# Computer Vision Assignment Five @ ETH Zurich

Image Segmentation

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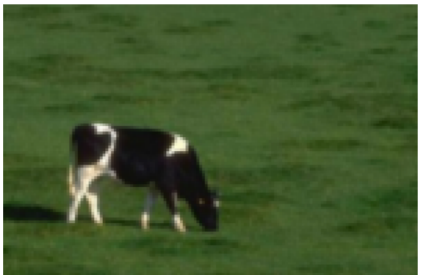
## 1 Image Preprocessing

**Figure 1:** Original Image.



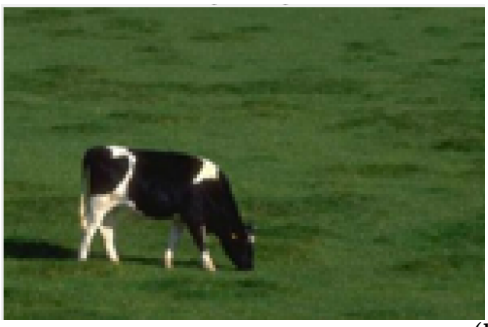
**(a)** Smoothed Image with a Gaussian filter of $\sigma = 5.0$.

**(b)** Converted Image to L*a*b space.

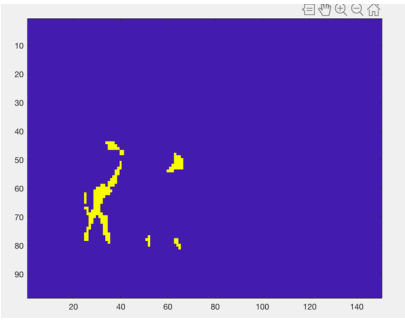
**Figure 2:** Preprocessing the image to apply the different segmentation techniques.

L* represents the lightness of color going from 0 (dark) to 100 (white), while the a* and b* channels are the two chromatic components. Inspired by the human visual system, we can easily distinguish colors these colors from one another. The L*a*b enables us to quantify these visual differences.

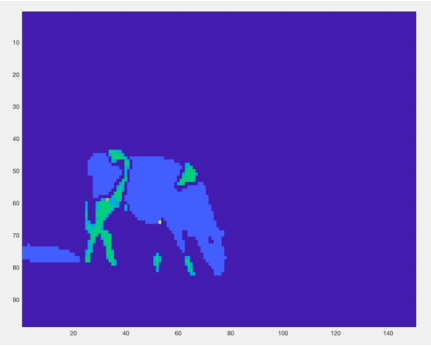
## 2 Mean Shift Segmentation



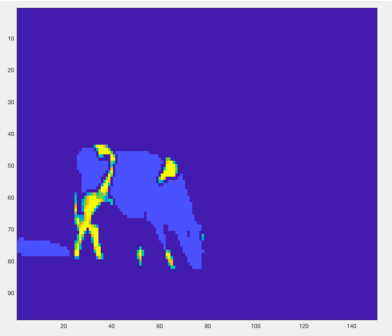
**(a)** Original Image.



**(b)** r = 60 and number of segments are 2 as seen above.



**(a)** r = 36 and number of segments are 6 as seen above.

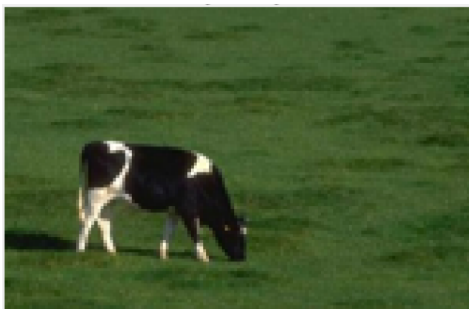


**(b)** r = 25 and number of segments are 7 as seen above.

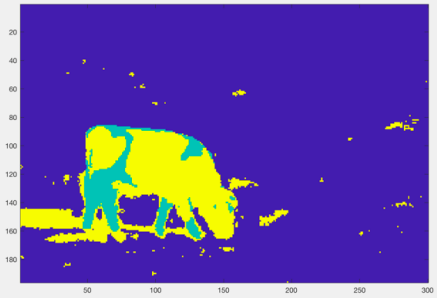
**Figure 4:** Applying Mean-Shift algorithm where the convergence criteria of the find peak is the difference $< 0.01 * r$.

The image is first reshaped to L * 3 where L is the number of pixels. Iteratively we find the peak around each pixel in a radius r and shift it to the mean untill convergence. Afterwards similar peaks are merged together. Similarity is defined by having a distance less than $r/2$

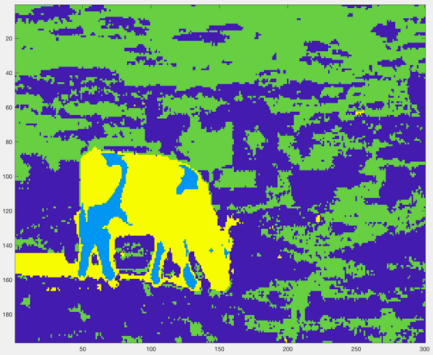
# 3 EM Segmentation



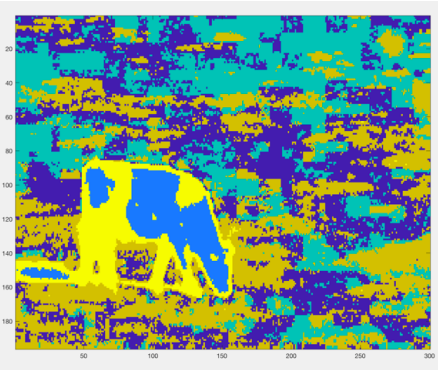
**(a)** Original Image.



**(b)** K=3



**(a)** K=4.



**(b)** K=5.

**Figure 6:** Applying EM algorithm where the convergence criteria is difference in $\alpha < 0.001$.

The following parameters $\theta$ were obtained for each K:

For K = 3:

$$mu = \begin{bmatrix} 89.1817 & 114.4105 & 149.1196 \\ 152.4943 & 125.4733 & 140.4569 \\ 41.4575 & 123.8891 & 136.9769 \end{bmatrix}$$

and

$$\sum_1 = \begin{bmatrix} 84.0879 & 0.7446 & -0.1415 \\ 0.7446 & 0.9824 & -0.2618 \\ -0.1415 & -0.2618 & 1.7351 \end{bmatrix}$$

and

$$\sum_2 = 1.0e+03 * \begin{bmatrix} 3.6827 & 0.1118 & 0.0231 \\ 0.1118 & 0.0118 & -0.0028 \\ 0.0231 & -0.0028 & 0.0250 \end{bmatrix}$$

and

$$\sum_3 = \begin{bmatrix} 881.1583 & -130.3942 & 246.0275 \\ -130.3942 & 31.9716 & -47.2008 \\ 246.0275 & -47.2008 & 83.8527 \end{bmatrix}$$

and

$$\alpha = \begin{bmatrix} 0.8576 & 0.0314 & 0.1109 \end{bmatrix}$$

For K = 4:

$$mu = \begin{bmatrix} 85.2474 & 114.2841 & 149.7571 \\ 167.0309 & 126.6429 & 140.2572 \\ 93.3862 & 114.6134 & 148.4174 \\ 39.7488 & 124.8384 & 135.1918 \end{bmatrix}$$

and

$$\sum_1 = \begin{bmatrix} 111.1322 & -0.2736 & 5.3281 \\ -0.2736 & 1.5597 & -0.1213 \\ 5.3281 & -0.1213 & 1.9939 \end{bmatrix}$$

and

$$\sum_2 = 1.0e+03 * \begin{bmatrix} 3.2831 & 0.0428 & 0.0384 \\ 0.0428 & 0.0059 & -0.0011 \\ 0.0384 & -0.0011 & 0.0274 \end{bmatrix}$$

and

$$\sum_3 = \begin{bmatrix} 27.4386 & -0.0419 & -0.6298 \\ -0.0419 & 0.4181 & -0.0373 \\ -0.6298 & -0.0373 & 0.5478 \end{bmatrix}$$

and

$$\sum_4 = \begin{bmatrix} 934.4371 & -115.3247 & 208.7664 \\ -115.3247 & 24.6402 & -34.1866 \\ 208.7664 & -34.1866 & 60.3744 \end{bmatrix}$$

and

$$\alpha = \begin{bmatrix} 0.4815 & 0.0257 & 0.3906 & 0.1022 \end{bmatrix}$$

K=5 parameters $\theta$ are ommited for the length of the report.