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Lecture 1. Perception-Driven Image Quality Measurement: Principles and Emerging Trends

Image Quality Assessment (IQA) is a cornerstone of Data Quality Assessment, enabling machines to evaluate visual information in ways that reflect human perception. Because images are routinely degraded during acquisition, processing, compression, and transmission, reliable quality measurement is essential—not only for photography and video streaming, but especially for medical imaging, where diagnostic accuracy and trust are critical. Traditional error-based metrics such as Mean Squared Error (MSE) fail to capture how humans perceive visual fidelity, motivating a shift toward perception-driven approaches.

This lecture traces the evolution of IQA from classical signal-based measures to modern bio-inspired and neuroscience-guided models that mimic how the human visual system interprets contrast, structure, and distortion. Particular emphasis is placed on single-image "blind" IQA methods, which estimate quality without a reference image—an ability vital for real-world clinical and autonomous systems. The lecture highlights recent advances that enable machines to "see" more like humans, producing accurate, efficient, and robust quality predictions across diverse imaging conditions.

Through examples from medical imaging and intelligent vision systems, the talk demonstrates how perception-driven IQA improves image reliability, supports clinical decision-making, and guides future human-centered AI technologies. It also showcases recent research achievements compared with the state of the art, offers insight into biological vision, and outlines emerging trends poised to reshape commercial and technological landscapes—revealing how bio-inspired computing is redefining visual quality assessment for the next generation of intelligent systems.

Lecture 2. Beyond the Limits: Quaternion Neural Networks for Challenging Environments

Abstract
Reliable environment perception is essential for safe autonomous driving, yet it is often degraded by illumination changes, noise, and severe weather. Fog, rain, and low-light conditions reduce image contrast and color fidelity, making critical computer-vision tasks—such as localization, semantic segmentation, and object detection—far more difficult. Traditional image-processing methods are unable to adequately remove these degradations, limiting the reliability of surveillance, navigation, and autonomous systems. This creates an urgent need for more robust and intelligent approaches to image enhancement and scene understanding under adverse conditions.

Although significant advances have been made in weather monitoring and forecasting, major gaps remain in translating this knowledge into practical, real-time decision support for safety-critical systems. These gaps can be addressed by improving how weather-affected visual data are modeled, analyzed, and integrated into perception pipelines.

This talk introduces **Quaternion Neural Networks (QNNs)** as a powerful new framework for weather-robust visual perception. Operating in a four-dimensional quaternion space, QNNs naturally capture correlations between color channels and spatial structures, enabling richer representations with fewer parameters and reduced overfitting. The talk will present the fundamentals of quaternion convolution and modern QNN transformers, and demonstrate their effectiveness for scene restoration, segmentation, and object detection in foggy, rainy, and cloudy environments. Attendees will see how QNN-based models consistently outperform conventional real-valued networks in restoring visibility and improving perception reliability for autonomous and intelligent systems.