**CT404/CT336: Graphics & Image Processing**

**Assignment 2: Image Processing & Analysis**

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**Task 1: Morphological Image Processing Pipeline for Medical Images**

**Step 1.1: Conversion to a Single Channel Image**  
After experimenting with grayscale and RGB channels, the green channel provided the best contrast, highlighting white fat globules and differentiating them from the pink-purple background tissue.

A close-up of a greyscale image

Description automatically generated

**Step 1.2: Image Enhancement**  
The histogram Equalization was applied to the grayscale image to improve contrast between the fat globules and the background. The result increased the brightness and contrast, clearly defining the edges of the globules.

**A close-up of a grey and white image

Description automatically generated**

**Step 1.3: Thresholding**  
I selected a threshold value of 200 to obtain a clear binary image, separating the fat globules as white regions and the background as black. This provided a good balance between capturing the globules and minimizing background noise.

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Description automatically generated**

**Step 1.4: Noise Removal**

**Morphological Operation Chosen:**  
Morphological opening was applied to remove small white noise dots while keeping the globules' shape and size.

A black and white image of white dots

Description automatically generated

**Step 1.5: Extraction of Connected Components**

I used connected components labelling to identify individual white regions. This enabled us to isolate each globule as a separate connected component, facilitating further analysis.

A close-up of colorful dots

Description automatically generated

**Step 1.6: Filtering of Fat Globules**

1. **Area**: I used a min area threshold of 190 pixels was applied to exclude small noise components.
2. **Compactness**: Compactness was calculated for each component, and values between 0.7 and 1.3 were retained. This range effectively filtered out non-globular shapes.

A black and white background with white dots

Description automatically generated

**Number of Fat Globules Detected:**  
34

**Step 1.7: Calculation of Total Fat Area Percentage**

**A black background with white text

Description automatically generated**

**Task 2: Filtering of Images in Spatial & Frequency Domains**

**Step 2.1: Spatial Domain Gaussian Smoothing**

**Parameters Selected:**

* Kernel Size: 15x15
* Sigma: 10

I used gaussian smoothing and applied it in the spatial domain, reducing wrinkles and creating a smoother appearance.

**A person with long hair smiling

Description automatically generated**

**Step 2.2: Frequency Domain Low-Pass Filter (FFT of Gaussian Kernel)**

A black square with a white light

Description automatically generated  
The 2D FFT of the Gaussian kernel was computed and plotted, showing a centered low-pass filter effect.

**Step 2.3: Frequency Domain Filtering with Low-Pass Filter**

**Parameters Chosen for Low-Pass Filter:**  
I used a low-pass circular filter of radius 50 pixels to apply in the frequency domain, creating a smoothed skin effect.

**A person with long hair smiling

Description automatically generated**

**Step 2.4: Comparison of Spatial and Frequency Domain Smoothing**

**Comparison:**  
The spatial and frequency domain images both achieved smoothing, but the frequency domain filter produced a slightly softer appearance.

**Preferred Domain for Task:**  
The frequency domain provided a smoother result, particularly suitable for reducing high-frequency details associated with wrinkles.

A close-up of a person

Description automatically generated

**Step 2.5: Unseen Image Testing**

**New Test Image Result:**  
After applying the frequency domain low-pass filter to an unseen image, the skin looked smoother, showing that the filter's work across different facial images.

A collage of a person

Description automatically generated