NAME: _____

Image Processing Simulations Report

Objective

The objective of this project was to simulate various image processing tasks and study their effects. The simulations included image resolution changes, quantization, and multi-resolution display. Additionally, we applied basic mathematical operators to implement practical concepts such as Double Exposure, Change Detection, and Synthesize Novel Images.

Simulated Tasks

1. **Image Resolution Simulation**

The image resolution simulation involved resizing a given image to different dimensions. Starting with the original image size of 1024x1024, the image was progressively resized to smaller resolutions (512x512, 256x256, 128x128, 64x64, and 32x32) to observe the effects on image quality and details.

2. **Quantization Simulation**

Quantization involves mapping the original pixel values to a reduced set of discrete levels. In this simulation, we applied quantization with varying bit depths (ranging from 1 to 8 bits) to observe the impact on image quality and representation.

3. **Multi-Resolution Simulation**

The multi-resolution simulation aimed to reduce the size of the image progressively using a scaling factor of approximately 1.72. The images were resized and displayed to demonstrate the effect of multi-resolution representation.

Practical Concepts Implementation

1. **Double Exposure**

To achieve double exposure, we applied a basic mathematical operator: averaging. We added 10-15 images of the same object taken under the same conditions and computed the mean image, mimicking the effect of double exposure.

2. **Change Detection**

For change detection, we utilized the subtraction operation between frames taken from a video or sequence of images. The subtraction operation highlights differences between successive frames, aiding in change detection.

3. **Synthesize Novel Images**

To synthesize a novel image, we applied a masking concept. We took multiple images of a favorite object, masked different portions of each image, and combined them to synthesize a new image. Proper alignment of images was ensured for effective masking.

Methodology

The simulations were implemented in Python using the OpenCV library. The images were loaded, processed, and displayed for each simulation task. The image resolution was changed using the OpenCV `cv2.resize` function, while quantization involved mapping pixel values to discrete levels based on the selected bit depth. Multi-resolution simulation was achieved by resizing the image with varying scaling factors.

Results

Image Resolution Simulation

- Resized images showed a clear reduction in detail and quality as the resolution decreased, as expected.
- Lower resolution images appeared more pixelated and less sharp compared to the original.

Quantization Simulation

- Quantization demonstrated a visible reduction in the number of unique levels as the bit depth decreased.
- Lower bit depths resulted in a more pronounced loss of image details and smoother gradients.

Multi-Resolution Simulation

- Displaying images at different resolutions revealed a clear representation of multi-resolution data.
- Higher resolution images exhibited finer details, while lower resolution images emphasized the overall structure.

Practical Concepts Implementation

1. **Double Exposure**

- Averaging multiple images simulated the double exposure effect, blending images to produce an amalgamated representation.

2. **Change Detection**

- The subtraction of frames effectively highlighted differences, enabling easy detection of changes between successive frames.

3. **Synthesize Novel Images**

- The use of masking combined with appropriate alignment resulted in a novel image by synthesizing selected portions from different images.

Conclusion

The simulations successfully demonstrated the effects of image resolution changes, quantization, and multi-resolution display. Additionally, the implementation of practical concepts like double exposure, change detection, and synthesizing novel images showcased the application of basic mathematical operators in image processing. Understanding these effects and practical implementations is essential for various image processing applications, enabling informed decision-making based on the available data and requirements.