

Avis de soutenance de thèse de Doctorat

Le Directeur de l'École Nationale des Sciences Appliquées de Khouribga annonce que :

Madame Hind Hafsi

Soutiendra publiquement sa thèse de Doctorat

Le Mardi 23 Juin 2026 à 10h à l'amphithéâtre de conférence de l'ENSA Khouribga

Intitulé de la thèse:

PLUG-AND-PLAY HYBRID LEARNING, DIRECTIONAL REGULARIZATION, AND COPULA MODELING FOR COMPLEX DEGRADATIONS

Devant le jury composé de :

Nom et Prénom	Grade	Établissement	Fonction
Pr. HAFIDI Imad	PES	Université Sultan Moulay Slimane, ENSA Khouribga	Président
Pr. NACHAOUI Mourad	PES	Université Sultan Moulay Slimane, FST Beni Mellal	Rapporteur
Pr. IZEM Nouh	PES	Université Ibn Zohr, Faculté des Sciences Agadir	Rapporteur
Pr. LACHGAR Mohamed	MCH	Université Cadi Ayyad, ENS Marrakech	Rapporteur
Pr. AFRAITES Lakbir	PES	Université Sultan Moulay Slimane, FST Beni Mellal	Examineur
Pr. ABOUTABIT Nouredine	PES	Université Sultan Moulay Slimane, ENSA Khouribga	Examineur
Pr. GHAZDALI Abdelghani	MCH	Université Sultan Moulay Slimane, ENSA Khouribga	Directeur de thèse

Résumé de la thèse

Modern imaging systems routinely produce observations corrupted by noise, blur, limited resolution, and other acquisition-related degradations that impair fine structures and compromise the reliability of subsequent analysis. These difficulties are substantially compounded when the degradation is statistically heterogeneous, partly signal-dependent, or governed by several simultaneously acting mechanisms—as in mixed Poisson–Gaussian noise encountered in fluorescence microscopy, clinical MRI, and photon-limited photography, or in inverse problems involving blur and downsampling. Addressing such settings requires restoration models that faithfully represent the statistical complexity of the degradation while preserving the geometric and structural content of the image. This thesis develops three progressive contributions within a unified inverse-problem perspective. The first contribution addresses mixed Poisson–Gaussian denoising through a dependency-aware two-stage framework: a Directional Total Variation (DTV) regularization stage via ADMM attenuates the additive Gaussian component while preserving oriented structures, followed by semiparametric copula-based Blind Source Separation whose family is selected adaptively by the Bayesian Information Criterion, separating the residual Poisson-related component without the restrictive independence assumptions of classical ICA. The second contribution extends this framework to medical imaging by introducing Structure-Adaptive Directional Total Variation (SA-DTV), in which a positive semi-definite anisotropy tensor derived from the local structure tensor modulates regularization according to local coherence and dominant orientation, preserving clinically relevant structures such as sulci, white-matter fibres, and vessel boundaries more faithfully than isotropic or fixed-direction alternatives. The third contribution broadens the scope to general inverse problems—denoising, deblurring, and single-image super-resolution—by introducing ARANet, a hybrid channel–frequency attention network embedded within a plug-and-play optimization-inspired framework. Trained once as a Gaussian denoiser, the same ARANet checkpoint is reused across tasks by adapting only the data-fidelity operator, demonstrating its effectiveness as a transferable learned prior. Experiments on synthetic and real images—covering BSD, Kodak24, Urban100, SIDD smartphone noise, Radiopaedia clinical MRI, and standard deblurring and super-resolution benchmarks—confirm competitive or state-of-the-art performance across the three contributions, while maintaining interpretability and principled grounding in inverse-problem theory.

Mots-clés : Image restoration · mixed Poisson–Gaussian noise · copula modeling · blind source separation · directional total variation · structure-adaptive regularization · MRI denoising · plug-and-play framework · hybrid attention network · image deblurring · single image super-resolution · inverse problems.