# Lecture 17
# Texture Analysis for Iris Recognition
## ECEN 5283 Computer Vision

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# Goals

- To review the Gabor filter bank for texture analysis.

- To showcase a real application of Gabor-based texture analysis, i.e., iris recognition.

# Fourier Basis vs. Gabor Filters

- The Fourier basis has not spatial selectivity but provides the best frequency selectivity.

$$f(x, y \mid k_x, k_y) = \exp^{j(k_x x + k_y y)} \quad \text{(Fourier basis)}$$

$$\delta(k_x, k_y) \leftarrow \text{Fourier transform}$$

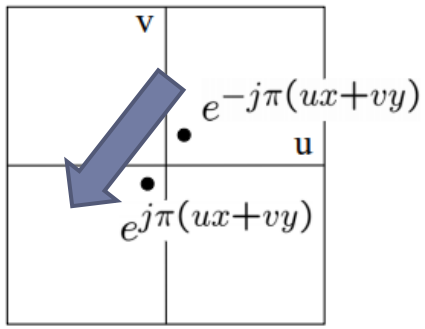
- Gabor filters can achieve ***localized frequency characterization*** by multiplying the Fourier basis elements with Gaussians.

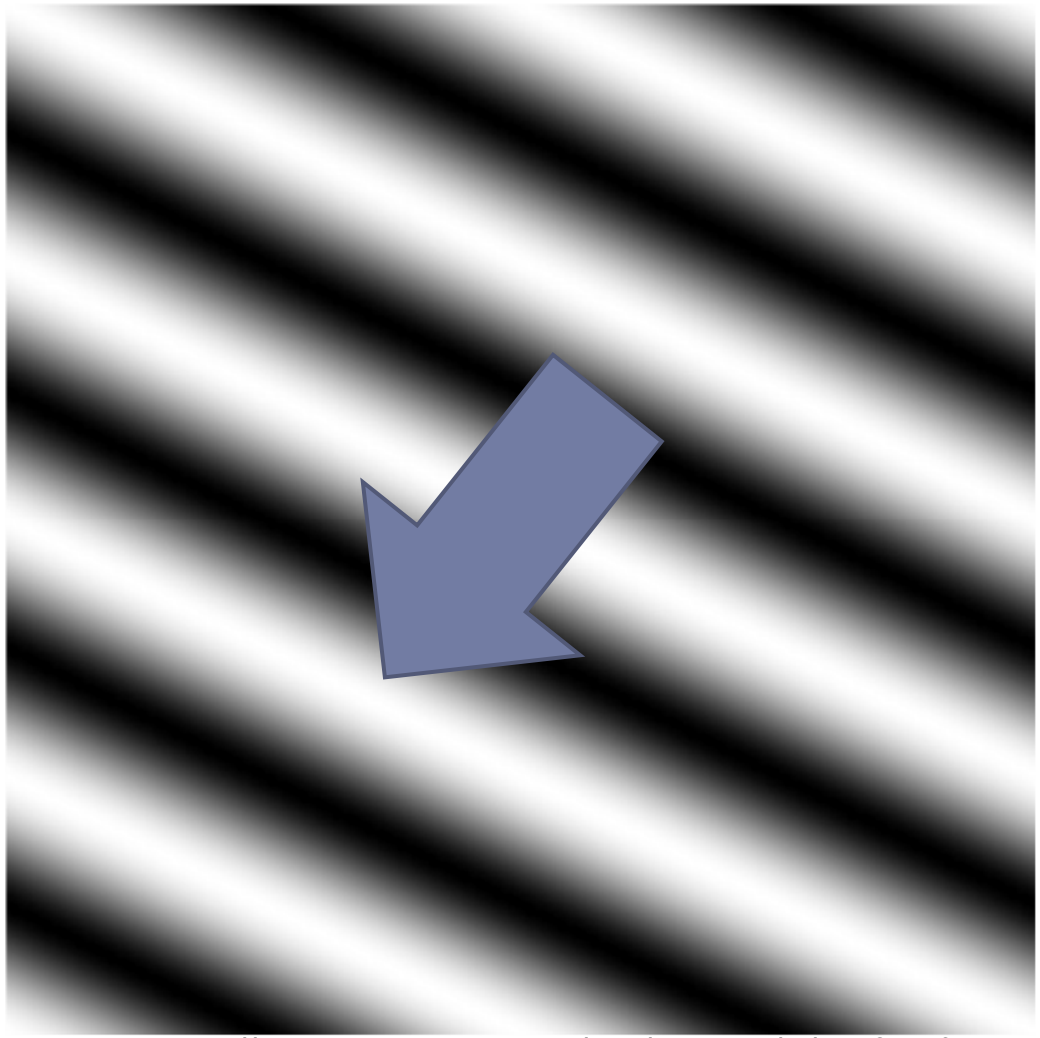
$$g(x, y \mid \omega_x, \omega_y) = \exp^{j(\omega_x x + \omega_y y)} \exp^{-\left\{\frac{x^2+y^2}{2\sigma^2}\right\}} \quad \text{(Gabor filter)}$$

- **Uncertainty principle:** spatial resolution and frequency resolution cannot be enhanced at the same time.

# Fourier Basis Images (1)

To get some sense of what basis elements look like, we plot a basis element --- or rather, its real part --- as a function of x,y for some fixed u, v. We get a function that is constant when (ux+vy) is constant. The magnitude of the vector (u, v) gives a frequency, and its direction gives an orientation. The function is a sinusoid with this frequency along the direction, and constant perpendicular to the direction.

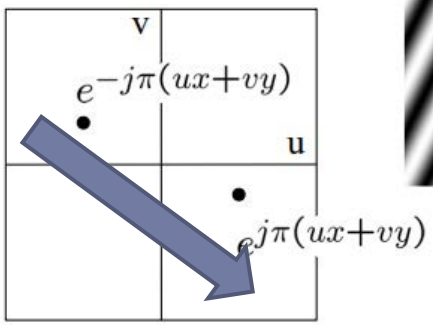


http://www.robots.ox.ac.uk/~az/lectures/ia/lect2.pdf

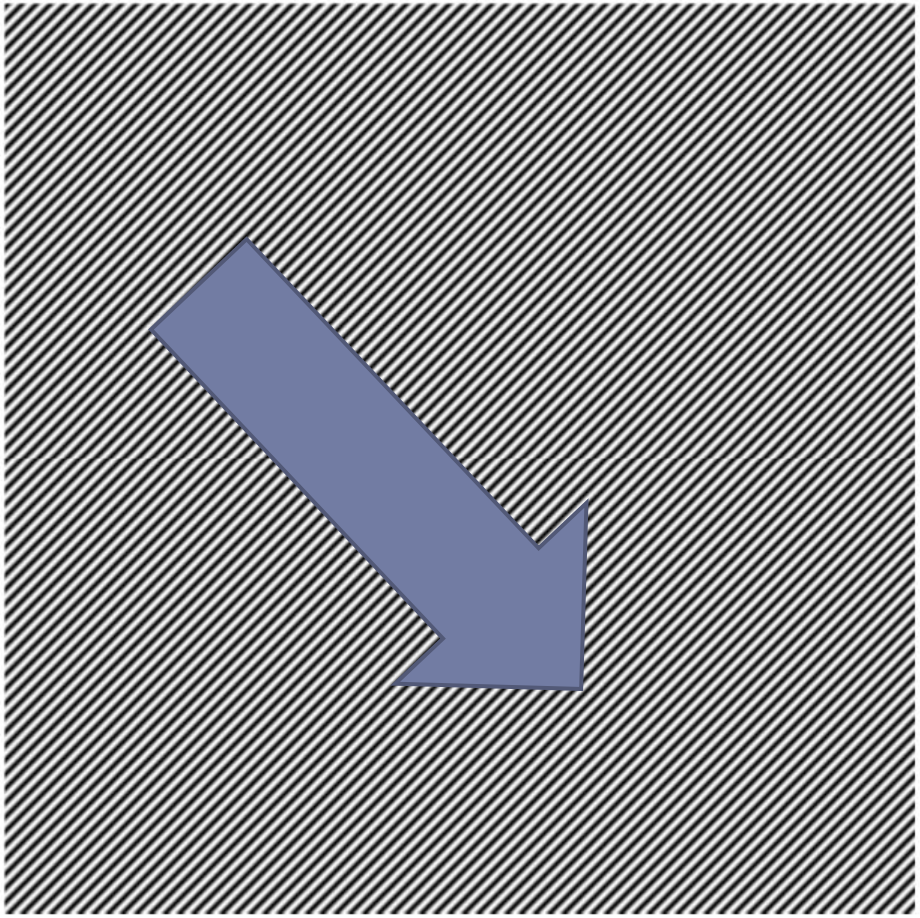
# Fourier Basis Images (2)

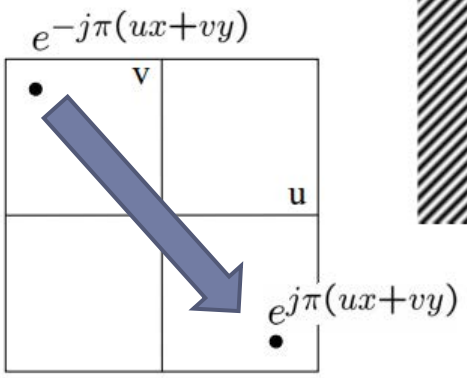
Here u and v are larger than in the previous slide.



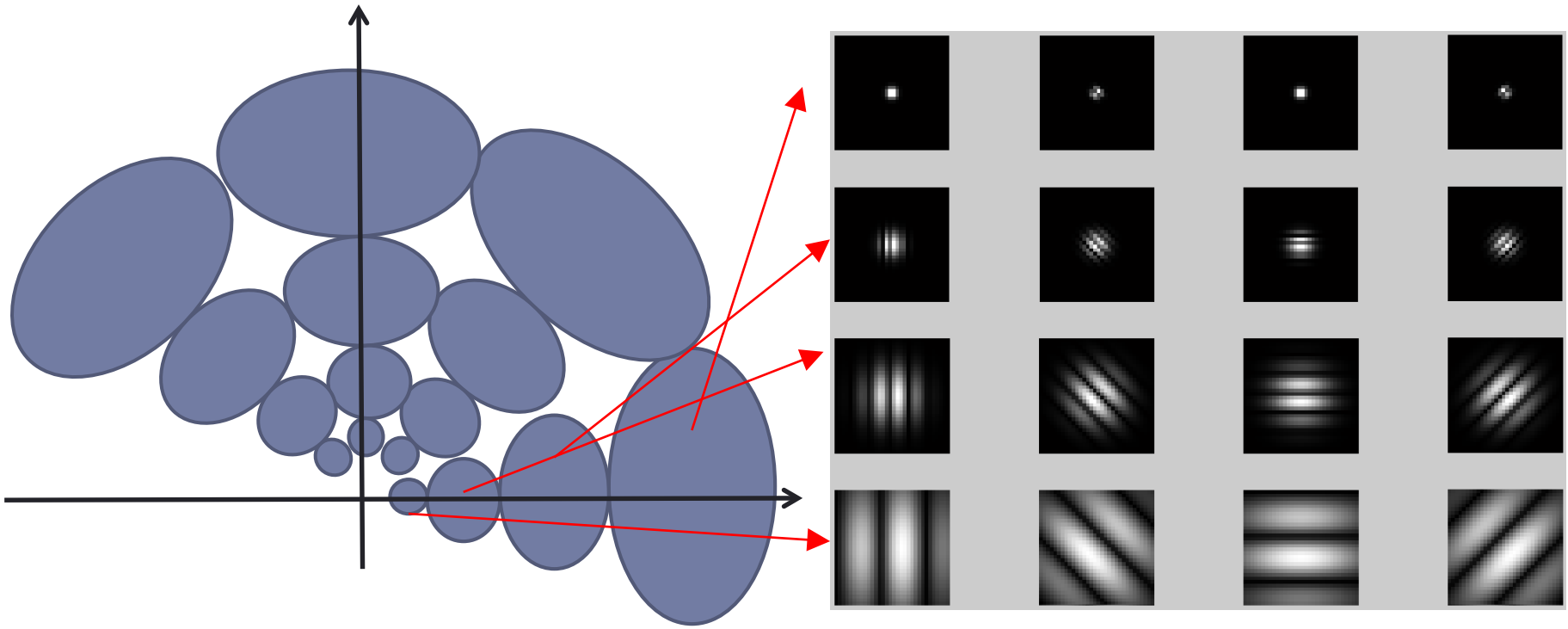
# Fourier Basis Images (3)

And larger still...





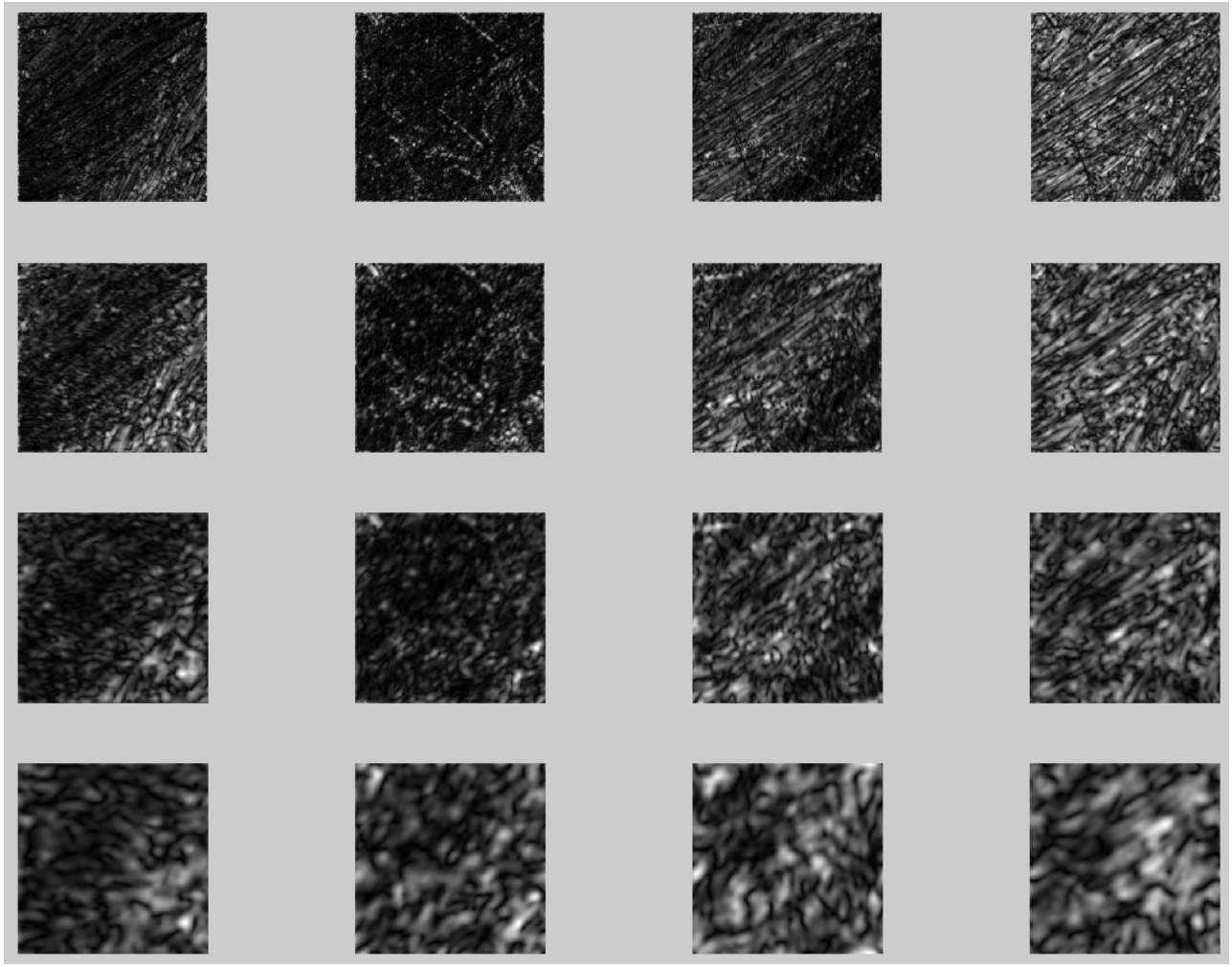
# Gabor Filter Kernels (Magnitude): 4 Scales and 4 Orientations

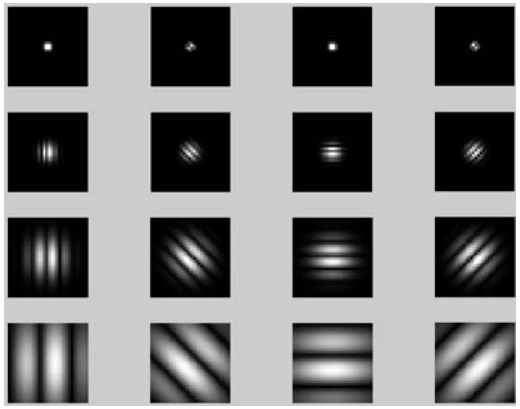


Frequency representation of the Gabor filter design

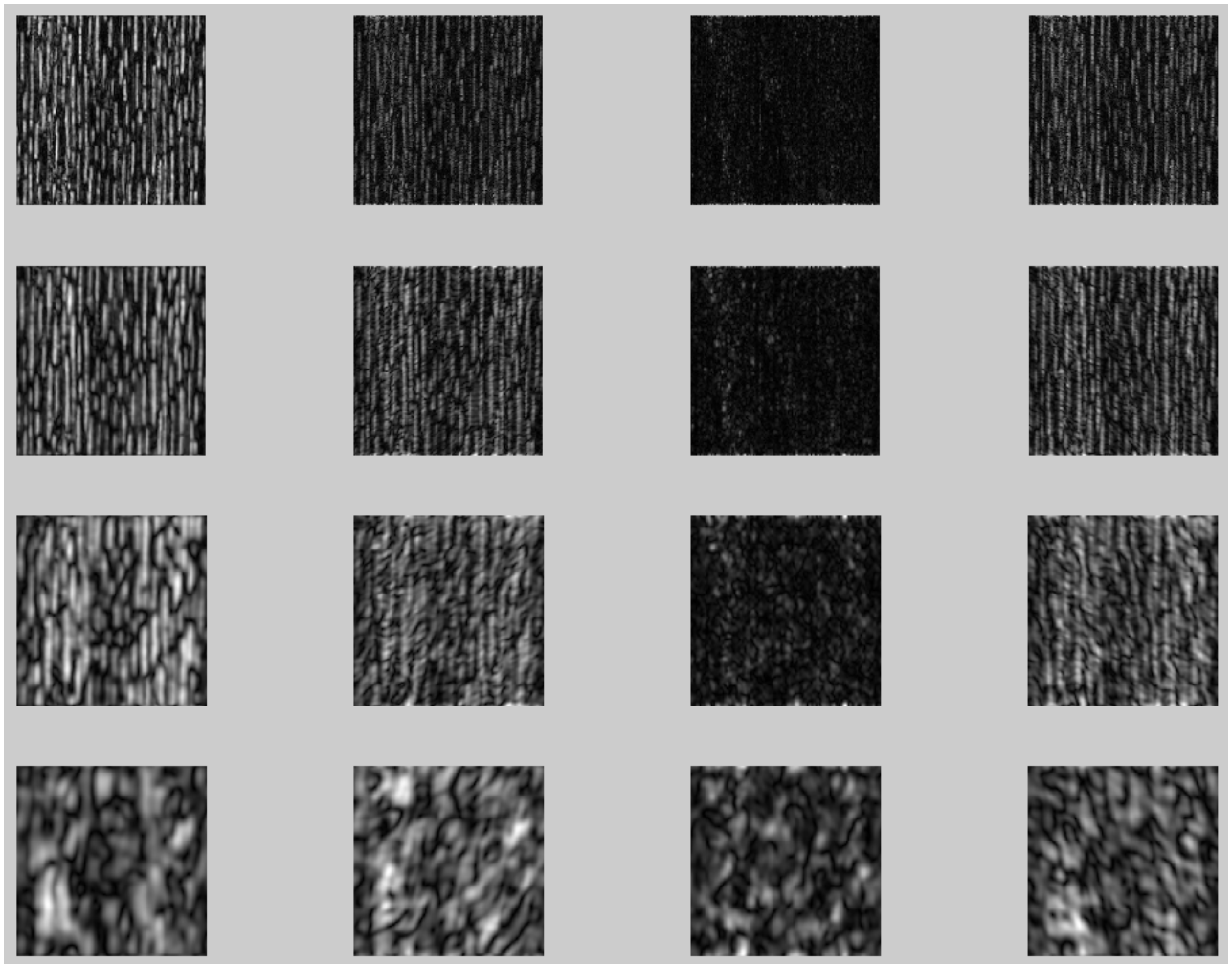
Spatial representation of of Gabor filter kernels

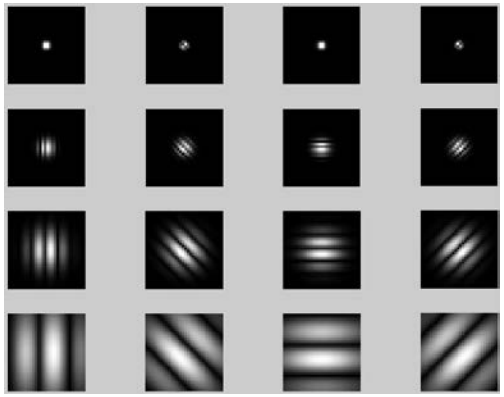
# Gabor Filtering of Brodaz Texture D15



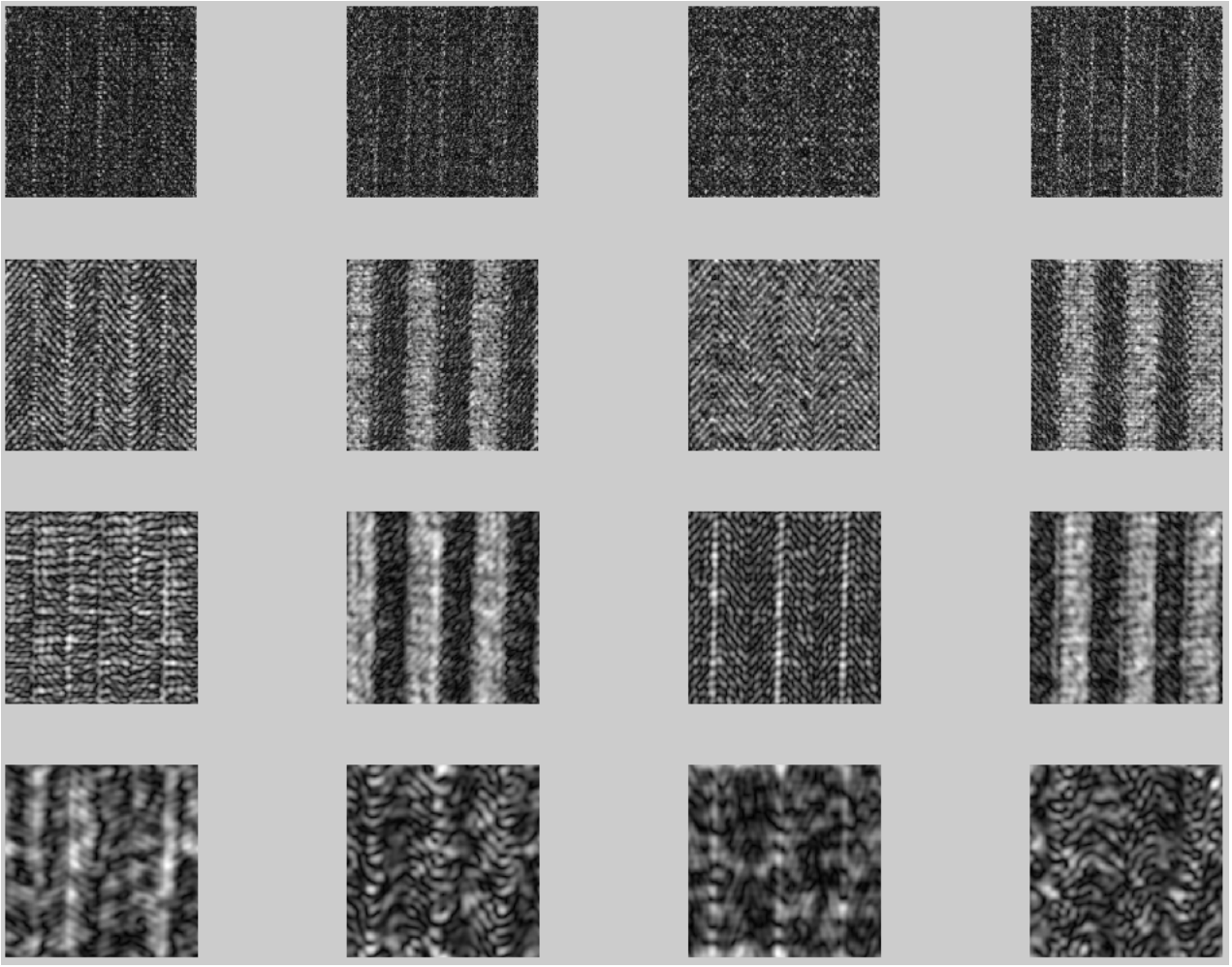


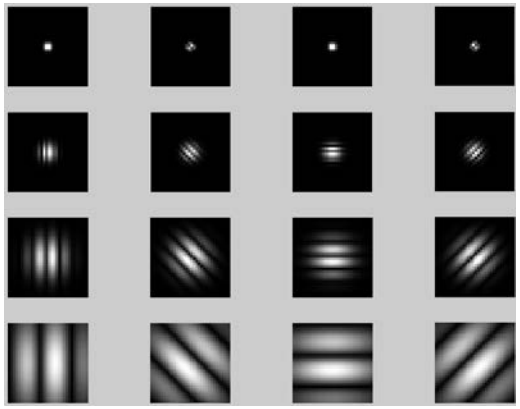
# Gabor Filtering of Brodaz Texture D68

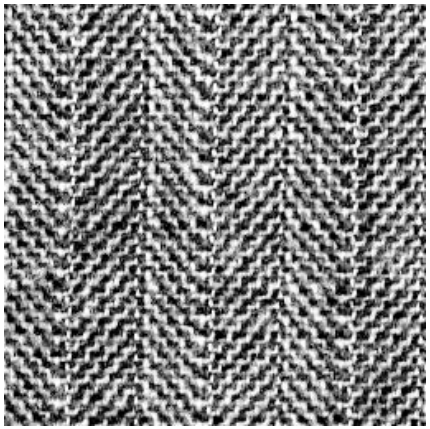




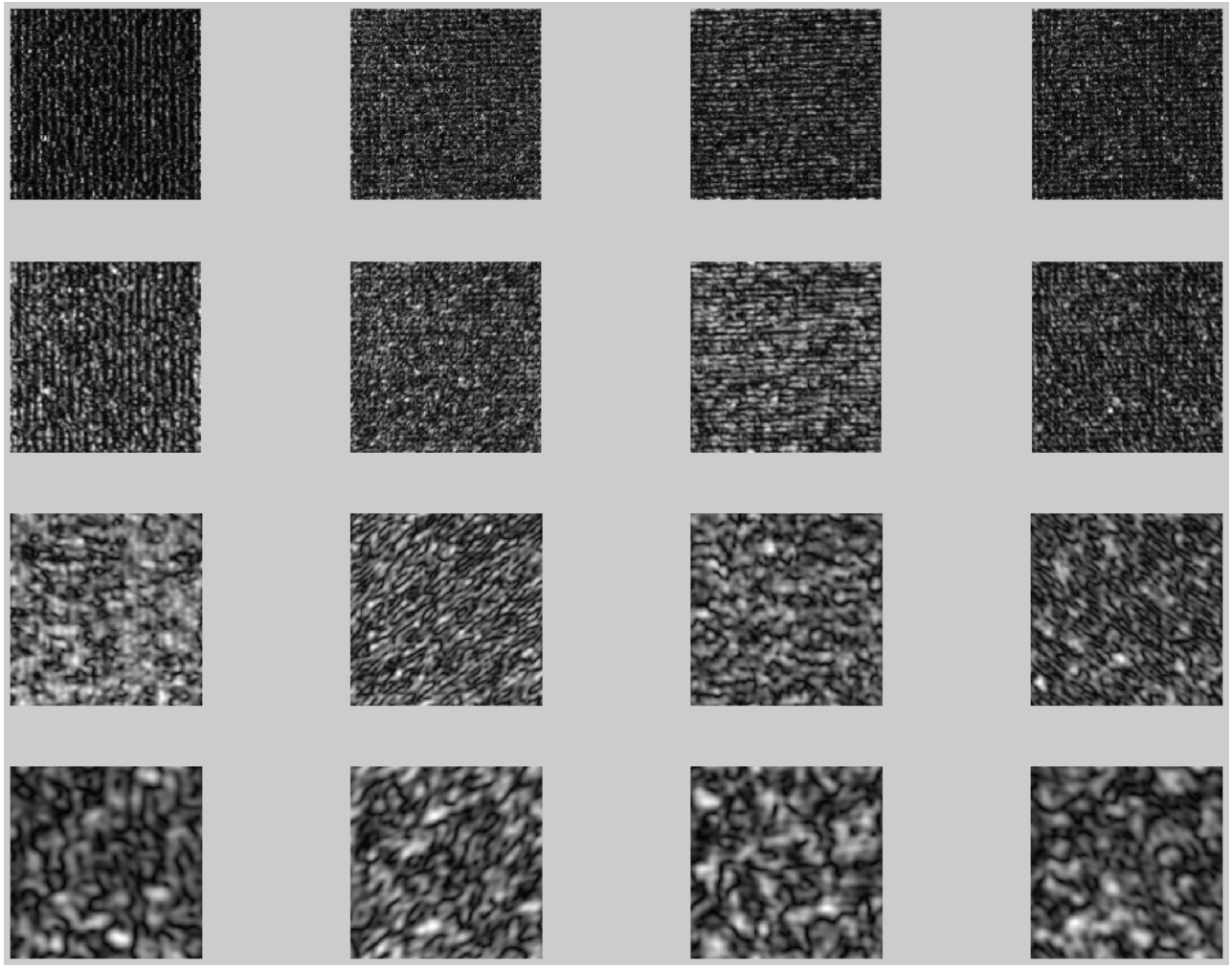
# Gabor Filtering of Brodaz Texture D16

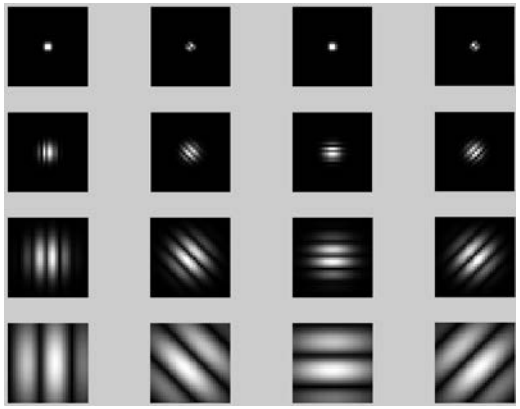




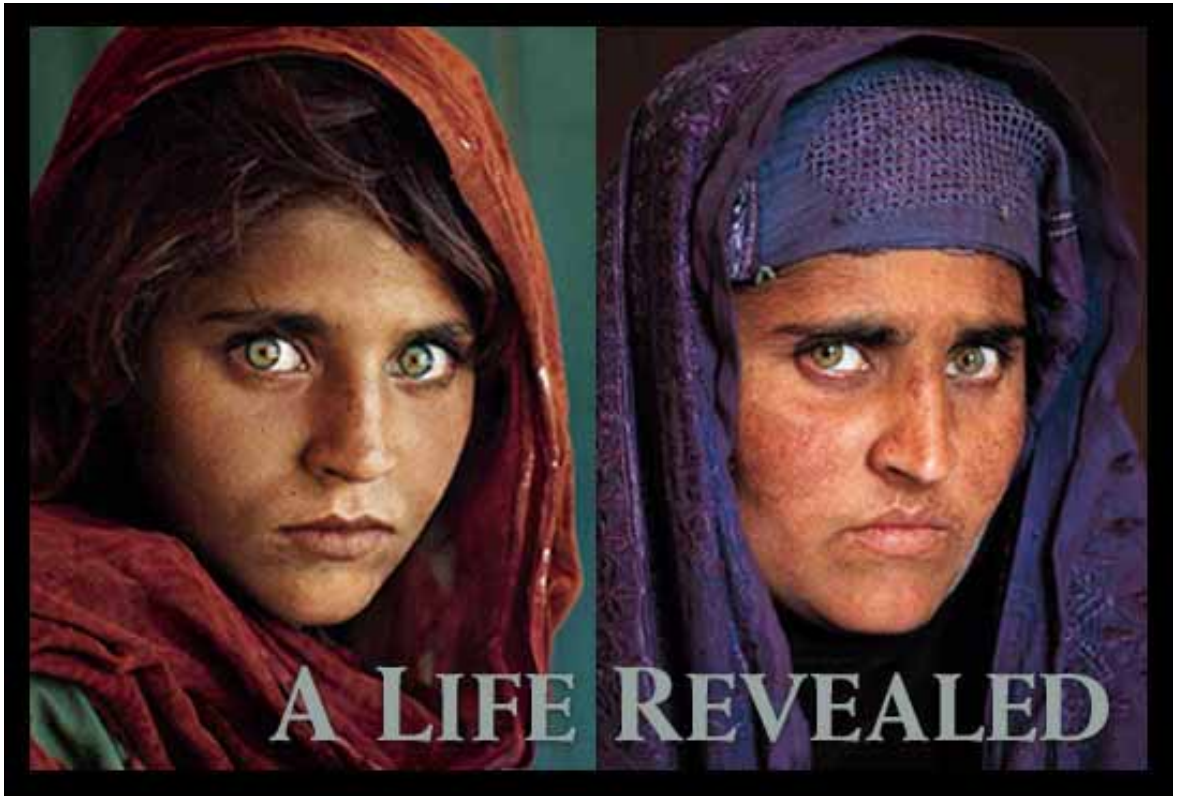


# Gabor Filtering of Brodaz Texture D84





# Iris Recognition: How the Afghan girl was Identified by her iris patterns?



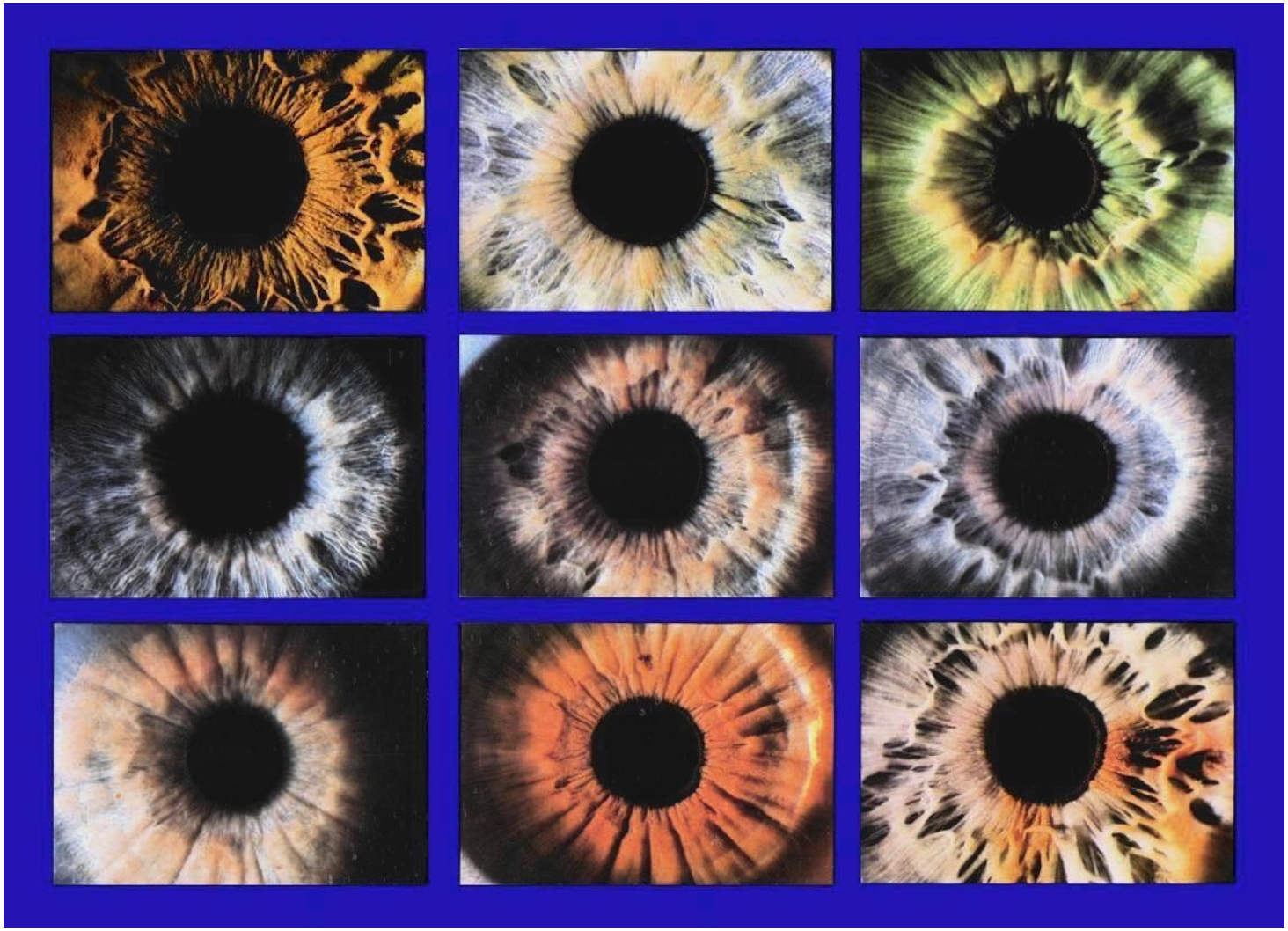

Portrait of a Survivor
Photograph by Steve McCurry

The young Afghan refugee who stared from the cover of *National Geographic* in June 1985 was an enigma for 17 years. What was her name? Had she survived? This past January photographer Steve McCurry joined a crew from National Geographic Television & Film to methodically search for her. They showed her photograph around the refugee camp in Pakistan where McCurry had encountered her as a schoolgirl in December 1984. Finally, after some false leads, a man who had also lived in the camp as a child recognized her. Yes, she was alive. She had left the camp many years before and was living in the mountainous Tora Bora region of Afghanistan. He said he could find her, and three days later he and a friend brought her back to the camp. There, the remarkable story of this woman, Sharbat Gula, began to be told.

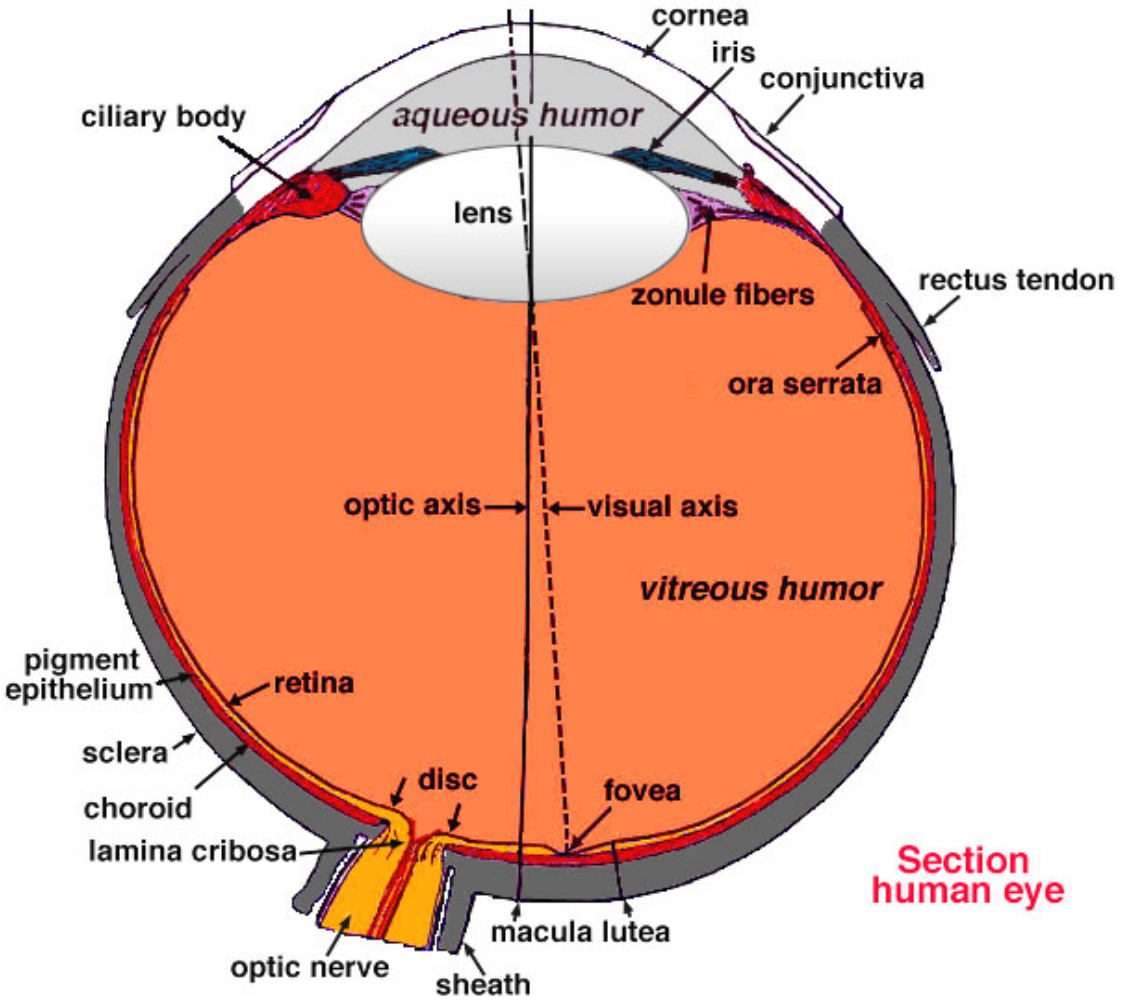
http://www.melia.com/ngm/0204/feature0/

# Retinal Scan for Identification

# Iris Recognition



# Where is the iris?

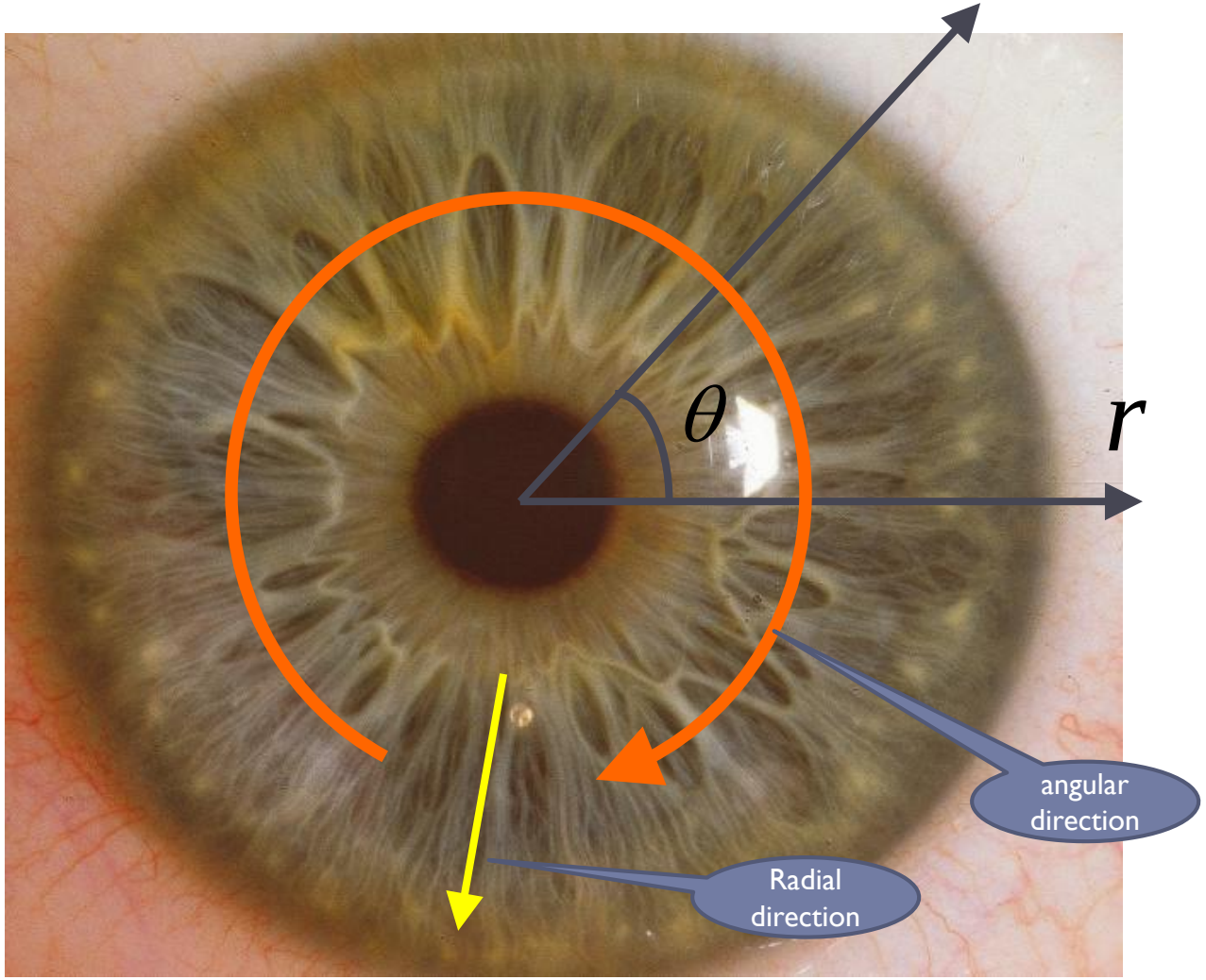


# A Close Look of Iris

The Cartesian 2D coordinate system is not appropriate here.

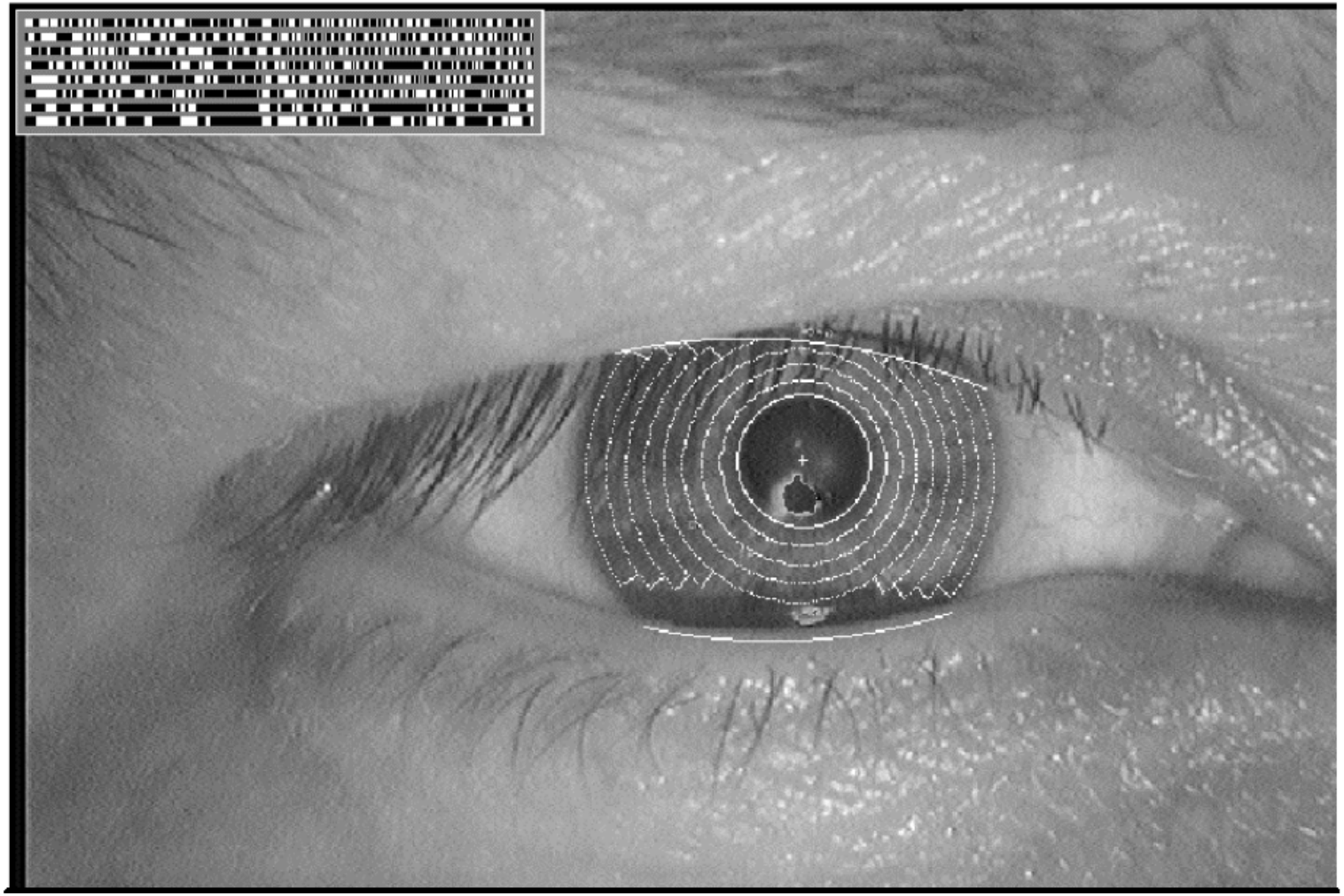
$$I(x, y) \leftrightarrow I(r, \theta)$$

Along which direction should we perform texture analysis?




http://www.cl.cam.ac.uk/users/jgd1000/

# Polar Coordinate System for Iris Representation



# Iris Recognition: Iris Matching Engine

$$\text{Hamming Distance} = \frac{\|(codeA \otimes codeB) \cap maskA \cap maskB\|}{\|maskA \cap maskB\|}$$

(The number of bits which differ between two binary strings)