Supplementary Material for Deep 3D Dual Path Nets for Automated Pulmonary Nodule Detection and Classification

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1. Detailed network structure for 3D Faster R-CNN with Deep 3D Dual Path Net in Nodule Detection

The encoder network is adapted from DPN92 directly by changing 7×7 filters into 3×3 [1]. The numbers of blocks are changed from 3, 4, 20, 3 to 2, 2, 2, 2. The decoder network is to make the network symmetric. The stride 2 of 3D convolution is added in the first 3×3×3 convolution in each block.

Stage	Output	Weights
Pre-dual path	96×96×96, 24	3×3×3, 24
Dual path block 1	48×48×48, 48	1×1×1, 24 3×3×3, 24, (stride 2) ×2 1×1×1, 32
Dual path block 2	24×24×24, 72	1×1×1, 48 3×3×3, 48, (stride 2) ×2 1×1×1, 56
Dual path block 3	12×12×12, 96	1×1×1, 72 3×3×3, 72, (stride 2) ×2 1×1×1, 80
Dual path block 4	6×6×6, 120	1×1×1, 96 3×3×3, 96, (stride 2) ×2 1×1×1, 104
Deconv. 1	12×12×12, 216	2×2×2, 216
Dual path block 5	12×12×12, 152	1×1×1, 128 3×3×3, 128 ×2 1×1×1, 136
Deconv. 2	24×24×24, 224	2×2×2, 152
Dual path block 6	24×24×24, 248	1×1×1, 224 3×3×3, 224 ×2 1×1×1, 232
Output	24×24×24, 3×5	Dropout, p=0.5 1×1×1, 64 1×1×1, 15

2. Detailed network structure for 3D Faster R-CNN with Deep 3D Residual Network in Nodule Detection

The encoder network is adapted from Res18 directly by changing 7×7 filters into 3×3 [2]. We find the latest reference for 3D Res18 network in [3], and will add it into the reference.

Stage	Output	Weights
Pre-Residual	96×96×96, 24	3×3×3, 24 3×3×3, 24
Residual block 1	48×48×48, 32	3×3×3, 32 3×3×3, 32, (stride 2) ×2
Residual block 2	24×24×24, 64	3×3×3, 64 3×3×3, 64, (stride 2) ×2
Residual block 3	12×12×12, 64	3×3×3, 64 3×3×3, 64, (stride 2) ×3
Residual block 4	6×6×6, 64	3×3×3, 64 3×3×3, 64, (stride 2) ×3
Deconv. 1	12×12×12, 128	2×2×2, 64
Residual block 5	12×12×12, 64	3×3×3, 64 3×3×3, 64 ×3
Deconv. 2	24×24×24, 128	2×2×2, 64
Residual block 6	24×24×24, 64	3×3×3, 64 3×3×3, 64 ×3
Output	24×24×24, 3×5	Dropout, p=0.5 1×1×1, 64 1×1×1, 15

3. Detailed network structure for Deep 3D Dual Path Net in Nodule Classification

We design 3D dual path network with 92 layers for nodule classification.

Stage	Output	Weights
Pre-dual path	32×32×32, 64	3×3×3, 64
Dual path	32×32×32, 320	1×1×1, 96

block 1		3×3×3, 96, (stride 2) ×3 1×1×1, 272
Dual path block 2	16×16×16, 672	$\left\{\begin{array}{l}1\times1\times1, 192\\3\times3\times3, 192, \text{(stride 2)}\\1\times1\times1, 544\end{array}\right\}\times4$
Dual path block 3	8×8×8, 1528	$\left\{\begin{array}{l}1\times1\times1, 384\\3\times3\times3, 72, \text{(stride 2)}\\1\times1\times1, 1048\end{array}\right\}\times20$
Dual path block 4	4×4×4, 2560	$\left\{\begin{array}{l}1\times1\times1, 768\\3\times3\times3, 768, \text{(stride 2)}\\1\times1\times1, 2176\end{array}\right\}\times3$
Output	2560 2	3D average pool 2560×2

References

[1] Y. Chen, J. Li, H. Xiao, X. Jin, S. Yan, and J. Feng. "Dual path networks." In Advances in Neural Information Processing Systems, pp. 4468-4476. 2017.

[2] K. He, X. Zhang, S. Ren, and J. Sun. "Deep residual learning for image recognition." In Proceedings of the IEEE conference on computer vision and pattern recognition, pp. 770-778. 2016.

[3] F. Liao, M. Li, Z. Li, X. Hu, and S. Song. "Evaluate the Malignancy of Pulmonary Nodules Using the 3D Deep Leaky Noisy-or Network." arXiv preprint arXiv:1711.08324 (2017).