MP4 Report

In this project, the focus is on detecting skin regions in images using color-based segmentation. Skin pixels were manually selected using a rectangular region from a training image. These pixels were used to train models in different color spaces where I used four different color spaces for diversity RGB, HSV, LAB, and YCrCb. The models are then applied to segment skin in three test images.

- **Histogram Model:** A 2D histogram is created using the first two channels of each color space like H and S in HSV. Pixels falling in learned skin color bins are classified as skin.
- **Gaussian Model:** A multivariate gaussian is trained on the selected skin pixels using all three channels in each color space. Prior to training, pixel values are normalized to [0,1] to ensure consistent channel scaling for covariance calculation. Detection is done based on the pixel likelihood under the gaussian model.

Observations

Color Space	Histogram Detection	Gaussian Detection	Comments
RGB	**Over-segmented** – detected many non-skin areas	**Better** – detected mostly skin, missed minor parts	RGB is sensitive to lighting; histogram picks up background while Gaussian is more selective.
HSV	**Excellent** – detected only skin	**Weak** – missed many valid skin pixels	HSV separates chrominance well; histogram benefits while Gaussian underfits due to tight variance.
LAB	**Good** – detected most skin but with some false positives	**Best** – detected only skin with minor detail loss	LAB handles color and light separately; Gaussian benefits from balanced channel distribution.
YCrCb	**Conservative** – missed skin in shadows	**Very good** – close to LAB in accuracy	Chrominance-based; histogram under-detects, Gaussian improves by modeling skin color distribution more fully.

Conclusion

The **histogram model** worked best in the **HSV color space**, accurately detecting only skin with minimal noise. In RGB and LAB, histogram detection included extra regions due to background similarity. YCrCb histogram was conservative, detecting only clear skin areas while missing other.

The **Gaussian model** performed best in **LAB** and **YCrCb**, offering precise and clean segmentation with minimal false positives. In RGB, it improved over histogram by reducing false positives. In HSV, however it underperformed due to high sensitivity to channel variance and tighter Gaussian boundaries.

From these results, I can interpret that the choice of color space plays a critical role in the effectiveness of both models, and that the best performing method depends on whether broader detection (histogram) or precision (Gaussian) is desired.