Comparative study of Defogging Algorithms

Examined three defogging algorithms — CLAHE, ODCM, and Scene-Adaptive Defogger — across multiple dimensions, including performance, visual quality, and adaptability. The analysis concludes with a final verdict on their suitability for different real-world applications.

Comparative Analysis of Defogging Algorithms

Aspect	CLAHE	ODCM	Scene-Adaptive Defogger
Full Form	Contrast Limited Adaptive Histogram Equalization	Optimal Dehazing via Contrast Maximization	Scene-Adaptive CNN or Rule-based Defogger
Method Type	Traditional Image Processing	Model-Based Optimization	Data/Scene-Driven Adaptive Approach
Computational Cost	Low (Real-time capable)	Moderate	High (CNN-based or complex scene analysis)
Detail Preservation	Limited (can over-amplify noise)	Good	Excellent (context-aware enhancement)
Color Fidelity	Poor to Moderate (can oversaturate)	Good	Best (learns natural color restoration)
Edge/Depth Awareness	None	Partial (via optimization)	Strong (semantic or learned features)
Adaptability to Scene Type	No	Limited	High (adapts to fog density, depth, content)
Artifacts / Haloing	Frequent	Moderate	Minimal (well-learned filters or rules)
Best Use Case	Fast preprocessing or medical/industrial enhancement	Balanced general-purpose use	Critical vision tasks (e.g. surveillance, autonomous driving)

Performance Summary (Based on Common Benchmarks)

Metric	CLAHE	ODCM	Scene-Adaptive
PSNR	14–18 dB	18–23 dB	22–28 dB
SSIM	0.6–0.75	0.75–0.85	0.85–0.95
NIQE / No-Reference Metrics	Poor (high scores)	Fair	Low (best quality)

My Opinion

CLAHE

Pros: Fast, simple, no training required. Great for preprocessing and lightweight systems.

Cons: Not truly fog-aware; exaggerates noise and fails under dense fog. Poor visual quality in natural scenes.

ODCM

Pros: A principled, optimization-based approach. Produces visually pleasing results for moderate haze levels.

Cons: Not fully adaptive; depends on initial assumptions about scene depth or contrast models. Slower than CLAHE.

Scene-Adaptive Defogger (Best Overall)

Pros: Learns context and fog density. Provides realistic restoration with good structure and color. Can handle a wide range of visibility conditions.

Cons: Computationally expensive, needs training data or intelligent rules. Not trivial to deploy on edge devices without optimization.

Final Verdict

If you're building a real-time or embedded system with minimal compute: CLAHE is your tool.
For balanced performance and ease of use: ODCM is a solid traditional method.
For best results in visual quality and generalization, especially under varied or dense fog conditions:
Scene-Adaptive Defogger is the best algorithm.

It aligns well with modern visual applications like autonomous navigation, aerial photography, and surveillance, where scene-awareness is key. Your observation is correct — Scene-Adaptive methods win in terms of output quality, and I would recommend it for any serious image dehazing task when compute is not a bottleneck.