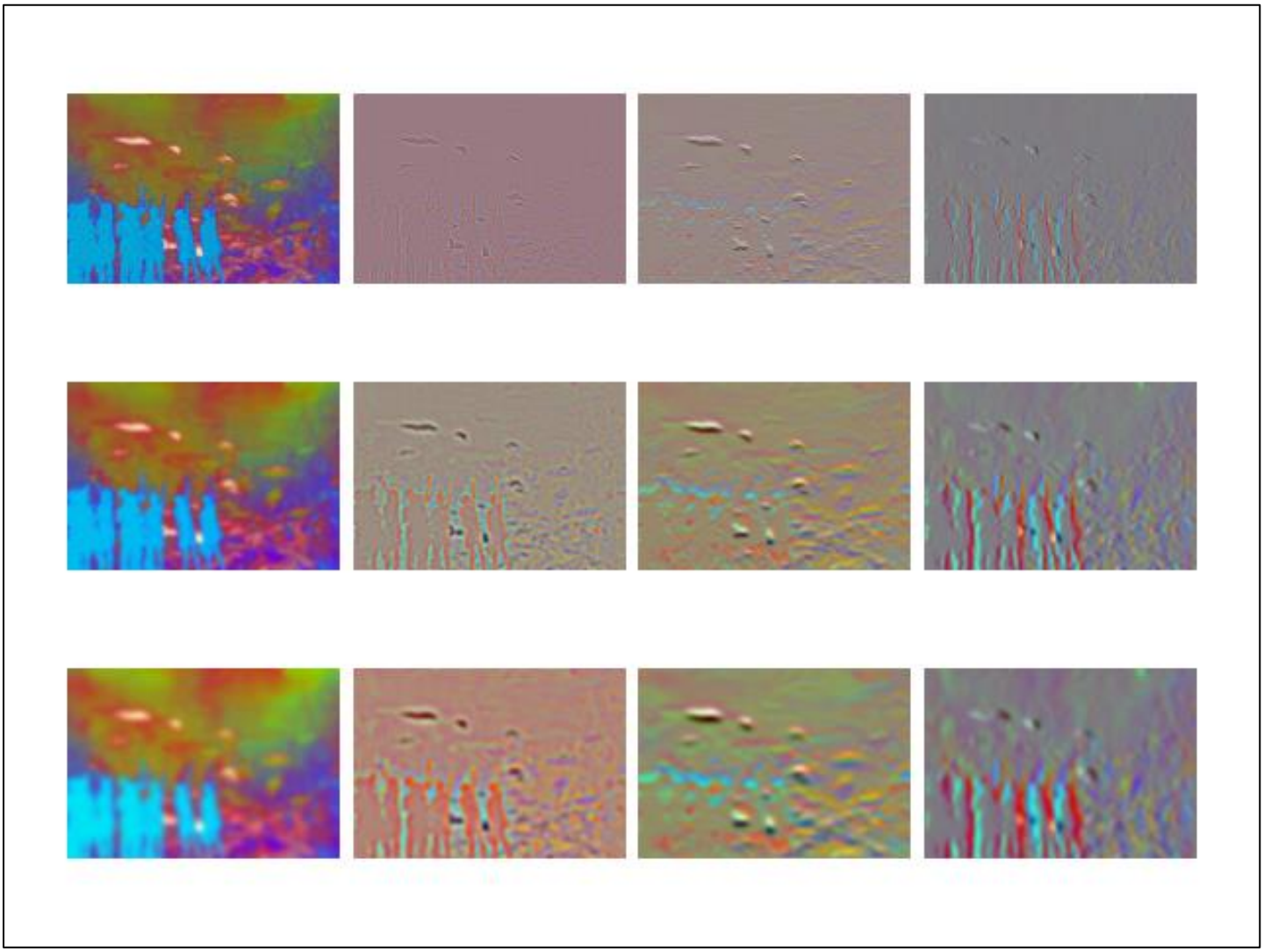
Q1.1.1

The features extracted by each of the filters are:

- **Gaussians**: This filters pickups the prominent features of the image by blurring out the less prominent ones, effectively extracting useful information and removing noise.
- **Laplacian of Gaussians**: This filter sharpens the gaussian blurred image, which extracts the significant edges in the image. If we directly used Laplacian, insignificant edges will also be extracted.
- **Gaussian Derivatives in x direction**: This filter will bring out the prominent contour changes along the x direction.
- **Gaussian Derivatives in y direction**: This filter will bring out the prominent contour changes along the y direction.

We need multiple scales of filters to control the amount of feature extraction from the images. For instance, a higher scale gaussian will blur out more features than a lower scale one. The more prominent ones will remain through all scales and thus, should be given more weightage.

Q 1.1.2

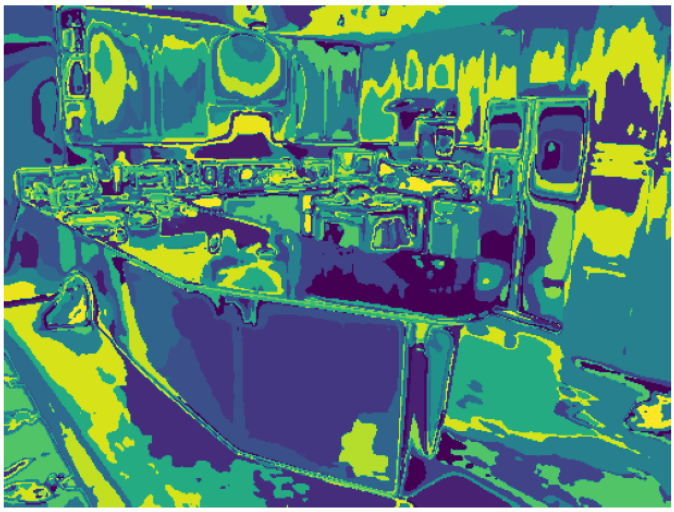


Filters = [Gaussian, Laplacian of Gaussian, Gaussian derivative in x direction, Gaussian derivative in y direction] {in x-direction}

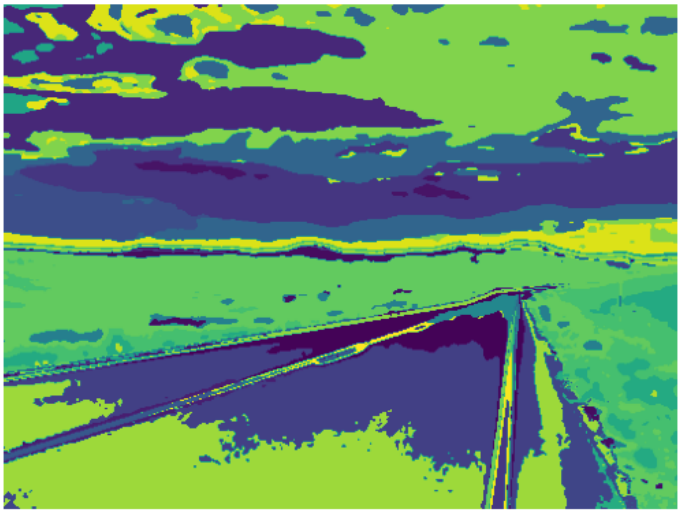
Filter Scales = [1, 3, 5] {in y-direction}

Q 1.3

kitchen/sun_aasmevtpkslccptd



highway/sun_bpflsdaxnddnwcqi.jpg



laundromat/sun_auuqfgwjayuyytxw.jpg

Q 2.5

Confusion Matrix:

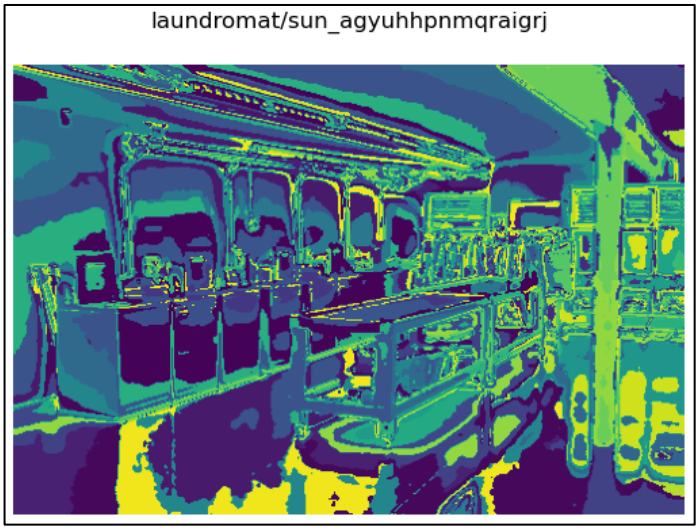
Index	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*
0	40	0	0	1	3	0	3	3
1	0	28	5	7	2	2	2	4
2	2	4	27	4	0	4	0	9
3	0	1	0	37	10	0	2	0
4	0	0	1	14	26	2	7	0
5	4	0	2	1	0	39	1	3
6	2	0	0	2	4	5	35	2
7	1	3	9	2	0	4	0	31

Accuracy Value:

0.6575

Q2.6

As seen in the confusion matrix, the kitchen (index 3) and the laundromat (index 4) have a high inaccuracy rate.



As shown above, both images have a very similar wordmap despite belonging to different classes. This is due to the similarities of the visual words such as the ‘rectangular white boxes. The boxes can be both kitchen cabinets and laundry machines.

Q 3.1 Ablation Study

S. No.	K	L	Alpha	Scales	Accuracy	Comment
1	10	1	25	2	0.4025	Default Values
2	10	3	25	2	0.5025	Improved accuracy
3	10	2	25	2	0.4475	Reduced Accuracy
4	50	2	25	2	0.605	Improved Accuracy
5	100	3	25	2	0.655	Improved Accuracy
6	100	2	35	2	0.6425	Reduced Accuracy
7	100	2	45	2	0.655	Improved Accuracy
8	100	2	35	3	0.6425	Reduced Accuracy
9	100	2	35	4	0.6425	No effect
10	100	2	25	2	0.6575	Best result

The given hyperparameters change the system accuracy by:

1. **K** – affects the number of visual words found. Directly improves accuracy with increasing value. Optimal value - 100
2. **L** – affects the number of layers done in spatial mapping. Causes better localization of visual words which improves accuracy. Optimal Value - 2
3. **Alpha** – affects the number of pixels sampled. Choosing a higher alpha will minutely improve accuracy while increasing compute exponentially. Optimal value - 25
4. **Scales** – affects the amount of feature extraction. As the images are being sampled randomly, the scale does not cause a huge difference. However, a high change in scale value does extract more features.