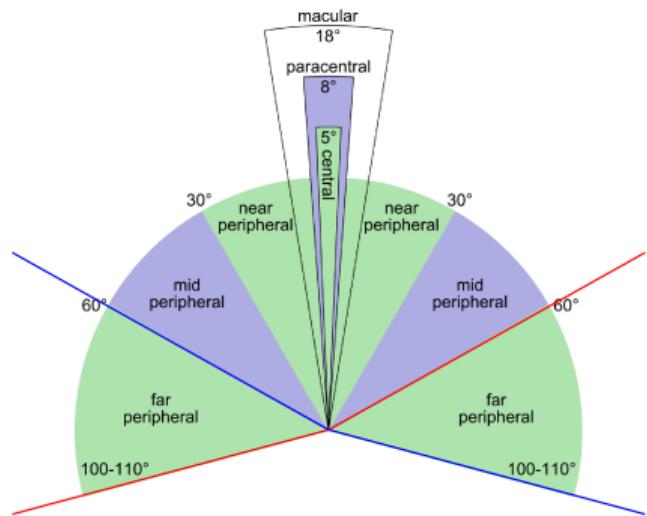


Biological Vision and Applications

Module 02-05: Peripheral Vision

Hiranmay Ghosh

Foveal Vision and Peripheral Vision



- $\approx 99\%$ of visual field is covered by peripheral vision
- Provides an approximate description of the visual field

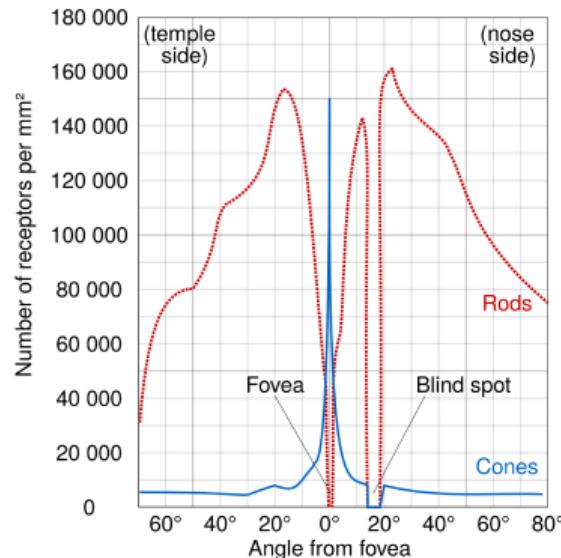
Role of preipheral vision

- Controls eye movement (saccade) in visual search
- Shifts attention to desired place in image



- A more realistic representation of the peripheral view

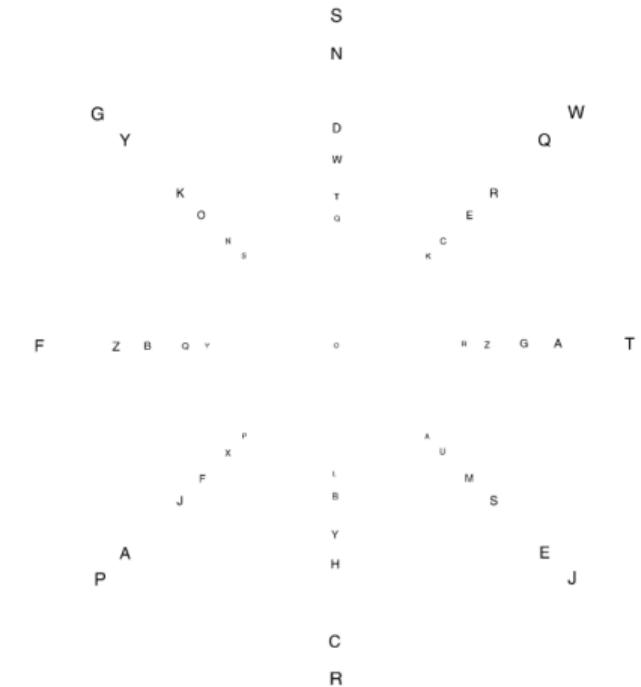
Cortical magnification



- As we move away from the foveal area of an eye
 - Linear decrease in rod density
 - The concentration of optic nerves also decreases.
 - rod:optic nerve ratio approx 600:1 at the far peripheral region
- Cortical magnification:** equal volume of neurons cover more and more visual area
 - Less information is available

Effect of Cortical magnification

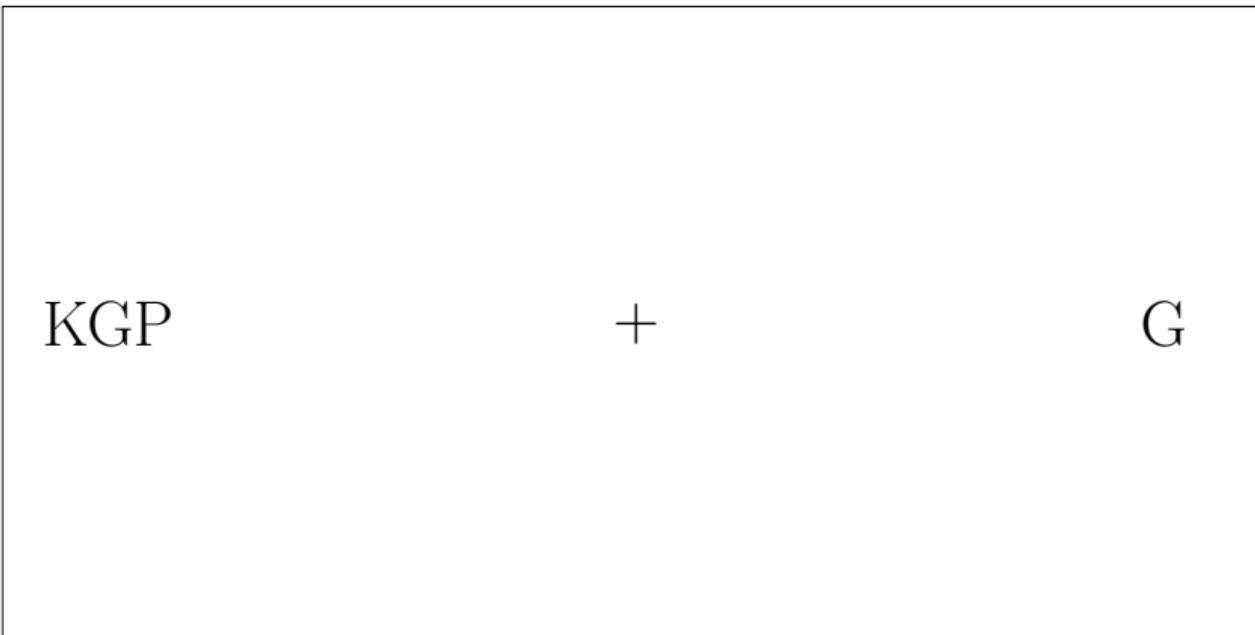
Minimum size of recognizable objects get bigger



Effect of Cortical magnification

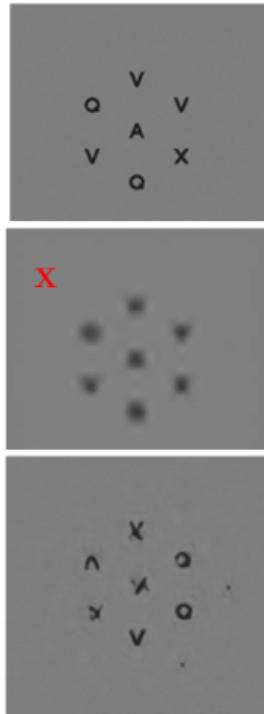
Crowding

- Focus on the cross-hair.
- Try to see the letter 'G' in the left image, and in the right image



Model of Cortical magnification

Some distinctive textures are retained



- Image compression results in blurred image
 - ▶ Pooling / wavelet decomposition
- Cortical magnification does something different
 - ▶ Some distinctive textures are retained
 - ▶ There may be some disparity regarding locations
- The distinctive patterns help peripheral vision to guide the foveal vision in visual search
- Mathematical models for the peripheral texture representation
 - ▶ Summary statistics: autocorrelation and pooling
 - ▶ We skip the details

Portilla. A parametric texture model ...

Mongrels



- **Mongrel:** synthesized image to have the same summary statistics as a given original stimulus.
 - ▶ There can be many mongrels to an original stimulus

Object recognition vs. scene recognition



- Object recognition
- Foveal vision
- Scene recognition
- Peripheral vision

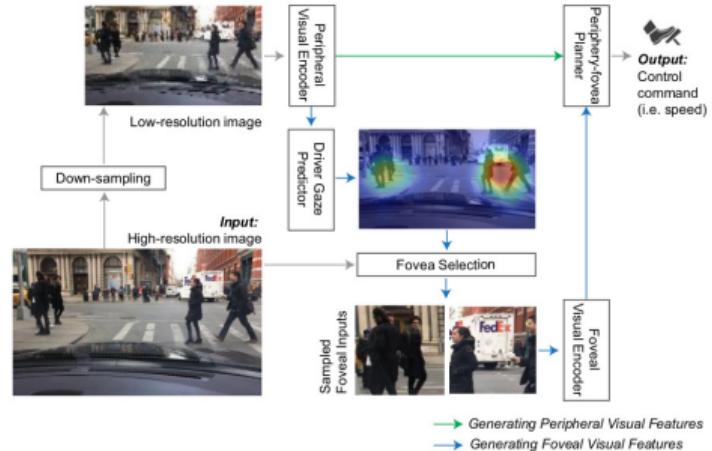
Application: Autonomous Driving



(a) Baseline: all LEDs turn on

(b) Static light: half of the LEDs turn on to hint steering direction

(c) Moving light: a number of LEDs iteratively turn on to hint steering direction



Borojeni, et al. Assisting Drivers with Ambient Take-Over Requests ... (2016)

Xia, et al. Periphery-Fovea Multi-Resolution Driving Model ... (2020)

Application: Logo design

Full-Field View of Logo Designs

Undistorted 512 x 512 Image



Peripheral View of Logo Designs

Foveating the Left-Most Point (x=0, y=256)



Quiz

No quiz for module 02-05

End of Module 02-05