

제 06회 담낭 용종 연구 보고

2020.12.28



이미지 유형 사전 실험 세팅

➤ 데이터 구성

- 109명의 환자 데이터
- Neoplastic : 30명, Non-neoplastic : 79명

➤ Train & Test Set

- 1,151장의 데이터셋
- Train Set : 87명(959장)
- Test Set : 22명(192장)

➤ Input Image

- Outline, Inline, Polyp, 담낭벽, 담낭벽+Polyp 각 이미지 유형으로 실험

➤ 모델 구성

- GoogleNet
- ResNext

➤ 30번 반복 실험

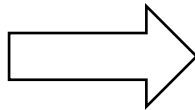
Experiment Settings

Original Image

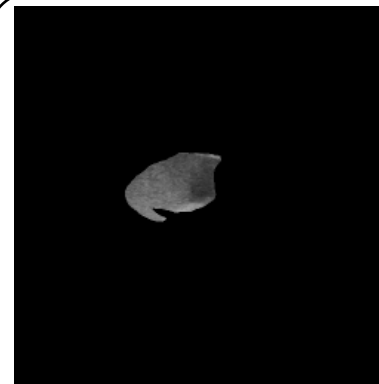


516 X 873

Resize Image
&
Cropped Image



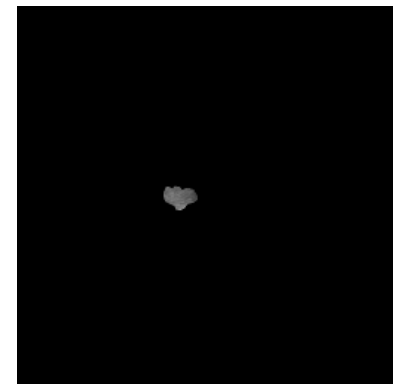
Input Image



Outline



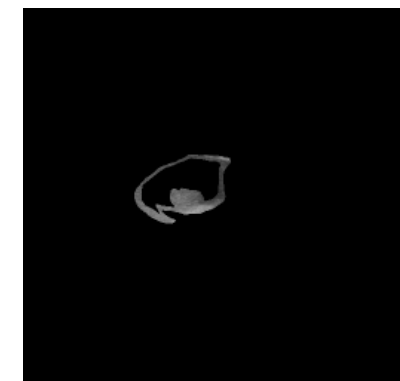
Inline



Polyp



담낭벽



담낭벽+Polyp

256 X 256

GoogleNet Classification Performance Table

Table . Metrics with 95% confidence interval of five Images (▼/△ indicates that the corresponding method is significantly worse/better than GoogleNet_outline based on paired t-test at 5% significance level).

Image	Metrics	AUC Mean	95% CI		p-value
			Lower	Upper	
Outline	AUC	0.784	0.766	0.802	
	Accuracy	0.707	0.665	0.749	
	Sensitivity	0.454	0.335	0.553	
	Specificity	0.829	0.751	0.907	
Inline	AUC	0.745	0.721	0.769	0.087
	Accuracy	0.683	0.634	0.732	0.555
	Sensitivity	0.364	0.229	0.499	0.452
	Specificity	0.802	0.696	0.908	0.740
Polyp	AUC	0.798	0.773	0.823	0.475
	Accuracy	0.714	0.681	0.747	0.832
	Sensitivity	0.526	0.419	0.633	0.423
	Specificity	0.804	0.732	0.876	0.704
담낭벽	AUC	0.751	0.726	0.776	0.137
	Accuracy	0.676	0.640	0.712	0.387
	Sensitivity	0.477	0.360	0.594	0.764
	Specificity	0.763	0.681	0.845	0.370
담낭벽+Polyp	AUC	0.786	0.767	0.805	0.901
	Accuracy	0.660	0.601	0.719	0.324
	Sensitivity	0.499	0.382	0.616	0.606
	Specificity	0.738	0.625	0.851	0.315

AUC, area under the curve; CI, confidence interval; NN, neural network. *: p-value < 0.01, **: p-value < 0.001

ResNext Classification Performance Table

Table . Metrics with 95% confidence interval of five Images (▼/△ indicates that the corresponding method is significantly worse/better than ResNext_outline based on paired t-test at 5% significance level).

Image	Metrics	AUC Mean	95% CI		p-value	
			Lower	Upper		
Outline	AUC	0.722	0.700	0.744		
	Accuracy	0.665	0.629	0.701		
	Sensitivity	0.350	0.259	0.441		
	Specificity	0.826	0.756	0.896		
Inline	AUC	0.707	0.691	0.723	0.394	
	Accuracy	0.703	0.671	0.735	0.244	
	Sensitivity	0.124	0.082	0.166	0.017	▼
	Specificity	0.968	0.954	0.982	0.026	△
Polyp	AUC	0.692	0.671	0.713	0.163	
	Accuracy	0.709	0.683	0.735	0.161	
	Sensitivity	0.185	0.117	0.253	0.066	
	Specificity	0.938	0.907	0.969	0.064	
담낭벽	AUC	0.660	0.634	0.686	0.034	▼
	Accuracy	0.691	0.660	0.722	0.397	
	Sensitivity	0.146	0.089	0.203	0.030	▼
	Specificity	0.930	0.899	0.961	0.078	
담낭벽+Polyp	AUC	0.644	0.626	0.662	0.009	*▼
	Accuracy	0.676	0.644	0.708	0.713	
	Sensitivity	0.071	0.038	0.104	0.008	*▼
	Specificity	0.961	0.942	0.980	0.032	△

AUC, area under the curve; CI, confidence interval; NN, neural network. *: p-value < 0.01, **: p-value < 0.001

이미지 유형 사전 실험 결과

➤ 유망한 네트워크 구조

- GoogleNet > ResNext

➤ 유망한 이미지 유형

- | | |
|------------------|------------------|
| • GoogleNet : | • ResNext : |
| 1순위) Polyp | 1순위) Outline |
| 2순위) Outline | 2순위) Inline |
| 3순위) 담낭벽 + Polyp | 3순위) Polyp |
| 4순위) Inline | 4순위) 담낭벽 |
| 5순위) 담낭벽 | 5순위) 담낭벽 + Polyp |

➤ 사전 실험 결과에 따른 향후 모형

- GoogleNet 모듈 사용
- Outline, Inline, Polyp, 담낭벽 + Polyp 유형 사용

파이프 라인 사전 실험 세팅

➤ Input Image

- Outline, Inline, Polyp, 담낭벽+Polyp 이미지 유형 사용

➤ 모델 구성

- GoogleNet – Pipeline 1 & 2
- ResNext – Pipeline 1 & 2

➤ Pipeline 1

- 각 이미지 유형별 CNN Classifier 결과를 Meta_Info(나이, 성별)와 결합
- Fully-Connected Layer 통해 판별

➤ Pipeline 2

- 이미지 유형들을 각 채널로 구성하여 하나의 Input Image로 구성
- CNN Classifier 결과와 Meta_Info를 결합 하여 FC Layer 통해 판별

➤ 30번 반복 실험

GoogleNet vs ResNext in Pipeline 1

Table . Metrics with 95% confidence interval of two NNs (▼/△ indicates that the corresponding method is significantly worse/better than GoogleNet Pipeline 1 based on paired t-test at 5% significance level).

Model	Metrics	AUC Mean	95% CI		p-value	
			Lower	Upper		
GoogleNet Pipeline 1	AUC	0.837	0.812	0.862		
	Accuracy	0.725	0.682	0.768		
	Sensitivity	0.651	0.545	0.757		
	Specificity	0.733	0.635	0.831		
ResNext Pipeline 1	AUC	0.763	0.735	0.791	0.027	▼
	Accuracy	0.734	0.710	0.758	0.767	
	Sensitivity	0.401	0.323	0.479	0.030	▼
	Specificity	0.877	0.841	0.913	0.075	

AUC, area under the curve; CI, confidence interval; NN, neural network. *: p-value < 0.01, **: p-value < 0.001

GoogleNet vs ResNext in Pipeline 2

Table . Metrics with 95% confidence interval of two NNs (▼/△ indicates that the corresponding method is significantly worse/better than GoogleNet Pipeline 2 based on paired t-test at 5% significance level).

Model	Metrics	AUC Mean	95% CI		p-value	
			Lower	Upper		
GoogleNet Pipeline 2	AUC	0.792	0.761	0.823		
	Accuracy	0.697	0.657	0.737		
	Sensitivity	0.434	0.309	0.559		
	Specificity	0.801	0.709	0.893		
ResNext Pipeline 2	AUC	0.718	0.679	0.757	0.043	▼
	Accuracy	0.688	0.652	0.724	0.786	
	Sensitivity	0.087	0.047	0.127	0.010	▼
	Specificity	0.948	0.912	0.984	0.062	

AUC, area under the curve; CI, confidence interval; NN, neural network. *: p-value < 0.01, **: p-value < 0.001

Pipeline 1 vs Pipeline 2

Table . Metrics with 95% confidence interval of three NNs (▼/△ indicates that the corresponding method is significantly worse/better than GoogleNet Pipeline 1 based on paired t-test at 5% significance level).

Model	Metrics	AUC Mean	95% CI		p-value	
			Lower	Upper		
GoogleNet Pipeline 1	AUC	0.837	0.812	0.862		
	Accuracy	0.725	0.682	0.768		
	Sensitivity	0.651	0.545	0.757		
	Specificity	0.733	0.635	0.831		
ResNext Pipeline 1	AUC	0.763	0.735	0.791	0.027	▼
	Accuracy	0.734	0.710	0.758	0.767	
	Sensitivity	0.401	0.323	0.479	0.030	▼
	Specificity	0.877	0.841	0.913	0.075	
GoogleNet Pipeline 2	AUC	0.792	0.761	0.823	0.122	
	Accuracy	0.697	0.657	0.737	0.455	
	Sensitivity	0.434	0.309	0.559	0.084	
	Specificity	0.801	0.709	0.893	0.430	
ResNext Pipeline 2	AUC	0.718	0.679	0.757	0.009	*▼
	Accuracy	0.688	0.652	0.724	0.317	
	Sensitivity	0.087	0.047	0.127	0.001	*▼
	Specificity	0.948	0.912	0.984	0.023	△

AUC, area under the curve; CI, confidence interval; NN, neural network. *: p-value < 0.01, **: p-value < 0.001

파이프 라인 사전 실험 결과

➤ 유망한 네트워크 구조

- GoogleNet > ResNext

➤ 유망한 파이프 라인

- 파이프 라인 1 > 파이프 라인 2

제안하는 파이프 라인 설명

➤ 파이프 라인 2에 파이프 라인 1의 구조를 녹여내는 구조

- 갑상선 연구에서 사용했던 Axial, Coronal, Sagittal을 각각 처리하는 모듈 방식을 차용
- Outline, Inline, Polyp, 담낭벽+Polyp을 각각 처리하는 모듈로 구성

➤ 모듈 구성

- 각 이미지 유형에 적합한 filter size와 Inception 모듈 사용

