

# **From Objective Imaging Metrics to Subjective Sharpness for Mobile Imaging**

by  
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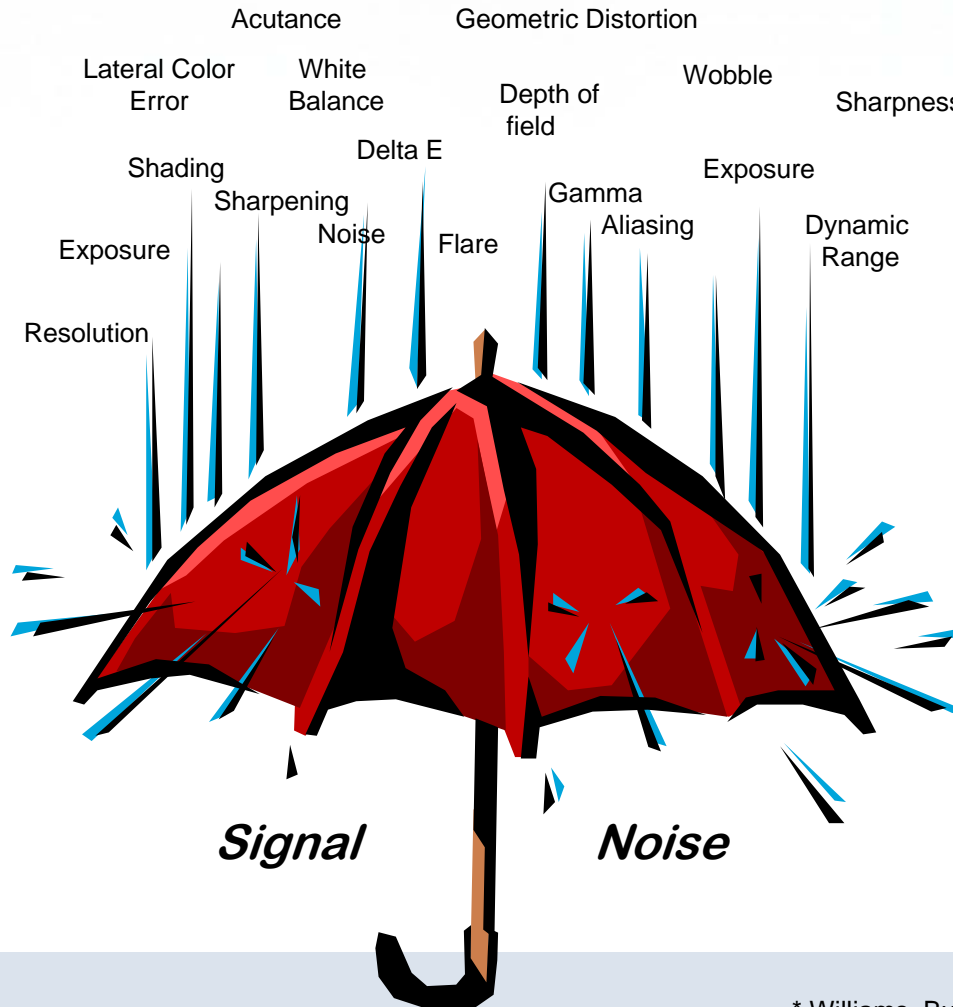
Which is Sharper ?  
Which has higher Acutance ?  
Which has higher resolution ?  
Which has more information ?  
Which has more utility ?

# What you'll see

- **Imaging Performance Metrics**
  - Top-Down Taxonomy
  - How different metrics and terms relate.
- **Spatial Frequency Response (SFR) ?**
  - Definition, Targets, Metrology protocols.
- **SFR ⇒ Acutance ⇒ Sharpness**
- **The Challenges for the Future**

# Imaging Performance Taxonomy \*

- staying dry in a storm of objective terms -



# Where does *Acutance* Lie ?

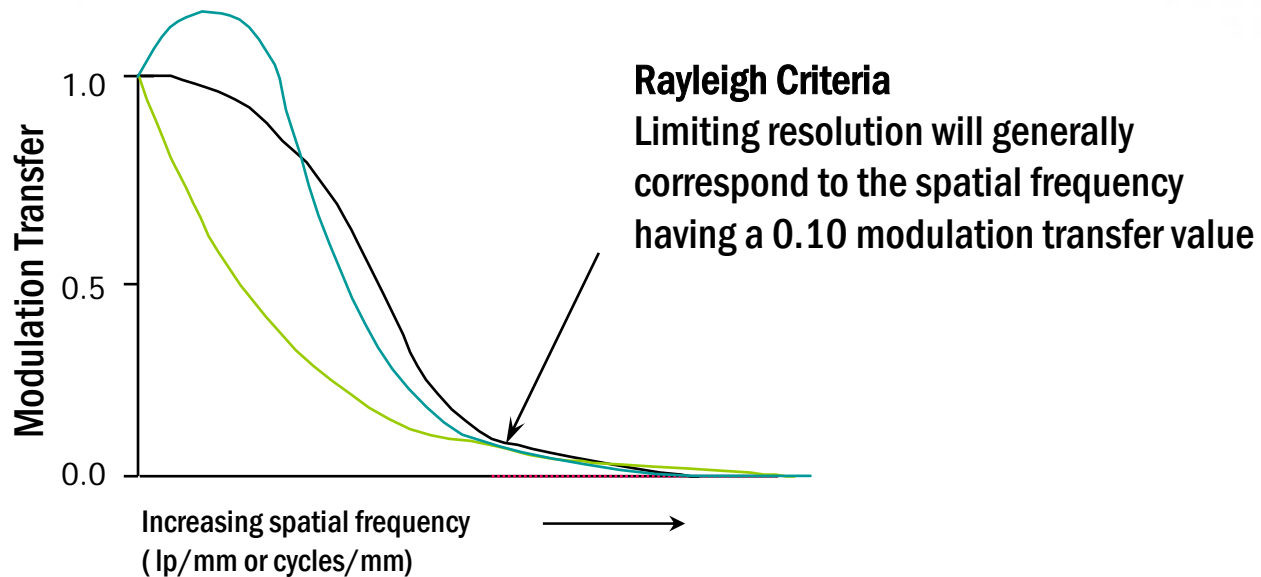
Foundation Attributes	Signal		Noise	

# What's the difference ?

- **Resolution** – the maximum spatial frequency of any utility for an imaging system (limiting resolution).
  - **Sharpening**- a class of image processing operations that enhances the contrast of selective spatial frequencies, usually visually important ones.
  - **Acutance** – An objective SFR based metric that is strongly correlated to the subjective perception of sharpness
- 
- **Sharpness** – The visually perceived quality of being crisp or of containing detail.

# Spatial Frequency Response (SFR)\* (also called MTF)

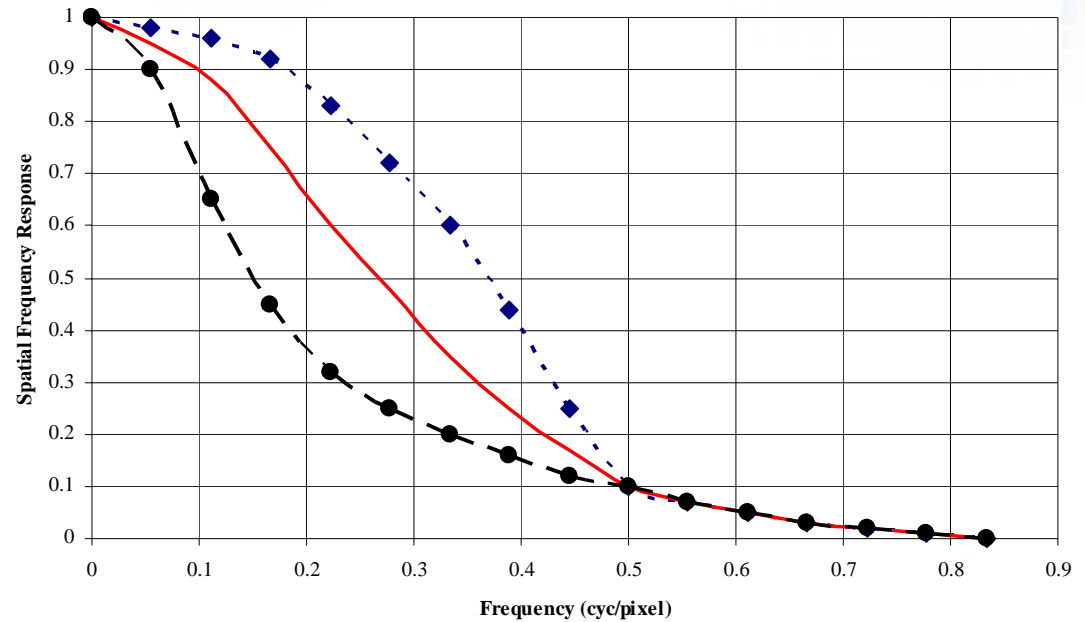
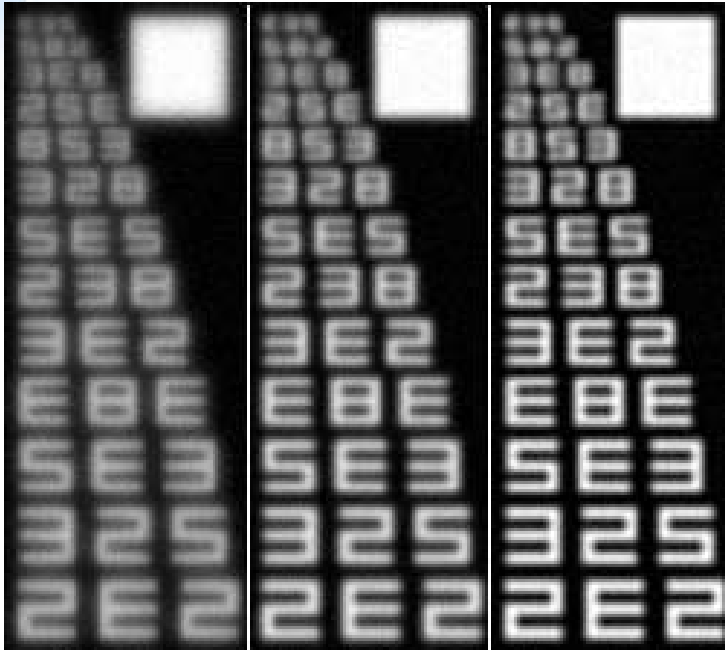
A descriptor of an imaging component or system to capture or maintain the relative contrast of increasingly fine spatial detail.



The lower the SFR response, the greater the relative contrast loss.  
The greater the contrast loss, the lower the delivered signal amplitude

# Why *Resolution* is flawed

SFRs for ISO 12233 Target  
Same Resolution, Different SFRs

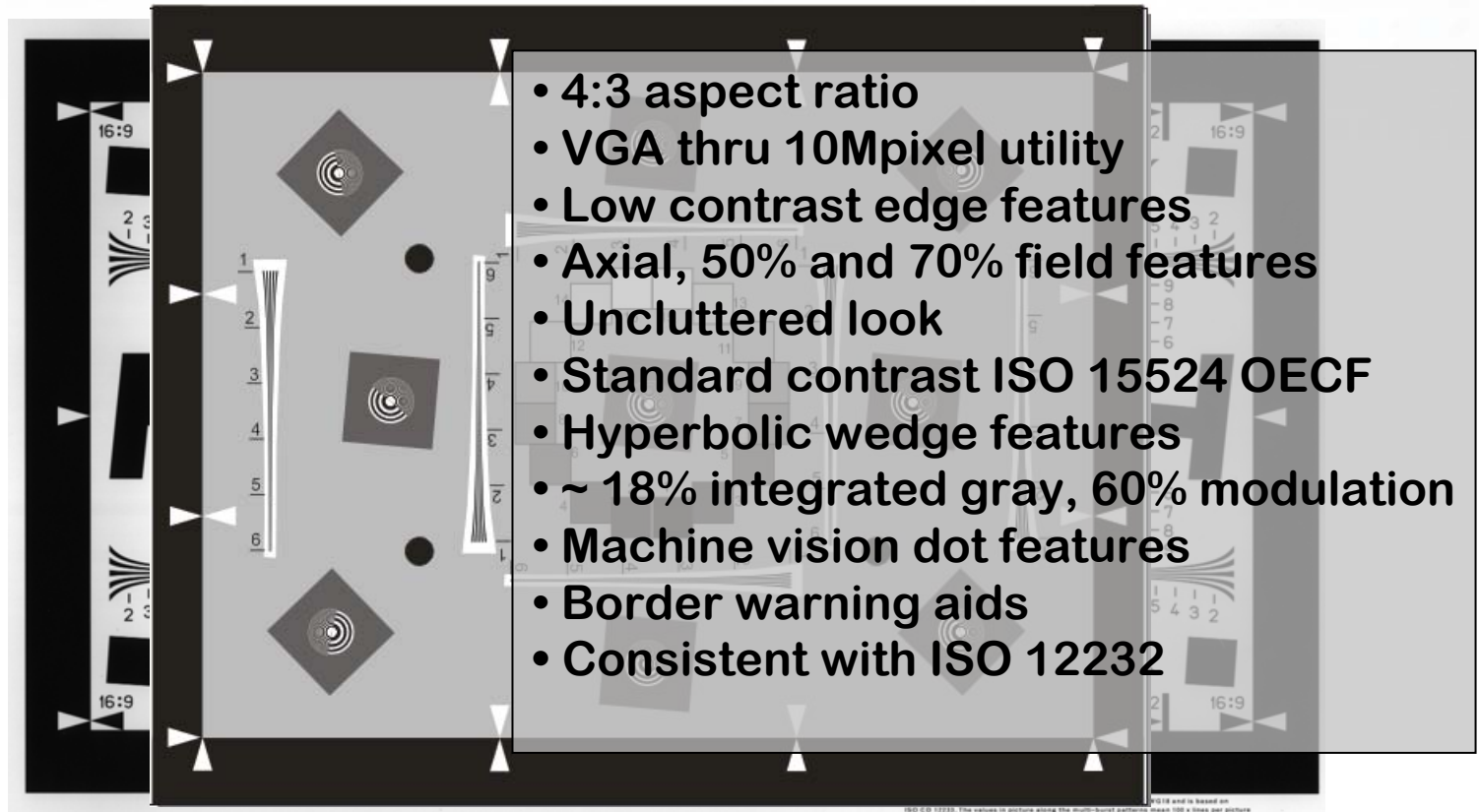


- ◆ - right image    - middle image    - ● - left image

- *“Resolution”* can serve so many purposes because it doesn't serve any of them very well. -

*G.C Brock 1967*

# Targets for measuring SFR past and present

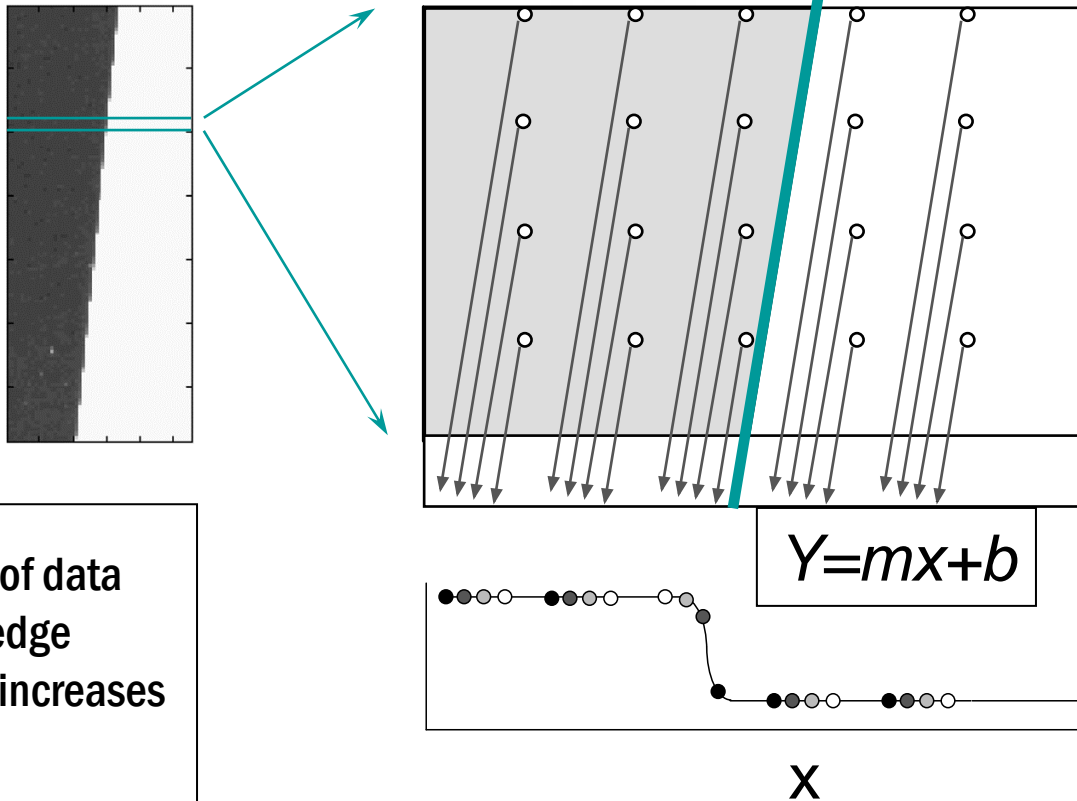


- 4:3 aspect ratio
- VGA thru 10Mpixel utility
- Low contrast edge features
- Axial, 50% and 70% field features
- Uncluttered look
- Standard contrast ISO 15524 OECF
- Hyperbolic wedge features
- ~ 18% integrated gray, 60% modulation
- Machine vision dot features
- Border warning aids
- Consistent with ISO 12232

ISO 12232. The values in picture along the multi-burst patterns mean 100 x lines per picture.  
ISO 15524 and is based on

# How SFR is Measured

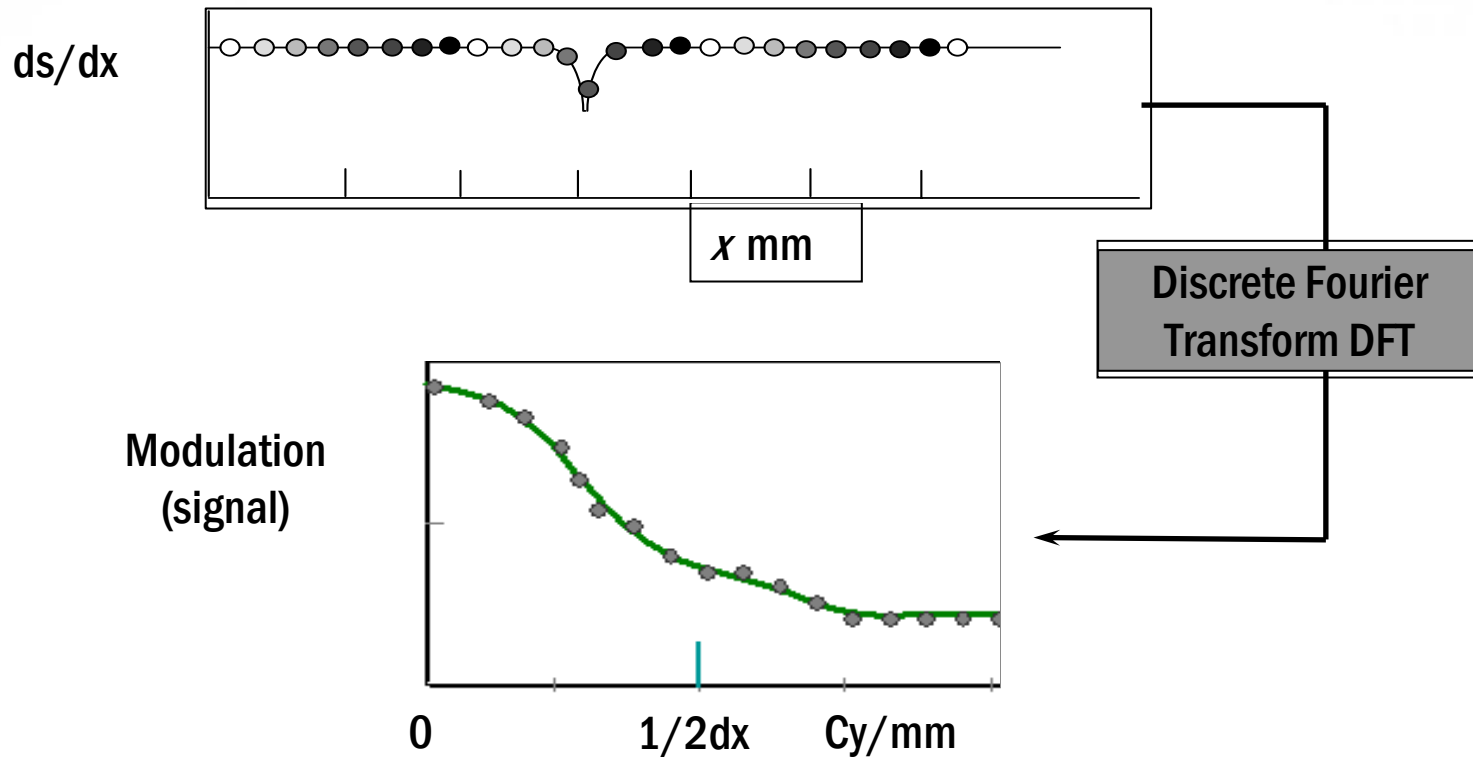
## Create super-sampled edge profile



Projection of data  
along the edge  
effectively increases  
sampling.

# How SFR is Measured

- Calculate derivative and perform transformation to SFR -





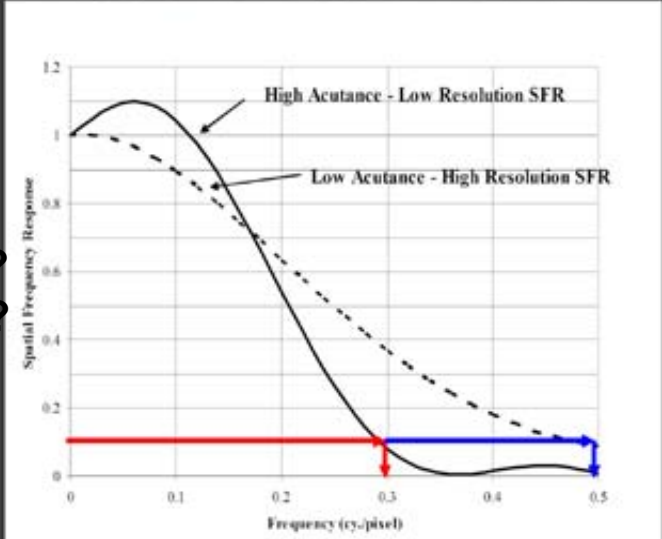
High Acutance - Low Resolution

Low Acutance - High Resolution



photo courtesy of P.Burns

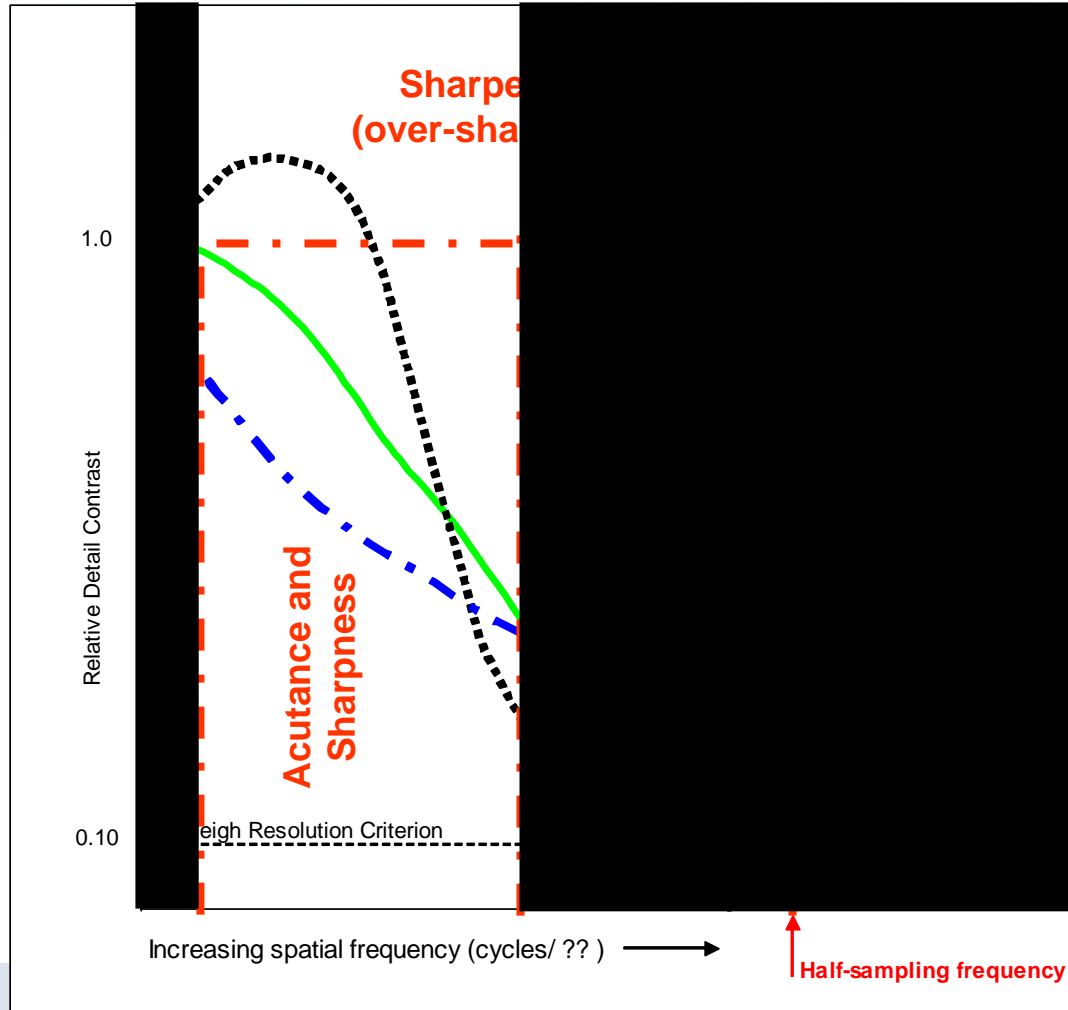
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# Cuts of SFR

- regions of behavior -

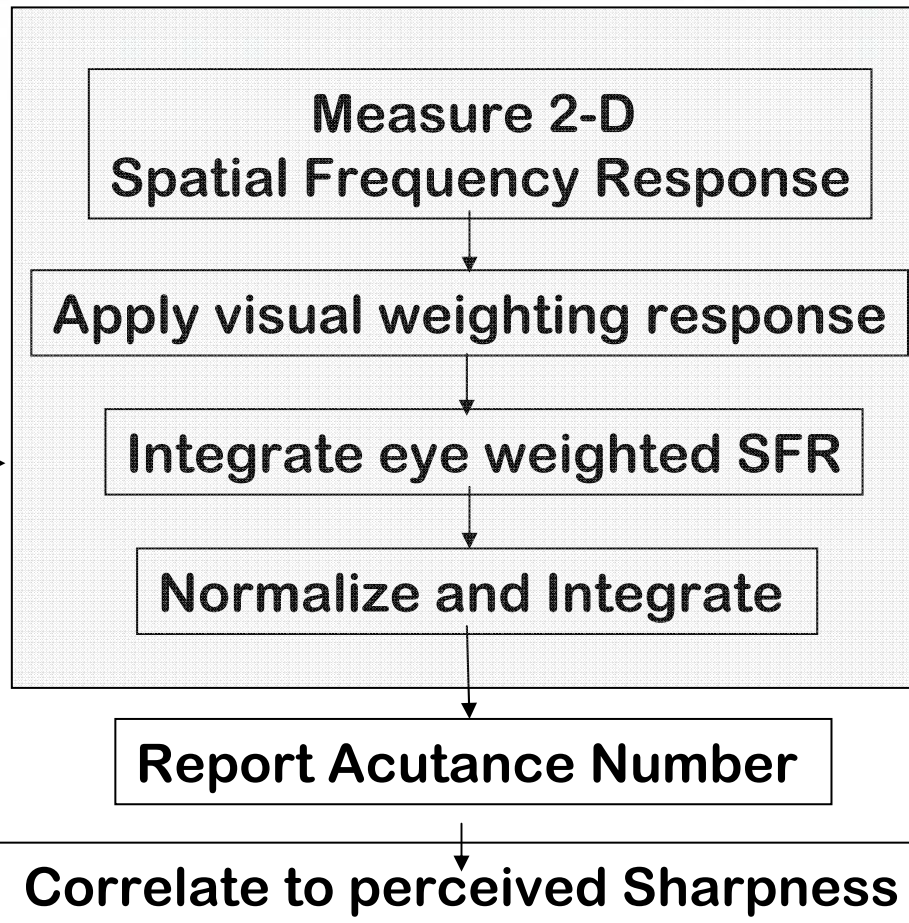


# SFR ⇒ Acutance ⇒ Sharpness

- the 90% solution -

another 10%

Apply field  
weighted eye  
response



# Acutance to Sharpness Challenges for Mobile Imaging

- Degree of Oversharpening
- Level of SFR field non-uniformity
  - Aliasing
  - De-Texturing