

Table of Contents

1. Introduction	1
1.1. Introduction	1
1.2. The Quality Assurance Problem	2
1.2.1. Quality Assurance Factors	3
1.2.1.1. Radiation Penetration	3
1.2.1.2. Patient Rotation	4
1.2.1.3. Lung Insufflation	4
1.3. The Architectural Background	5
1.3.1. A Brief Explanation of Deep Learning	5
1.3.1.1. Linear Layer	6
1.3.1.2. Learning? No, Optimization	6
1.3.2. Convolutional Neural Networks	7
1.3.2.1. The Convolution Layer	7
1.3.2.2. The Residual Block	8
1.3.3. Attentional Models	9
1.3.3.1. The Attention Block	9
1.3.4. The Segmentation Problem	10
1.4. Base Models	11
1.4.1. U-Net	11
1.4.2. ResNet	12
1.4.2.1. ResNet Architectures	12
1.4.3. Swin Transformer	13
1.4.3.1. SW-MSA Module	13
1.4.3.2. Swin Block Architecture	14
1.4.4. BoTNet: Bottleneck Transformers	15
1.4.4.1. BoTNet Multi-Head Self Attention Module	15
1.5. Loss Functions and Metrics	16
1.5.1. Dice-Sørensen Score	16
1.5.2. Cross-Entropy Loss	17
2. Related Work	18
2.1. Image Segmentation	18
2.2. Chest X-Ray Structure Segmentation	19
2.3. Quality Assurance Models	20
3. U-Net Models for Thorax Segmentation	23
3.1. Blocks	23

3.1.1. Three Head Attention Block	23
3.1.2. Spatial Attention Block	23
3.1.3. Spatial Multi-Head Cross Attention Block	25
3.2. Architectures	26
3.2.1. U-Net	26
3.2.2. Encoder Variations	26
3.2.3. Skip Layer Variations	26
3.2.4. Decoder Variations	26
4. Data and Image Preprocessing for Thorax Segmentation in U-Net Models	28
4.1. Datasets	28
4.1.1. JSRT Dataset	28
4.1.2. Montgomery County TB Dataset	28
4.1.3. Shenzhen TB Dataset	28
4.1.4. VinDr-RibCXR Dataset	29
4.1.5. PadChest	29
4.2. Image Preprocessing	29
4.2.1. Resizing	29
4.2.2. Contrast and Histogram Equalization	29
4.2.3. Data Augmentation	29
5. Supervised Training Methods for U-Net Models in Thorax Segmentation	31
5.1. Training Methodology	31
5.1.1. Evaluation	31
5.2. Result Analysis	31
5.2.1. Encoder Variations	31
5.2.2. Skip Layer Variations	33
5.2.3. Decoder Variations	33
6. Quality Assurance Determination Based on Semantic Chest Structures Segmentation	36
6.1. Centered Image and Segmentation Pre-Check	36
6.2. Patient Rotation	36
6.3. Lung Insufflation	38
6.4. Radiation Penetration	40
6.5. Result Analysis	42
7. Conclusions and Discussion	47
7.1. Discussion	47
7.1.1. U-Net Based Chest X-Ray Image Segmentation	47
7.1.2. Quality Assurance Determination for Chest X-Ray Imaging	48
7.2. Ongoing Work	48
7.3. Future Work	48
Bibliography	50
ANNEXES	53
A. Additional Results	53

A.1.	Visualization of Cases	53
A.1.1.	Image Sample	53
A.1.2.	Complex Cases in Lung Segmentation	53
A.1.3.	Heart Segmentation Sample	54
A.1.4.	Rib Segmentation Sample	55
A.1.5.	Clavicle Segmentation Sample	55
B.	Architecture Representations	55
B.1.	UNet	56
B.2.	ResNet-UNet	56
B.3.	Swin-UNet	56
B.4.	Three Head Attention U-Net	57
B.5.	Spatial Attention U-Net	57
B.6.	Double Spatial Attention U-Net	57
B.7.	Full Spatial Attention U-Net	58
B.8.	Spatial Decoder U-Net	58