MEDICAL IMAGING PROCESSING

FOURTH STAGE

2025-2026

Image Compression Using JPEG and Wavelets

BY

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Lec 7

Learning Outcomes

1.Understand the concept of redundancy in digital images.

2.Distinguish types of redundancy.

3.Recognize JPEG and JPEG 2000 compression methods.

4.Understand the role of wavelets in image compression.

Introduction

Introduction to Redundancy in Digital Images Redundancy in digital images refers to the presence of excessive or repeated information that can be exploited to reduce data size without significantly affecting image quality.

Redundancy can be categorized into several main types:

Statistical Redundancy: Refers to the statistical relationship between pixel values in an image, where the value of a given pixel can often be predicted based on the values of its neighboring pixels.

Spatial Redundancy: Based on the similarity among adjacent pixels in an image. Homogeneous regions tend to contain similar pixel values, resulting in repeated information.

Psychovisual Redundancy: Involves exploiting characteristics of human visual perception to remove visually insignificant information. The human eye is less sensitive to fine details and minor variations, making it possible to eliminate some data without noticeable loss in visual quality.

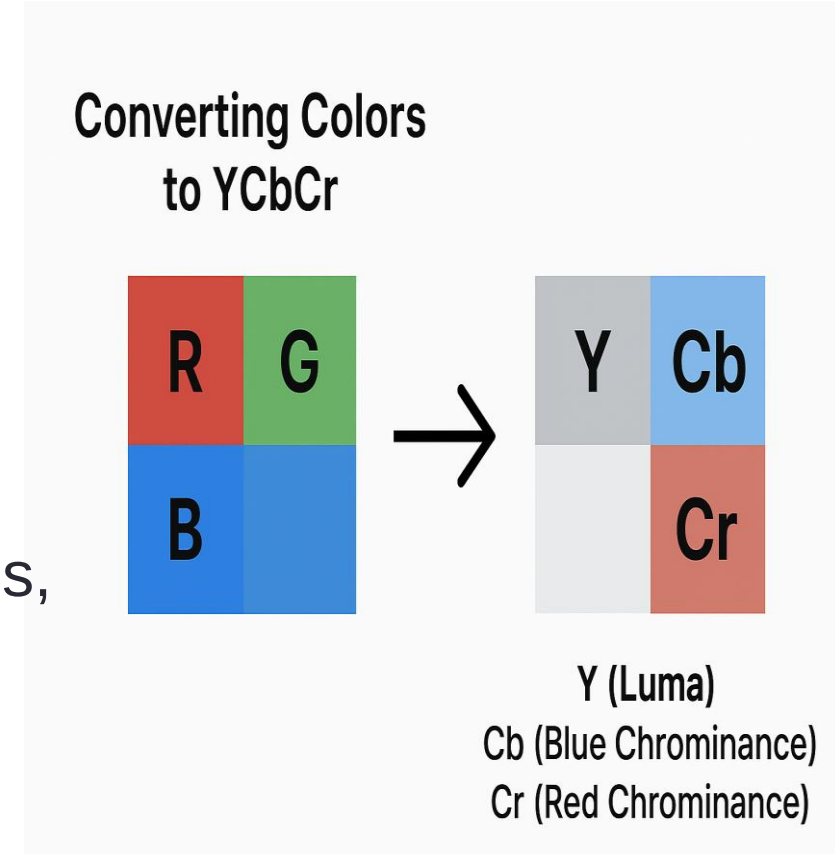
Converting Colors to YCbCr

In this step, the color space is converted from **RGB (Red, Green, Blue)** to **YCbCr**, where:

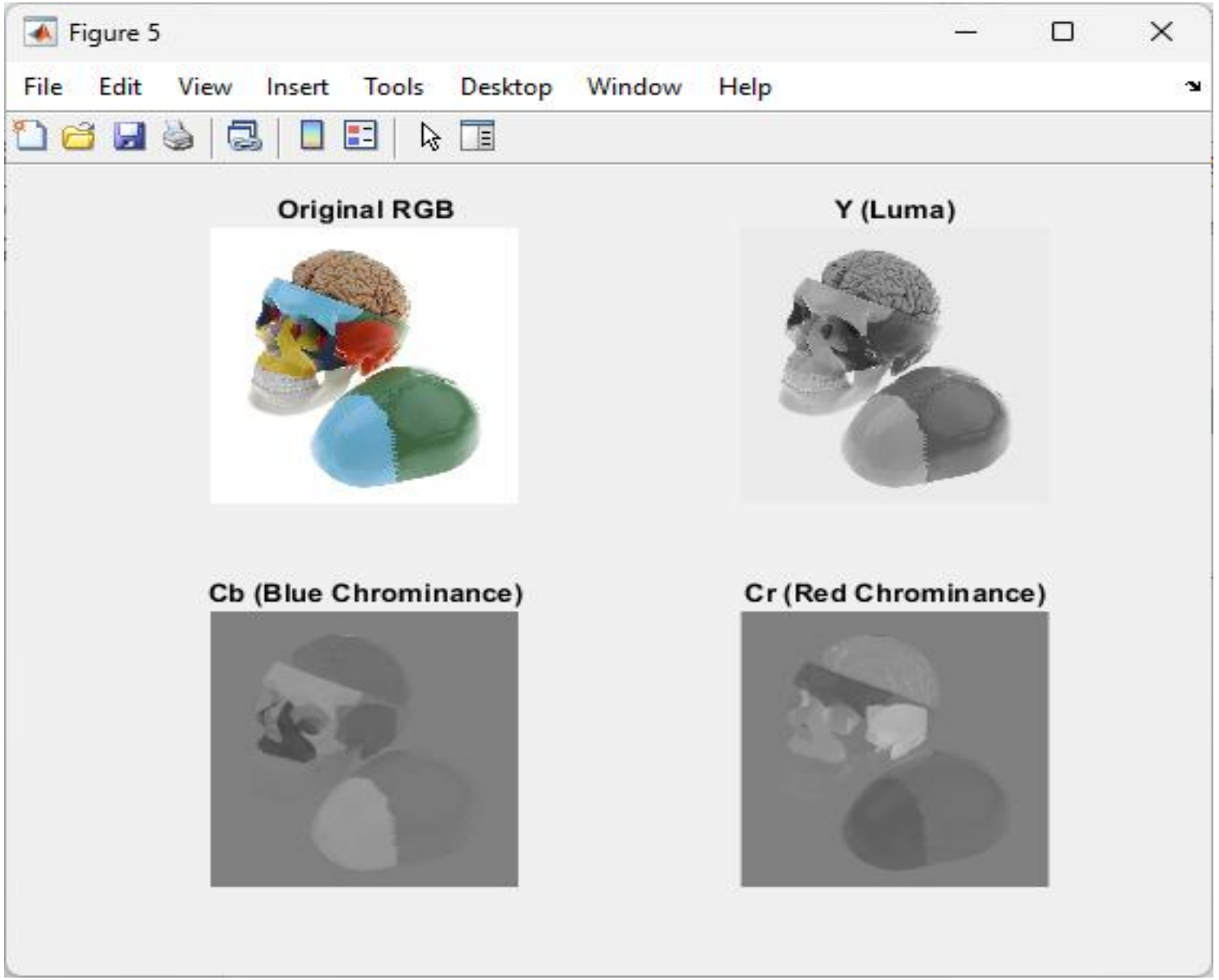
- **Y** represents the luminance (brightness).
- **Cb** and **Cr** represent the chrominance components (blue-difference and red-difference).

Reason:

The human eye is more sensitive to brightness changes than to color variations. Therefore, chrominance components can be stored with lower precision without noticeable visual loss, which helps reduce data size during compression.

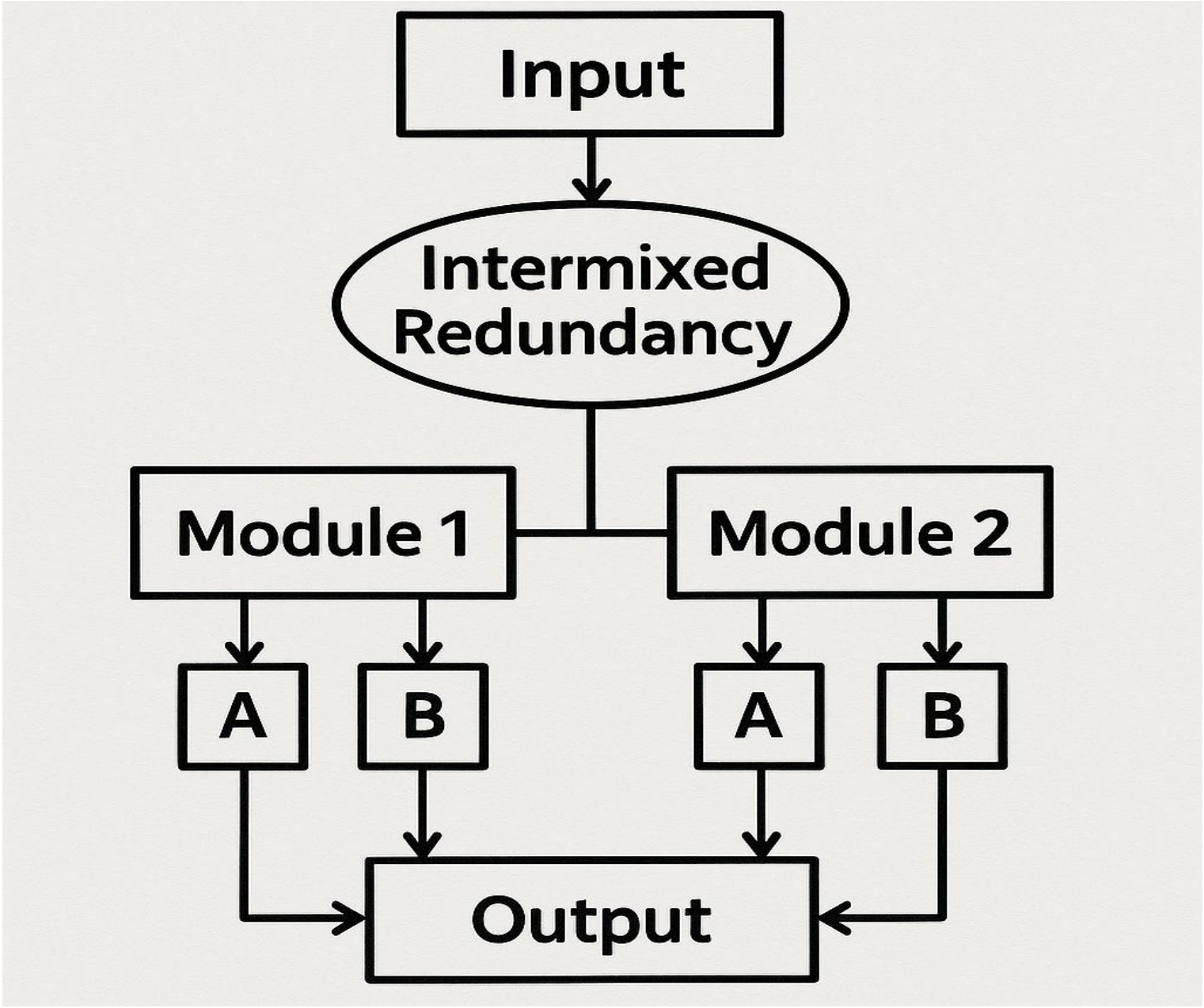


Converting Colors to YCbCr



📌 Introduction to Intermixed Redundancy

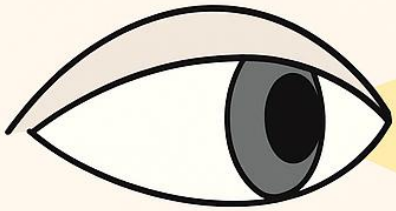
- **Intermixed Redundancy** refers to redundancy that arises from the interaction or combination of multiple types of redundancies within a digital image.
  Instead of appearing as one single
- Images often contain overlapping redundancies—statistical, spatial, and psychovisual—working together. Compression techniques like JPEG and MPEG use this overlap to achieve higher compression efficiency.


Input
Intermixed Redundancy
Module 1
Module 2
A
B
A
B
Output

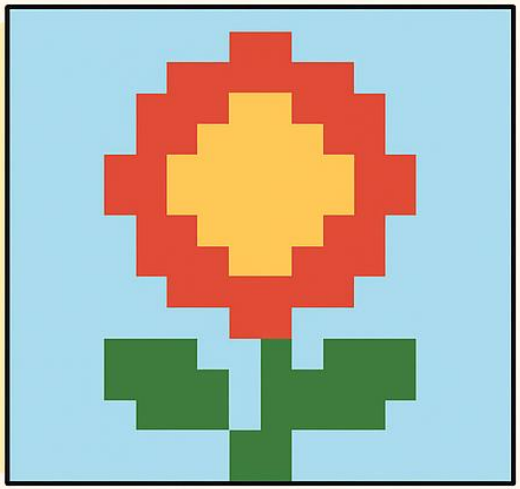
📌 Introduction to Psychovisual Redundancy

- **Psychovisual Redundancy** is based on understanding how the human visual system works.
  It refers to image information that **exists mathematically**, but the human eye **cannot see or does not notice**, making it safe to remove during compression.
- **Human vision is:**
- More sensitive to brightness detail
- Less sensitive to small color changes
- Unable to notice very fine, high-frequency details
- Therefore, these visually insignificant details can be discarded without affecting perceived image quality.

Psychovisual Redundancy



Human visual system



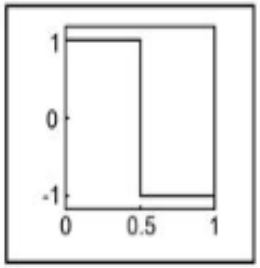
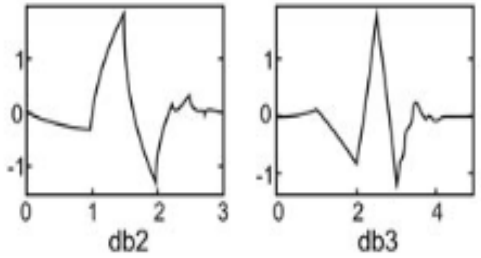
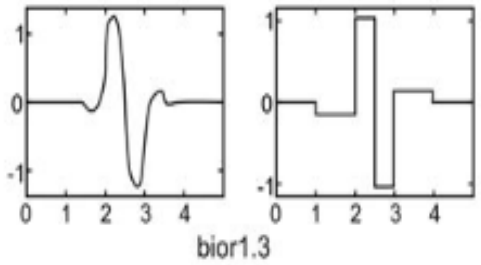
Mathematical image information

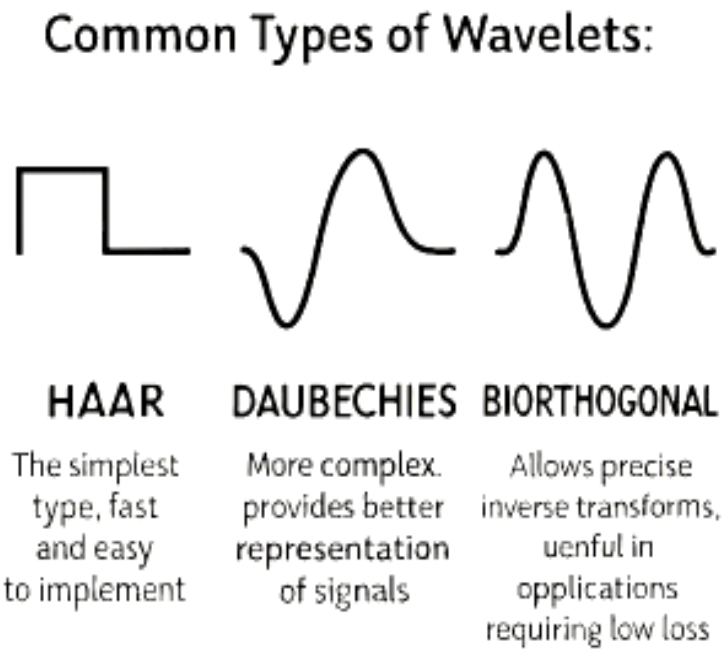
Visually insignificant

Wavelets

- **Definition of a Wavelet**: A mathematical function used to analyze signals and decompose them into components of multiple frequencies and time locations.
- **Comparison between Wavelets and DCT:**
- Wavelets provide multi-resolution analysis, while DCT relies on fixed analysis.
- - Wavelets are more efficient in representing signals with sudden changes or edges.
- - DCT is used in traditional JPEG, whereas wavelets are used in JPEG 2000.
- **Common Types of Wavelets:**
- **- Haar**: The simplest type, fast and easy to implement.
- - **Daubechies**: More complex, provides better representation of signals.
- **- Biorthogonal**: Allows precise inverse transforms, useful in applications requiring low loss.

الجدول (1) أنواع المويجات الأساسية وأشكالها ومزاياها وتطبيقاتها الرئيسية.

اسم المويجة وشكلها	السمات	التطبيقات
مويجة هار Haar 	بسيطة الشكل والتوصيف، وأسرع تنفيذاً، ومتناظرة	تطبيقات الكفاءة العالية، ونسبة ضغط عالية كالصور الطبية والفضائية
مويجات دوبيشيس Daubechies 	خصائصها مماثلة لمويجة هار، لكنها تختلف من حيث الشكل. توفر معلومات جيدة وكافية، تنتج أحداثاً مماثلة للسلاسل الزمنية، ذات تكلفة حسابية عالية	تطبيقات الإشارة غير المنتظمة للصور الطبية والفضائية
المويجات مضاعفة التعامد 	أعقد من السابقتين، لأنها تحتاج إلى موجتين، إحداهما للتحليل والثانية لإعادة البناء	الإشارات المعقدة نسبياً



GOOD LUCK EVERYONE