

A-EnLN

(Adaptive Enhancement Local Normalization)

ISL
안재원

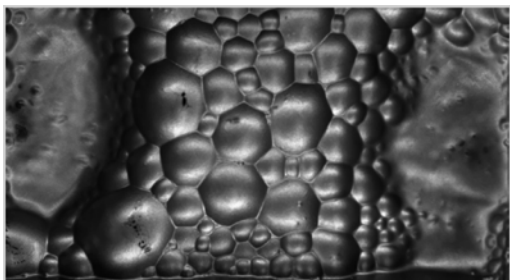
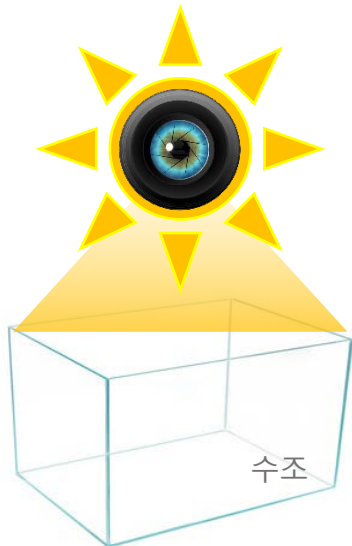
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Intro(Local Normalization)

거품의 경계 검출

- 밝기 기반의 경계 검출



- 거품 영상과 Sobel operation 예시 영상.

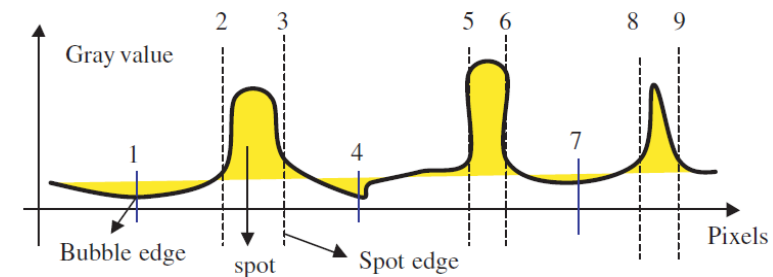
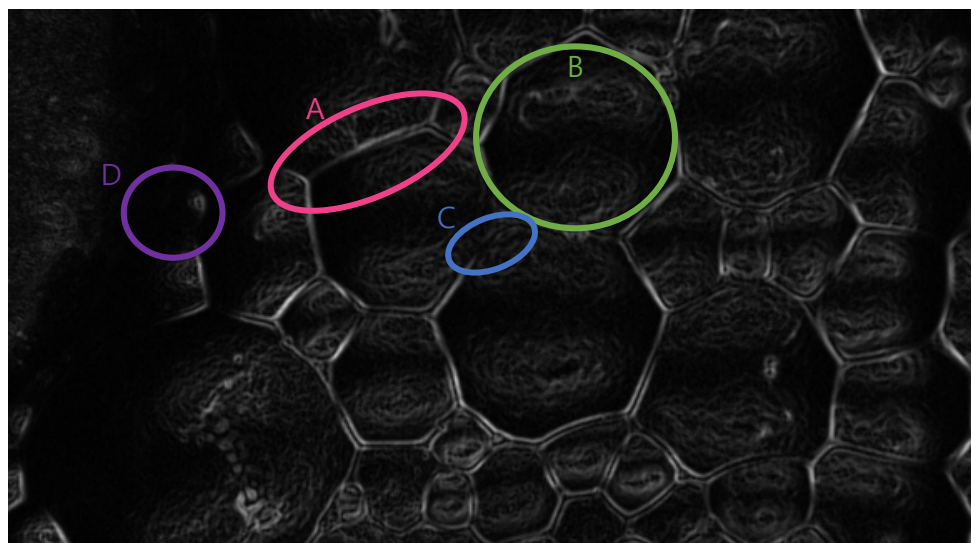
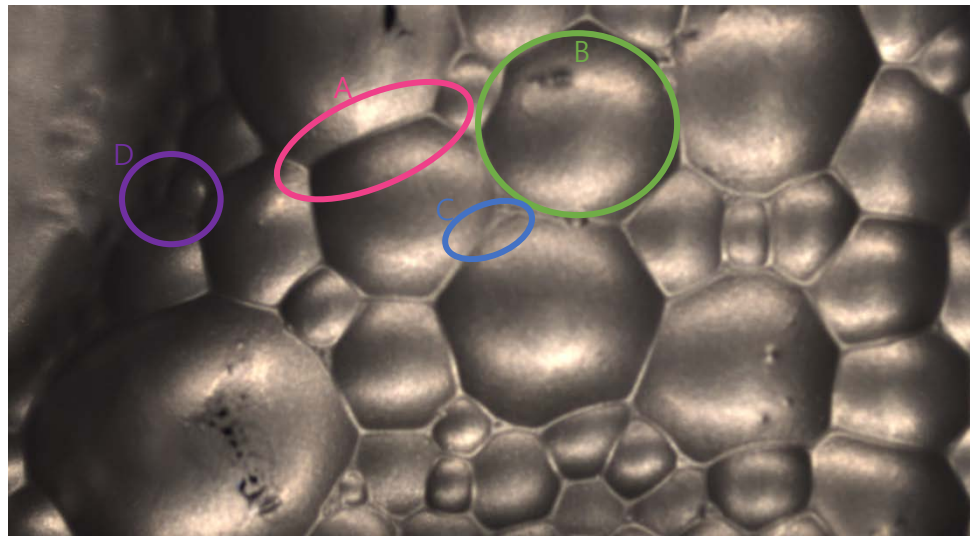


Fig. 6. Gray value versus pixels of a cross-section of a froth image.

- A : 거품의 경계가 검출된다.
- B : 조명 성분에 의한 노이즈를 확인 할 수 있다.
- C : 변화폭이 작아 경계가 명확하지 않다.
- D : 어두운 부분의 경계 검출은 힘들다.

Intro(Local Normalization)

Local Normalization ※ Xie, Xudong, et al. "An efficient illumination normalization method for face recognition." *Pattern Recognition Letters*(2006)

- Local normalization



- 외부 조명에 상관 없이 촬영된 대상의 윤곽 정보(Gradient)를 획득할 수 있다.
- 노이즈가 포함된 결과가 얻어진다.
- 노이즈는 평균과 분산을 구하는 영역의 크기에 영향을 받는다.

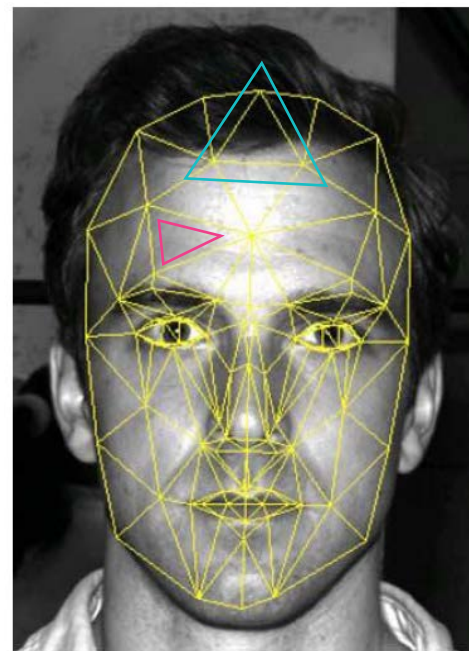


- 구역별로 Normalization을 진행하기 때문에 구역의 크기에 영향을 받는다.

Good?

$$I_p(x, y) = \frac{I(x, y) - E(I(x, y))}{\sigma(I(x, y))}$$

- CANDIDE-3 model



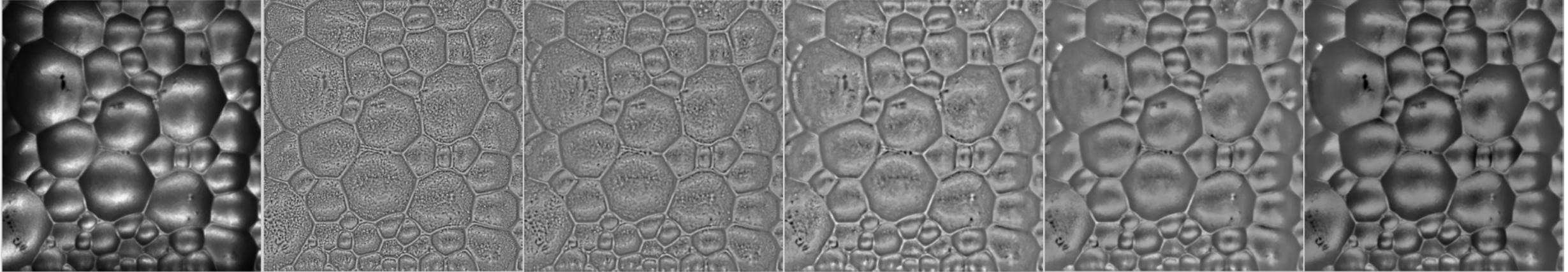
- A : 적절한 크기
- B : 마스크 영역이 작은 경우
- C : 마스크 영역이 큰 경우

- 평균과 분산 값의 신뢰성 문제

Intro(Local Normalization)

Local Normalization

- 거품 영상의 Local normalization



원본 영상

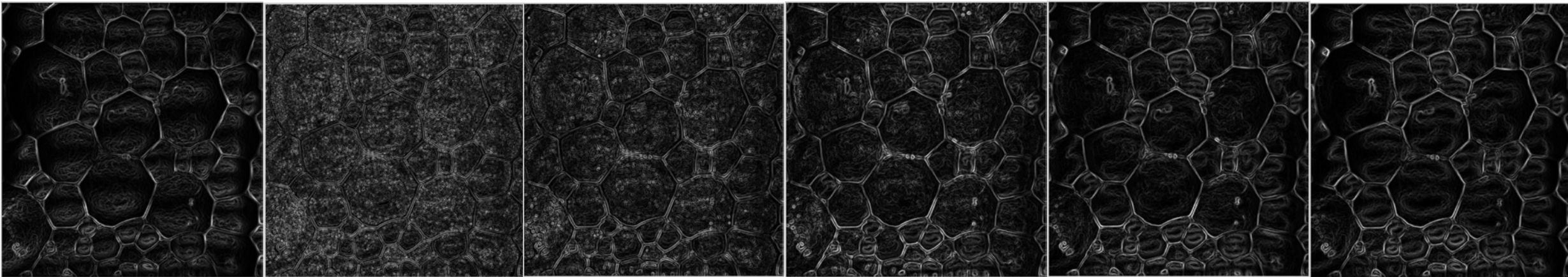
11 × 11

21 × 21

41 × 41

81 × 81

161 × 161

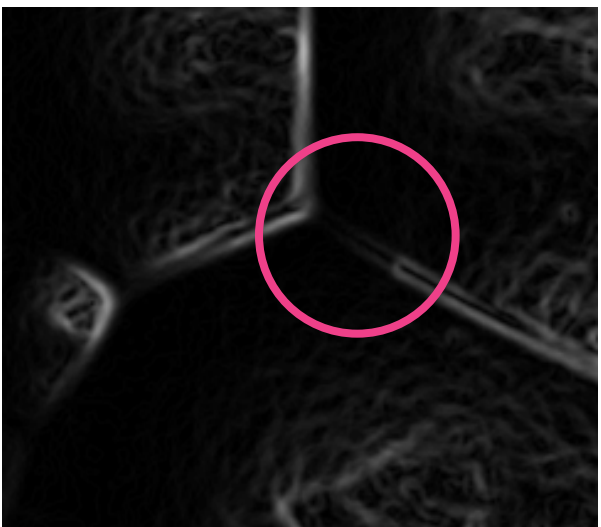
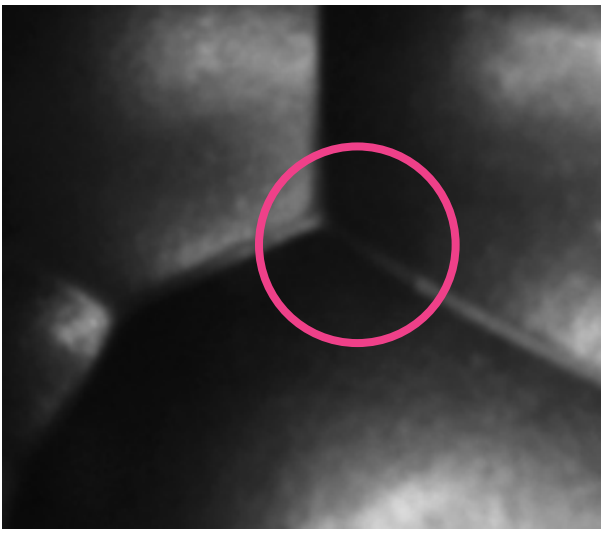


Intro(Local Normalization)

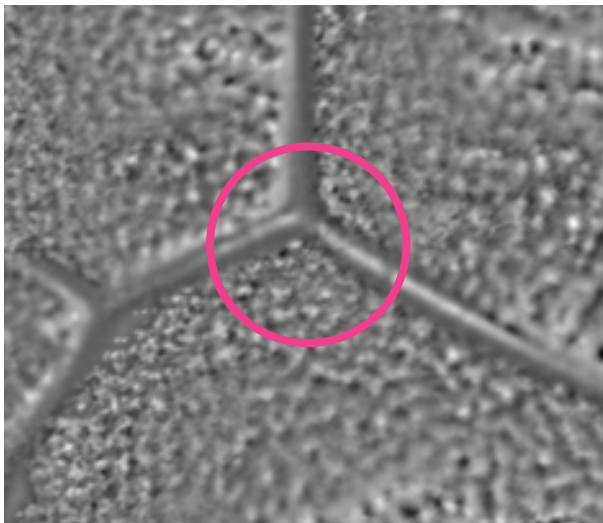
Local Normalization

- 거품 영상의 Local normalization

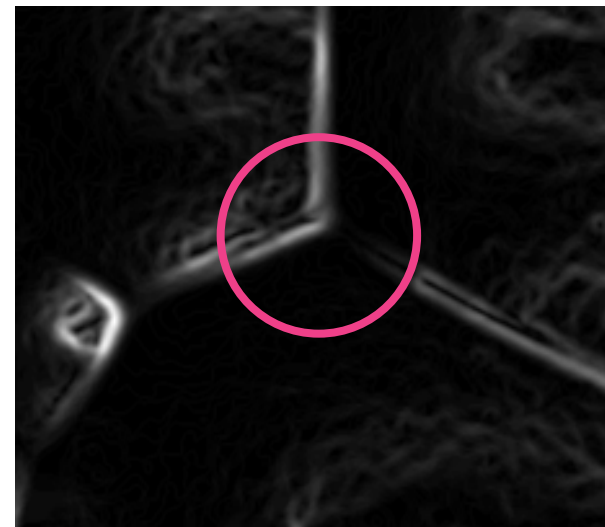
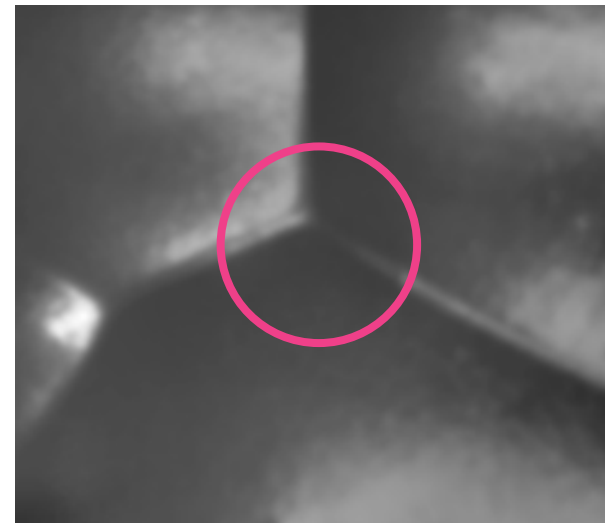
원본 영상



11 × 11



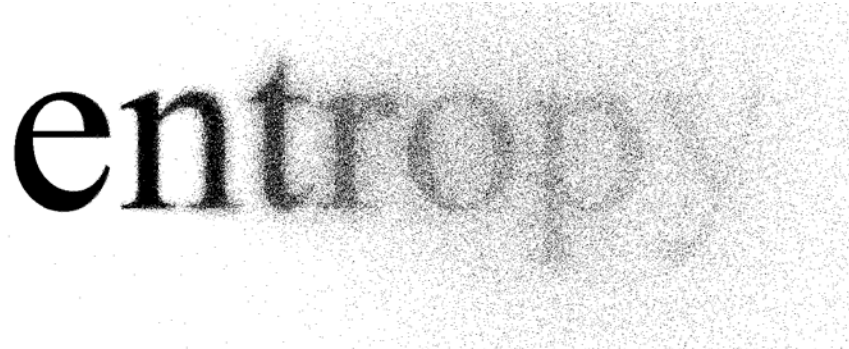
161 × 161



Entropy

- Entropy란?

- 자연 물질이 변형되어, 다시 원래의 상태로 환원될 수 없게 되는 현상을 말한다. 에너지의 사용으로 결국 사용 가능한 에너지가 손실되는 결과를 가져온다.
- (통계학적) 주어진 거시적 상태에 대응하는 미시적 상태의 수의 로그



$$S = -k_B \sum_i p_i \ln p_i$$

k_B : 볼츠만 상수
 p_i : 분포의 확률



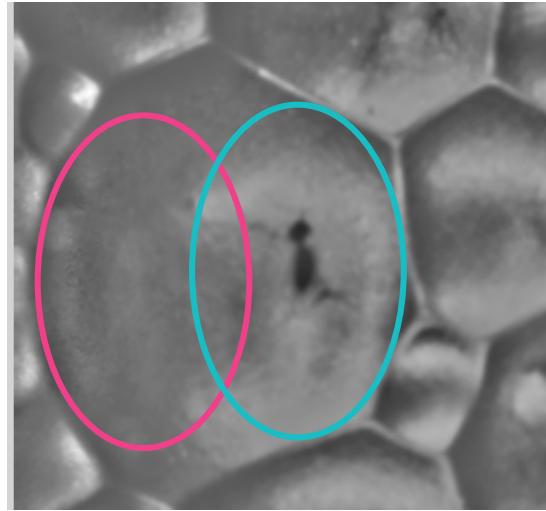
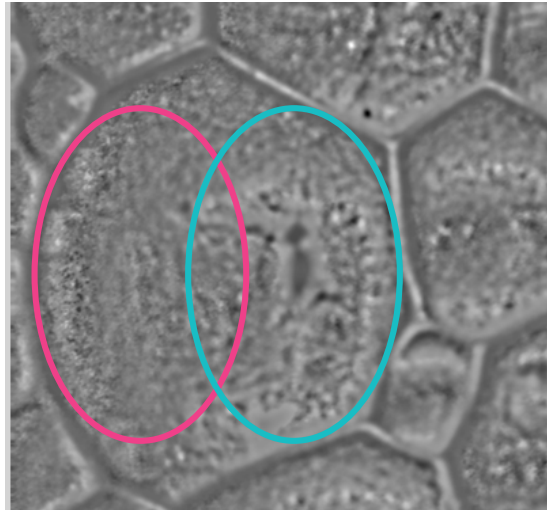
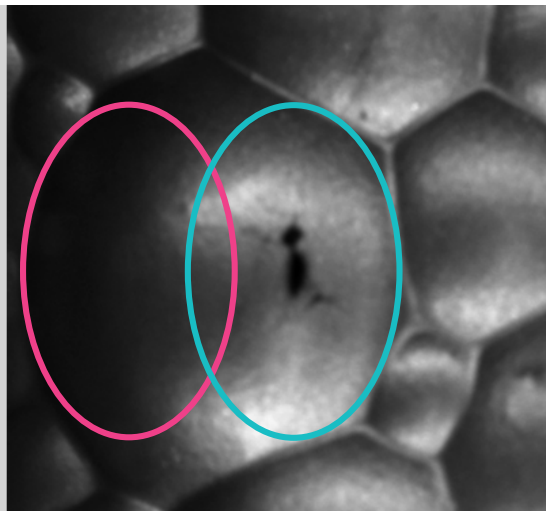
$$S = -\sum_i p_i \ln p_i$$

k_B : 상수이기 때문에 무시(=1)
 p_i : 일정 영역(Ω)에서 i 값을 갖는 픽셀의 비율



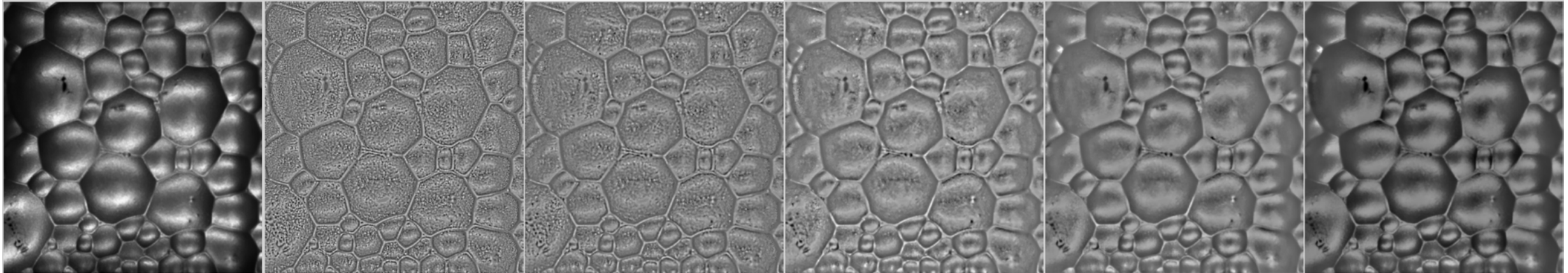
- S 가 크면 클 수록 다양한 값이 분포되어 있다.
- 즉, 노이즈 성분이 많이 포함되어 있다.

- Local Normalization 결과의 Entropy는?



- A : 원본 영상의 Entropy가 작은 영역의 변화
- B : 원본 영상의 Entropy가 큰 영역의 변화

Entropy 연산 결과 영상



원본 영상

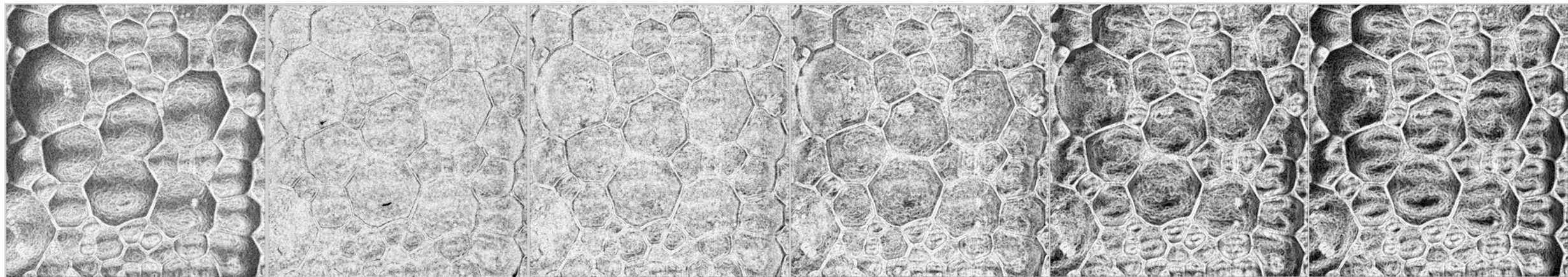
11 × 11

21 × 21

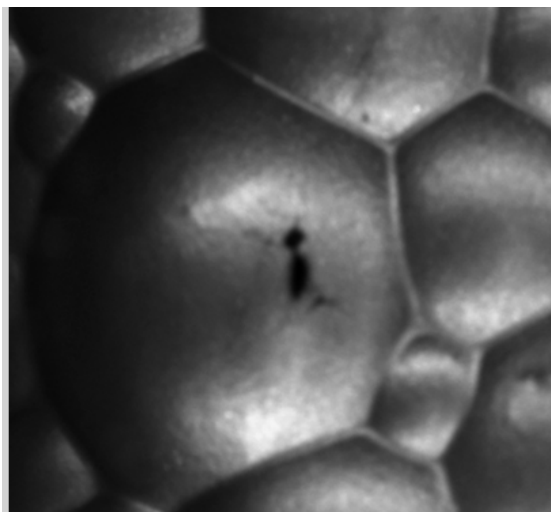
41 × 41

81 × 81

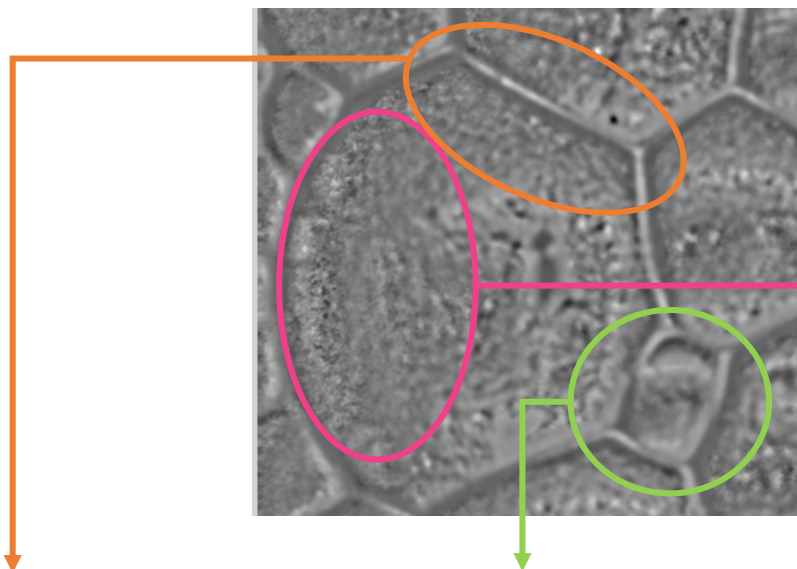
161 × 161



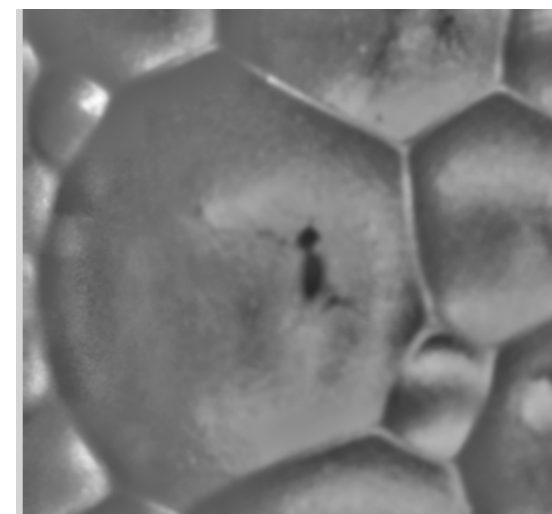
Enhancement Local Normalization



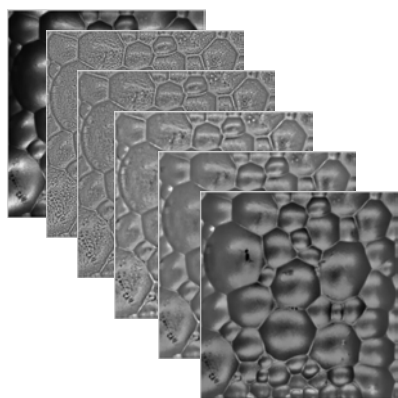
원본 영상



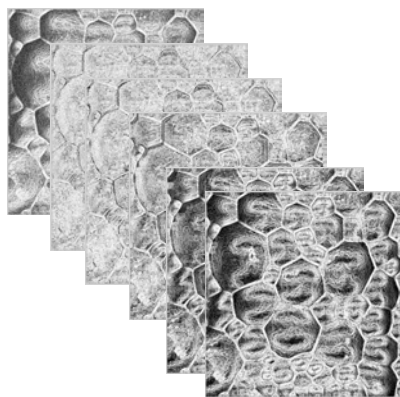
적당한 마스크를 이용한 LN 영상



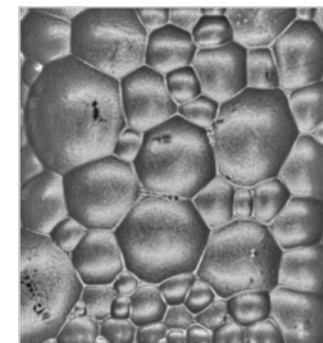
큰 마스크를 이용한 LN 영상



- Local Normalization



- Local Entropy

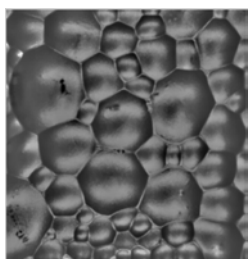
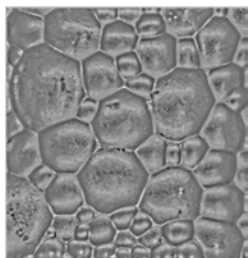
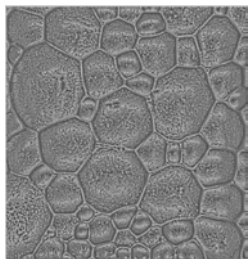


- Enhancement Local Normalization

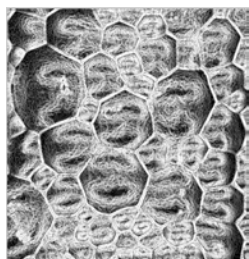
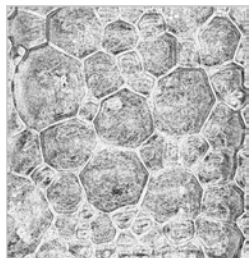


Enhancement Local Normalization

- Local Normalization


 LN_j

- Local Entropy



$$S_j = -\sum_i p_i \ln p_i$$

- Enhancement Local Normalization

$$EnLN(x, y) = \frac{1}{(J-1)} \sum_{j=1}^J \left(1 - \frac{S_j(x, y)}{\sum_{j=1}^J S_j(x, y)} \right) \cdot LN_j(x, y)$$

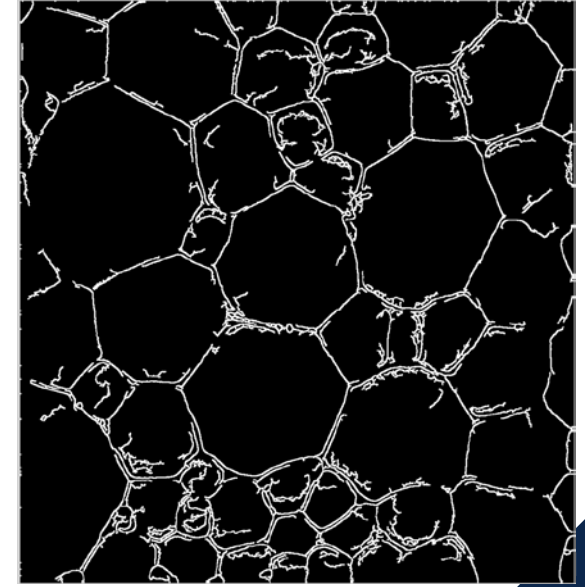
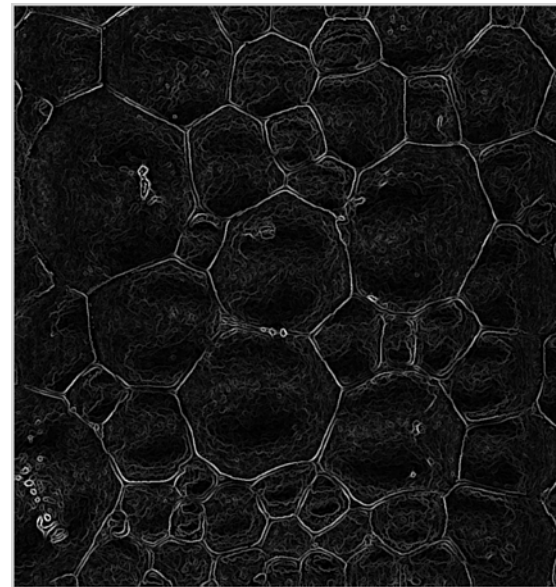
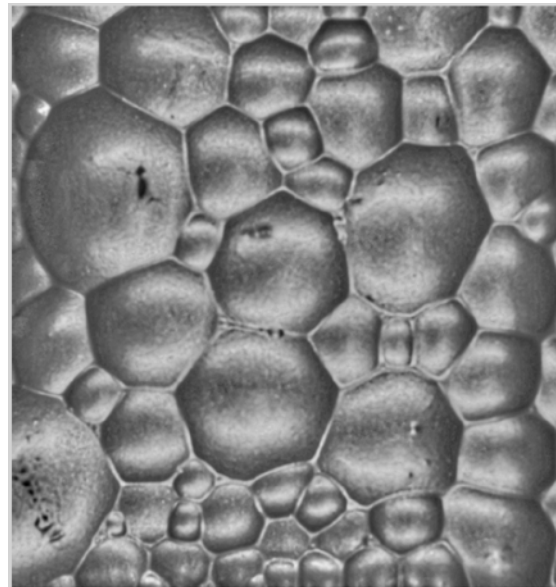
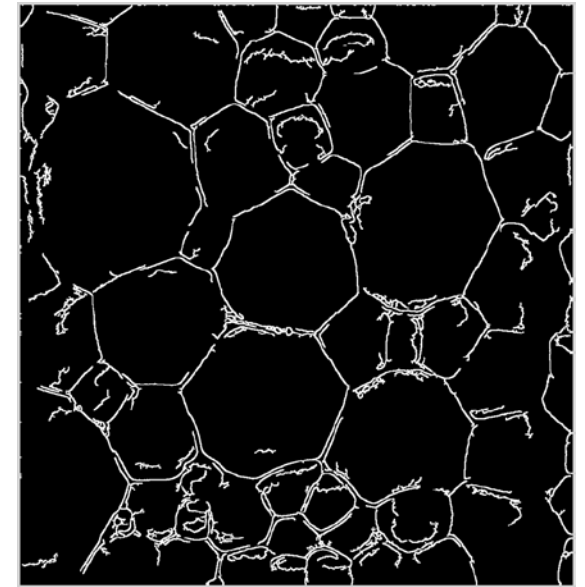
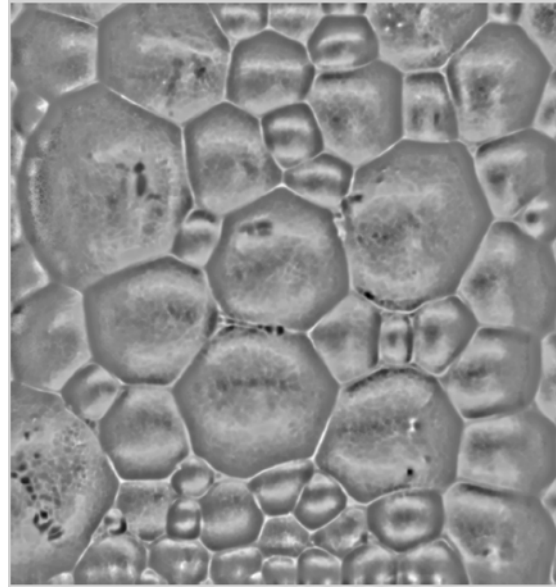
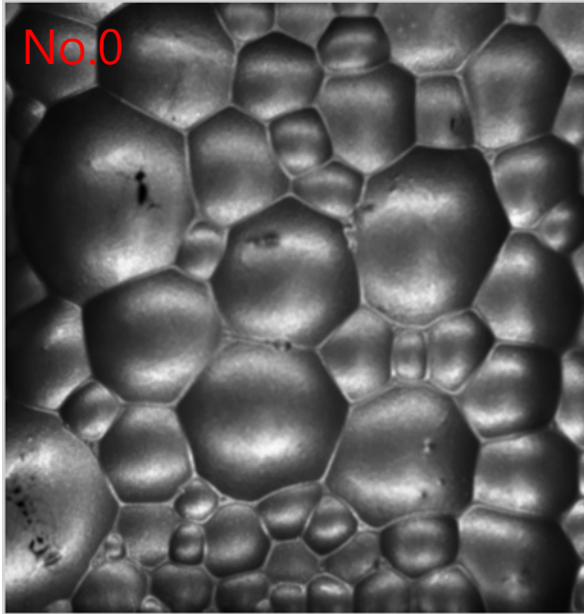
Entropy 값이 작을 수록 큰 비율로 EnLN 영상을 생성.

$LN_j(x, y)$: j 번째 Local Normalization 영상의 (x,y) 위치의 값.

$S_j(x, y)$: j 번째 Local Normalization 영상의 Entropy 영상의 (x,y) 위치의 값.

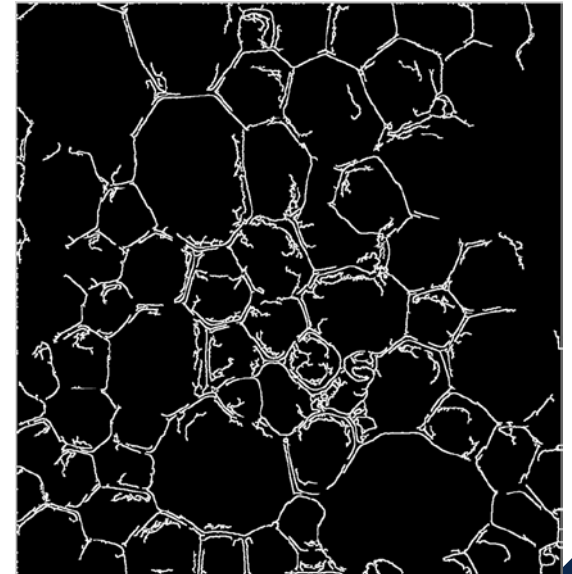
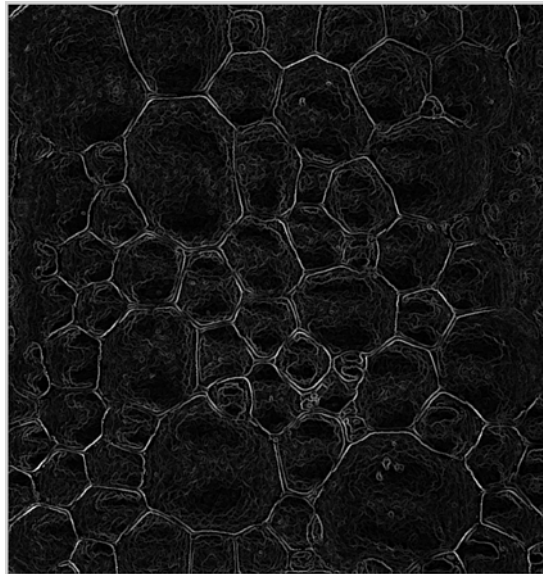
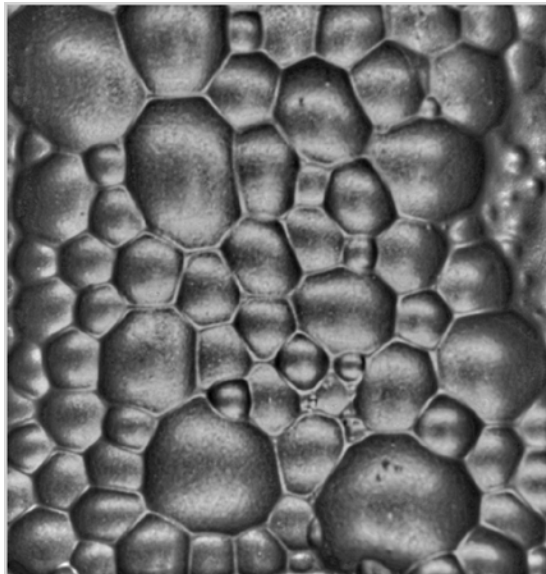
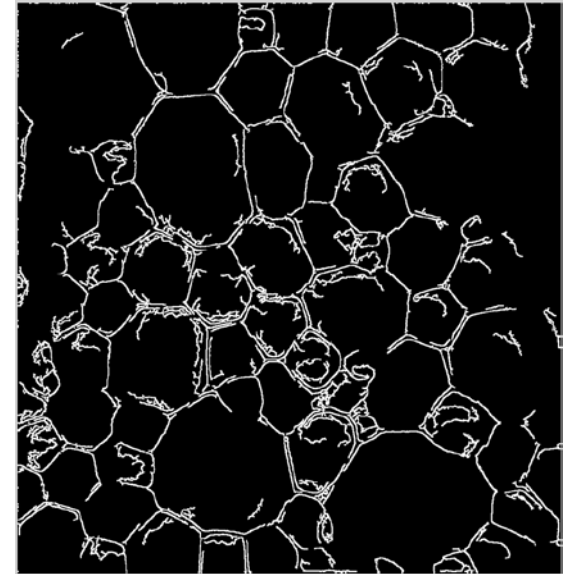
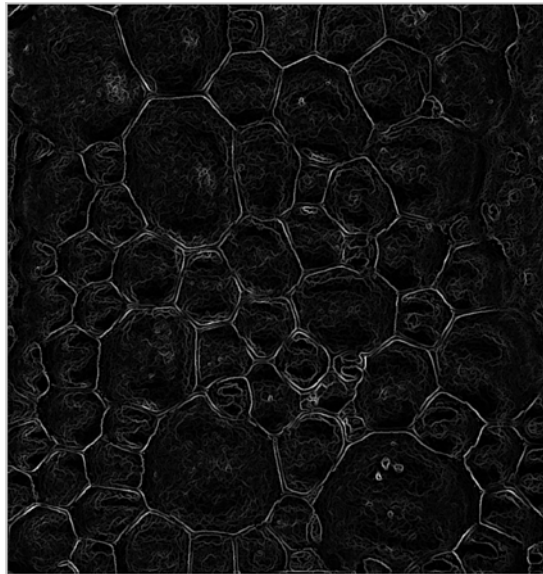
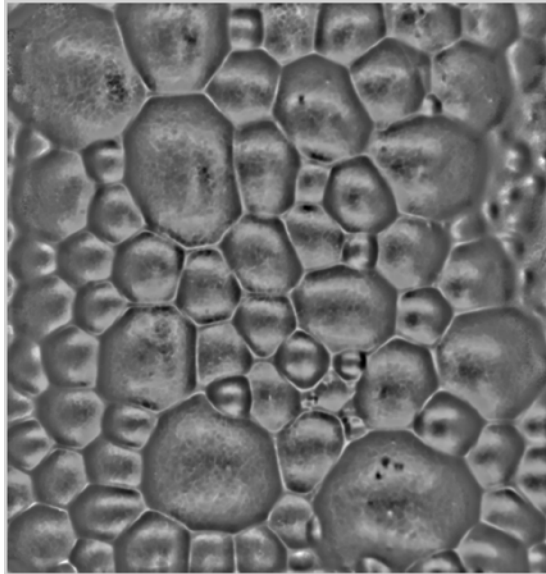
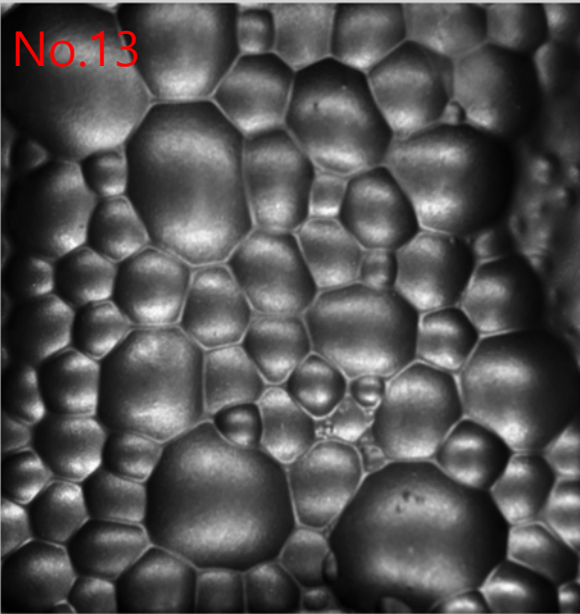
J : Local Normalization 영상의 수

EnLN Result #1



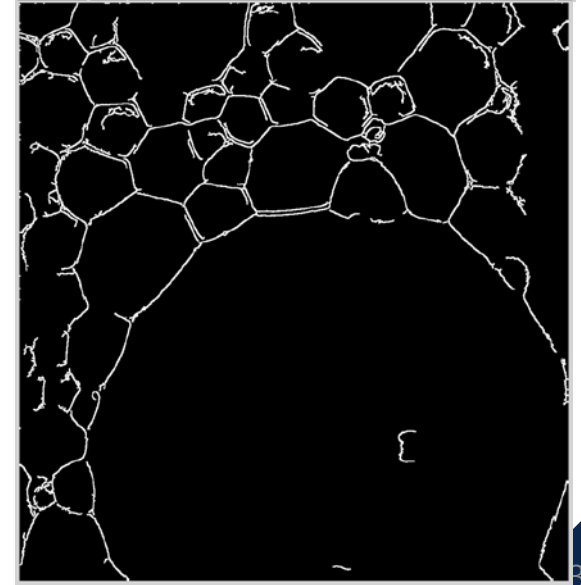
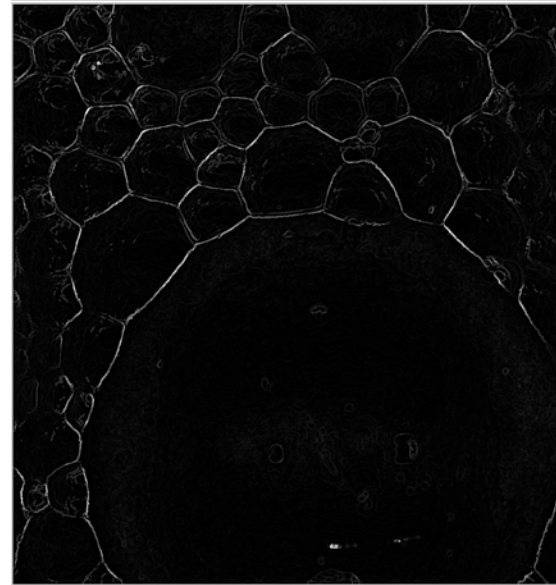
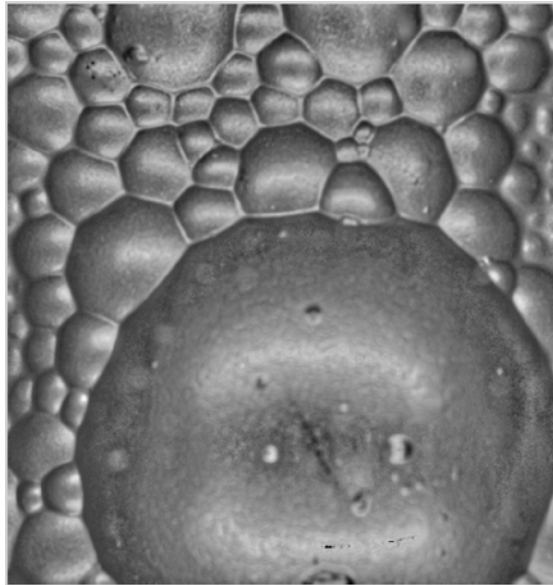
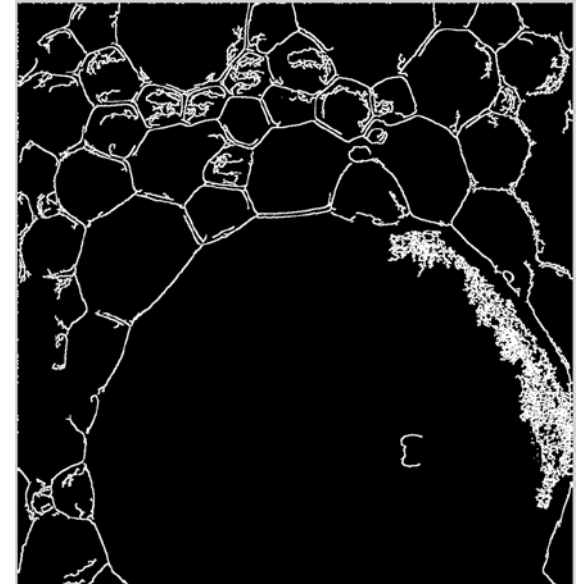
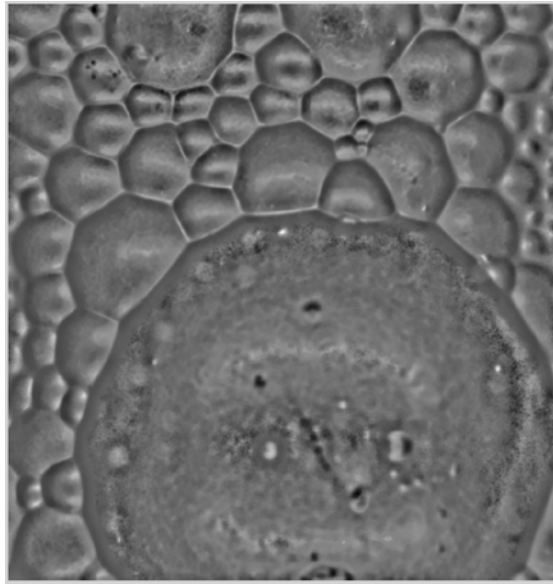
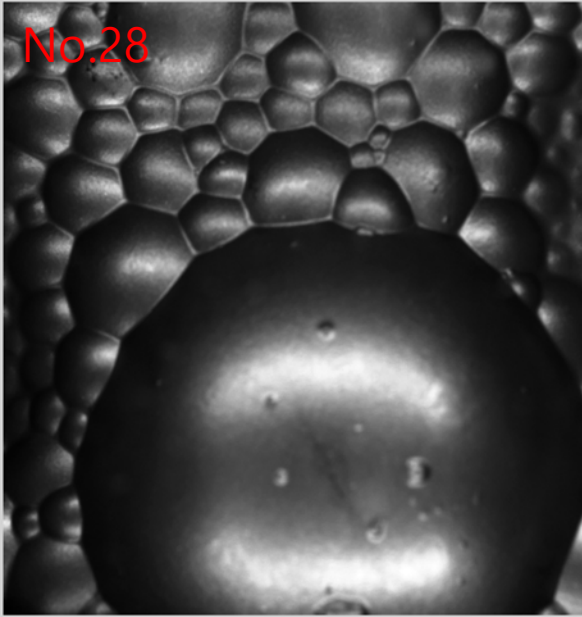
- LN 결과 영상의 마스크 사이즈 : 51 x 51
- EnLN 결과 영상의 마스크 사이즈 : 21 x 21 / 81 x 81 / 321 x 321

EnLN Result #2



- LN 결과 영상의 마스크 사이즈 : 51 x 51
- EnLN 결과 영상의 마스크 사이즈 : 21 x 21 / 81 x 81 / 321 x 321

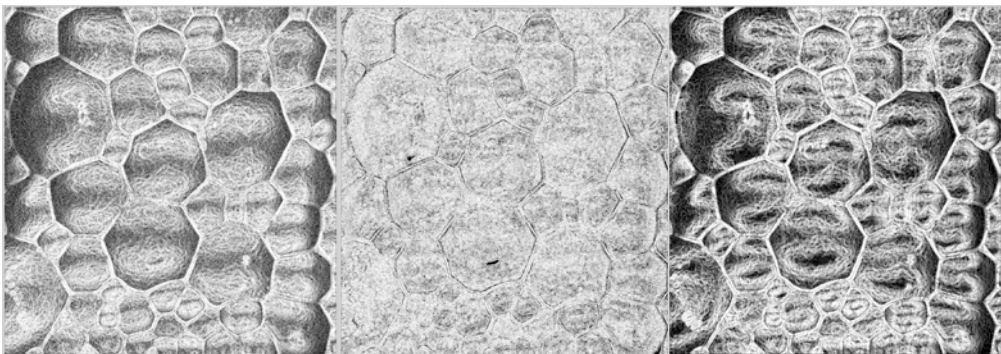
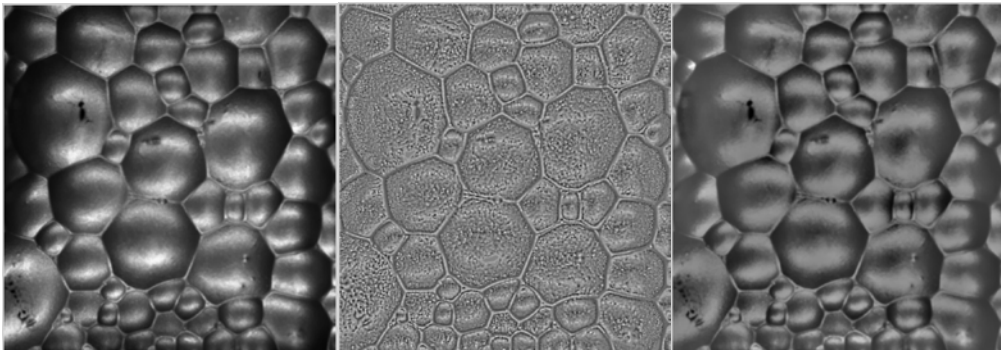
EnLN Result #3



- LN 결과 영상의 마스크 사이즈 : 51 x 51
- EnLN 결과 영상의 마스크 사이즈 : 21 x 21 / 81 x 81 / 321 x 321

Adaptive Enhancement Local Normalization

- 원본 영상의 Entropy



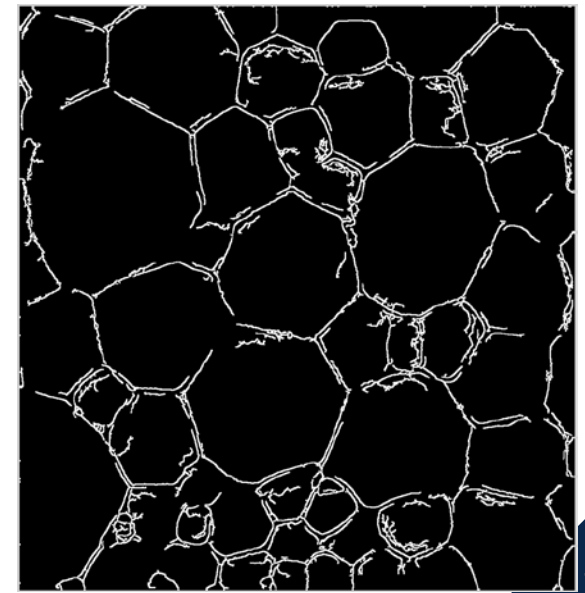
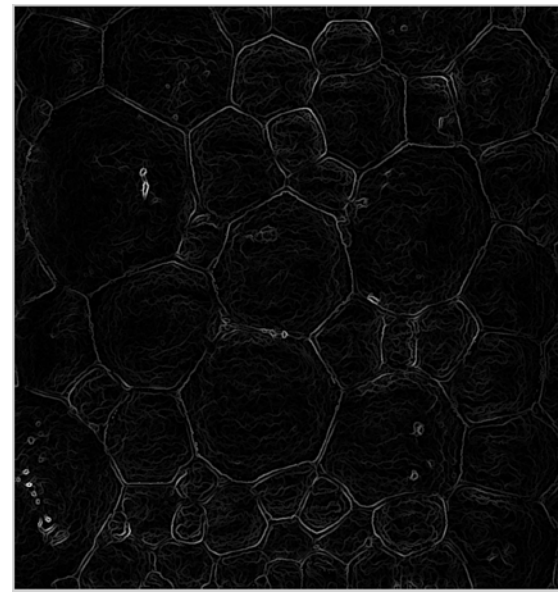
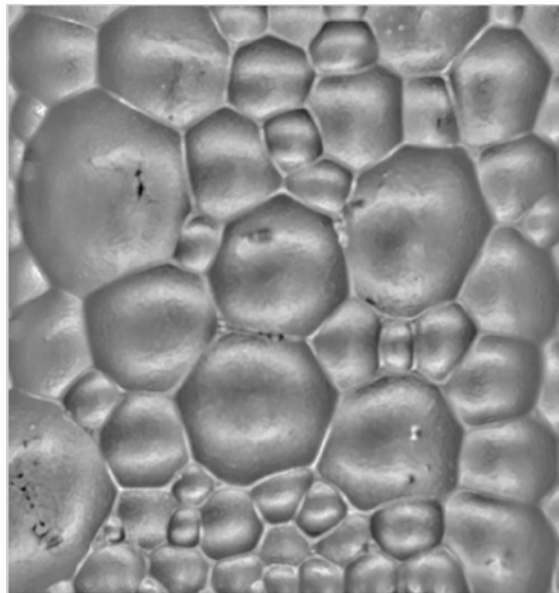
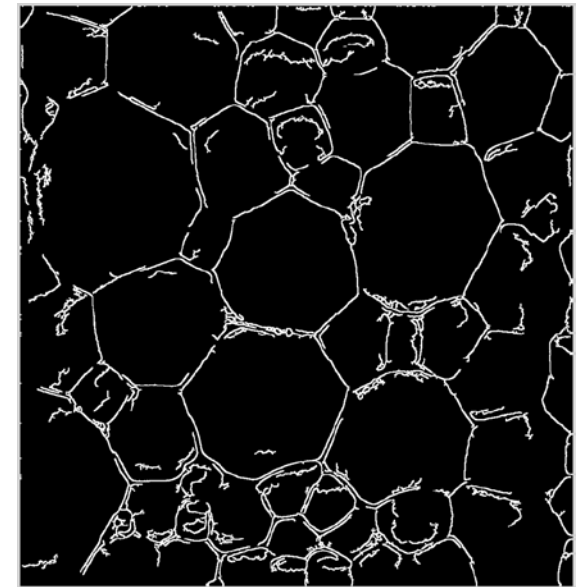
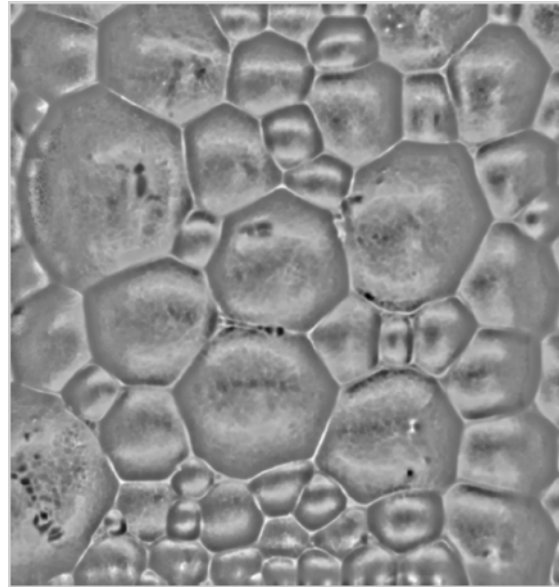
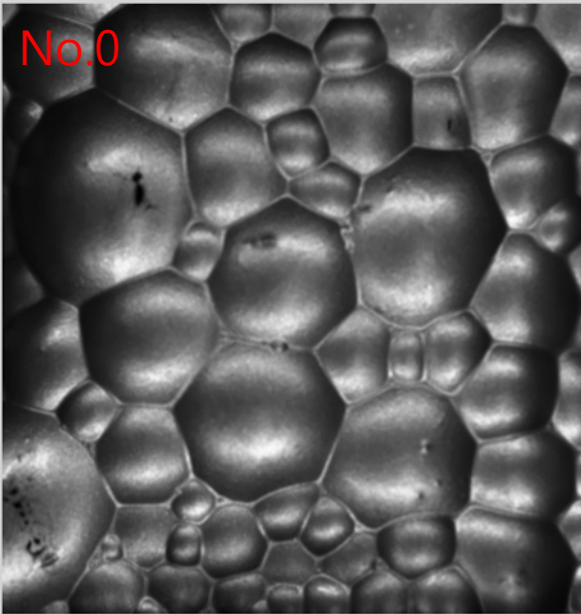
- Entropy가 작은 것이 무조건 좋은가?
- 어떤 Entropy를 갖는 정보가 더 효율적인가?
- 거품 경계의 Entropy는 큰 값을 갖는다.
- LN 과정에서 마스크의 크기가 작으면 LN영상의 Entropy는 원본 영상의 Entropy보다 커지는 경향을 보인다.
- LN 과정에서 마스크의 크기가 크면 LN영상의 Entropy는 원본 영상의 Entropy보다 작아지는 경향을 보인다.
- 원본 영상의 Entropy가 작으면 LN 영상의 Entropy도 작도록 큰 마스크를 사용.
- 원본 영상의 Entropy가 크면 LN 영상의 Entropy도 크도록 작은 마스크를 사용.

- Local Normalization의 마스크 크기 선정.

$$LNmask(x, y) = MAXmask \cdot \left(1 - \frac{S(x, y) - \min(S)}{\max(S) - \min(S)} \right)$$

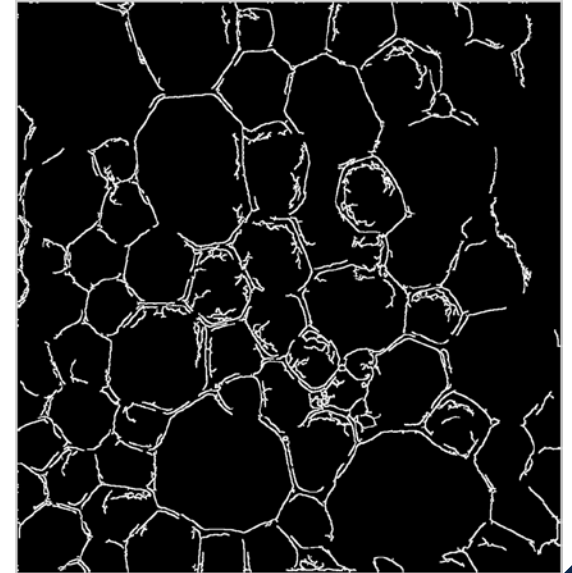
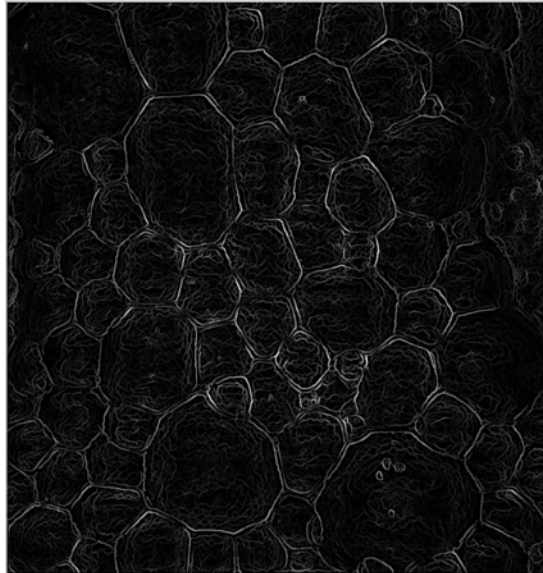
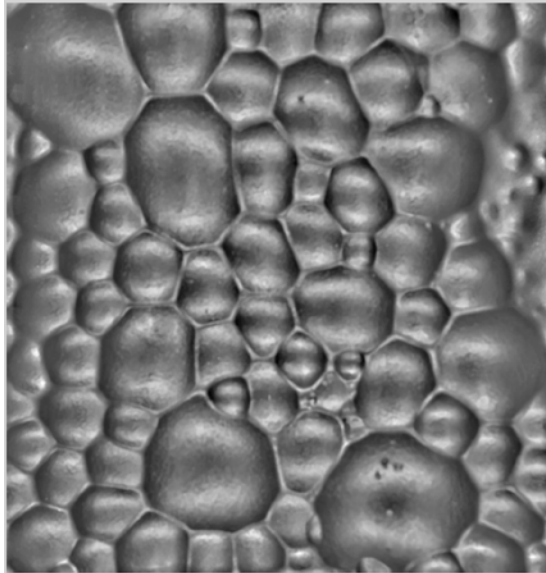
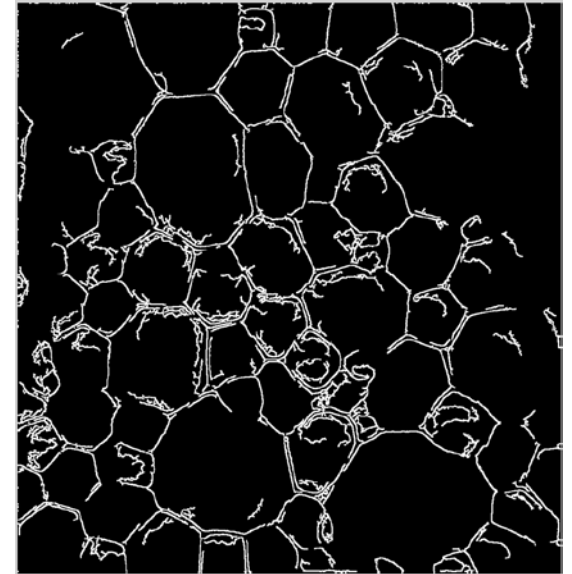
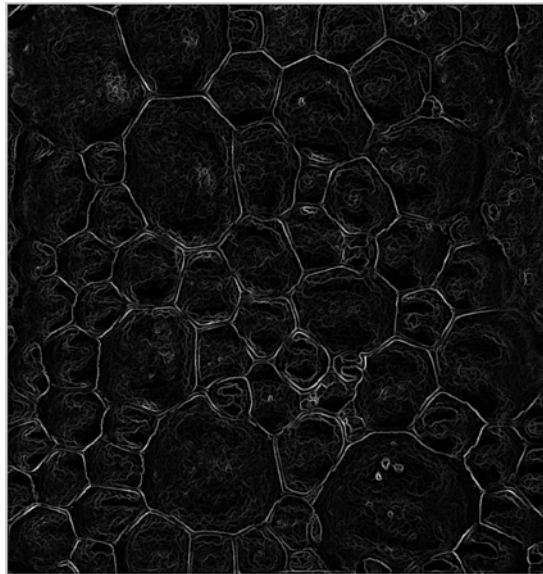
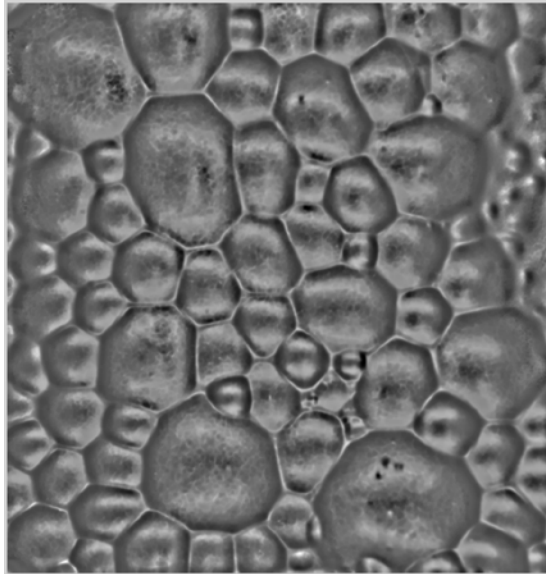
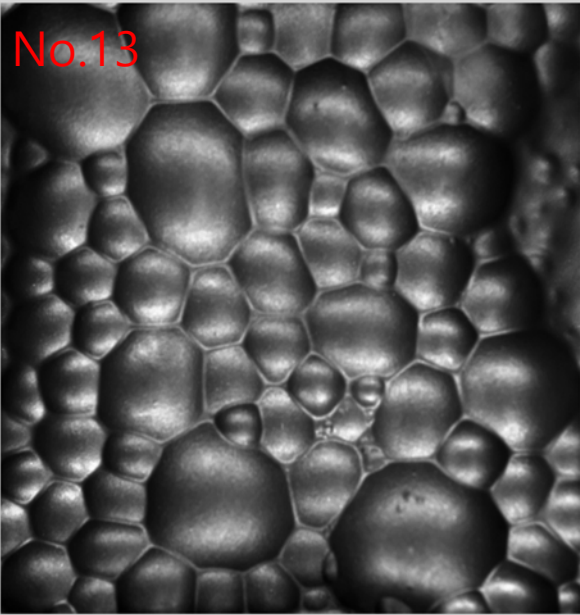
- ↳ $LNmask(x, y)$: (x,y)의 값을 LN하기 위해 사용할 마스크의 크기
- ↳ S : 입력 영상의 Entropy 값
- ↳ $MAXmask$: LN을 하기 위해 사용할 마스크의 최대 크기

A-EnLN Result #1



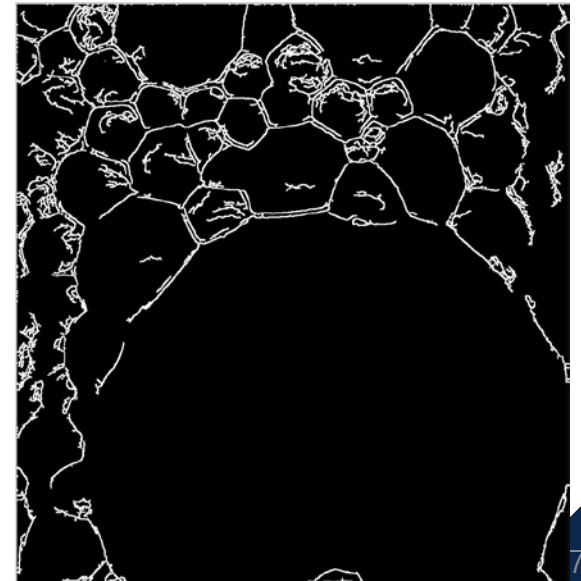
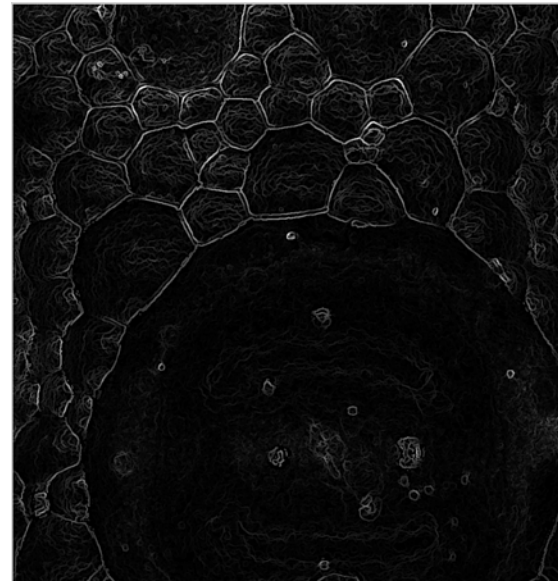
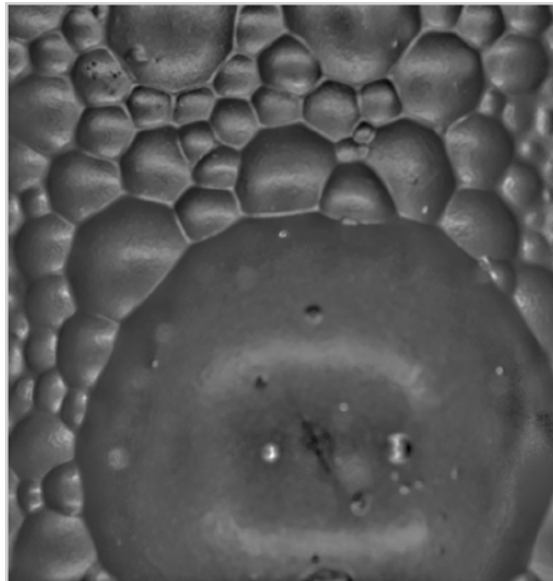
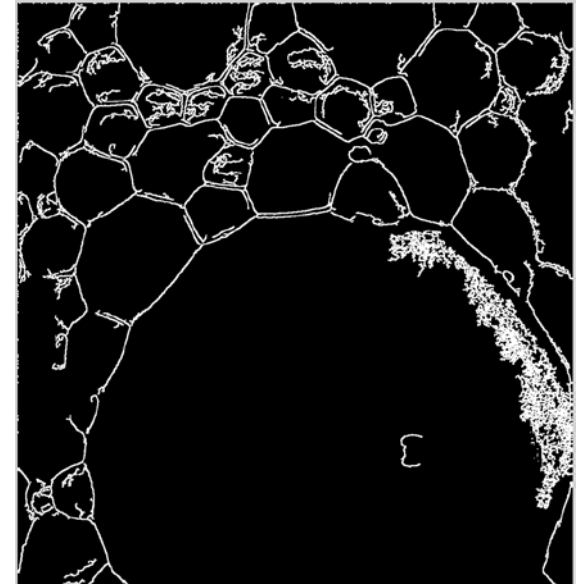
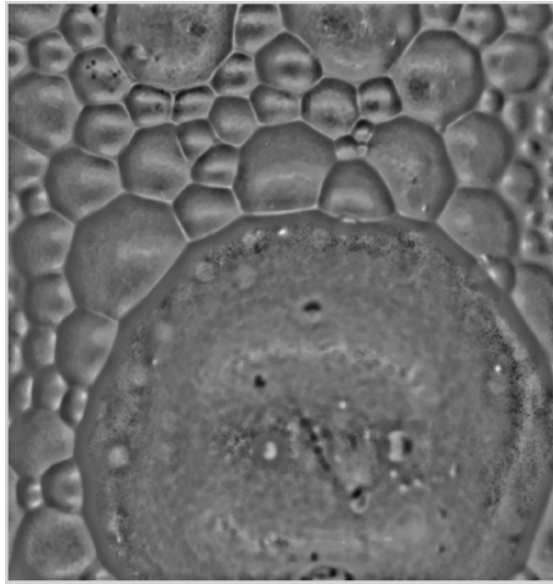
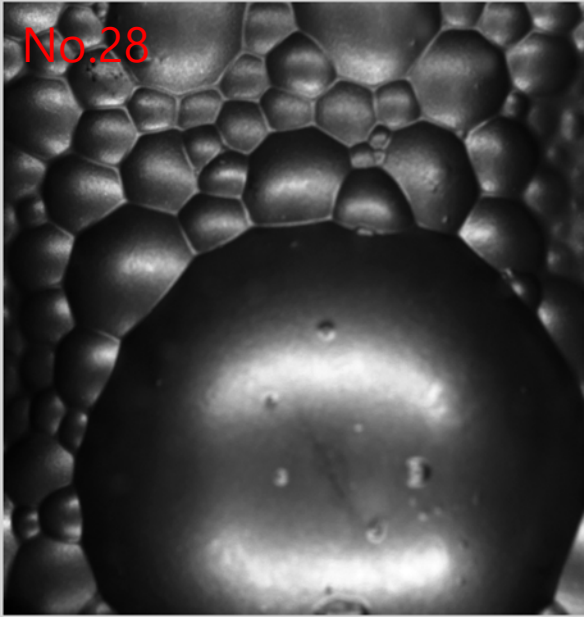
- LN 결과 영상의 마스크 사이즈 : 51 x 51
- A-EnLN 결과 영상의 최대 마스크 사이즈 : 201 x 201

A-EnLN Result #2



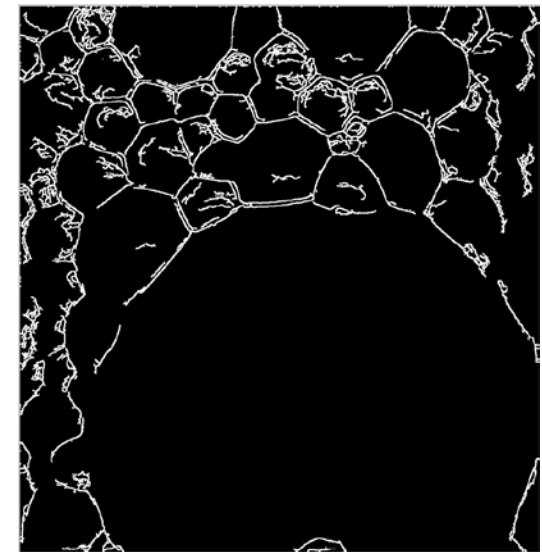
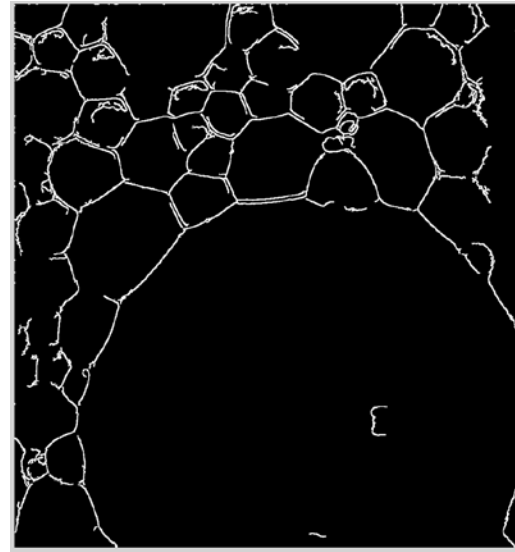
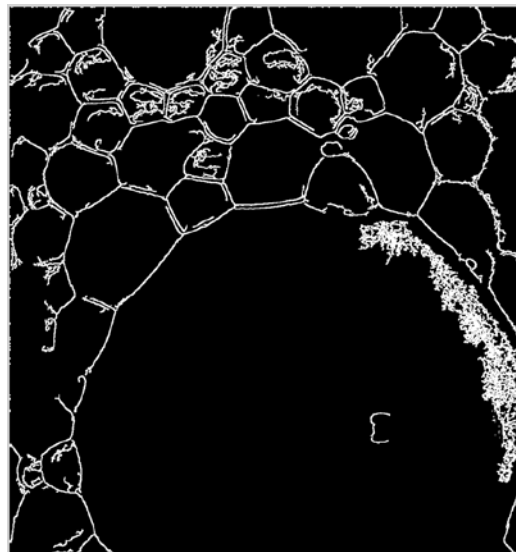
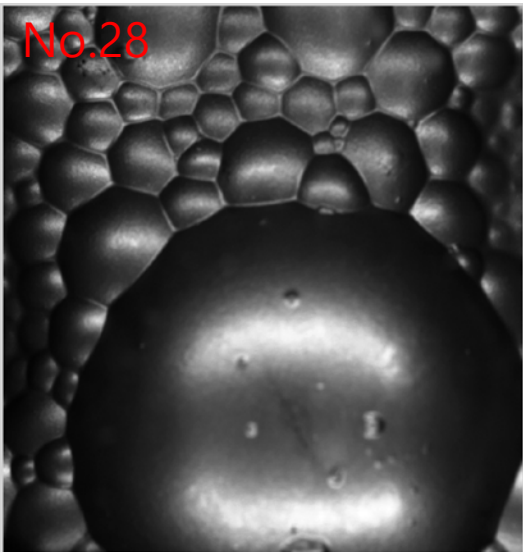
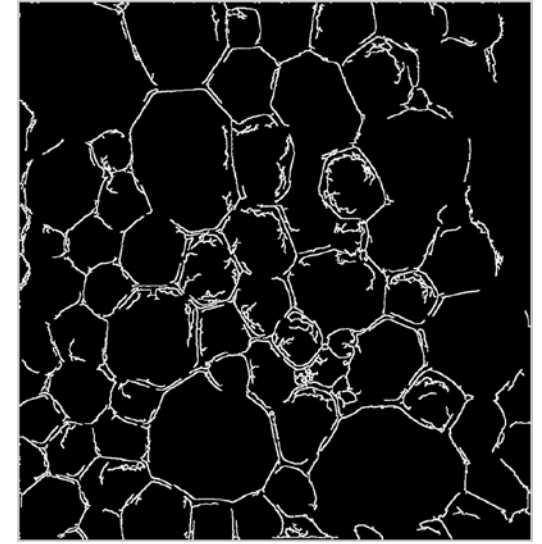
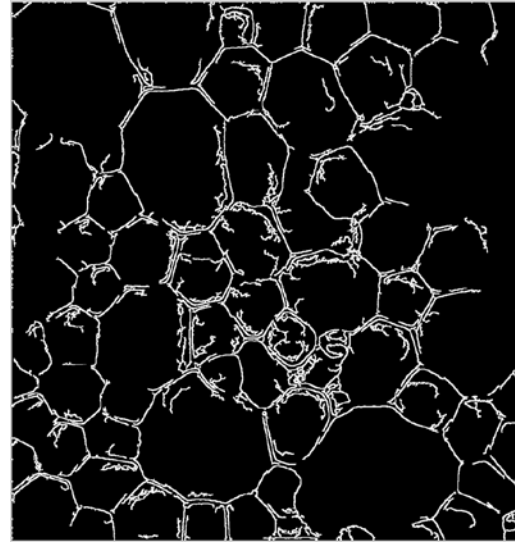
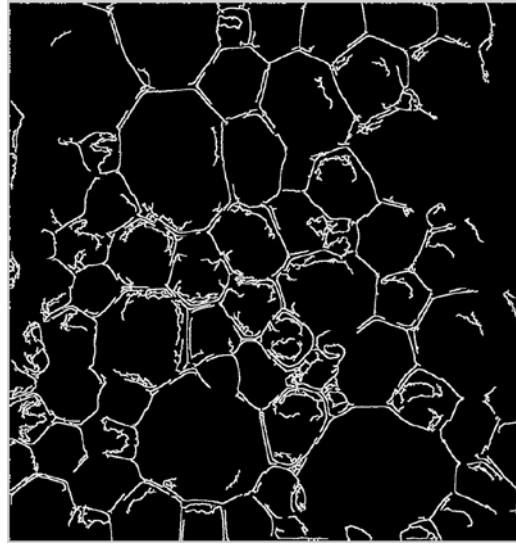
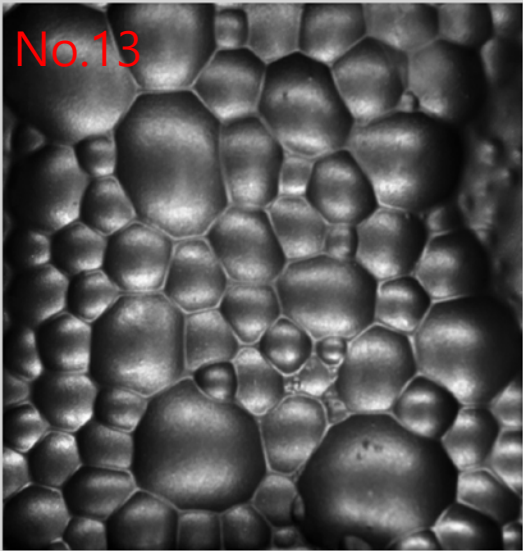
- LN 결과 영상의 마스크 사이즈 : 51 x 51
- A-EnLN 결과 영상의 최대 마스크 사이즈 : 201 x 201

A-EnLN Result #3



- LN 결과 영상의 마스크 사이즈 : 51 x 51
- A-EnLN 결과 영상의 최대 마스크 사이즈 : 201 x 201

Compare LN, EnLN, A-EnLN



- Local Normalization

- Enhancement LN

- Adaptive EnLN

Q & A
