Denoising of Optical Coherence Tomography Images in Ophthalmology using deep learning: A systematic review

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Table S1

TABLE S1: LIST OF EXCLUDED STUDIES AND THE REASONS

Author, Year	Title	Reason
Dong, 2020 [1]	Optical coherence tomography image denoising using a generative adversarial network with speckle modulation	The dataset and the splitting procedure were not explained
Liu, 2021 [2]	Axial and horizontal registration guided speckle suppression in single-line HD mode for retinal optical coherence tomography images	Did not use any deep learning approaches
Cheng, 2021 [3]	Robust three-dimensional registration on optical coherence tomography angiography for speckle reduction and visualization	
Cheong, 2020 [4]	DeshadowGAN: A Deep Learning Approach to Remove Shadows from Optical Coherence Tomography Images	The dataset and the splitting procedure were not explained
Liu, 2017 [5]	Patch-based denoising method using low-rank technique and targeted database for optical coherence tomography image	Did not use any deep learning approaches
Daneshmand, 2021 [6]	Reconstruction of Optical Coherence Tomography Images Using Mixed Low Rank Approximation and Second Order Tensor Based Total Variation Method	
Samieinasab, 2020 [7]	Multivariate Statistical Modeling of Retinal Optical Coherence Tomography	
Hu, 2020 [8]	Noise Redistribution and 3D Shearlet Filtering for Speckle Reduction in Optical Coherence Tomography	
Fang, 2012 [9]	Sparsity based denoising of spectral domain optical coherence tomography images	
Chen, 2021 [10]	Optical coherence tomographic image denoising based on Chi-square similarity and fuzzy logic	
Liu, 2020 [11]	Using a dual-tree complex wavelet transform for denoising an optical coherence tomography angiography blood vessel image	
Gomez-Valverde, 2021 [12]	Adaptive compounding speckle-noise-reduction filter for optical coherence tomography images	
Esmaeili, 2020 [13]	Three-dimensional curvelet-based dictionary learning for speckle noise removal of optical coherence tomography	
Yu, 2022 [14]	A noise statistical distribution analysis-based two-step filtering mechanism for optical coherence tomography image despeckling	
Smitha, 2021 [15]	A nonlocal deep image prior model to restore optical coherence tomographic images from gamma distributed speckle noise	The dataset and the splitting procedure were not explained
Chen, 2021 [16]	Fusion denoising algorithm of optical coherence tomography image based on point-estimated and block-estimated	Did not use any deep learning approaches

Fan, 2020 [17]	OCT Image Restoration Using Non-Local Deep Image Prior	The outcome of the model was not adequately reported
Jorjandi, 2021 [18]	Statistical modeling of retinal optical coherence tomography using the Weibull mixture model	Did not use any deep learning approaches
Paul, 2019 [19]	Speckle Removal Using Diffusion Potential for Optical Coherence Tomography Images	
Wong, 2010 [20]	General Bayesian estimation for speckle noise reduction in optical coherence tomography retinal imagery	
Cheng, 2016 [21]	Speckle Reduction in 3D Optical Coherence Tomography of Retina by A-Scan Reconstruction	
Thapa, 2015 [22]	Reduction of speckle noise from optical coherence tomography images using multi-frame weighted nuclear norm minimization method	
Bian, 2015 [23]	Multiframe denoising of high-speed optical coherence tomography data using interframe and intraframe priors	
Cheng, 2015 [24]	Speckle reduction in optical coherence tomography by matrix completion using bilateral random projection	
Karri, 2016 [25]	Simultaneous reconstruction and restoration of sparsely sampled optical coherence tomography image through learning separable filters for deep architectures	The outcome of the model was not adequately reported
Lv, 2018 [26]	Speckle noise reduction of multi-frame optical coherence tomography data using multi-linear principal component analysis	Did not use any deep learning approaches
Cheng, 2019 [27]	Pixel Reconstruction For Speckle Reduction In 3D Optical Coherence Tomography Of Retina	
Yoo, 2019 [28]	Adaptive Weighted Nuclear Norm Minimization for Removing Speckle Noise from Optical Coherence Tomography Images	
Husvogt, 2021 [29]	Maximum a posteriori signal recovery for optical coherence tomography angiography image generation and denoising	
Chitchian, 2012 [30]	Retinal optical coherence tomography image enhancement via shrinkage denoising using double-density dual-tree complex wavelet transform	
Kopriva, 2016 [31]	Enhanced low-rank + sparsity decomposition for speckle reduction in optical coherence tomography	
Hu, 2019 [32]	Selective retinex enhancement based on the clustering algorithm and block-matching 3D for optical coherence tomography images	
Huang, 2021 [33]	Image Noise Recognition Algorithm Based on Improved DenseNet	The outcome of the model was not adequately reported
Hu, 2022 [34]	Unsupervised denoising of retinal OCT with diffusion probabilistic model	Did not use any deep learning approaches
Yan, 2020 [35]	Speckle reduction of OCT via super resolution reconstruction and its application on retinal layer segmentation	
Gupta, 2022 [36]	A De-Speckling Framework for Optical Coherence Tomography Images	
Huang, 2020 [37]	Both speckle reduction and contrast enhancement for optical coherence tomography via sequential optimization in the logarithmic domain based on a refined Retinex model	
Hu, 2021 [38]	Noise reduction by adaptive-SIN filtering for retinal OCT images	
Li, 2021 [39]	Speckle noise removal based on structural convolutional neural networks with feature fusion for medical image	The dataset and the splitting procedure were not explained

P.S, 2022 [40]	Despeckling of OCT images using DT-CWT based fusion technique	Did not use any deep learning approaches
Amini, 2019 [41]	Speckle Noise Reduction and Enhancement for OCT Images	
Yu, 2021 [42]	A two-step filtering mechanism for speckle noise reduction in OCT images	
Guo, 2020 [43]	Deep OCT image compression with convolutional neural networks	The dataset and the splitting procedure were not explained and the outcome of the model was not adequately reported
Wu, 2020 [44]	Cooperative Low-Rank Models for Removing Stripe Noise From OCTA Images	Did not use any deep learning approaches
Das, 2021 [45]	A diagnostic information based framework for super-resolution and quality assessment of retinal OCT images	
Schirrmacher, 2017 [46]	QuaSI: Quantile Sparse Image Prior for Spatio-Temporal Denoising of Retinal OCT Data	
Huang, 2021 [47]	Cluster-based filtering framework for removing speckles with structural protection in OCT images	
Yoo, 2020 [48]	CycleGAN-based deep learning technique for artifact reduction in fundus photography	The dataset and the splitting procedure were not explained and the outcome of the model was not adequately reported
Dong, 2020 [49]	Optical coherence tomography image de-noising using a generative adversarial network with speckle modulation	The dataset and the splitting procedure were not explained
Xu, 2021 [50]	Enhanced Visualization of Retinal Microvasculature via Deep Learning on OCTA Image Quality	The dataset and the splitting procedure were not explained and the outcome of the model was not adequately reported
Menon, 2019 [51]	A Novel Deep Learning Approach for the Removal of Speckle Noise from Optical Coherence Tomography Images Using Gated Convolution–Deconvolution Structure	The dataset and the splitting procedure were not explained
Gisbert, 2020 [52]	Self-supervised Denoising via Diffeomorphic Template Estimation: Application to Optical Coherence Tomography	The dataset and the splitting procedure were not explained and the outcome of the model was not adequately reported

Table S2

TABLE S2: RISK-OF-BIAS ASSESSMENT OF PAPERS REVIEWED

Author, Year	Reference	D1	D2	D3	D4
Devalla, 2019	53				

Cheong, 2021	54				
Tian, 2020	55				
Hu, 2020	56				
Akter, 2020	57				
Halupka, 2018	58				
Wei, 2018	59				
Chen, 2020	60				
Gour, 2020	61				
Hassan, 2021	62				
Ma, 2018	63				
Guo, 2020	64				
Qiu, 2020	65				
Huang, 2021	66				
Halupka, 2018	67				
Qiu, 2021	68				
Abassi, 2019	69				
Kande, 2020	70				
Qiu, 2020	71				
Shi, 2019	72				
Huang, 2020	73				
Yu, 2018	74				
Tajmirriahi, 2021	75				
Sengupta, 2021	76				
Mehdizadeh, 2021	77				
Cai, 2018	78				
Zhou, 2022	79				
Anoop, 2021	80				
Fu, 2021	81				

Wang, 2021	82				
Zhou, 2022	83				
Zhou, 2021	84				
Wu, 2021	85				
Das, 2020	86				
Huang, 2019	87				
Ge, 2022	88				
Ma, 2022	89				
Xie, 2022	90				
Xie, 2023	91				
Ahmed, 2022	92				
Ahmed, 2022	93				
Ahmed, 2022	94				
Zhou, 2023	95				

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