Image Pyramids

16-385 Computer Vision (Kris Kitani)

Carnegie Mellon University

What are image pyramids used for?

Image compression

Multi-scale texture mapping

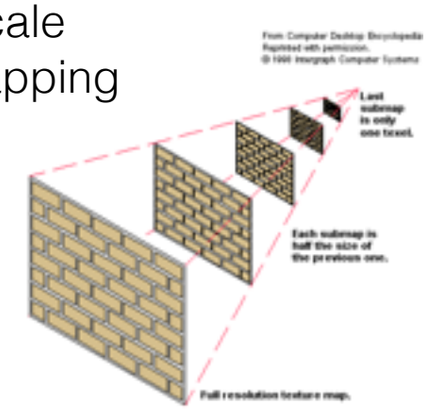
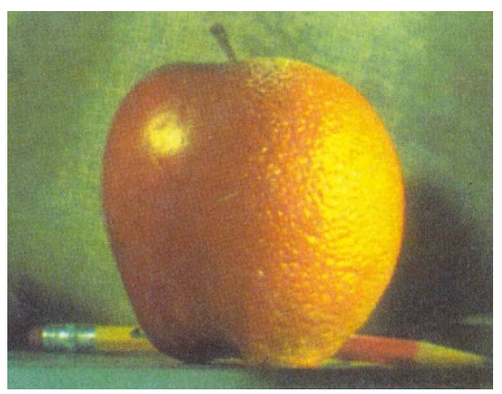
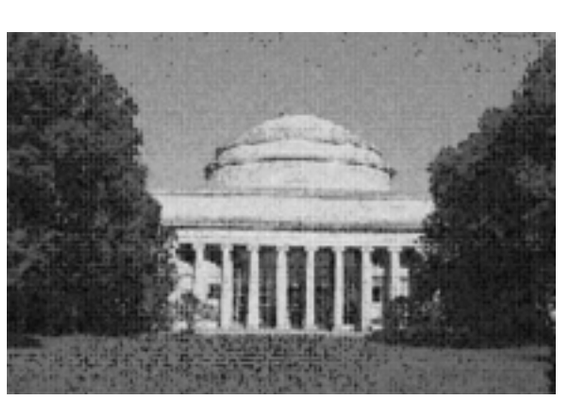


Image blending

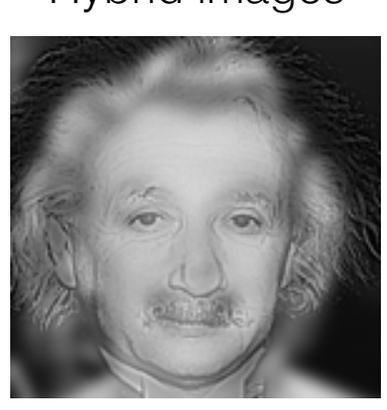


Multi-focus composites

Noise removal

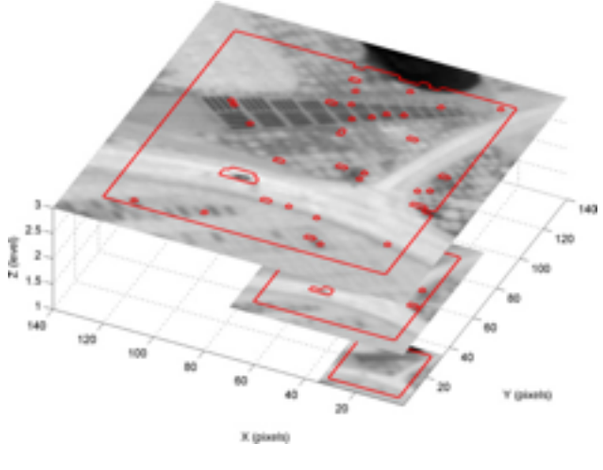


Hybrid images

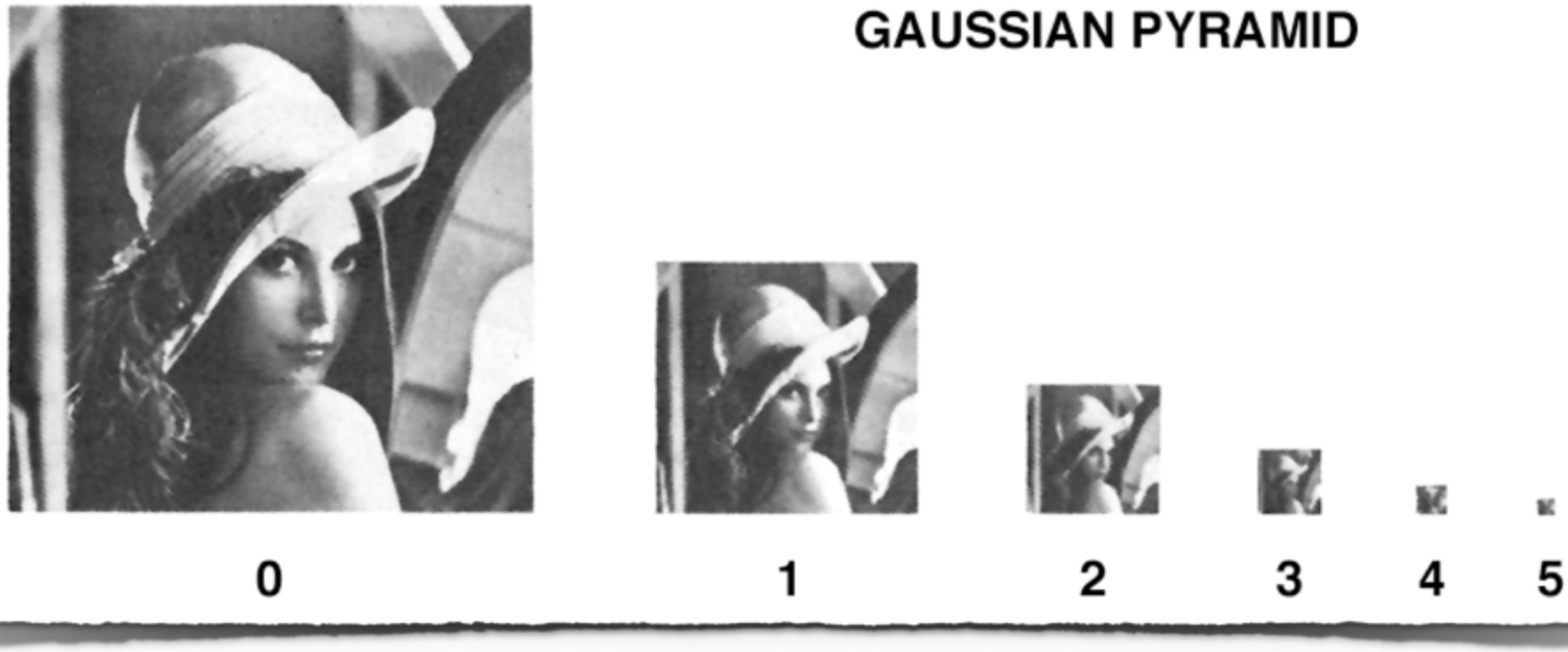


Multi-scale detection

Multi-scale registration



GAUSSIAN PYRAMID

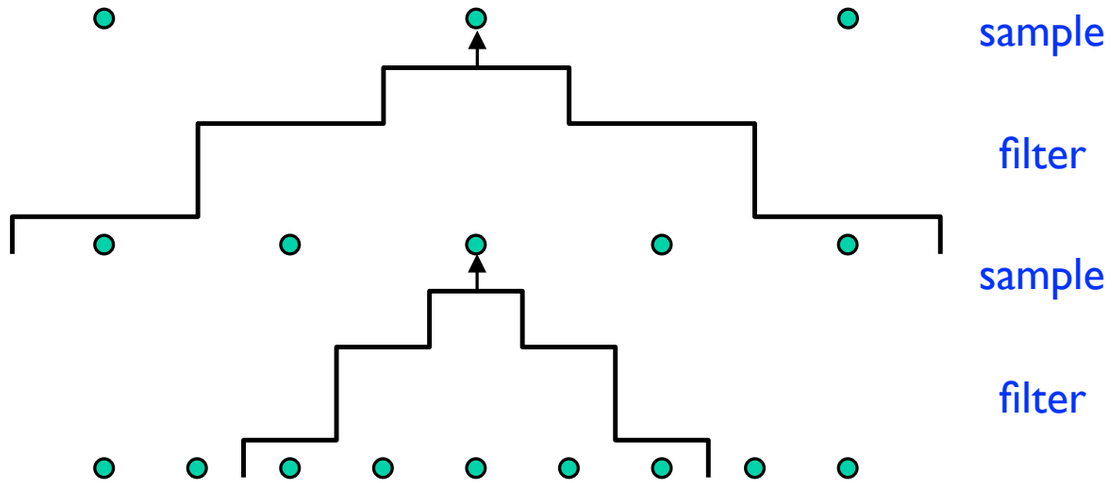


The Laplacian Pyramid as a Compact Image Code (1983)

Peter J. Burt and Edward H. Adelson

Constructing a Gaussian Pyramid

```
repeat
    filter
    subsample
until min resolution reached
```



Whole pyramid is only 4/3 the size of the original image!

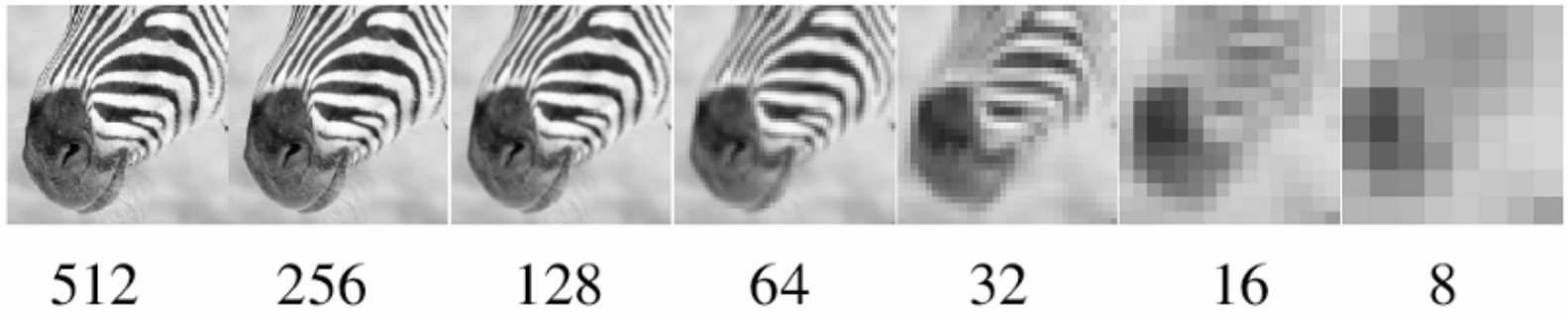
Gaussian pyramid

What happens to the details of the image?

What is preserved at the higher scales?

How would you reconstruct the original image using the upper pyramid?

Gaussian pyramid



What happens to the details of the image?

What is preserved at the higher scales?

Not possible

Level 0

Level 1

What is lost between levels?

What does blurring take away?

Level 0

-

Level 1

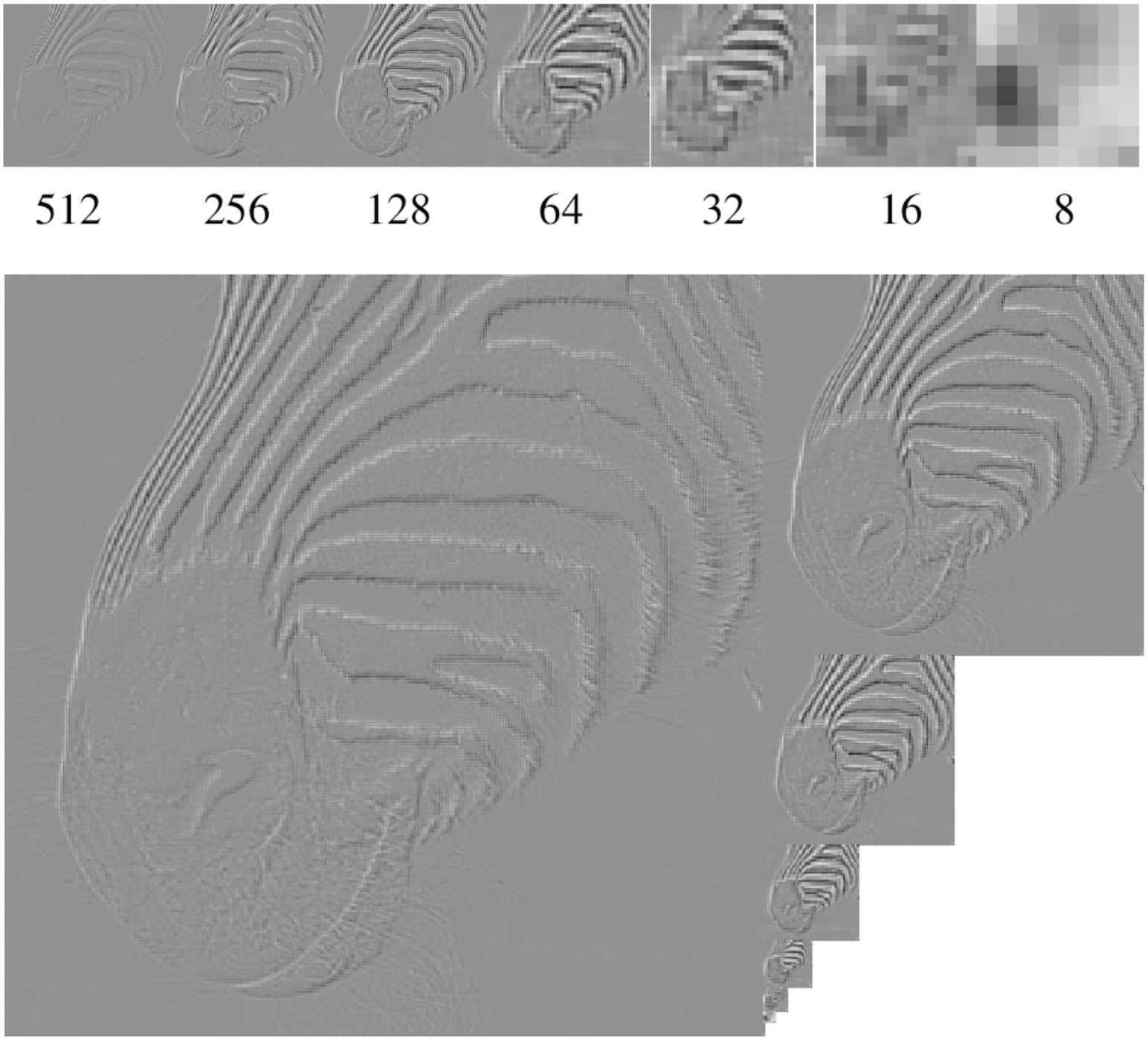
=

Residual

(thrown away by blurring)

(band-pass filter)

We can retain the residuals with a ...



Laplacian pyramid

Retains the residuals (details) between pyramid levels

Can you reconstruct the original image using the upper pyramid?

What exactly do you need to reconstruct the original image?

Partial answer:

Level 0

=

Level 1
(resized)

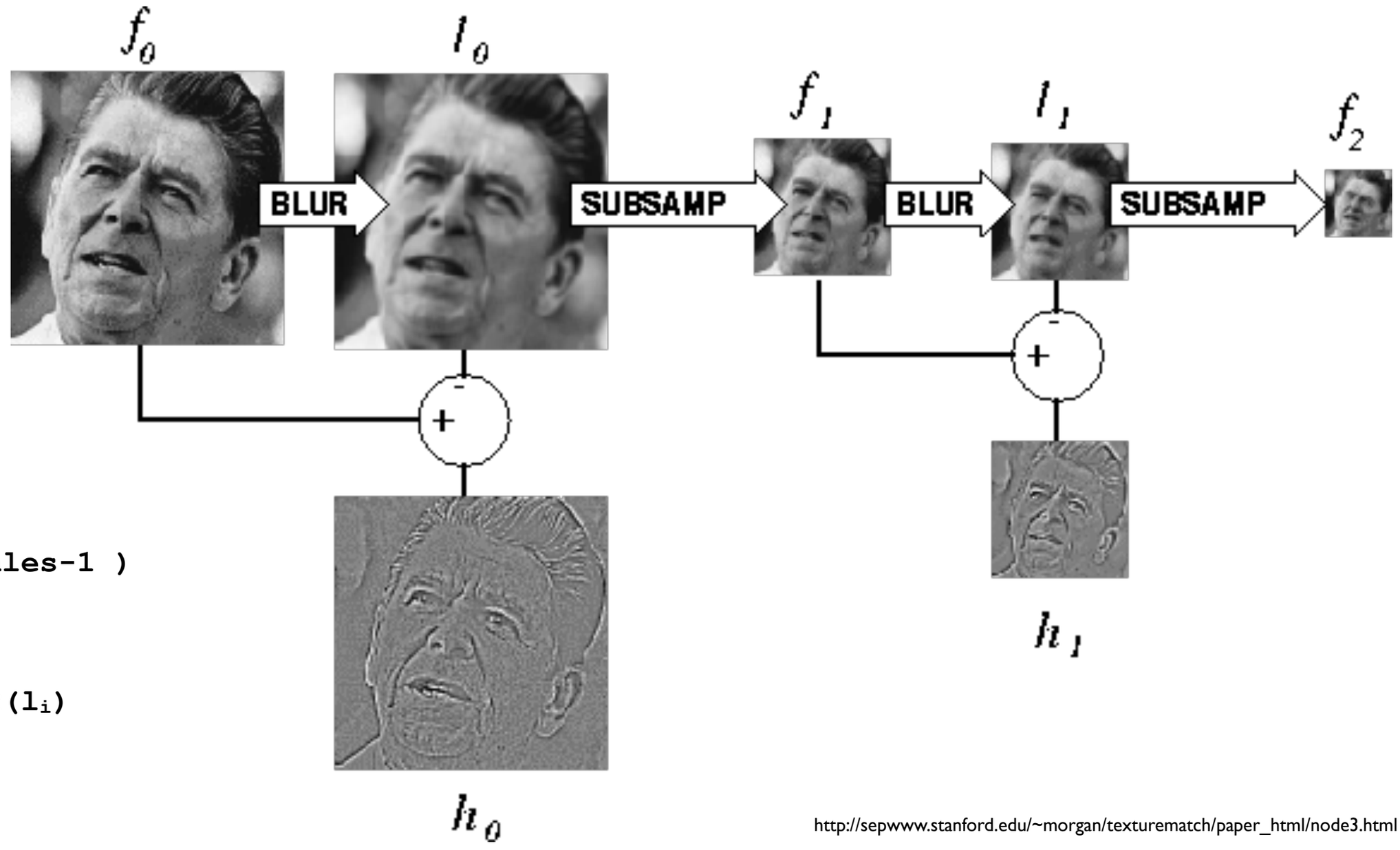
Low frequency component

+

Level 0

High frequency component

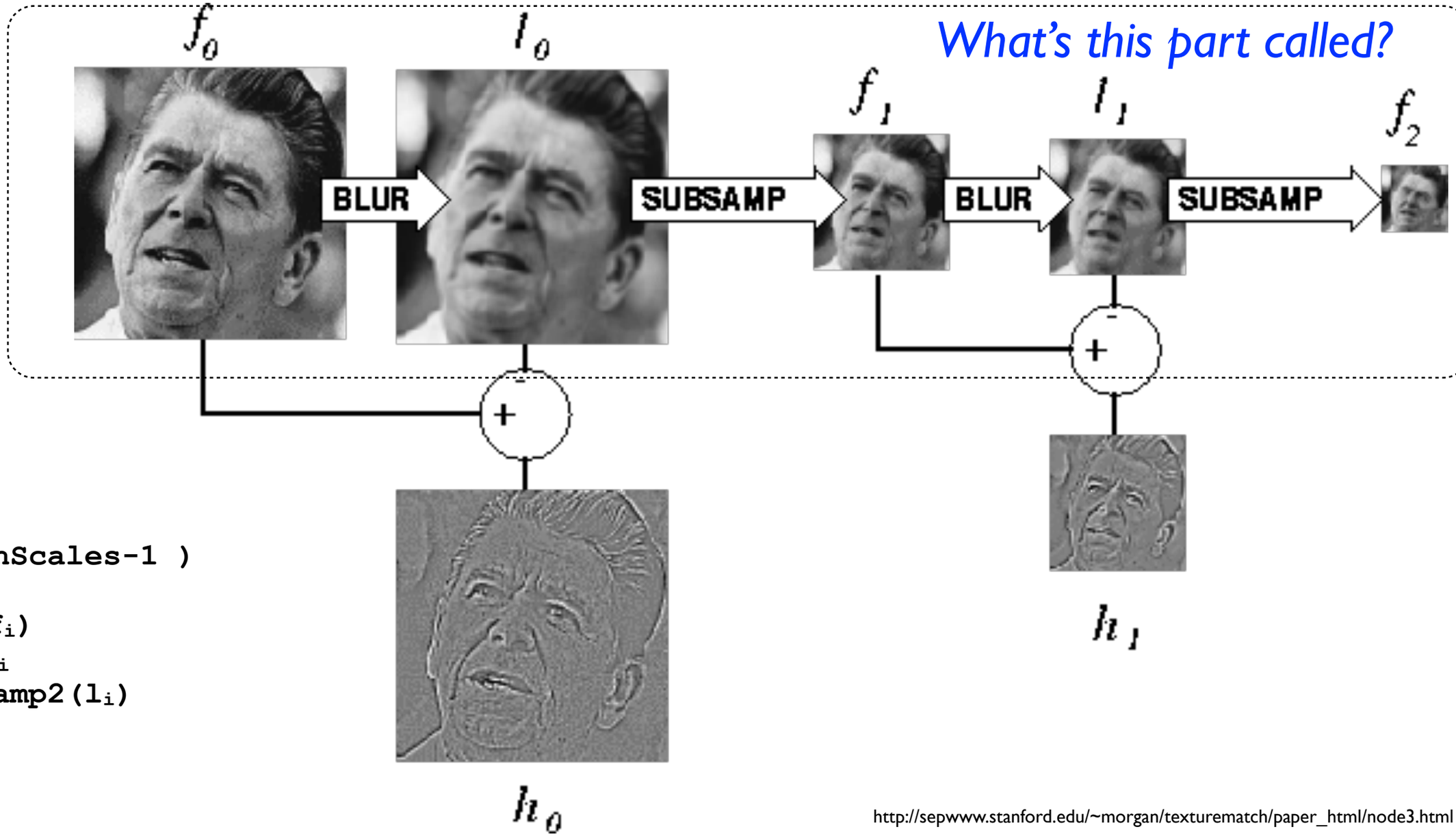
Constructing the Laplacian Pyramid




```
do( i = 0 : nScales-1 )
{
  l_i = blur(f_i)
  h_i = l_i - f_i
  f_i+1 = subSamp2(l_i)
}
```

http://sepwww.stanford.edu/~morgan/texturematch/paper_html/node3.html

Constructing the Laplacian Pyramid

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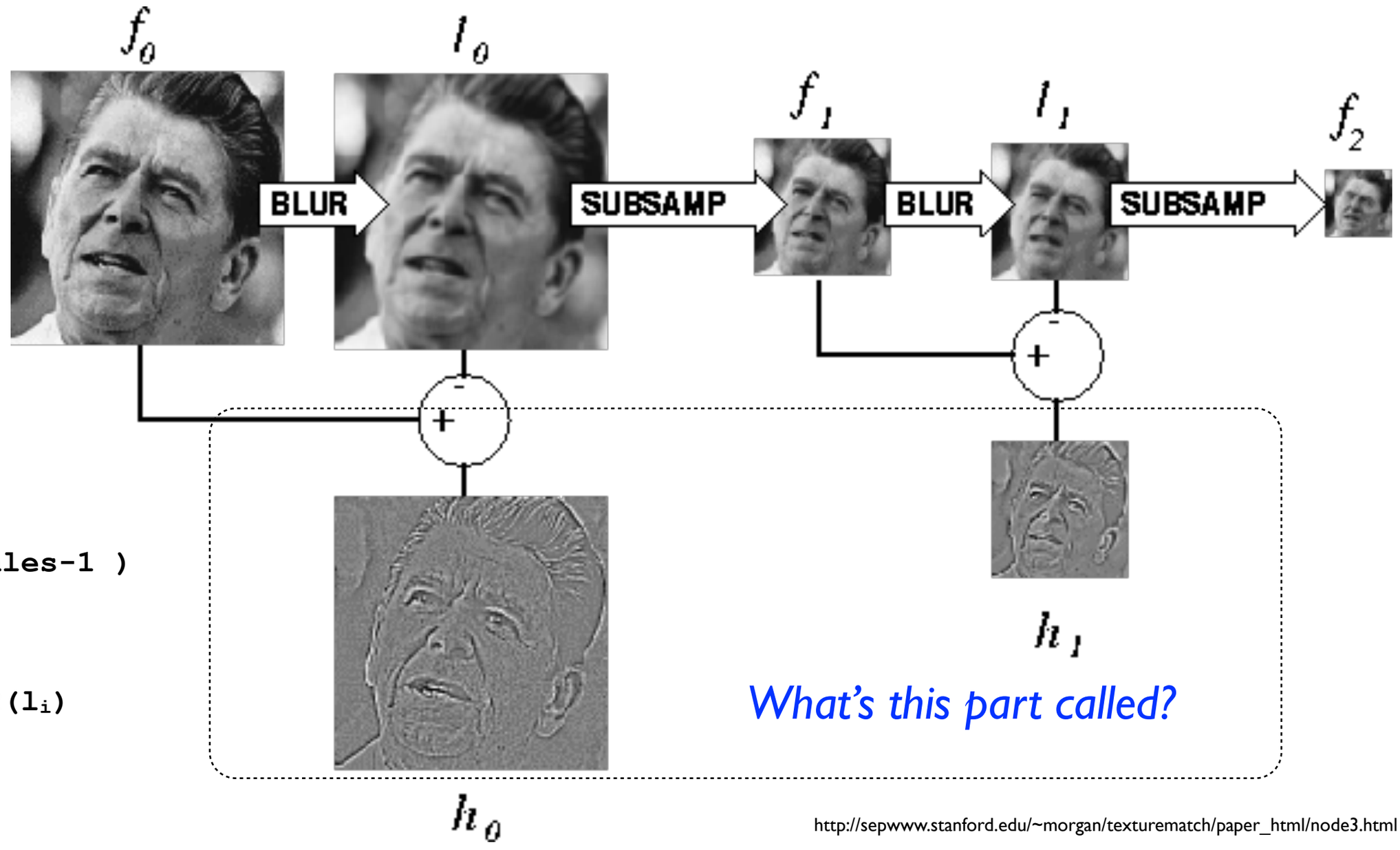
Constructing the Laplacian Pyramid




```
do( i = 0 : nScales-1 )
{
   l_i = blur(f_i)
   h_i = l_i - f_i
   f_i+1 = subSamp2(l_i)
}
```

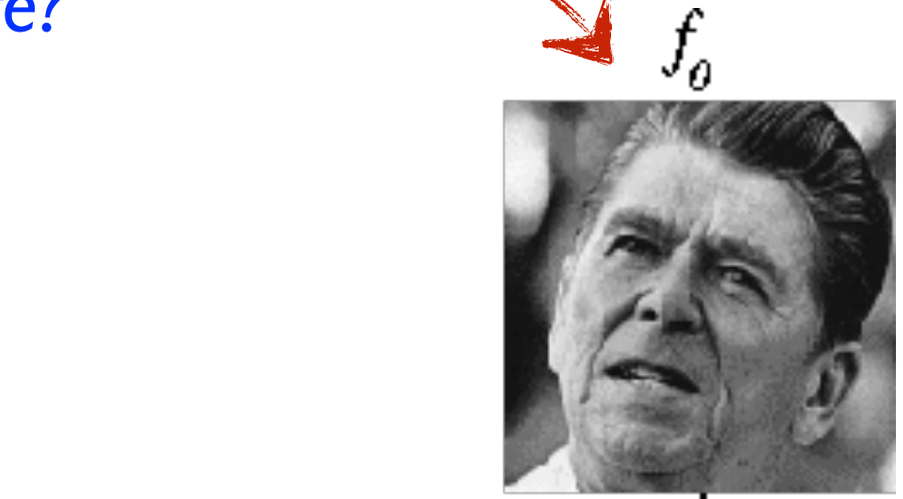
http://sepwww.stanford.edu/~morgan/texturematch/paper_html/node3.html

What do you need to construct the original image?

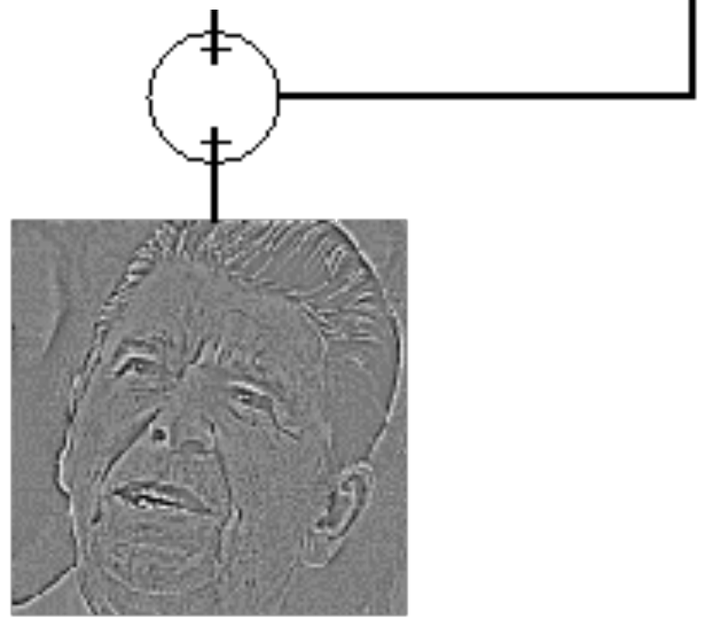
f_0

What do you need to construct the original image?

h_1



f_0



h_0

(1) Residuals

What do you need to construct the original image?

f_2

(2) smallest image

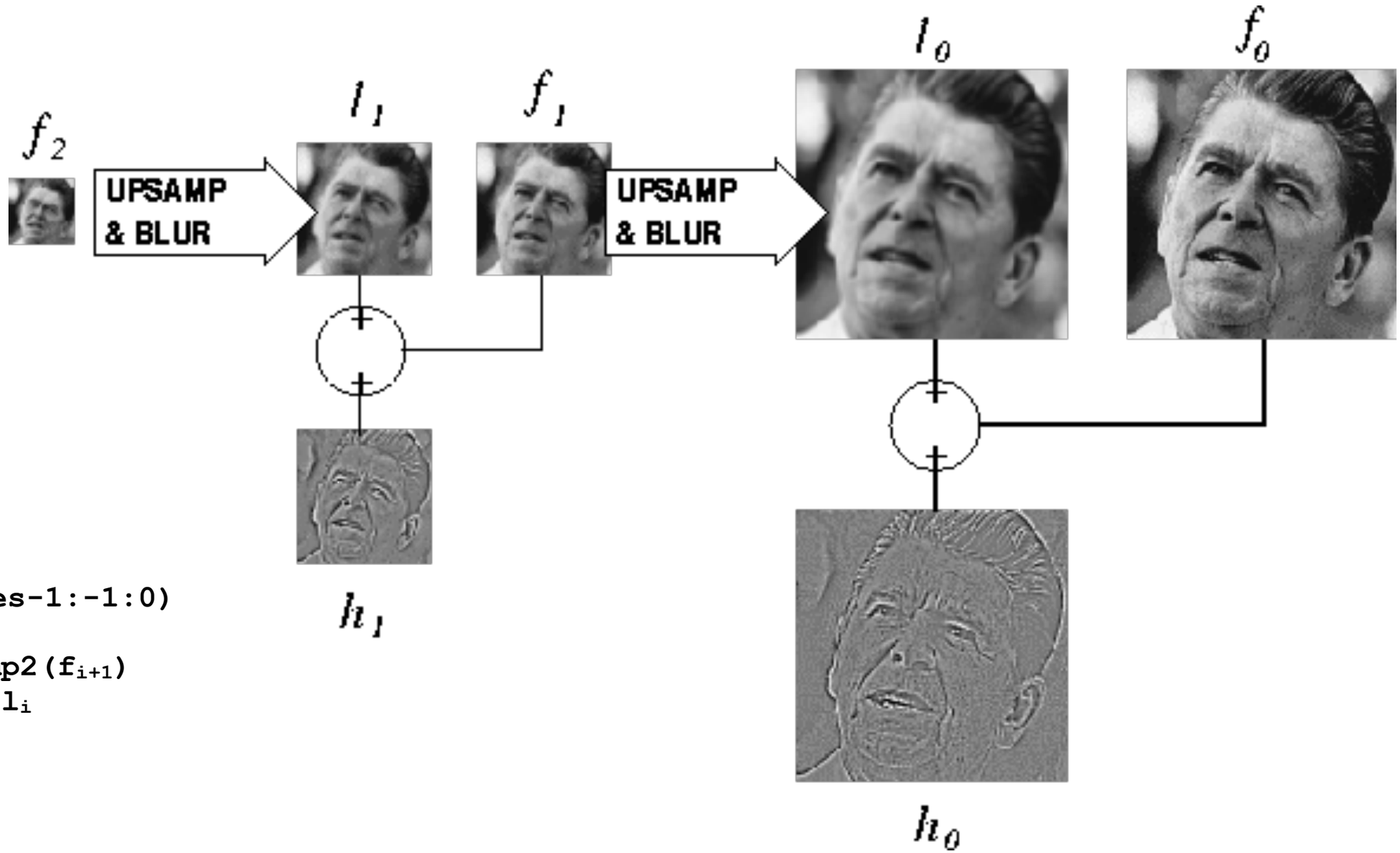
h_1

(1) Residuals

f_0

h_0

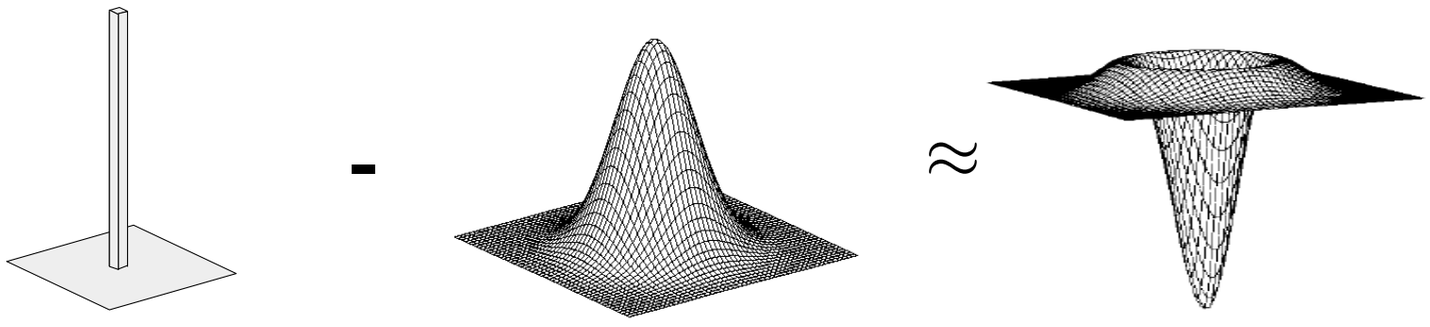
Reconstructing the original image



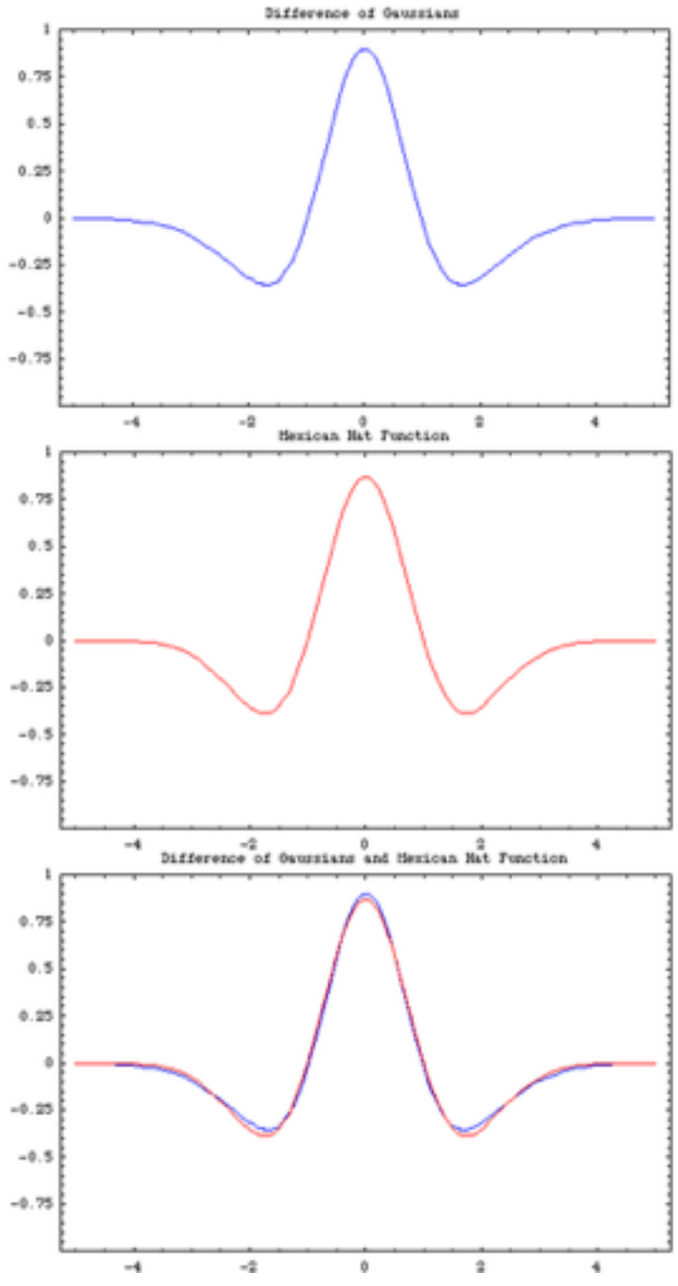

```
do( i = nScales-1:-1:0)
{
     l_i = upSamp2(f_i+1)
     fi = h_i + l_i
}

output: f_0
```

Why is it called the Laplacian Pyramid?



Difference of Gaussians approximates the Laplacian



http://en.wikipedia.org/wiki/Difference_of_Gaussians