

# Image Fusion

## Theories, Techniques and Applications

**Assoc. Prof Xiao Gang**

**Email: [Xiaogang@sjtu.edu.cn](mailto:Xiaogang@sjtu.edu.cn)**

**Office: Aerospace Room.1431**

**Tel/Fax:021-34206192**

**Mobile:13918459696**



# 课程内容

## 第一部分：理论部分

- 第一讲 绪论
- 第二讲 多源图像融合预处理
- 第三讲 多源图像像素级融合
- 第四讲 多源图像特征级融合
- 第五讲 多源图像决策级融合
- 第六讲 多源图像优化融合
- 第七讲 多源动态图像融合
- 第八讲 多源图像融合评价体系

## 第二部分：应用部分

- 第九讲 可见光与红外图像融合系统
- 第十讲 空间信息处理开发平台
- 第十一讲 基于多源数据融合的航道桥梁船舶碰撞预警系统
- 第十二讲 基于多源信息融合的机场跑道异物(FOD)检测系统
- 第十三讲 车载融合实验及关键技术研究



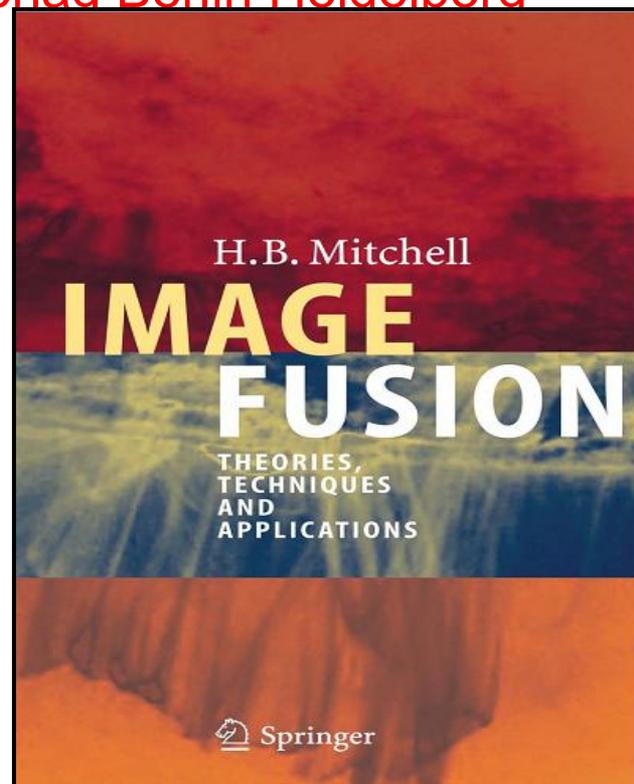
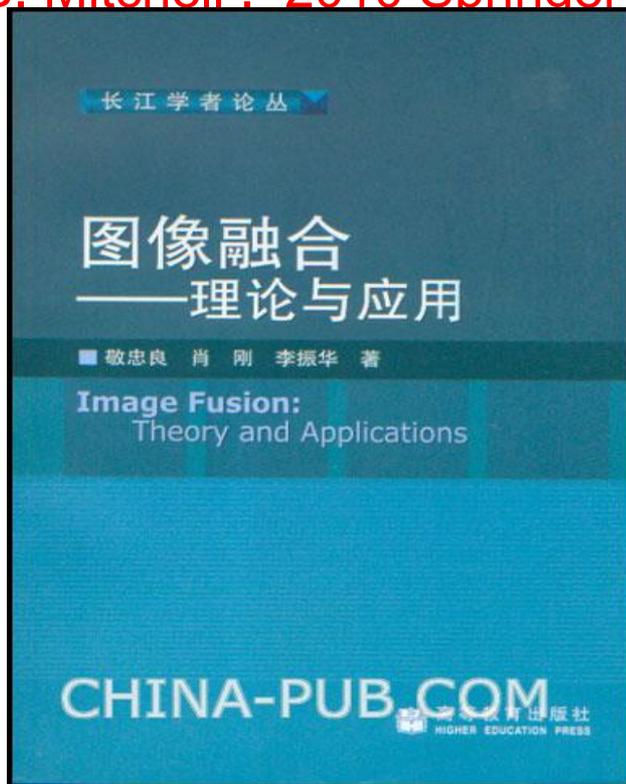
# 参考教材

## 1. 《图像融合：理论与应用》

敬忠良，肖刚，李振华. 高等教育出版社，2007.10（第一版）/2010.5（第二版）

## 2. 《Image Fusion: Theories, Techniques and Applications》

H.B. Mitchell, 2010 Springer-Verlag Berlin Heidelberg



# 推荐文献数据库

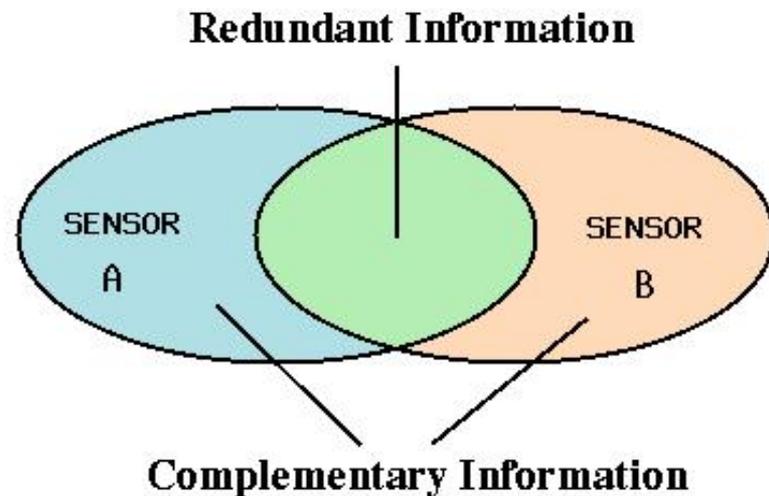
- 外文文献数据库
  - IEEE/IEE Electronic Library
  - OSA-The Optical Society of America
- 主要专业期刊
  - Information Fusion( EISEVIER), IF=1.606
  - International Journal of Image and Data Fusion
- 主要国际会议
  - International Conference on Information Fusion  
(International Society of Information Fusion-ISIF)
  - 中国信息融合大会  
(中国航空学会信息融合分会)



# 1. Introduction of Image Fusion

- Image Fusion

Produce a single image from a set of input images. The fused image should have more complete information which is more useful for human or machine perception.



# 1. Introduction of Image Fusion

- **Advantages of Image Fusion**
  - Improve reliability  
(by redundant information)
  - Improve capability  
(by complementary information)
- **Objectives of Image Fusion Schemes**
  - Extract all the useful information from the source images
  - Do not introduce artifacts or inconsistencies which will distract human observers or the following processing
  - Reliable and robust to imperfections such as mis-registration



# 1. Introduction of Image Fusion

- **Related Research Fields of Image Fusion**
  - Computer Vision
  - Automatic object detection
  - Image processing
  - Parallel and distributed processing
  - Robotics
  - Remote sensing



# 1. Introduction of Image Fusion

- **Examples of image fusion combination**

<b>Sensor-1</b>	<b>Sensor-2</b>	<b>Effect</b>
TV/CCD	IR	Penetration, day/night
MMW/CCD	IR	Penetration, discrimination
TV/CCD	Laser(high-power)	Induced vibration signatures
IR	UV	Background discrimination
Multi-spectral	Panchro	Discrimination features and context
ALL	Digital terrain map	Discrimination and location
Laser(pulsed)	TV/IR	Thermal signature
TV/CCD	SAR	Mapping



# 2.Experiments and Results



**Original Image**  
(CHANGZHOU Airport, Jiangsu, China, 2004)



**Registration Result**





# 2.Experiments and Results



全色高分辨率影像 (空间分辨率为0.61米)  
(影像大小: 1024×1024 像素)



Quickbird Band3~Band1合成多光谱影像  
(空间分辨率为2.44米, 升采样后为0.61米)  
(影像大小: 1024×1024 像素)



采用基于小波分解的最优特征融合方法的融合影像 (空间分辨率为0.61米)

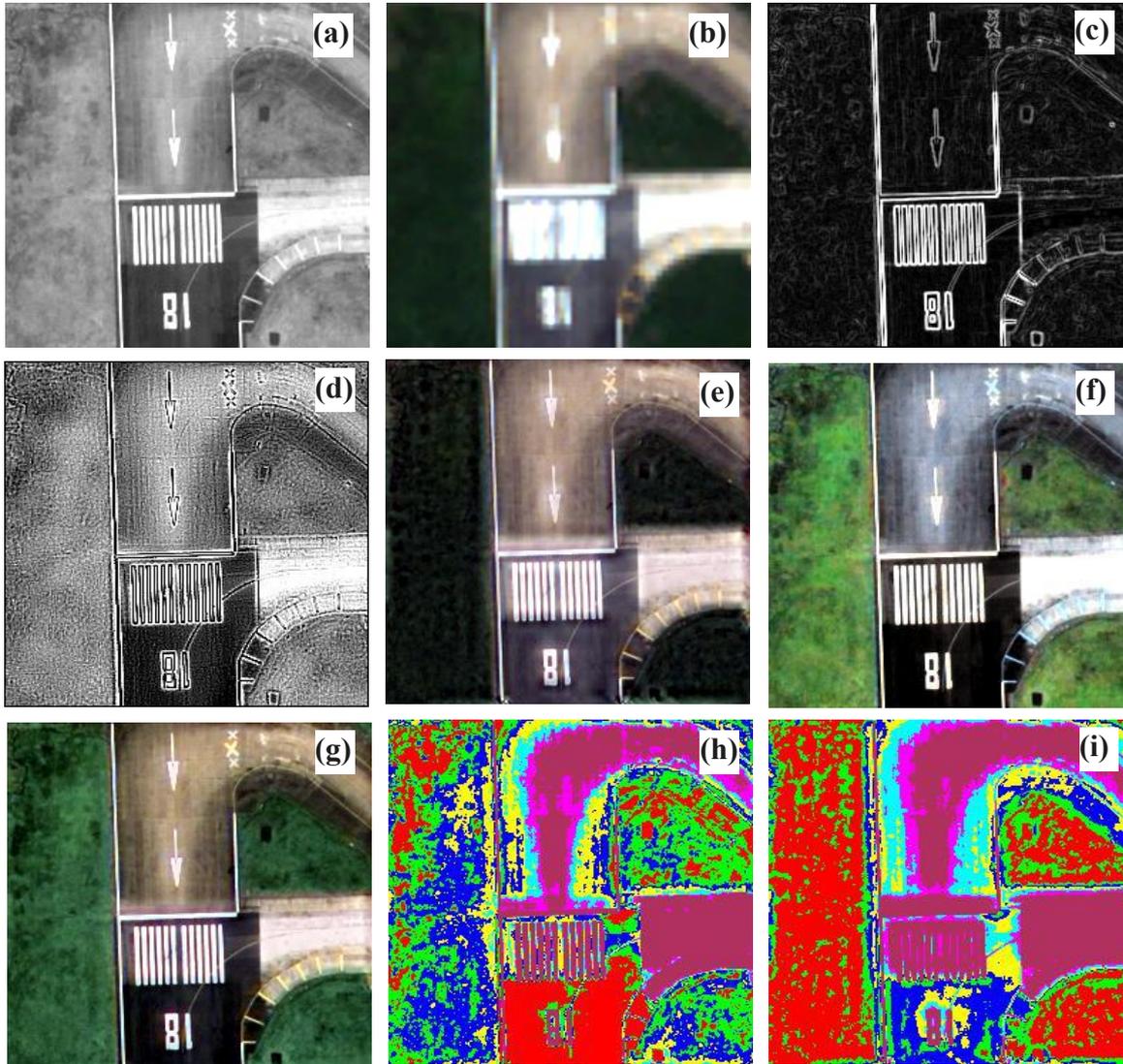
(影像融合的最优权值:  $K1=0.662$ ;  $K2=0.338$ )

(影像大小: 1024×1024 像素 放大一倍显示)

**The fusion of different resolution multi-spectral image (Quick Bird Satellite data)  
(Hongqiao International Airport, Shanghai, China, 2004)**



# 2.Experiments and Results



## The Fused Result Images for Multi-sources Remote Sensing Data (Quick Bird)

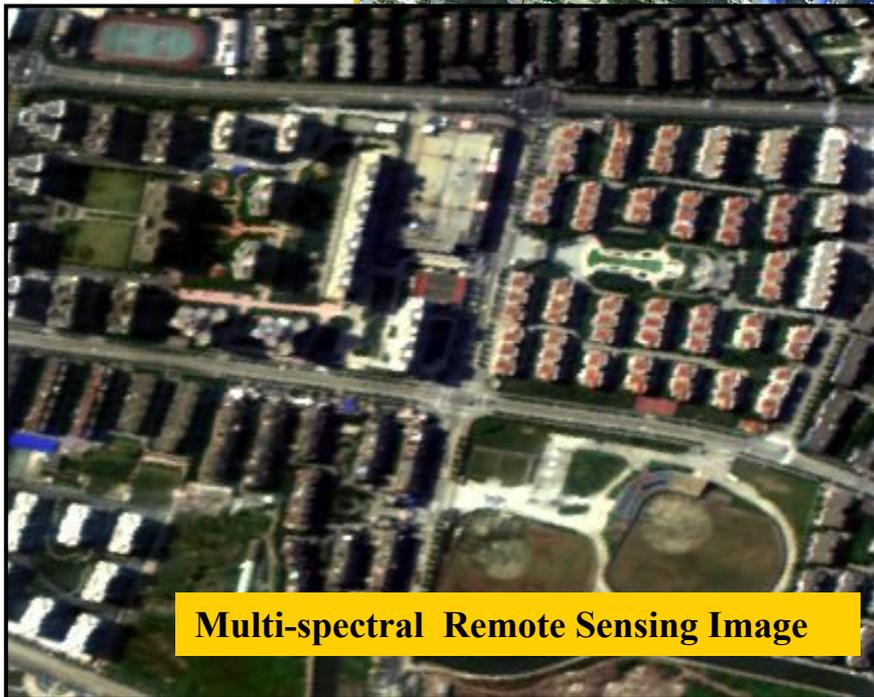
(a) A panchromatic image with 0.61 meter spatial resolution (b) The re-sampled multi-spectral image with 0.61 meter spatial resolution (the original spatial resolution is 2.44 meter) (c) The geometric feature extracting result (d) The texture feature extracting result (e) The fused image with IHS method (f) The fused image with WT method (g) The fused image with FOF method (h) The classified image based on fused image with IHS method (i) The classified image based on fused image with FOF method

(Shanghai Hongqiao international Airport, 2004)





CCD Remote Sensing Image



Multi-spectral Remote Sensing Image



Fusion Result

(Shanghai City, China, 2005)

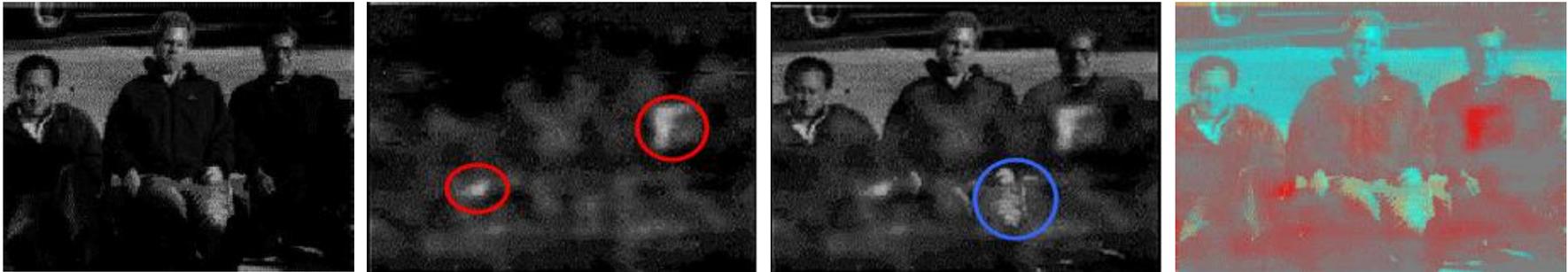
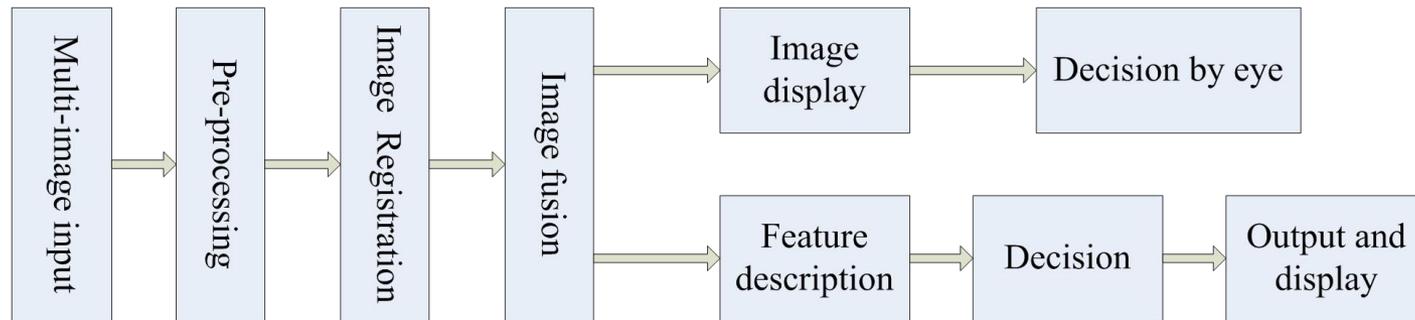
# 2. Experiments and Results



## The Platform of multi-source face recognition (IR and Visual CCD Face Image)



# 3. Experiments and Results

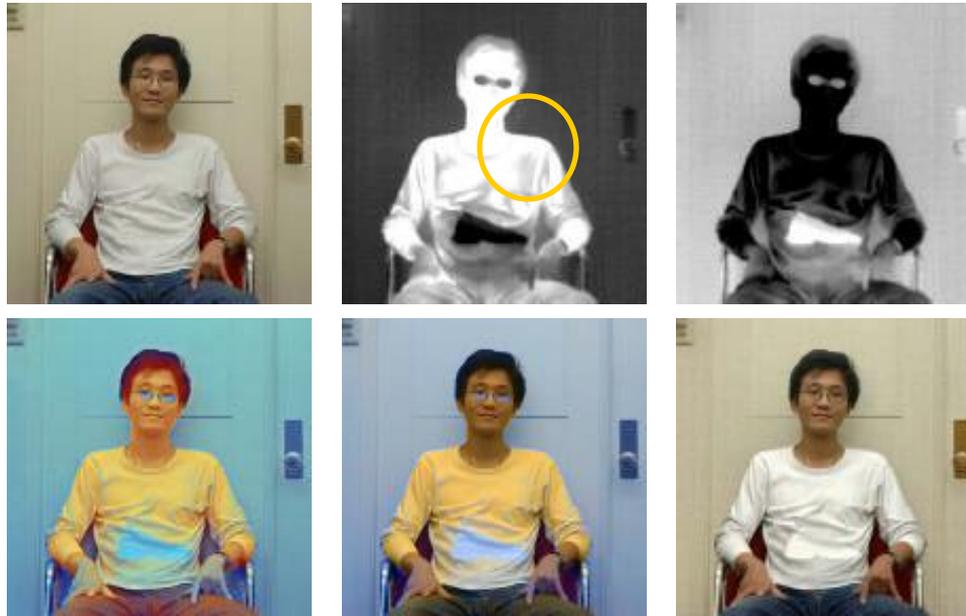


The flowchart and demo of Concealed Weapons Detection

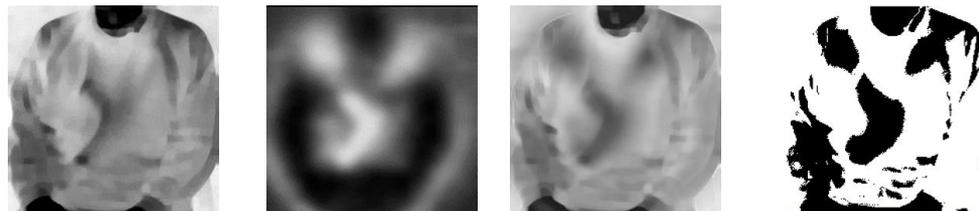
(Image source : IEEE Signal Processing Magazine 2005, Vol.22, Issue: 2, pp. 52-61. )



# 2. Experiments and Results



(a) visual image (b) infrared image (c) convert of infrared image (d) false color image  
(e) false color image2 (f) final fused image



(a) infrared image (b) millimeter microwave image (c) fused image (d) segmentation result



# 2. Experiments and Results



(a) Single target tracking and surveillance



(b) Single target tracking and surveillance under complex background

# 2.Experiments and Results



**IR Dynamic Image**



**CCD Dynamic Image**

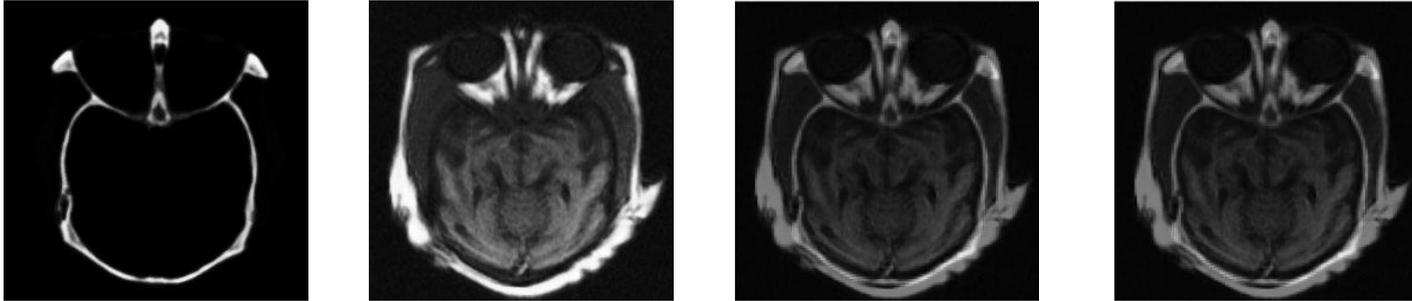


**Dynamic Image Fused Result**

(Images from TNO Human Factors Institute, The Netherlands )



# 3. Experiments and Results



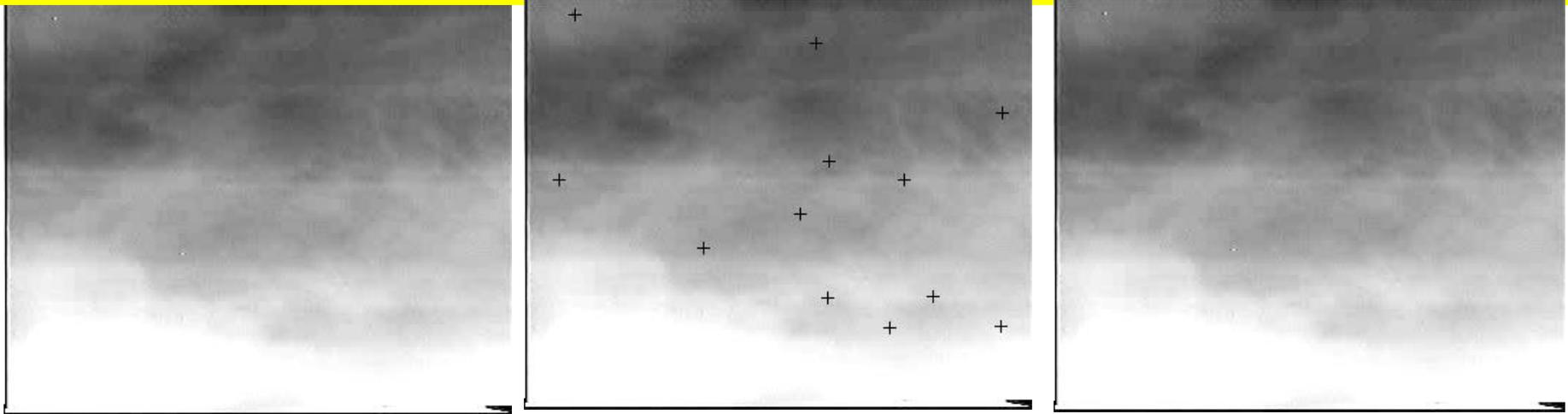
(a) CT image of skull (b) MR image of skull (c) the fusion image through weighted average means of wavelet coefficients (d) the optimizing fusion result.

**The Compare evaluation indexes for fused images**

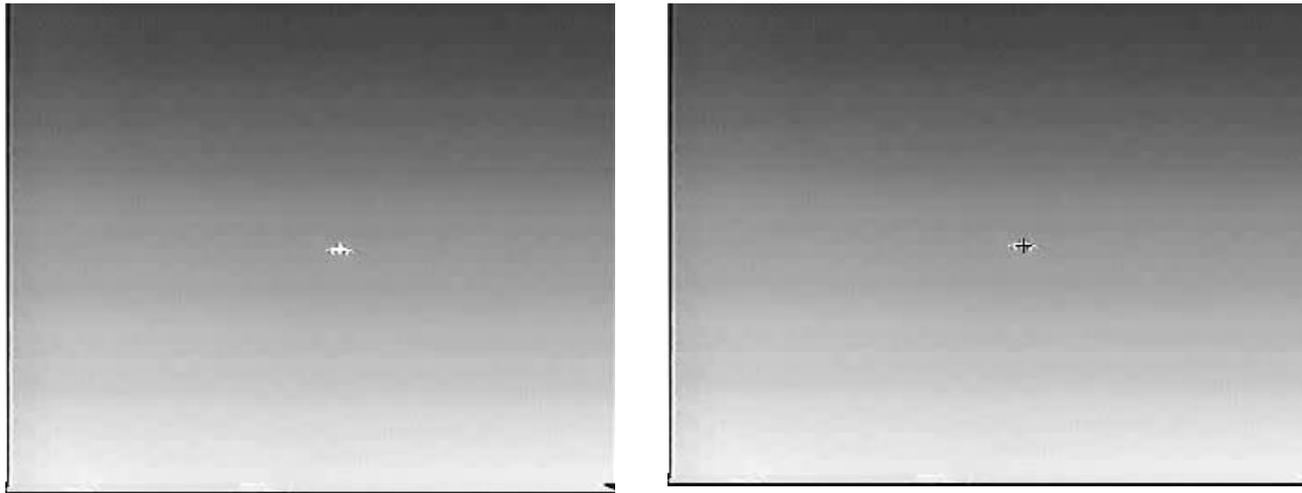
	<b>E</b>	<b>AG</b>	<b>EP</b>
<b>CT</b>	<b>2.0325</b>	<b>1.9201</b>	<b>/</b>
<b>MR</b>	<b>6.6328</b>	<b>2.8164</b>	<b>/</b>
<b>WT</b>	<b>5.9957</b>	<b>1.9524</b>	<b>0.4115</b>
<b>Optimizing fusion</b>	<b>6.3580</b>	<b>2.7968</b>	<b>0.5843</b>



# 3. Experiments and Results



**Detect and track point target (IR serial image)**



**Detect and track small target (IR serial image)**



- Thanks!
- Questions?

