Machine Vision – Project 1

CS 7367
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Abstract

This project explores the concepts of sampling, quantization, and color quantization in image processing. The process of altering spatial resolution in grayscale and color images is examined. At first down-sampling and subsequent up-sampling, various sampling factors are applied to images, such as reducing a 1024x1024 pixel image to 512x512, 256x256, 128x128, 64x64, and 32x32 dimensions before restoring it to its original resolution. This experimentation showcases the effects of different sampling factors on image quality. Next, we explore quantization, where the grayscale levels of an 8-bit grayscale image, initially consisting of 256 gray levels, which are systematically reduced to 128, 64, 32, 16, 8, 4, and 2 levels, respectively. Each iteration showcases the impact of decreasing the number of gray levels on the image and hence its visual effects. Finally, color quantization is eexecuted, whereby the color levels of a 24-bit color image are adjusted. Initially boasting an extensive array of colors, the image undergoes quantization to feature 2^6 and 2^3 distinct colors, revealing the color discrepancies of reducing e image complexity. Through these processes, this exercise offers insights into the manipulation of image attributes, providing valuable understanding for image processing applications.

Results

Sampling

As shown below the sampling process involves changing the spatial resolution of grayscale and color images by down-sampling and then up-sampling them back to their original resolution.

Figure 1 Original Image

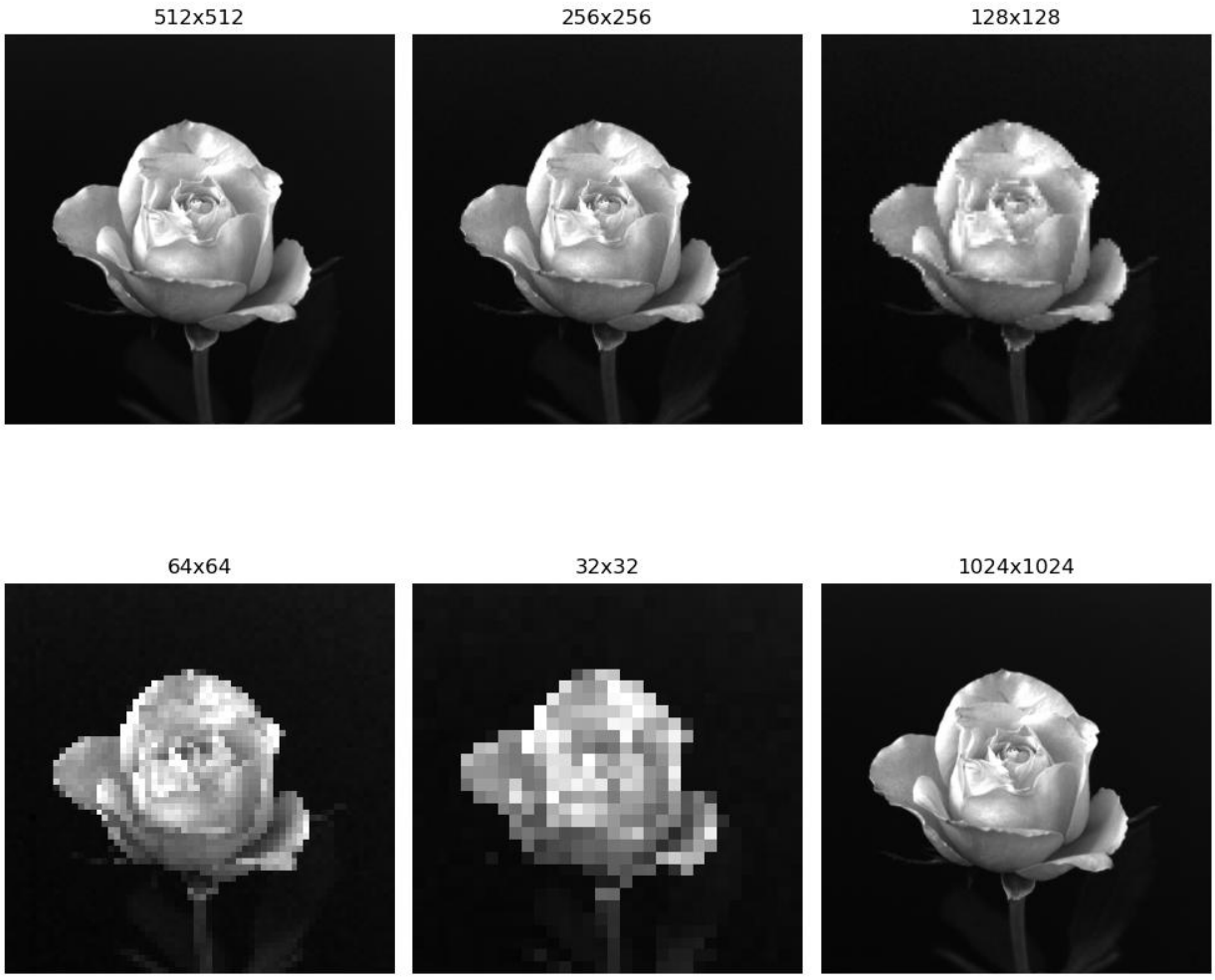

Figure 2 Sampling results.

Quantization

The image below exposes the impact of quantization which becomes more pronounced as the number of gray levels decreases. Higher levels of quantization lead to more noticeable degradation in image quality. (Compare to original image Fig1)

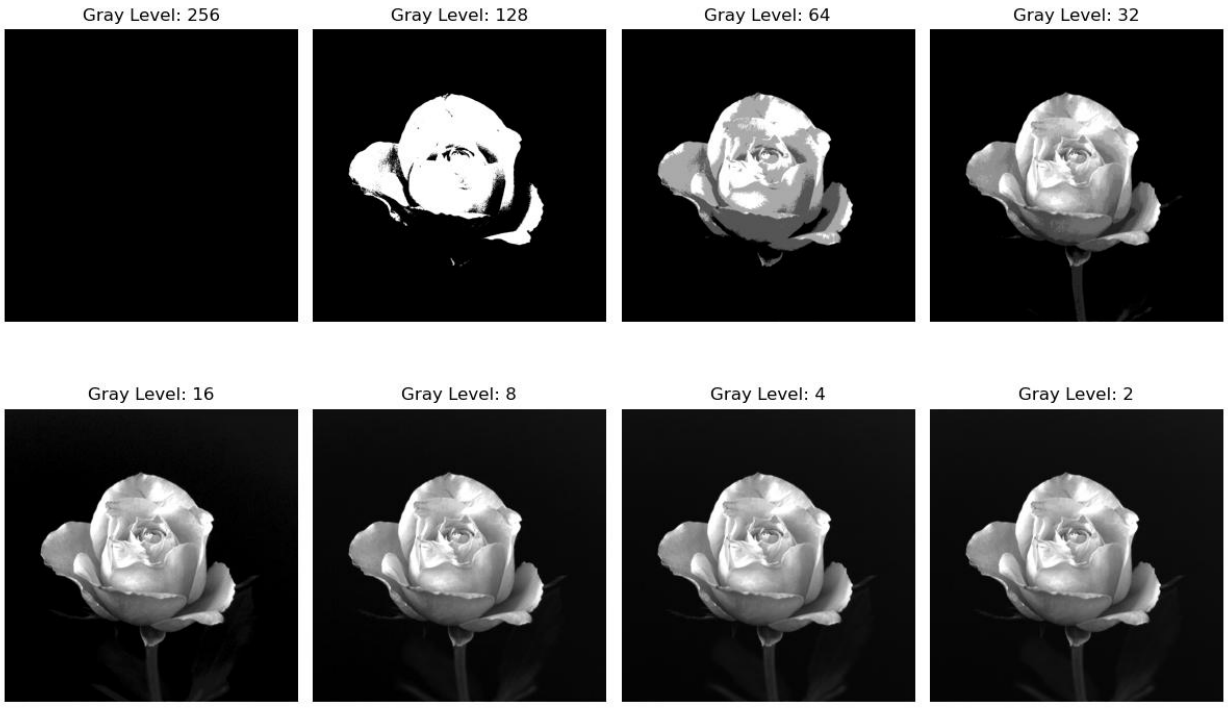

Figure 3 Gray Scale Quantization

Color Quantization

Similar to grayscale quantization, the effects of color quantization become more apparent as the number of distinct colors decreases. Higher levels of color quantization result in more noticeable color distortion and simplification.

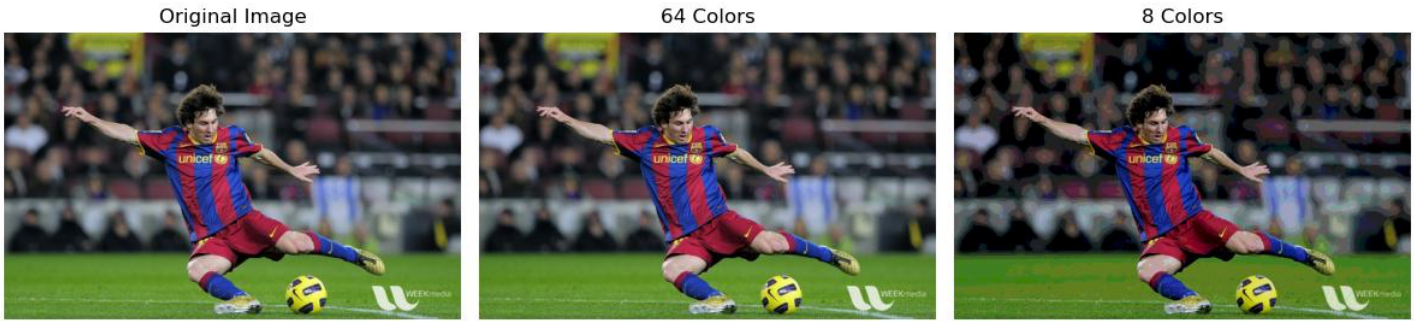

Figure 4 Color Quantization

Working on this exercise involving sampling, quantization, and color quantization in image processing has provided valuable insights and lessons learned in the field of digital image manipulation.

The project deepened my understanding of fundamental concepts in image processing, including sampling, quantization, and color quantization. I believe these concepts are essential for various applications, such as image compression, enhancement, and analysis.

Experimenting with different parameters, such as sampling factors, grayscale levels, and color levels, demonstrated the impact they have on image quality and appearance. It emphasized the importance of carefully selecting parameters based on specific requirements and objectives.

I acquired a deeper knowledge about, aliasing artifacts in down-sampled images, loss of detail in quantized images, and color distortion in color quantized images.

Provided hands-on experience with implementing image processing algorithms and techniques using Python. I decided to use OpenCV and Matplotlib instead of MATLAB since in my experience these packages are more widespread. Furthermore, this practical application enhanced my technical skills and problem-solving abilities.

Given more time, potential future work could involve further exploration and experimentation with advanced image processing techniques, exploring more sophisticated sampling methods, adaptive quantization algorithms, and/or exploring the application of machine learning for image enhancement or restoration technique implementation.