

# Homework 2

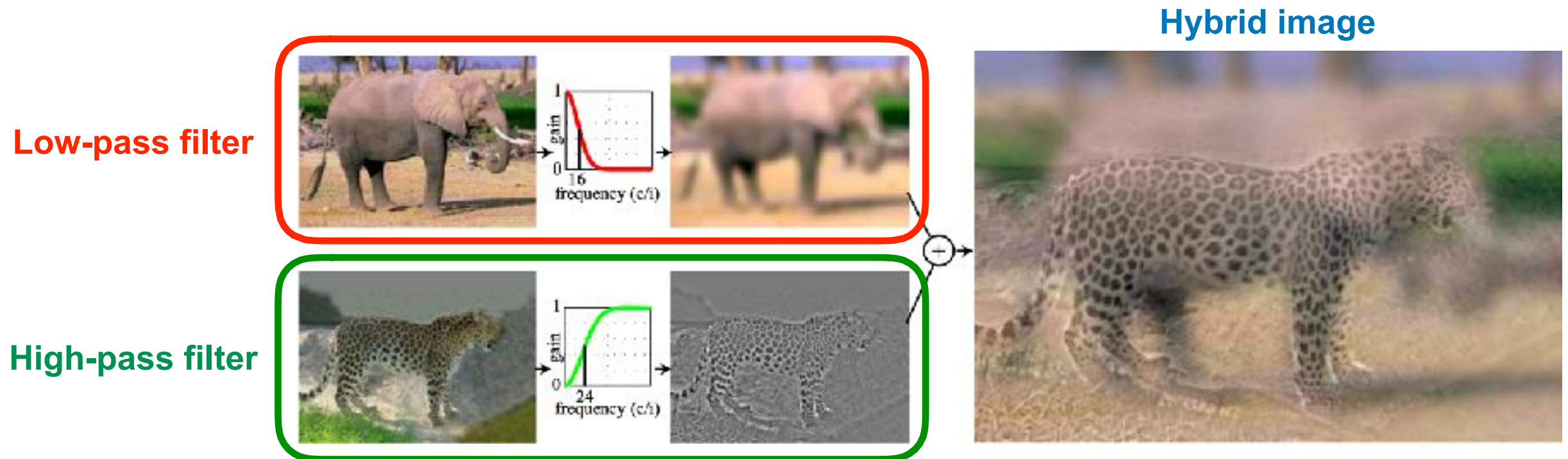
# Instructions

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- Deadline: **2021/04/15 23:55:00**
- Hand in a complete report, as detailed as possible, including:
  - your introduction
  - implementation procedure
  - experimental results (**of course you should also try your own images**)
  - discussion (what difficulties you have met? how you resolve them?)
  - conclusion
  - work assignment plan between team members.
- Tasks:
  1. Hybrid image
  2. Image pyramid
  3. Colorizing the Russian Empire

# Overview

A hybrid image is the sum of a low-pass filtered version of the one image and a high-pass filtered version of a second image. There is a free parameter, which can be tuned for each image pair, which controls how much high frequency to remove from the first image and how much low frequency to leave in the second image. This is called the “cutoff frequency”.



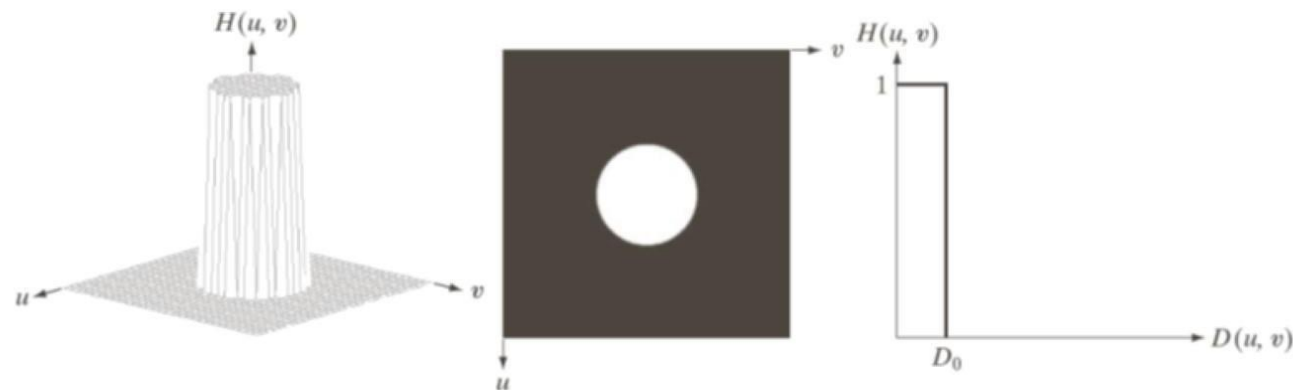
# Overview

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# Low pass filter

## Ideal low pass filter



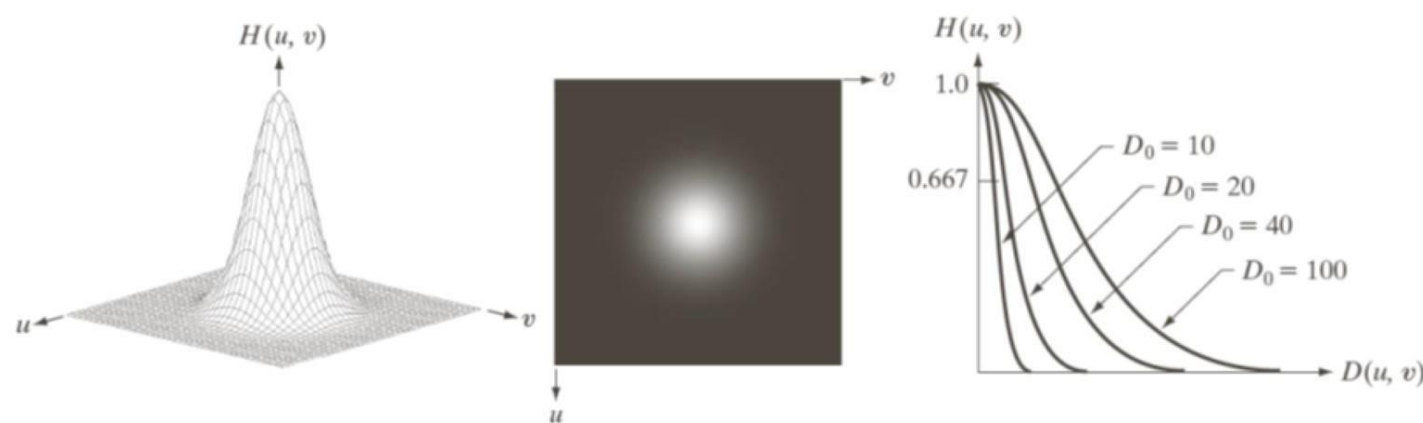
a b c

**FIGURE 4.40** (a) Perspective plot of an ideal lowpass-filter transfer function. (b) Filter displayed as an image. (c) Filter radial cross section.

$$H(u, v) = \begin{cases} 1 & \text{if } D(u, v) \leq D_0 \\ 0 & \text{if } D(u, v) > D_0 \end{cases}$$

$D_0$ : cutoff frequency  
 $D(u, v) = (u^2 + v^2)^{1/2}$

## Gaussian low pass filter



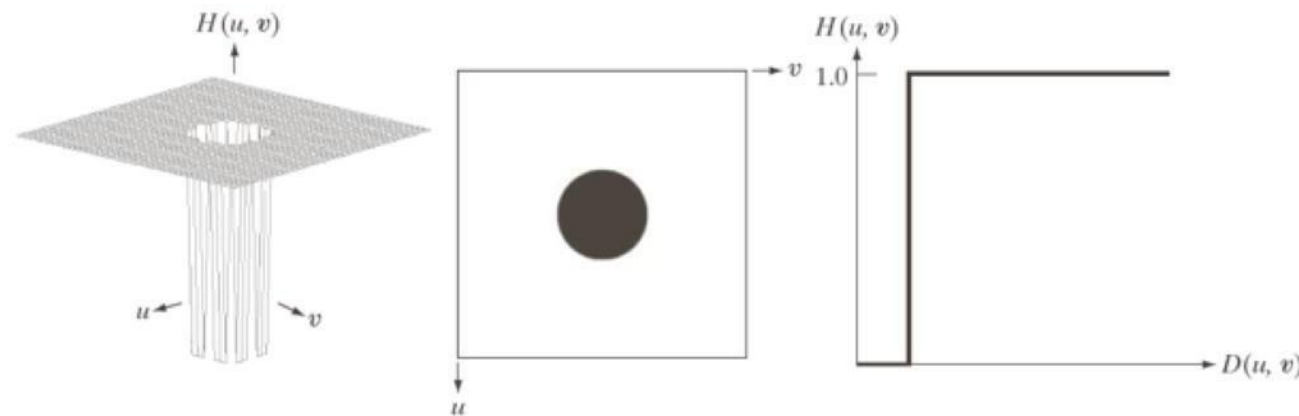
a b c

**FIGURE 4.47** (a) Perspective plot of a GLPF transfer function. (b) Filter displayed as an image. (c) Filter radial cross sections for various values of  $D_0$ .

$$H(u, v) = e^{-D^2(u, v) / 2D_0^2}$$

# High pass filter

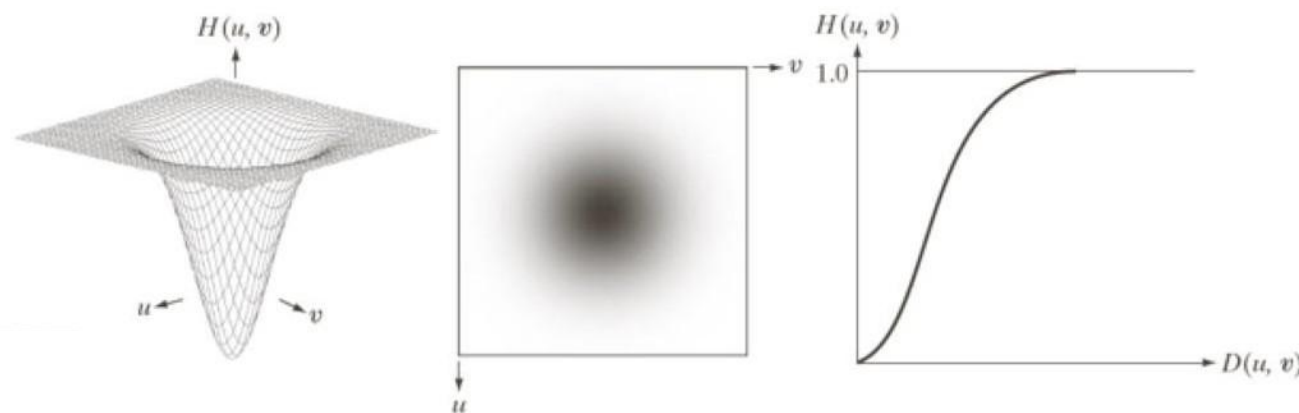
## Ideal high pass filter



$$H(u, v) = \begin{cases} 0 & \text{if } D(u, v) \leq D_0 \\ 1 & \text{if } D(u, v) > D_0 \end{cases}$$

$D_0$ : cutoff frequency  
 $D(u, v) = (u^2 + v^2)^{1/2}$

## Gaussian high pass filter



$$H(u, v) = 1 - e^{-D^2(u, v) / 2D_0^2}$$

# Procedure

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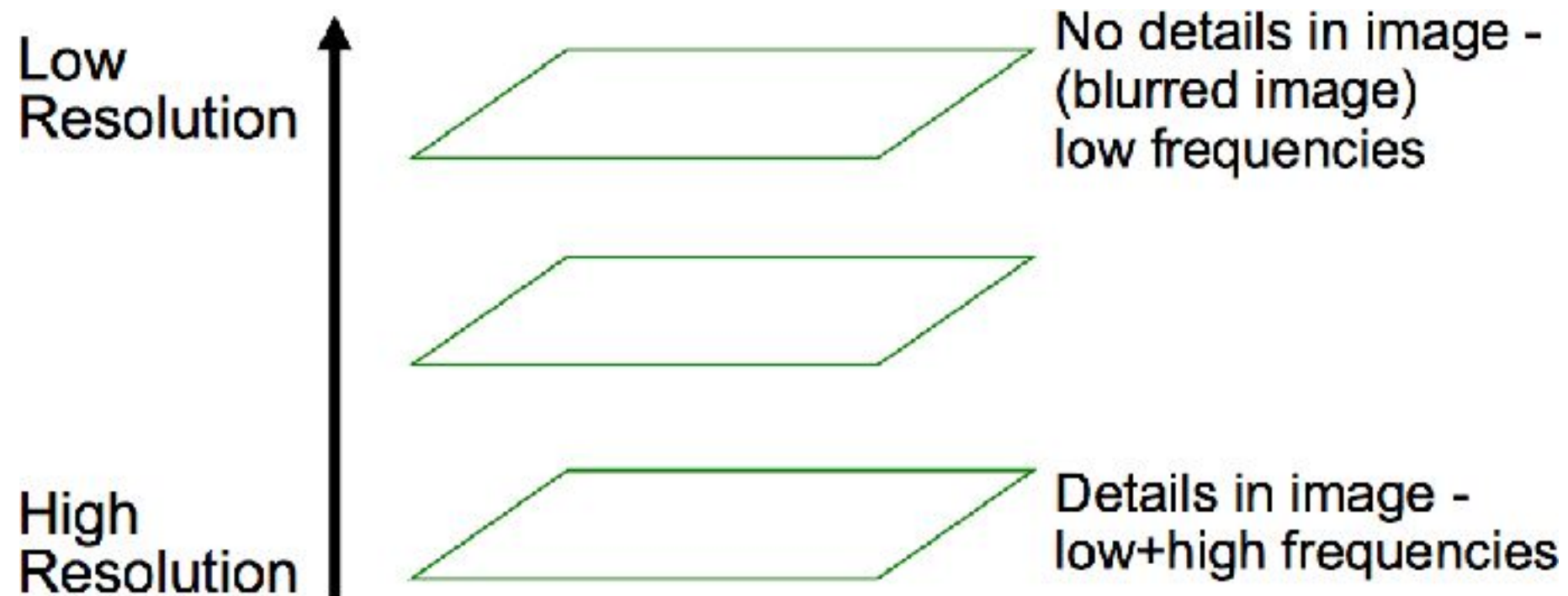
1. Multiply the input image by  $(-1)^{x+y}$  to center the transform.
2. Compute Fourier transformation of input image, i.e.  $F(u,v)$ .
3. Multiply  $F(u,v)$  by a filter function  $H(u,v)$ .
4. Compute the inverse Fourier transformation of the result in (3).
5. Obtain the real part of the result in (4).
6. Multiply the result in (5) by  $(-1)^{x+y}$ .



# Overview

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An **image Pyramid** is a collection of representations of an image.



A collection of images at different resolutions.

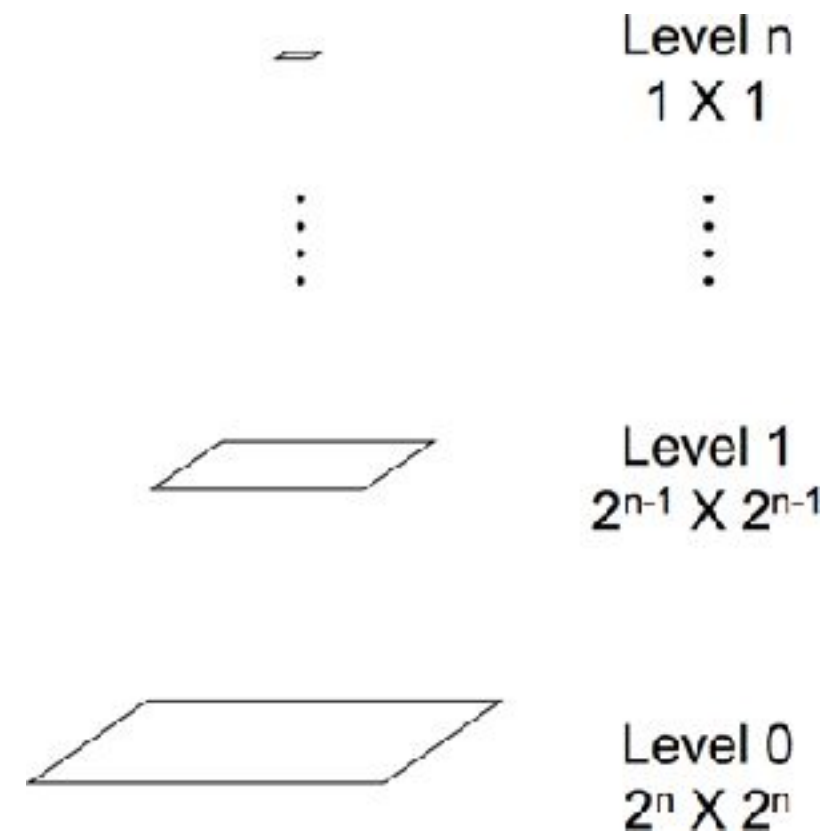
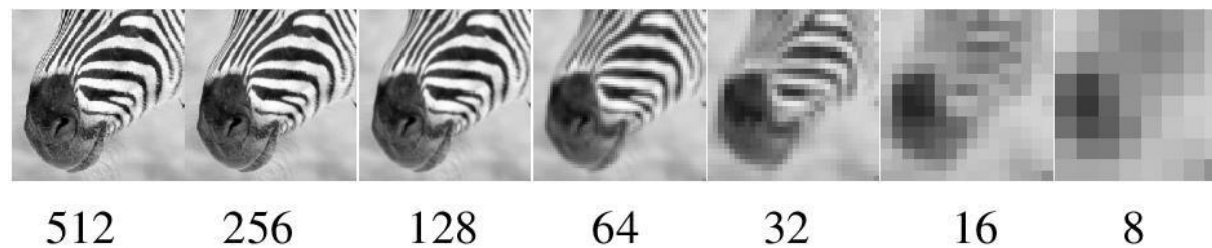
Refer to: [http://cs.haifa.ac.il/hagit/courses/ip/Lectures/lp11\\_MultiscaleRepx4.pdf](http://cs.haifa.ac.il/hagit/courses/ip/Lectures/lp11_MultiscaleRepx4.pdf)



## 2. Image pyramid

# Gaussian image pyramid

High resolution  $\longrightarrow$  Low resolution



# Procedure

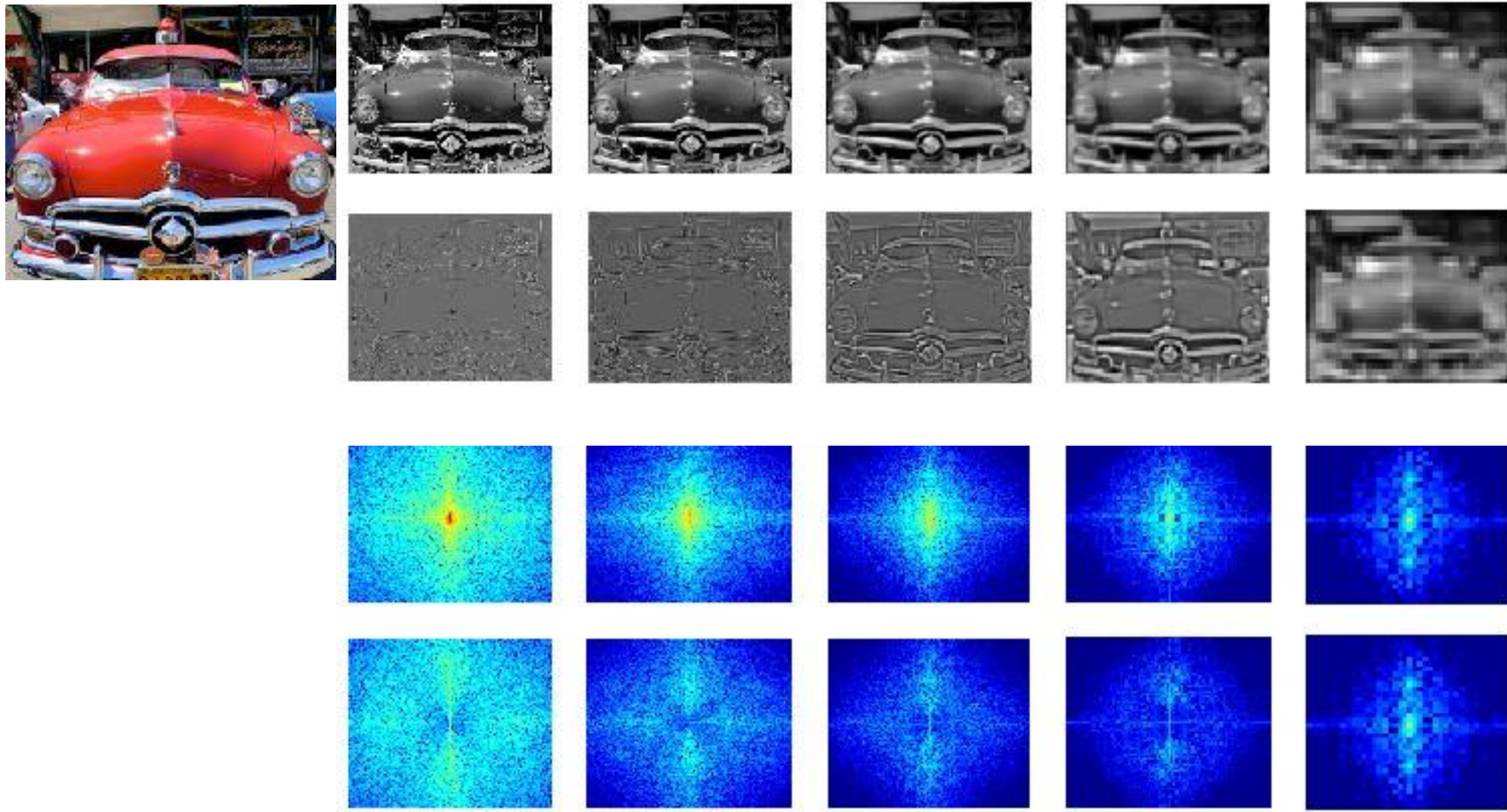
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Set the finest scale layer to the image

For each layer, going from next to finest to coarsest

Obtain this layer by smoothing the next finest layer with a Gaussian, and then subsampling it.

End



# Overview

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**Goal:** automatically produce a color image from the digitized Prokudin-Gorskii glass plate images with as few visual artifacts as possible.

The glass plate images record three exposures of every scene onto a glass plate using a red, a green, and a blue filter. In order to do this, extract the three color channels from the glass plate, then place and align one above the other so that the combination forms a single RGB color image.

Assume that a simple  $x,y$  translation model is sufficient for proper alignment. However, the full-size glass plate images are very large, the alignment procedure will need to be fast and efficient.

Refer data:

<http://www.cs.cmu.edu/afs/cs.cmu.edu/academic/class/15463-s10/www/proj1/www/abarnat/images/standard/>



### 3. Colorizing the Russian Empire

# Procedure

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Divide the original image into three images with same size.

