大话成像之

数字成像系统 32讲

图像防抖

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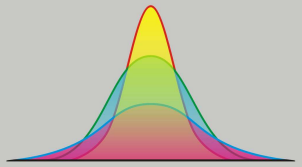
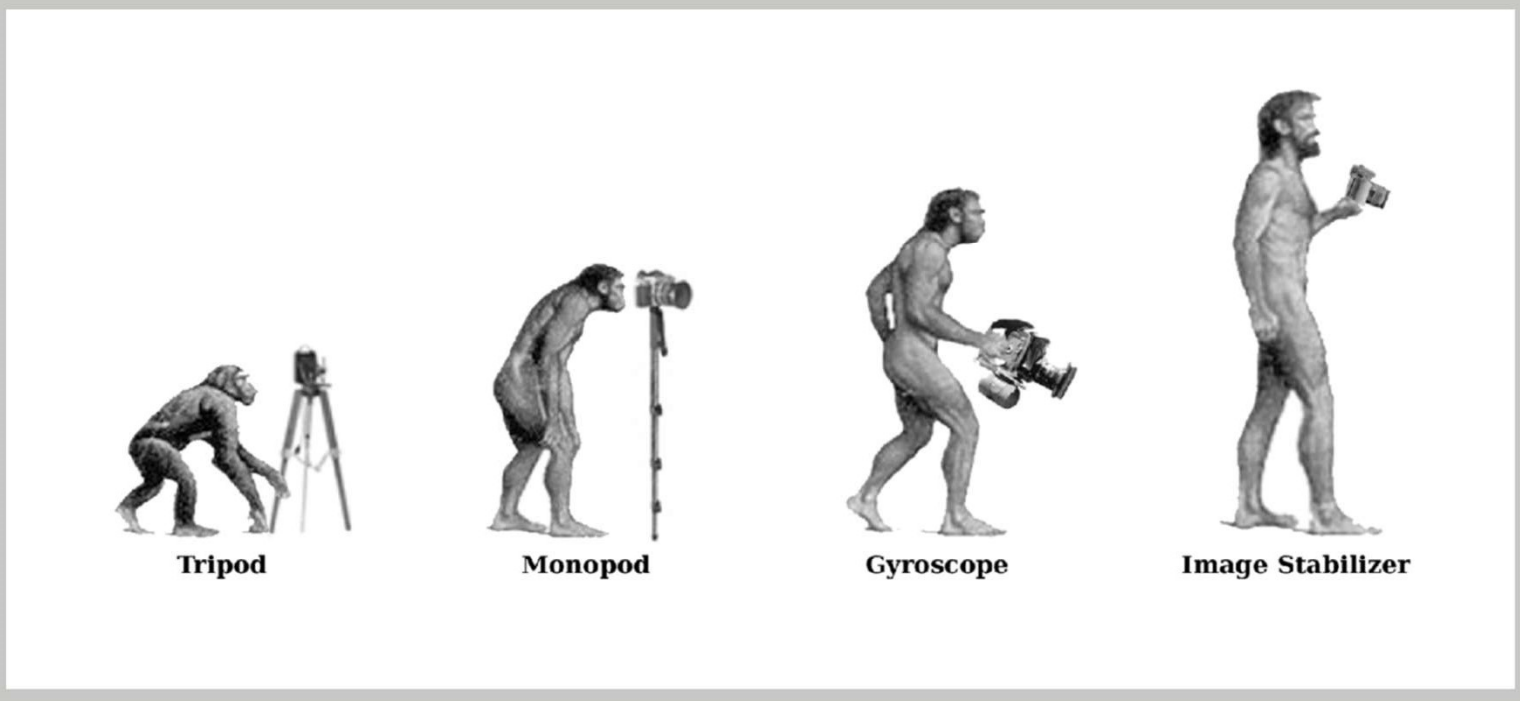
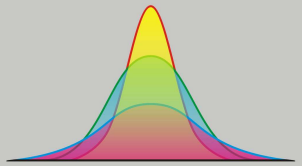
staff camera engineer

zxzombie@msn.com



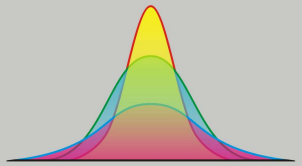

Tripod
Monopod
Gyroscope
Image Stabilizer

拍照抖动引起的问题

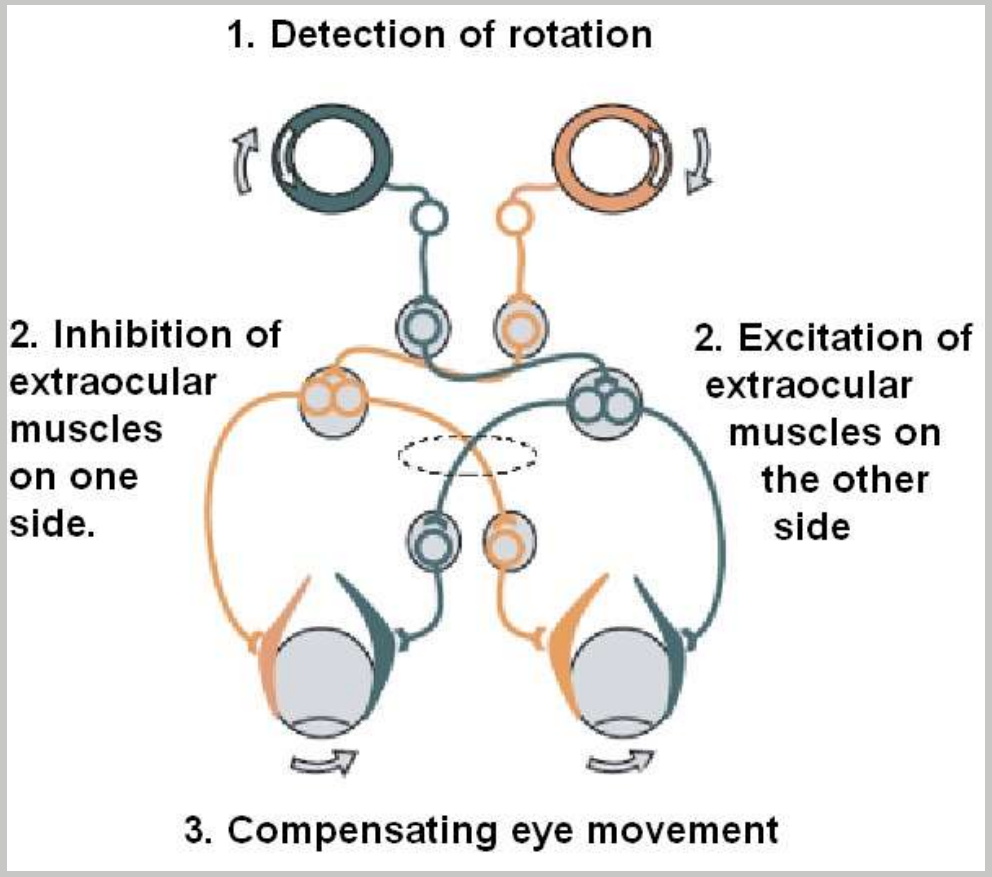


图像防抖的分类

- 光学防抖
  - 镜头移动
  - Sensor 移动
  - 两者一起移动
- 电子防抖
- 视频后处理过滤器
- 外置的防抖支架
- 防抖CCD



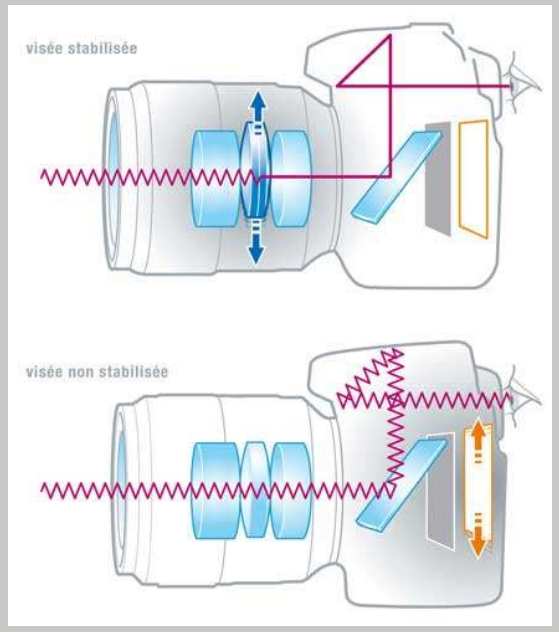
人眼的防抖方式

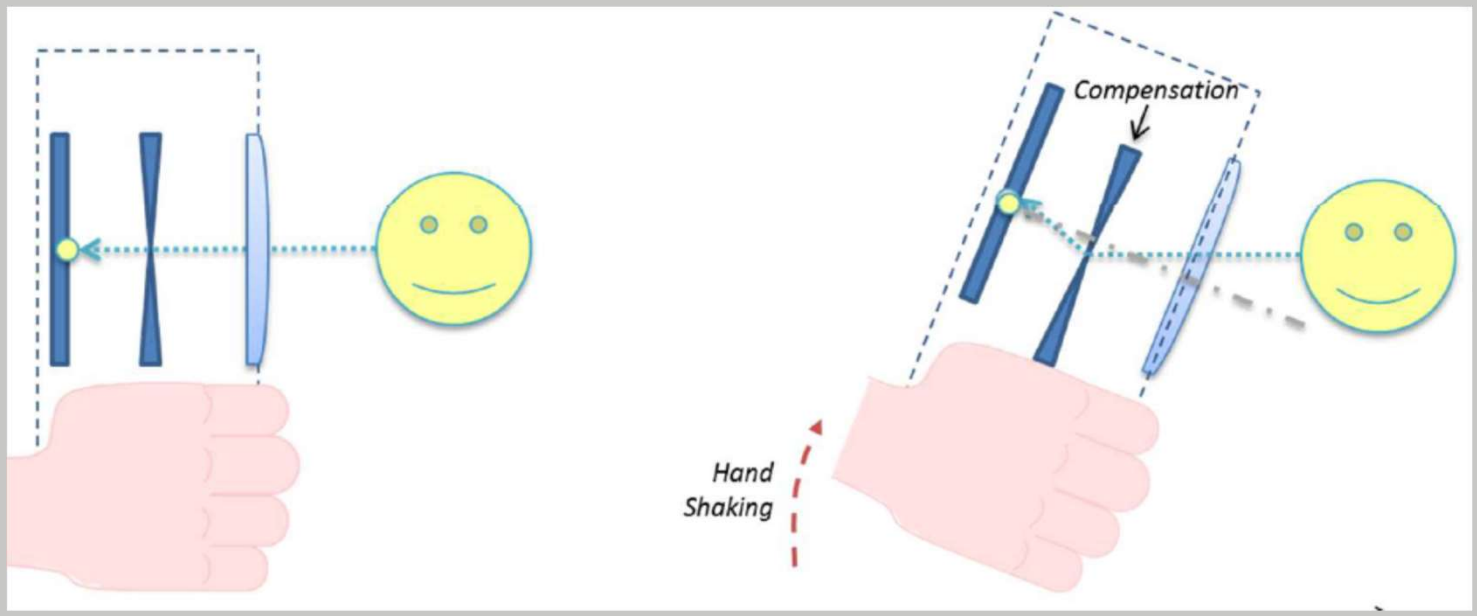

1. Detection of rotation
2. Inhibition of extraocular muscles on one side.
2. Excitation of extraocular muscles on the other side
3. Compensating eye movement


Main Parts of a Steadicam®
Supportive Vest
Camera Sled
Iso-elastic Arm
©2001 HowStuffWorks

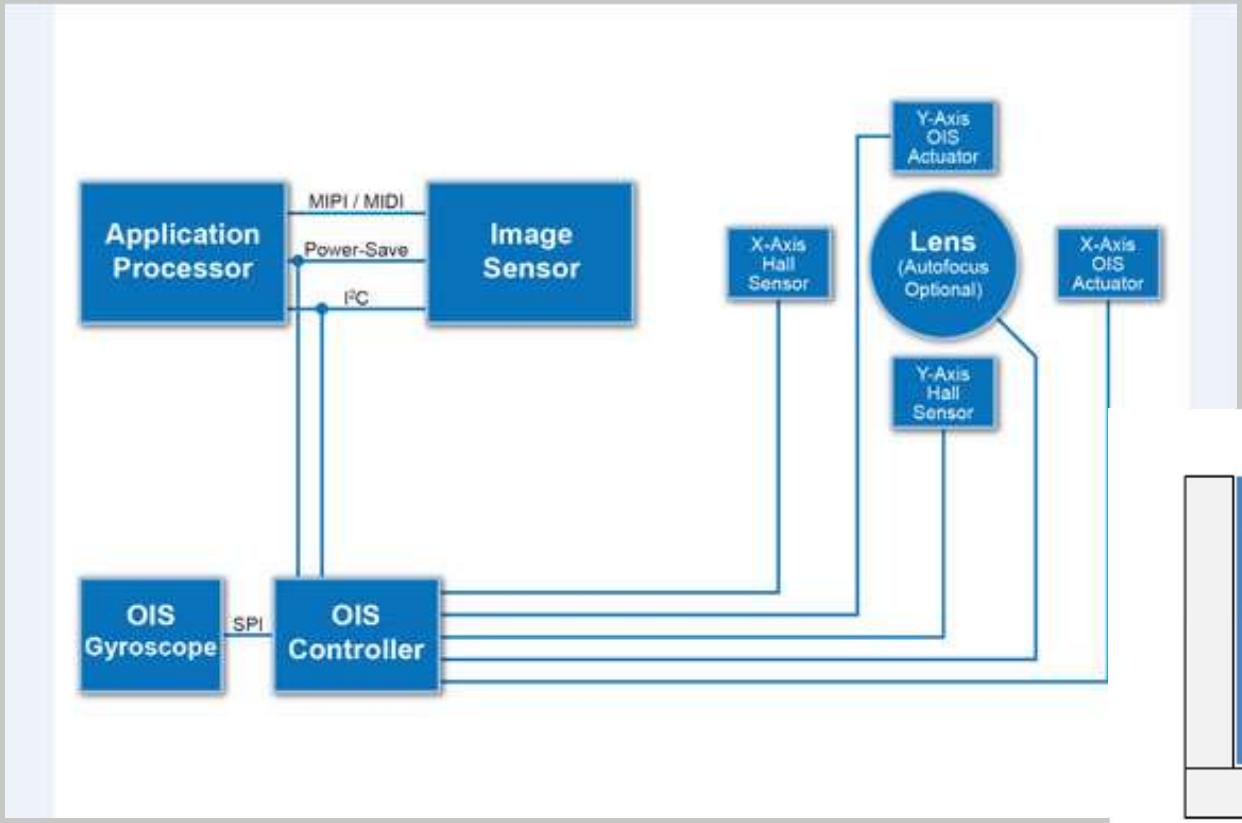
外置的稳像设备

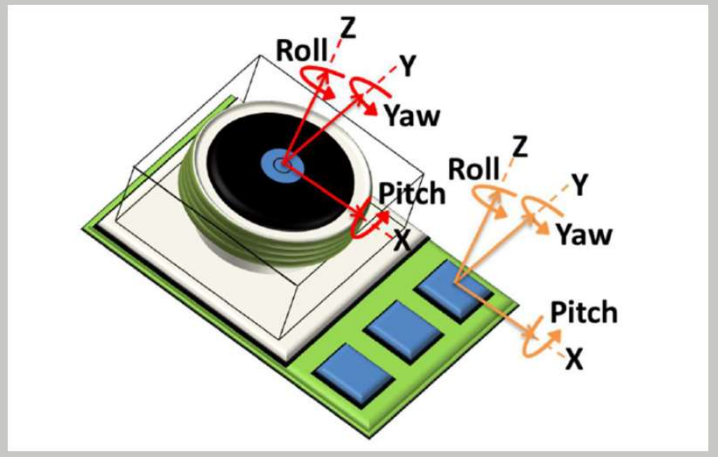
单反中的OIS

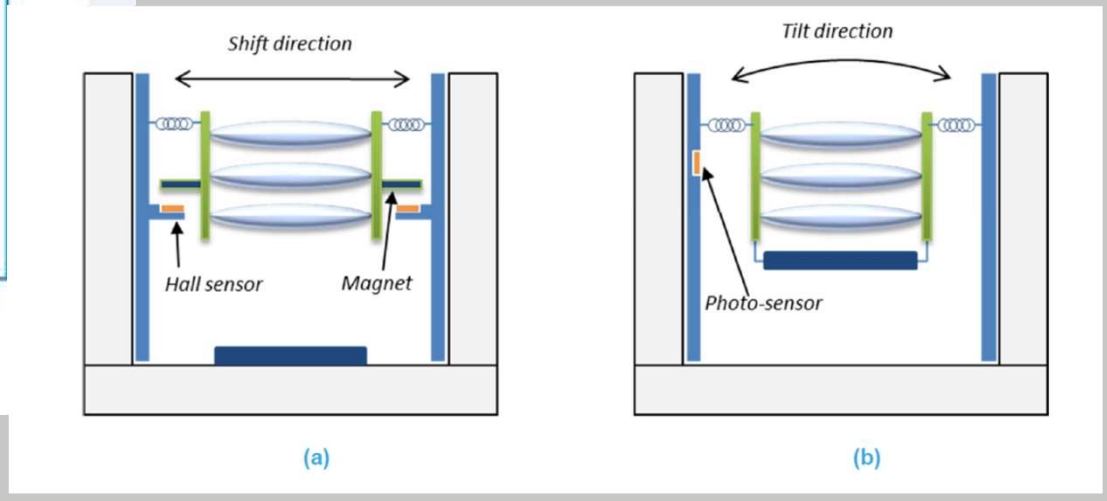

visée stabilisée
visée non stabilisée


Compensation
Hand
Shaking

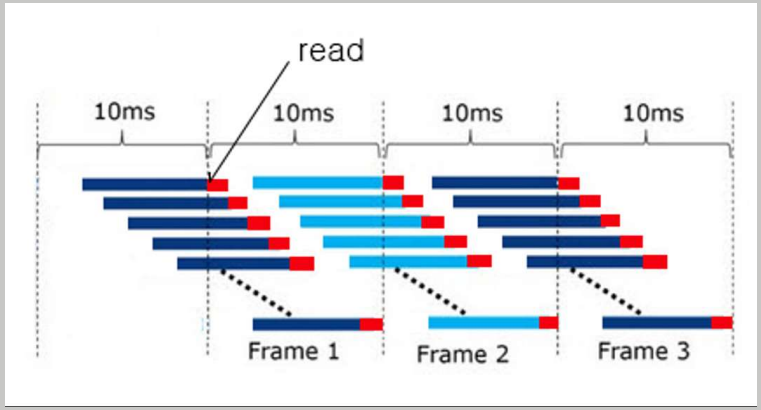
手机中的OIS模组

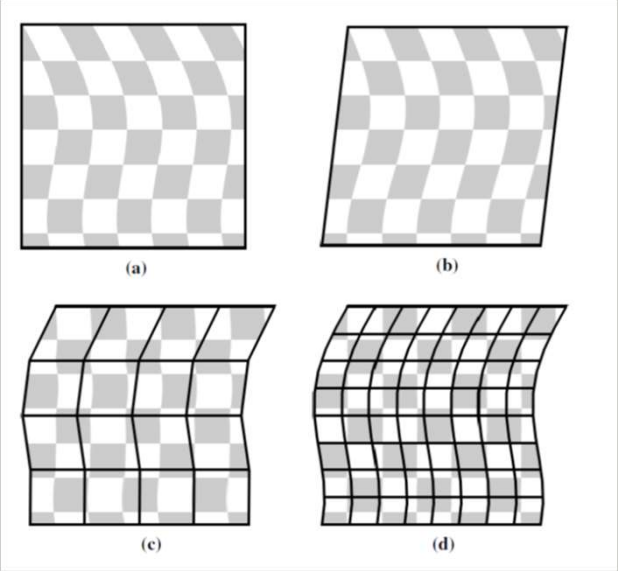

Application Processor
MIPI / MIDI
Power-Save
I²C
Image Sensor
Y-Axis OIS Actuator
X-Axis Hall Sensor
Lens (Autofocus Optional)
X-Axis OIS Actuator
Y-Axis Hall Sensor
OIS Gyroscope
SPI
OIS Controller

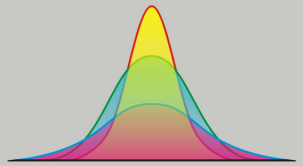

Roll
Z
Y
Yaw
Pitch
X
Roll
Z
Y
Yaw
Pitch
X


Shift direction
Hall sensor
Magnet
(a)
Tilt direction
Photo-sensor
(b)

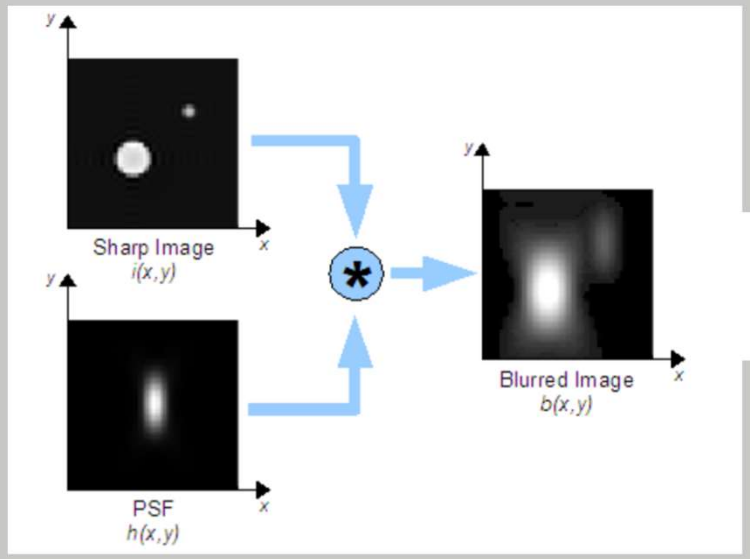
卷帘门效应







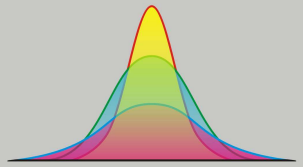
Motion Blur 模型



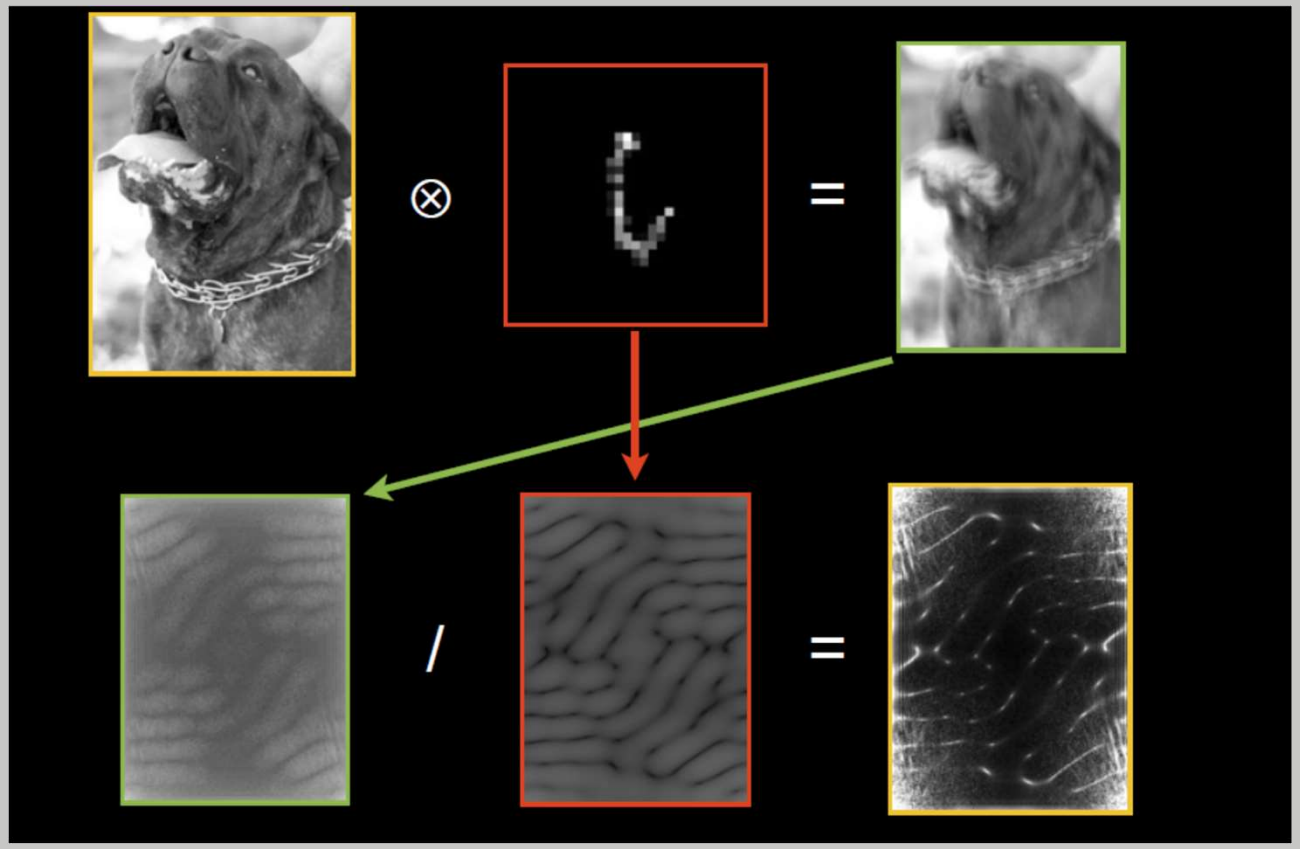
$$b(x,y)=i(x,y)*h(x,y)$$

$$b(x,y) = i(x,y) * h(x,y) + n(x,y) = \int_{-\infty}^{+\infty}\int_{-\infty}^{+\infty} i(\alpha,\beta)h(x-\alpha,y-\beta)\,d\alpha d\beta + n(x,y)$$

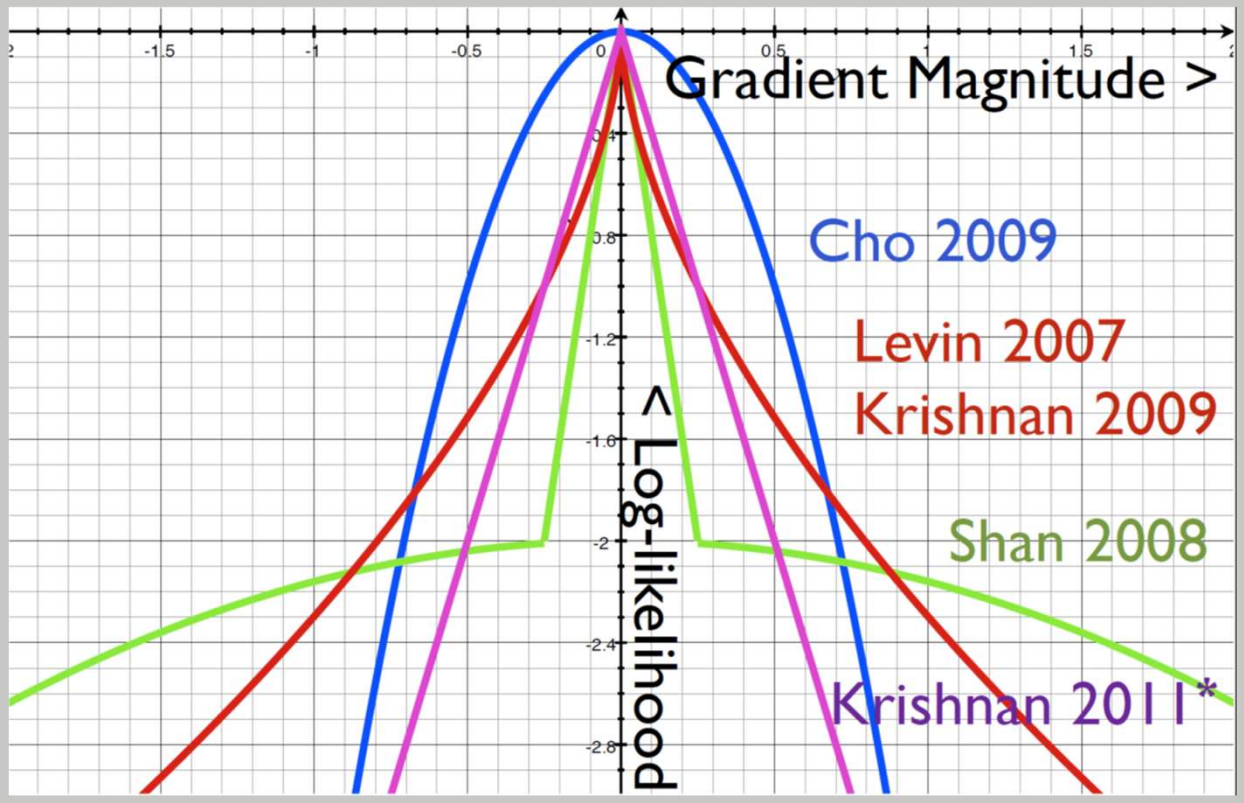
$$b_e(x,y) = \sum_{i=0}^{M-1}\sum_{j=0}^{N-1} i_e(i,j)h_e(k-i,l-j) + n_e(k,l)$$

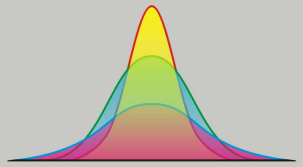


盲目解卷积

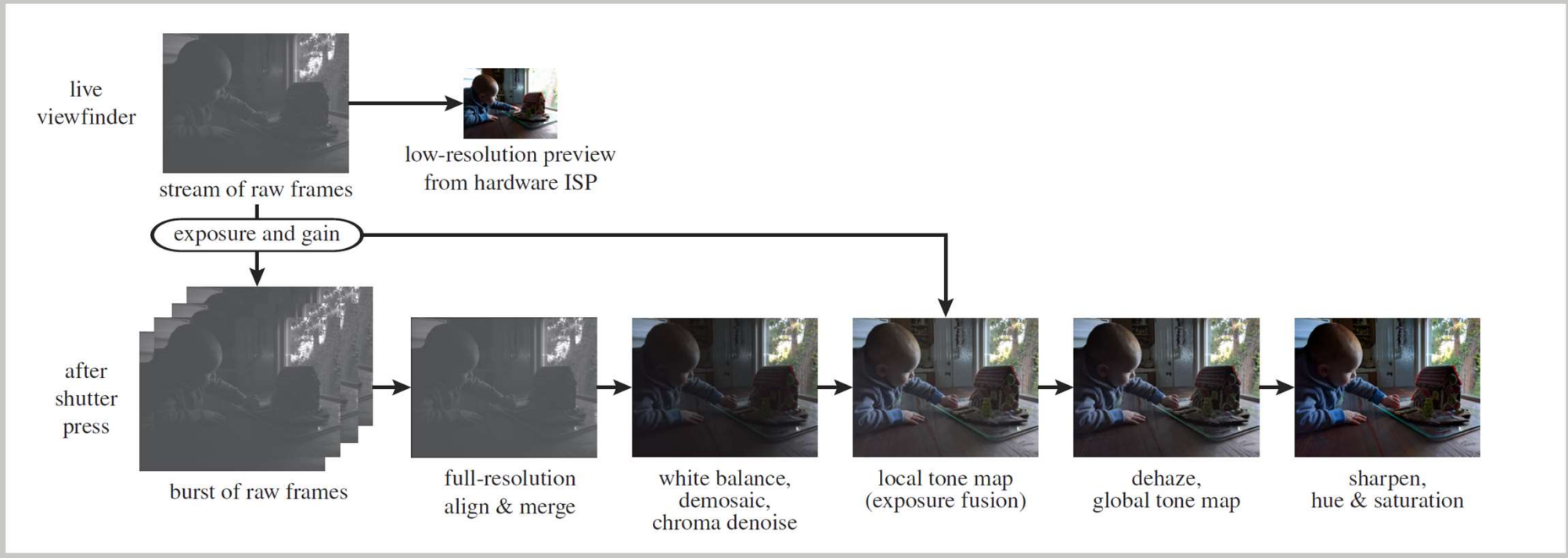


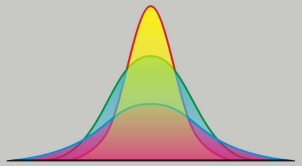
PSF的估计


Gradient Magnitude >
< Log-likelihood
Cho 2009
Levin 2007
Krishnan 2009
Shan 2008
Krishnan 2011*

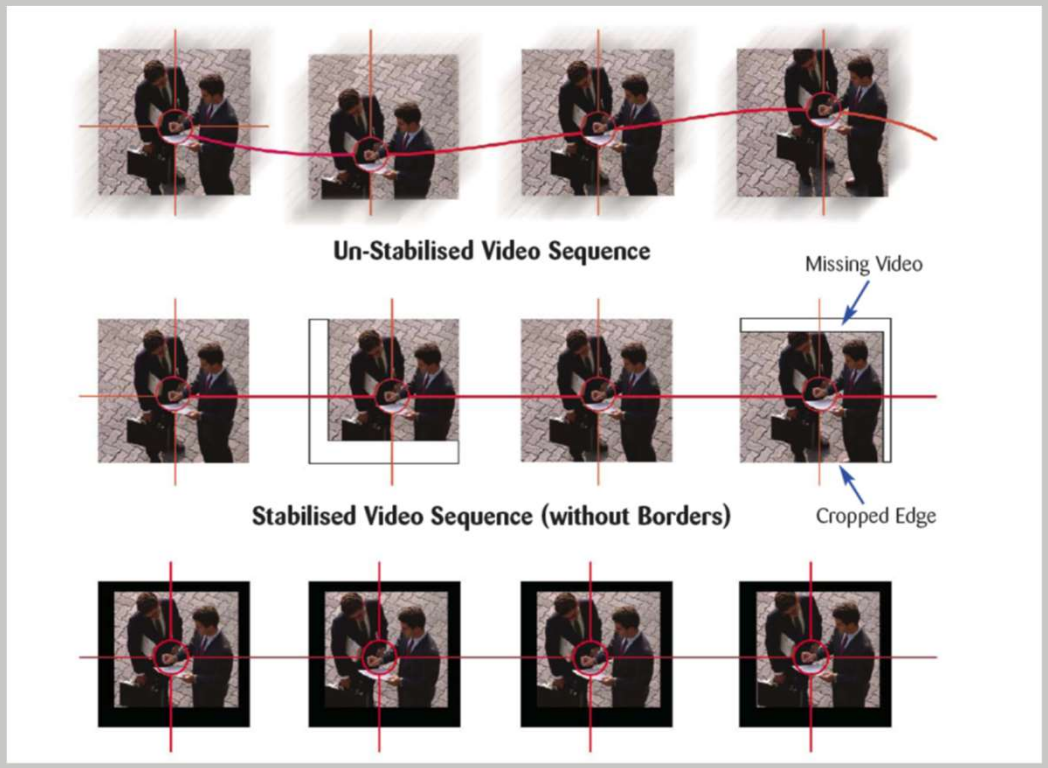


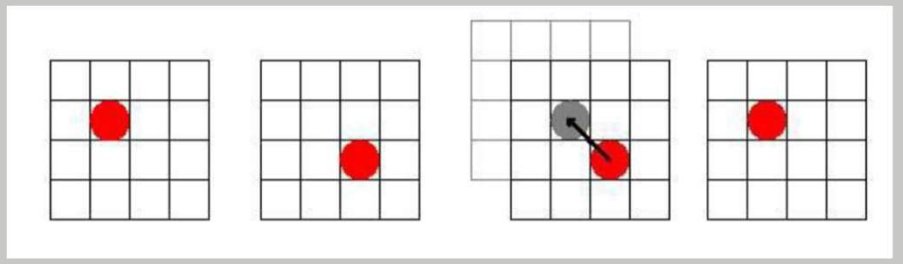
多帧短曝光

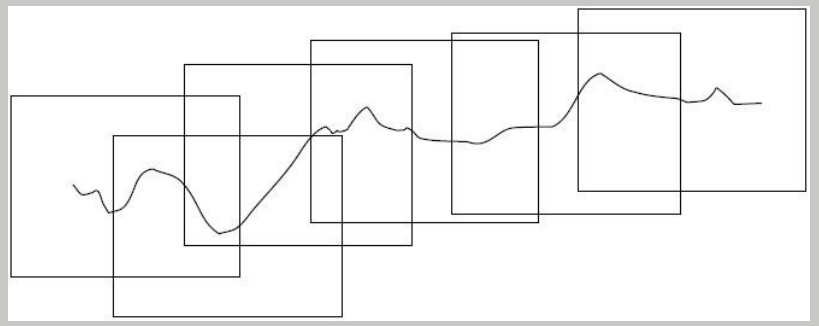

live
viewfinder
stream of raw frames
low-resolution preview
from hardware ISP
exposure and gain
after
shutter
press
burst of raw frames
full-resolution
align & merge
white balance,
demosaic,
chroma denoise
local tone map
(exposure fusion)
dehaze,
global tone map
sharpen,
hue & saturation

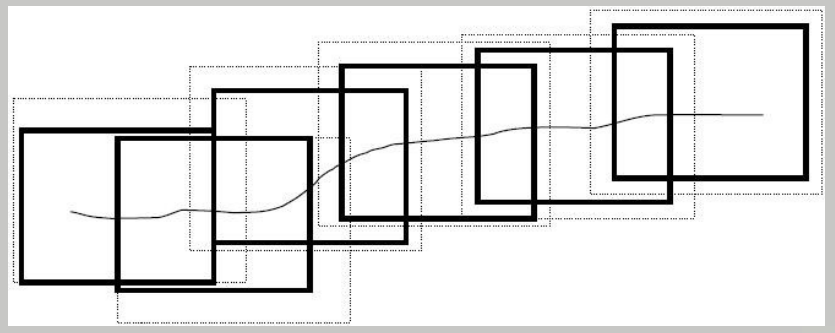


视频防抖

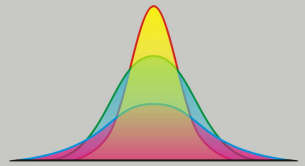

Un-Stabilised Video Sequence
Missing Video
Stabilised Video Sequence (without Borders)
Cropped Edge

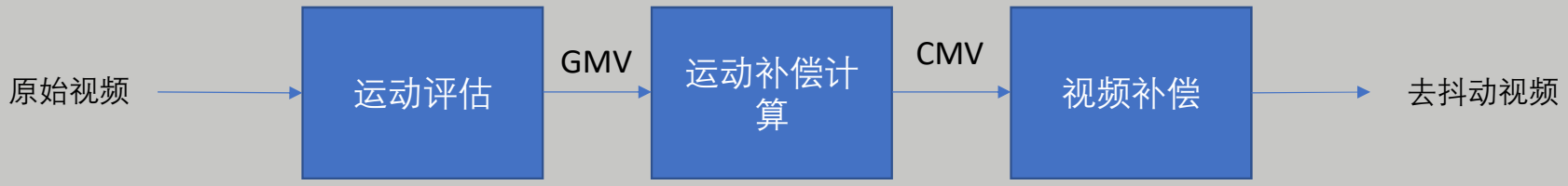






防抖的基本流程

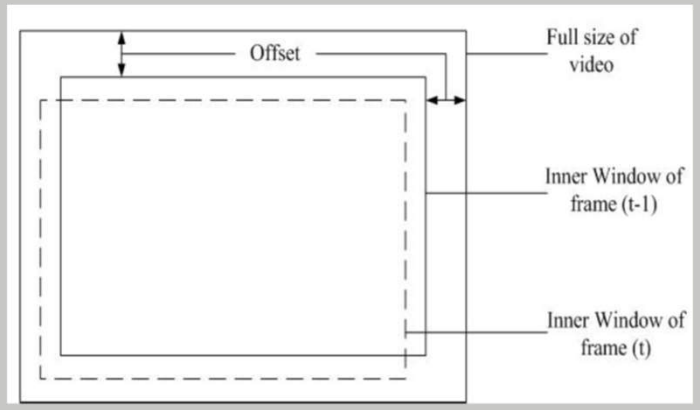




GMV (Global motion vector)

CMV (Compensating motion vector)

$$HMV(n) = GMV(n) - SMV(n)$$

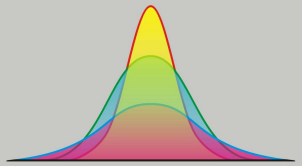


运动矢量分析方法

- (a) 灰度投影法
- (b) 块匹配法
- (c) 位平面匹配法
- (d) 特征点匹配法
- ……

$$I_{\Sigma}(x,y)=\sum_{i=0}^{i\le x}\sum_{j=0}^{j\le y}I(x,y)$$

$$D_i=(C_i-GMV_i+R_i)$$



比较信号相似度的方法

1绝对平均误差函数

$$MAD(i,j)=\frac{1}{N^2}\sum_{m=x}^{x+N-1}\sum_{n=y}^{y+N-1}\left|I_k(m,n)-I_{k-1}(m+i,n+j)\right|$$

2互相关函数

$$CCF(i,j)=\frac{\sum_{m=x}^{x+N-1}\sum_{n=y}^{y+N-1}I_k(m,n)I_{k-1}(m+i,n+j)}{\left[\sum_{m=x}^{x+N-1}\sum_{n=y}^{y+N-1}I_k(m,n)\right]^{1/2}\left[\sum_{m=x}^{x+N-1}\sum_{n=y}^{y+N-1}I_{k-1}(m+i,n+j)\right]^{1/2}}$$

3均方误差函数

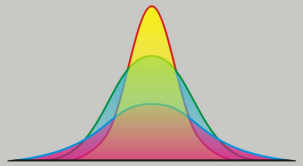
$$MSE(i,j)=\frac{1}{N}\sum_{m=x}^{x+N-1}\sum_{n=y}^{y+N-1}\sqrt{\left|I_k(m,n)-I_{k-1}(m,n)\right|^2}$$

4最大误差最小函数

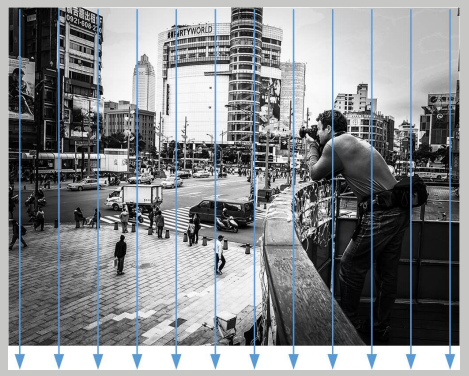
$$MME(i,j)=\max\left|I_k(m,n)-I_{k-1}(m+i,n+j)\right|$$

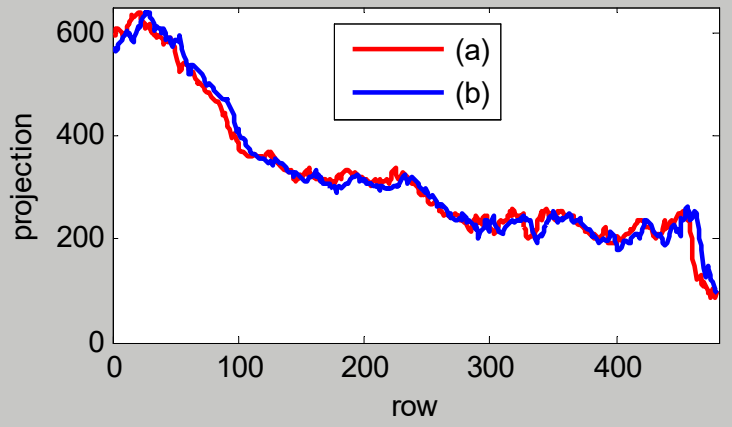
5 绝对差之和SAD

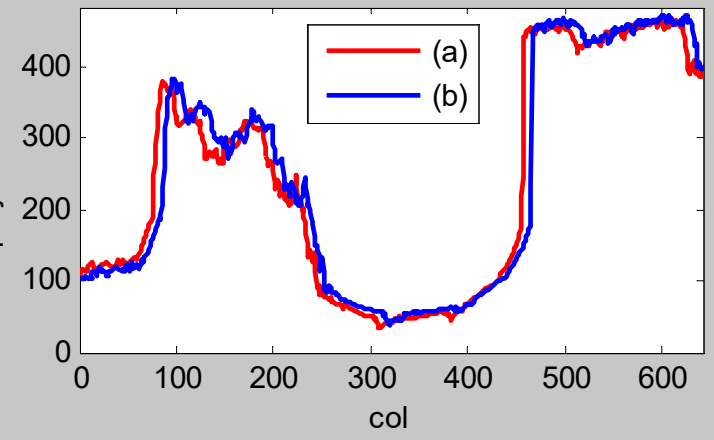
$$SAD(i,j)=\sum_{m=x}^{x+N-1}\sum_{n=y}^{y+N-1}\left|I_k(m,n)-I_{k-1}(m+i,n+j)\right|$$



灰度投影法

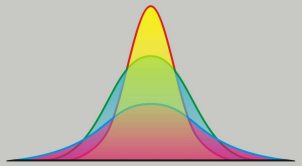




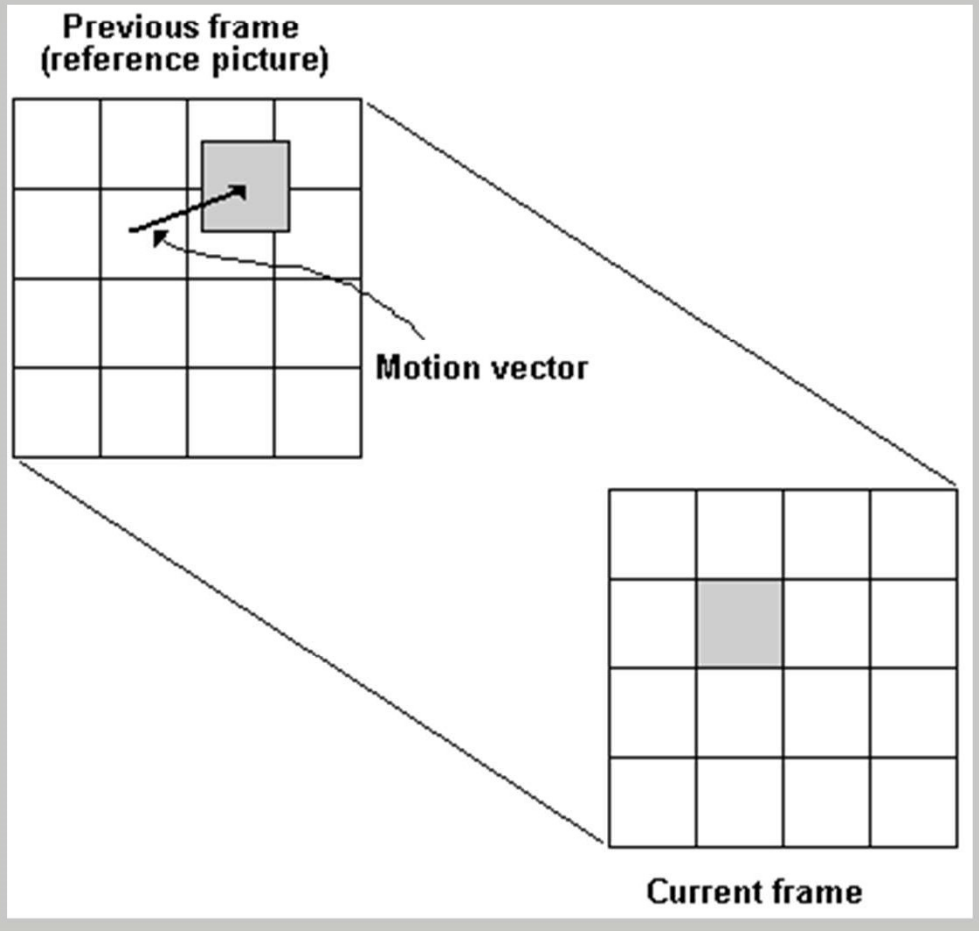


$$G_k(i) = \sum_{j=1}^{N} G_k(i,j)$$

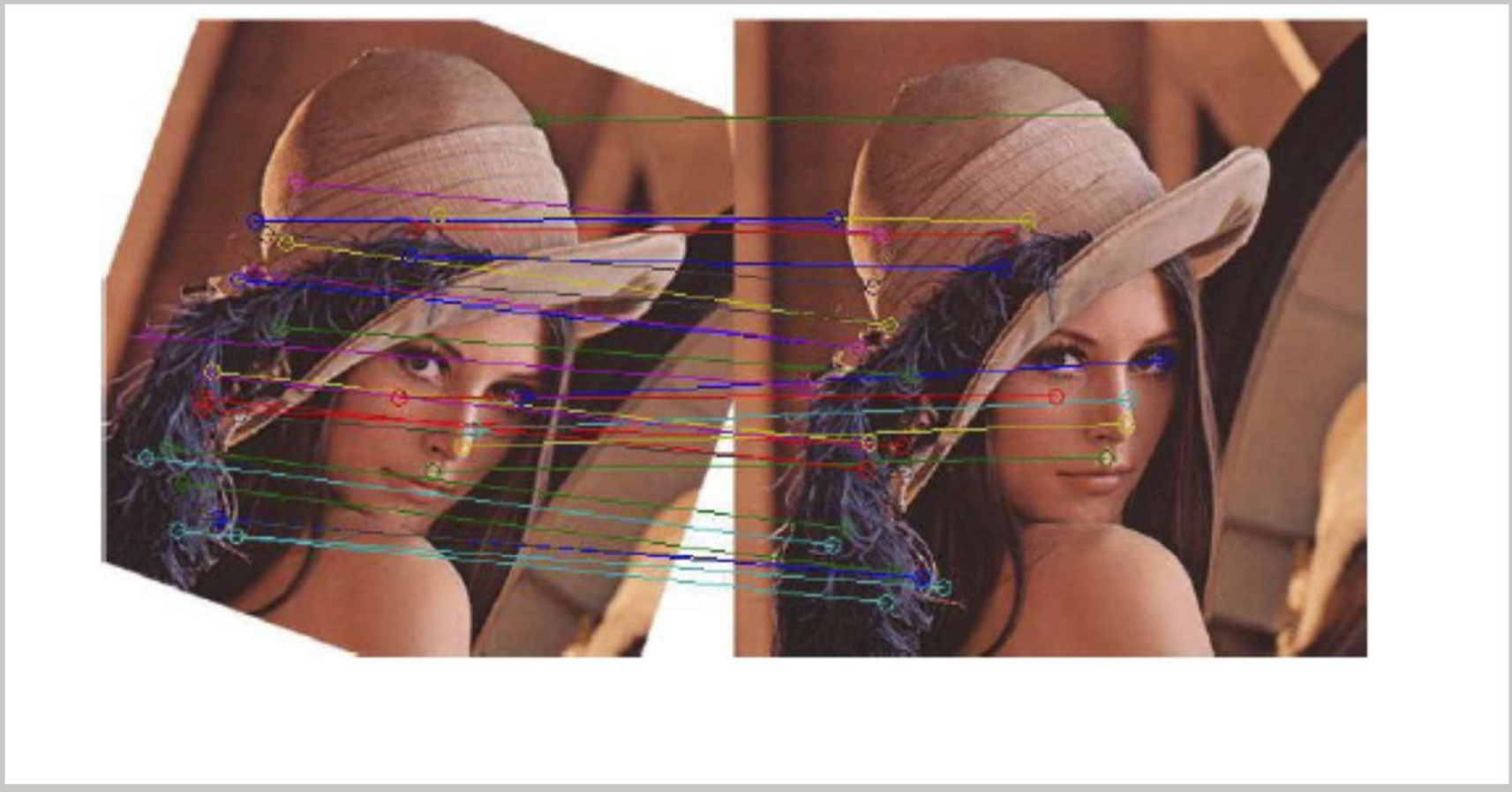
$$G_k(j) = \sum_{i=1}^{M} G_k(i,j)$$



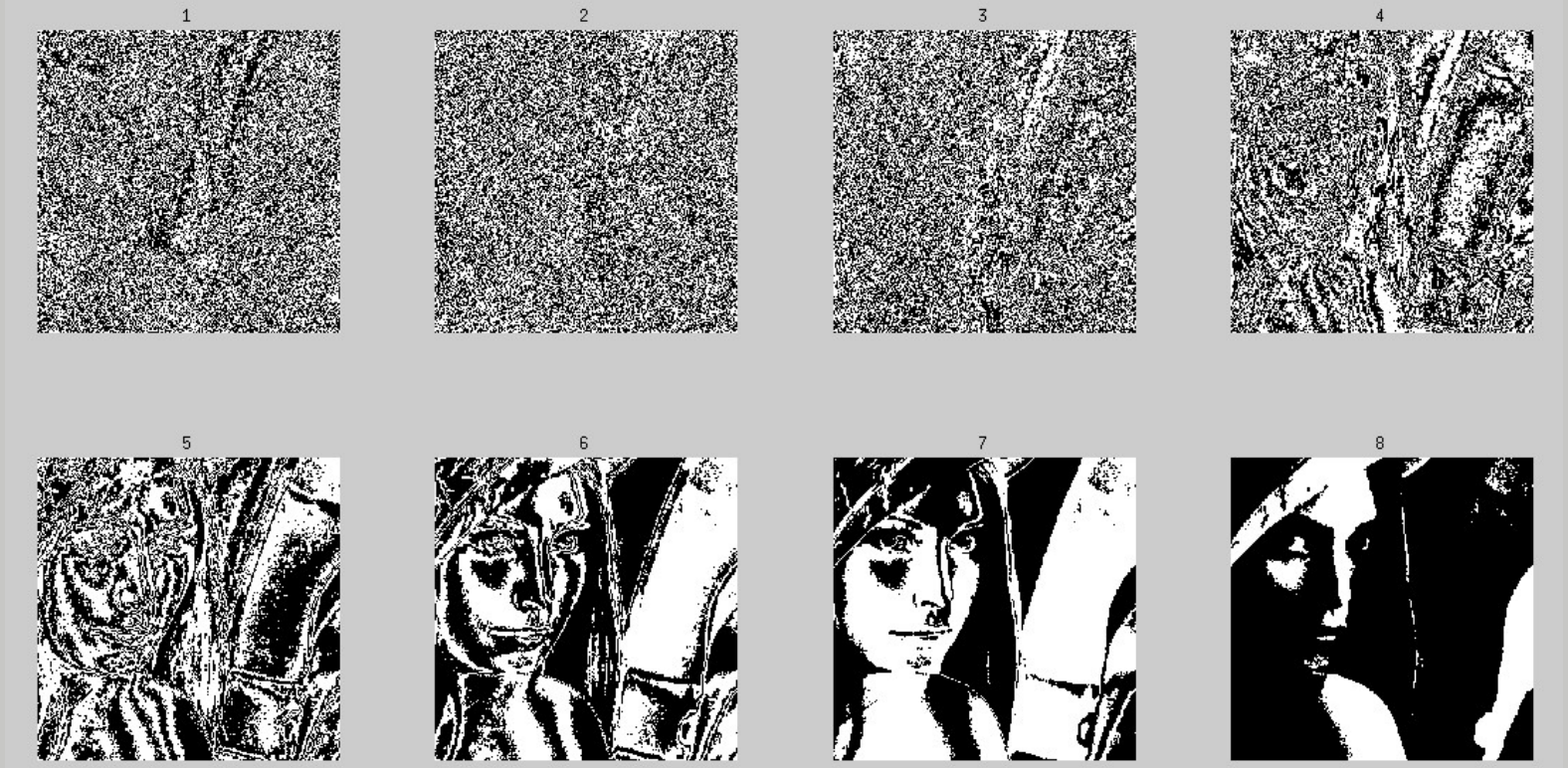
块匹配法


Previous frame
(reference picture)
Motion vector
Current frame

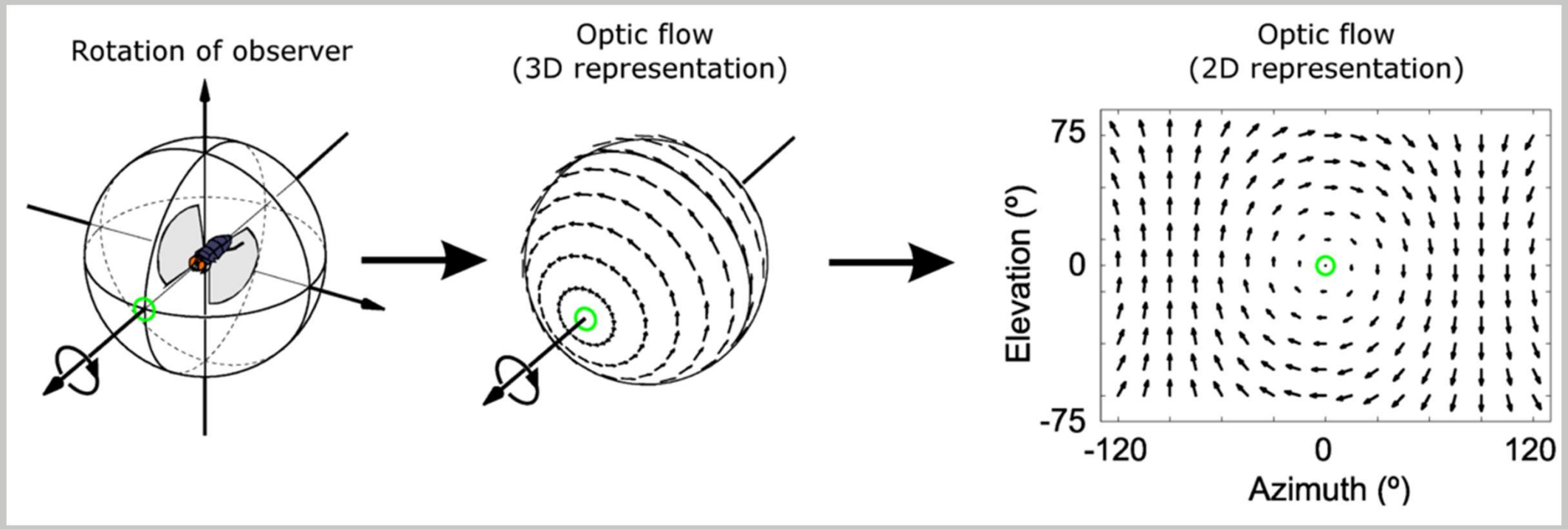
特征点匹配

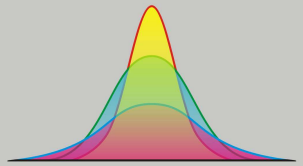


位平面法

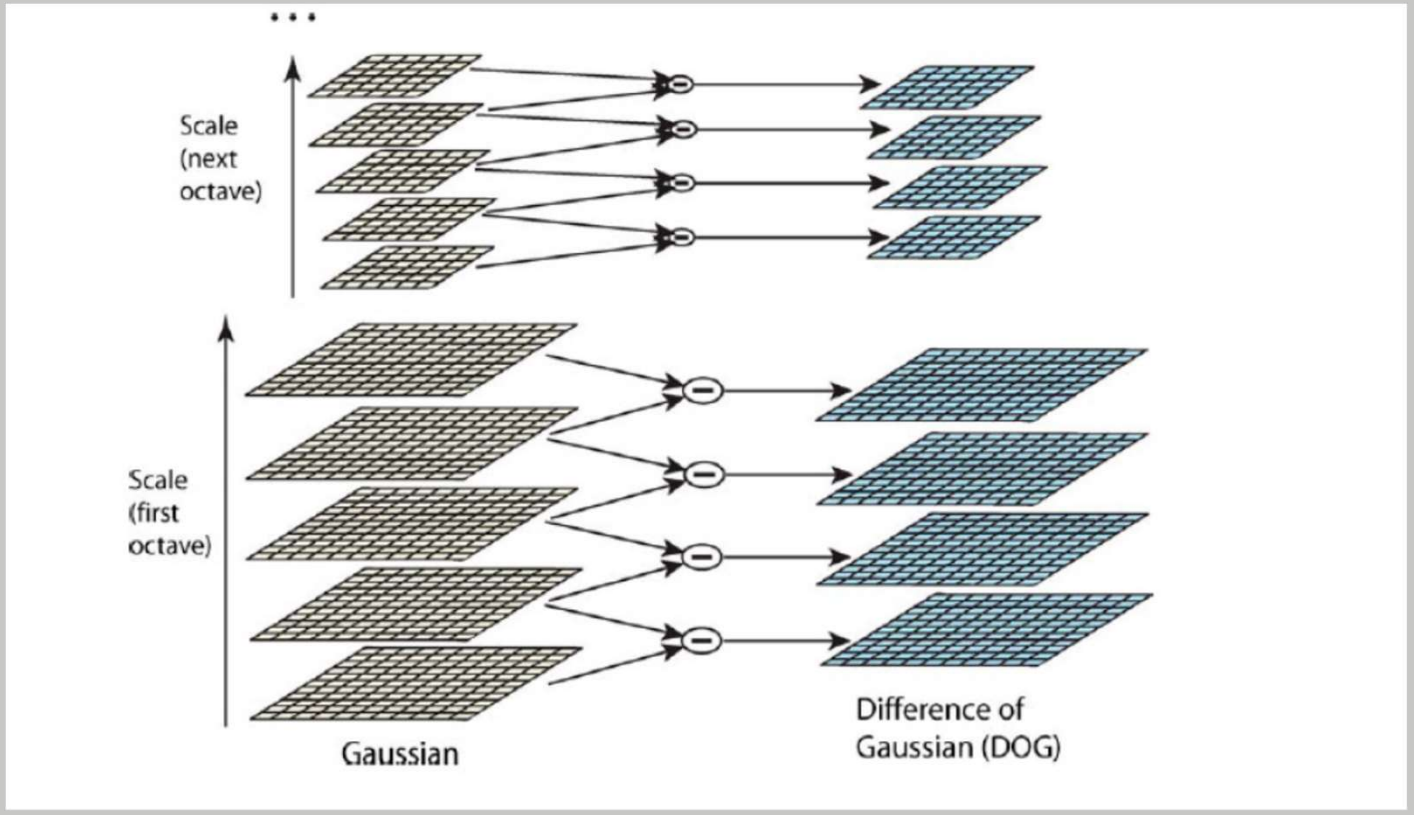


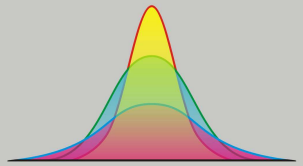
光流法


Rotation of observer
Optic flow
(3D representation)
Optic flow
(2D representation)
75
0
-75
Elevation (°)
-120
0
120
Azimuth (°)

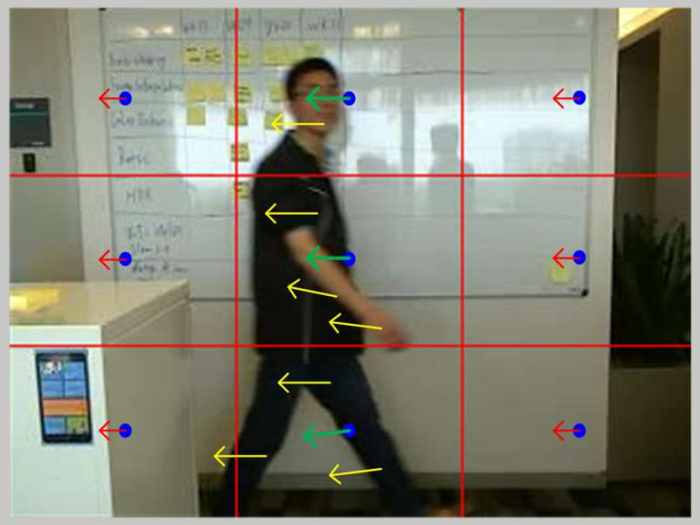


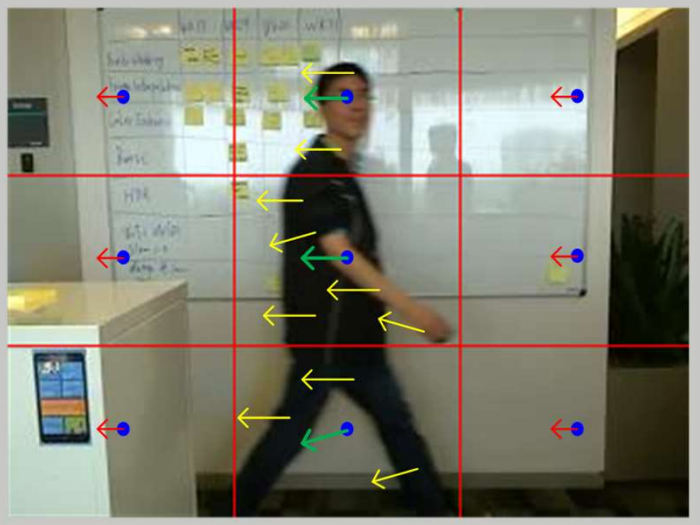
SIFT

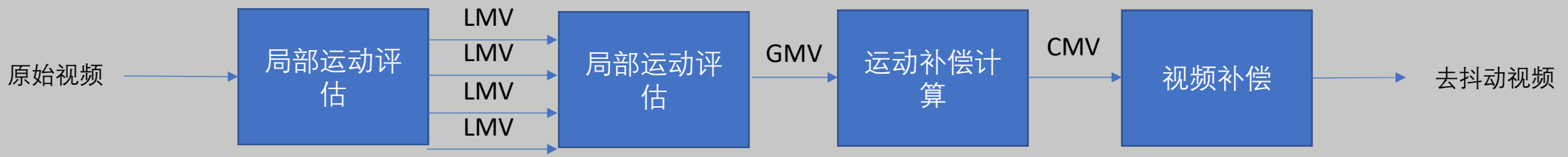

Scale
(next
octave)
Scale
(first
octave)
Gaussian
Difference of
Gaussian (DOG)



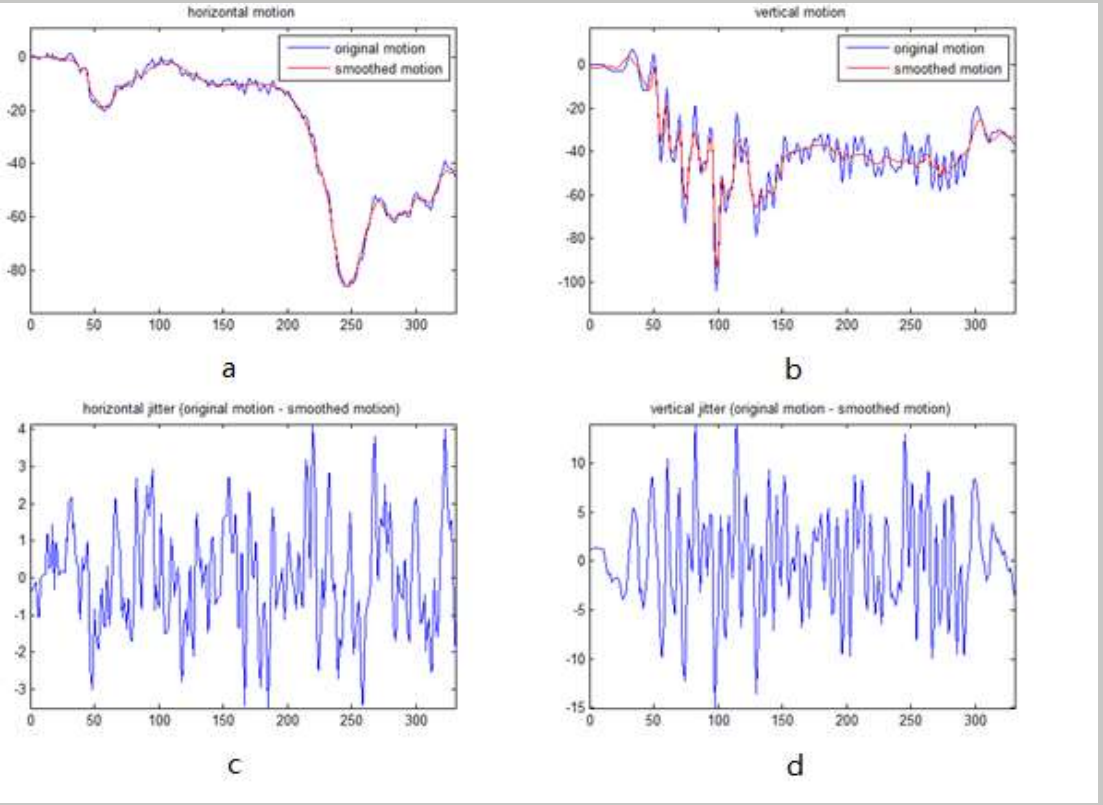
局部运动矢量和全局运动矢量







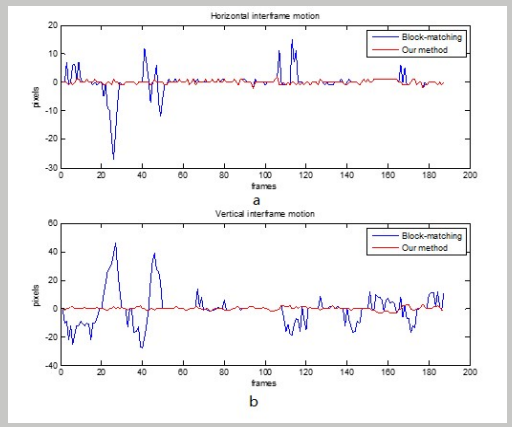
运动和抖动分离

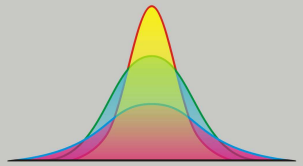


1 滑动平滑滤波器
2 曲线拟合法
3 卡尔曼滤波法
4 高斯核滤波法
5长特征路径的直接优化法

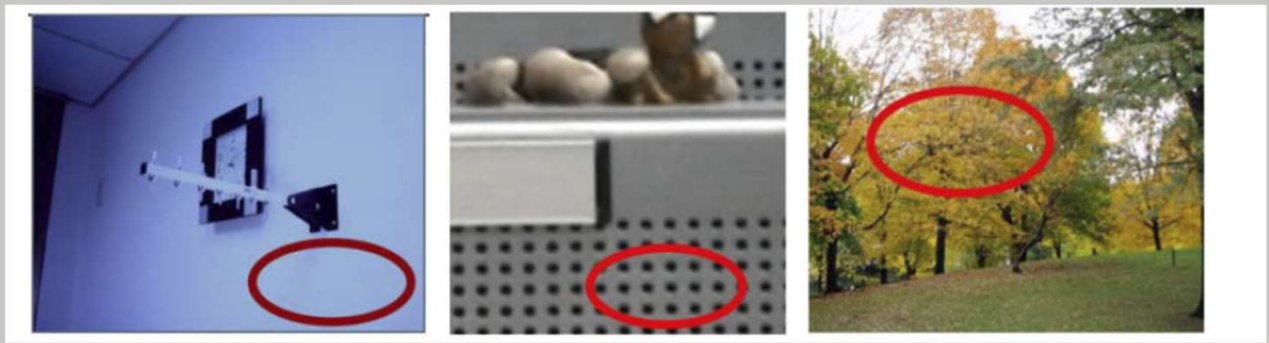
$$MTraj_o(t) = \sum_{i=1}^{t} GMV(i),$$

$$MTraj_c(t) = \left(\sum_{i=1}^{t} GMV(i) \right) - CMV(t),$$

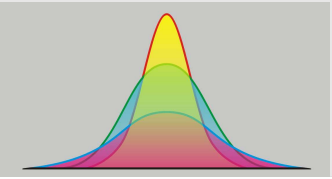




影响EIS系统的几个原因



- 缺乏特征(Lack of Feature, LOF)；
- 重复模式(Repeated Pattern, RP)；
- 低信噪比(Low SNR, LowSNR)；
- 存在运动物体(Moving Objects)。
- 透视角造成同一物体远近运动量不同；
- 光照突然变化，如闪光灯；
- 运动模糊(Motion Blur)；
- 大面积阴影



EIS use gyro

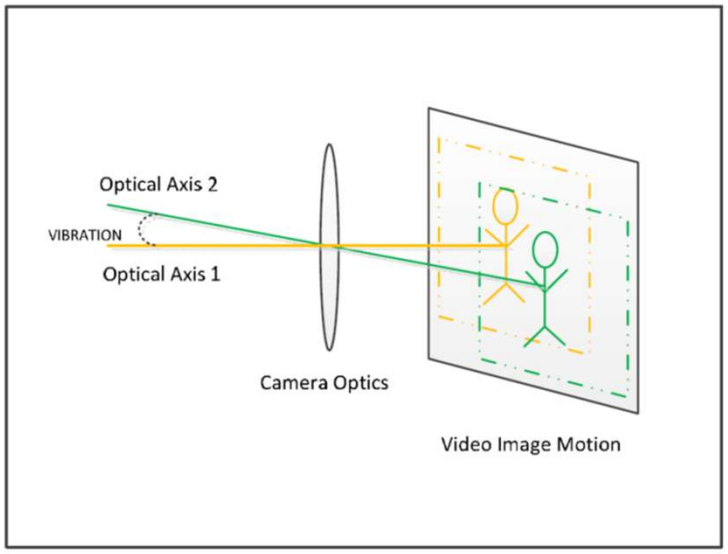
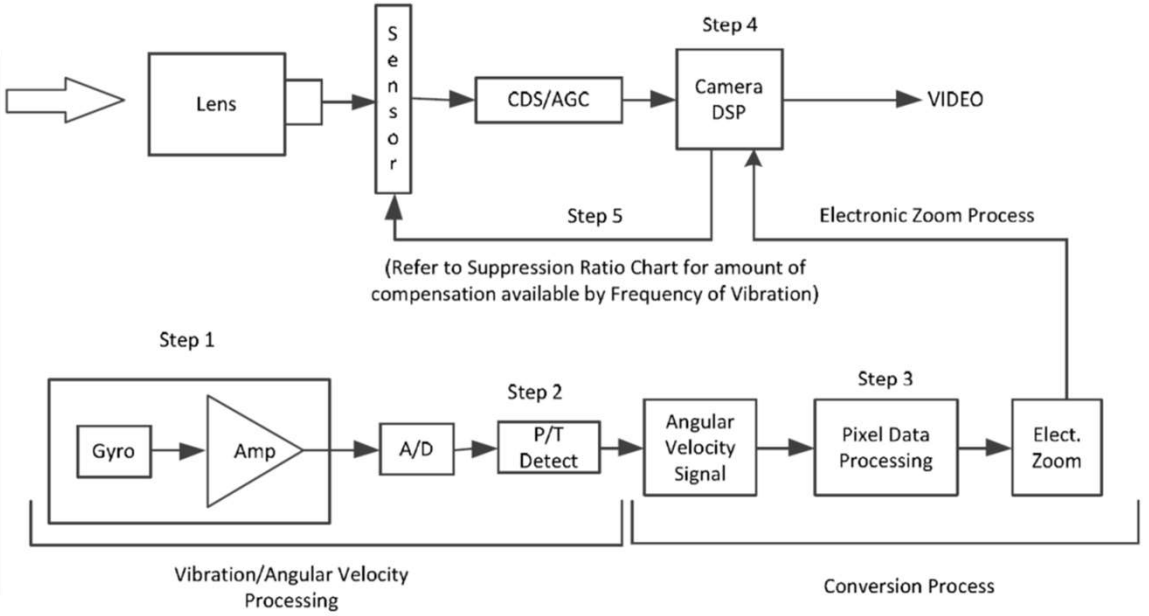
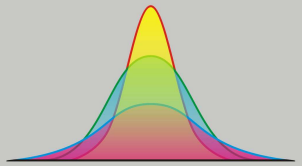
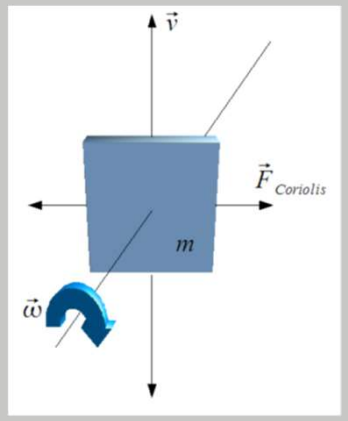


Diagram 1

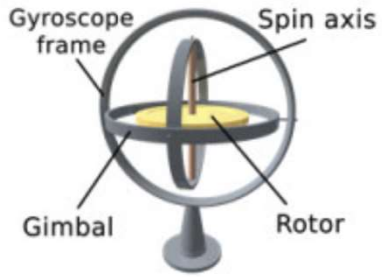




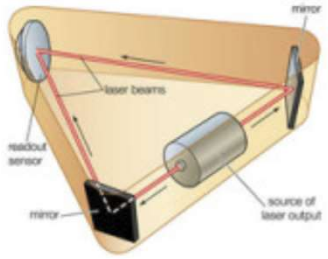
Gyro



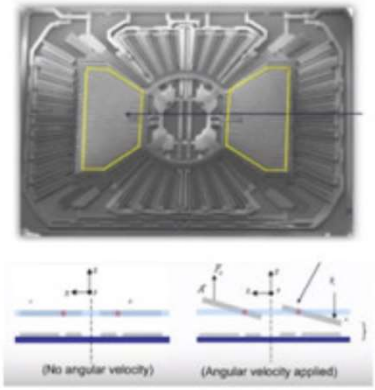
$$\vec{F}_{Coriolis} = -2m(\vec{v}\times\vec{\omega})$$



机械陀螺仪

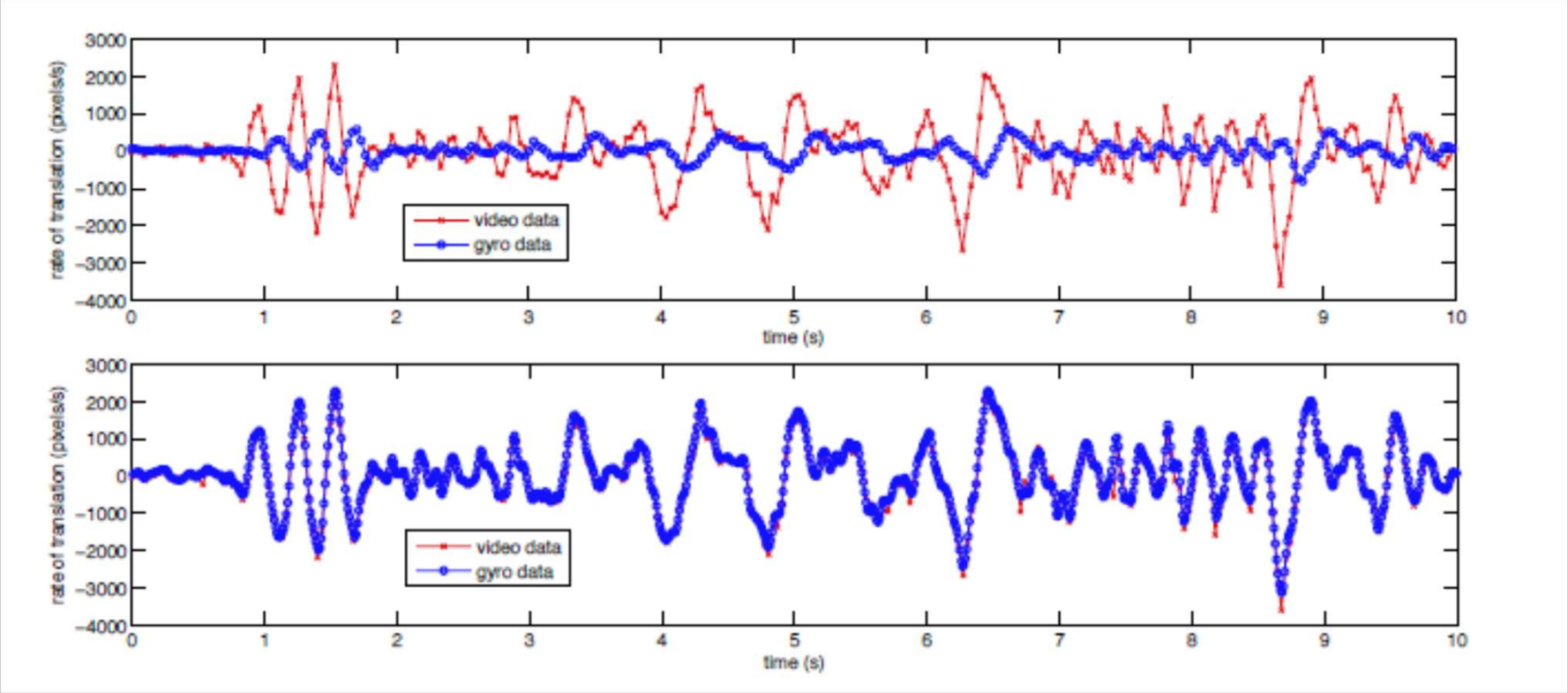


激光陀螺仪



MEMs陀螺仪

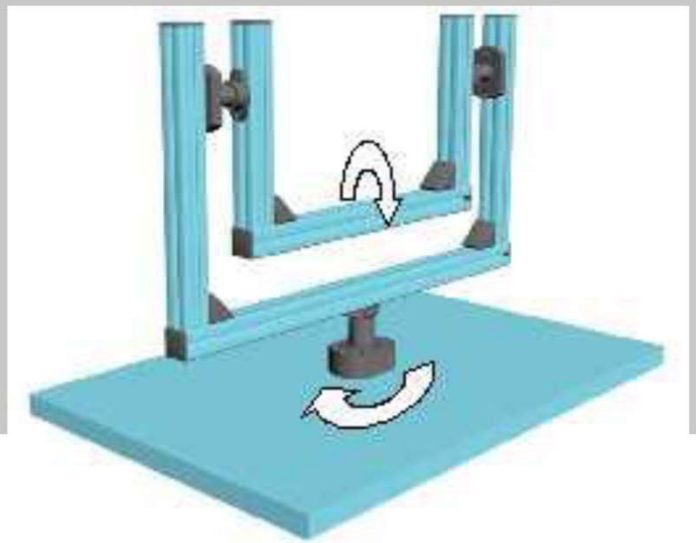
Gyro 和图像匹配的问题

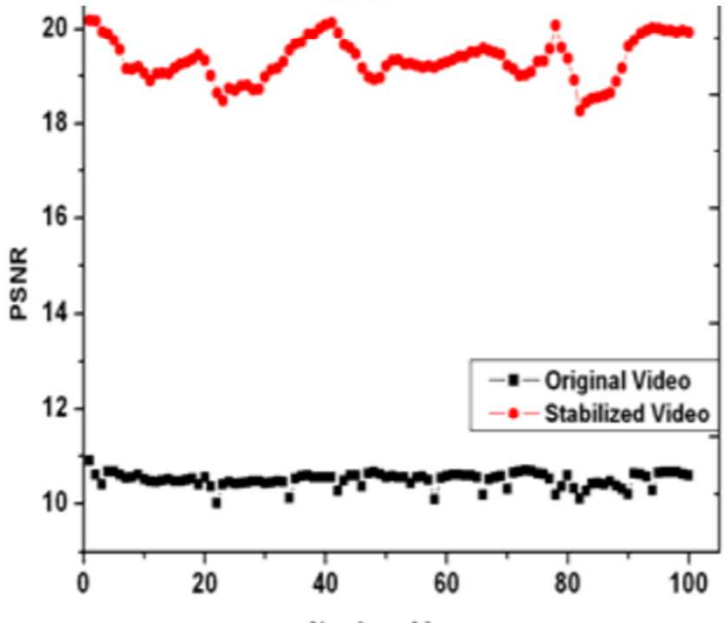


防抖效果的评估

$$PSNR(I_t, I_{t+1}) = 10 \lg \frac{255^2}{MSE(I_t, I_{t+1})}$$

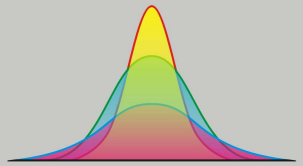
$$MSE(I_t, I_{t+1}) = \frac{1}{M \times N} \sum_{m=1}^{M} \sum_{n=1}^{N} (I_t(m,n) - I_{t+1}(m,n))^2$$





THANKS

本课程由 Eric Zhang提供



大话成像之
数字成像系统 32 讲

内容目录