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Computer Vision Seminar-1

Gradient-Based Methods in Image Processing and Motion Detection

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Introduction

- Fundamental tasks in computer vision
- Applications in robotics, autonomous vehicles, medical imaging
- Encode intensity changes in images
- Extract features like edges, shapes, and motion patterns

Background

- Early works by Roberts (1965), Prewitt (1970)
- Foundation for gradient-based methods in edge detection
- Sobel operator: simplicity and efficiency
- Canny edge detector: multi-stage algorithm for superior performance

Advanced Gradient Operators

- Steerable Filters: Adapt orientation based on local image structure
- Adaptive Thresholding Techniques: Adjust thresholds based on local image statistics
- Multi-scale Gradient Analysis: Detect edges at different levels of detail

Gradient-Based Image Enhancement

- Image Denoising: Anisotropic diffusion filtering, Total variation minimization

- Sharpening and Contrast Enhancement: Enhance high-frequency components, Improve contrast along edges

Gradient-Based Motion Detection

- Optical Flow Estimation: Calculate motion of pixels between frames
- Background Subtraction: Differentiate foreground objects from static background
- Object Tracking: Follow motion of objects over time

Deep Learning Integration

- Gradient Features in CNNs: Calculate gradients at different scales
- Gradients in Loss Functions: Guide learning by focusing on relevant features

Emerging Trends

- Real-Time Applications: Efficient algorithms for low latency processing
- Robust Detection in Challenging Environments: Techniques for poor illumination, dynamic backgrounds
- Hybrid Approaches: Combine gradient-based methods with other techniques

Conclusion

- Gradients crucial for edge detection, image enhancement, motion analysis
- Integration with deep learning promising for future advancements
- Real-time processing, robust detection, hybrid approaches, learning-based filters
- Explainable models for reliability and trust


Thank
You