Random and hand picked versions respectively

(a) Random 2 (b) Random 4 (c) Random 8 (d) Random 16 (e) Random 32

(a) Selected 2 (b) Selected 4 (c) Selected 8 (d) Selected 16 (e) Selected 32

(a) Random 2 (b) Random 4 (c) Random 8 (d) Random 16 (e) Random 32

(a) Selected 2 (b) Selected 4 (c) Selected 8 (d) Selected 16 (e) Selected 32

(a) Random 2 (b) Random 4 (c) Random 8 (d) Random 16 (e) Random 32

(a) Selected 2 (b) Selected 4 (c) Selected 8 (d) Selected 16 (e) Selected 32

Explanations

The algorithm I have used is K-means as requested. It is a clustering algorithm. It starts with some K data points (pixels on this occasion), these are called initial centroids and all the other points are joined to the nearest centroid. Then in each cluster, new centroids are determined by taking the average of the cluster's data points. Then all the data points are re-clustered using these new centroids. This iterative process repeats until it converges, i.e. no data points shift clusters. Yet usually a limit of iteration may be needed because it may take too long for the algorithm to converge and very little progress can be made after a point. I have chosen 10 as the limit as suggested in the description of the homework.

Comments on results

Number of colors used visible increases quality from 2 to 32. Which is to be expected because more of the information is preserved.
Difference between handpicked and randomly chosen initial centroids decreases as the number of colors increases. This is also expected because when a large number of points chosen randomly, all major colors that one would pick by hand are likely to be chosen. But smaller areas such as the face of the motorcycle rider are missed when choosing randomly and that information is lost.
I have also implemented the bonus with 3D histogram, I had to use opencv though. I have observed that the images seemed detailed but not semantically separated.

Figure 7: Bonus with 3D color histogram K=3

Notes

We were restricted with only 2 pages for the report that is why I had to shrink the images drastically, that is why the differences are somewhat harder to see. I can provide the actual images if you like.