Froth Edge

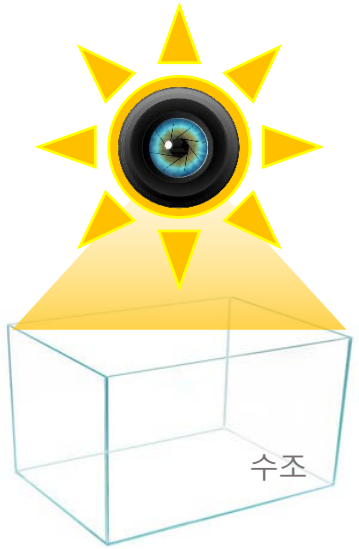
ISL
안재원

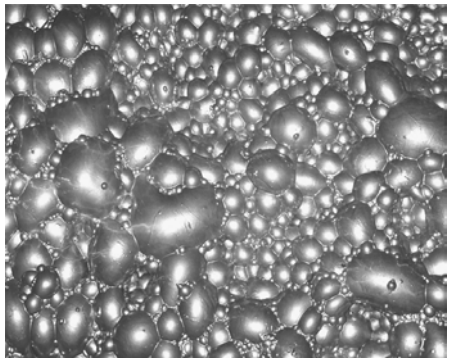
CONTENTS

Intro

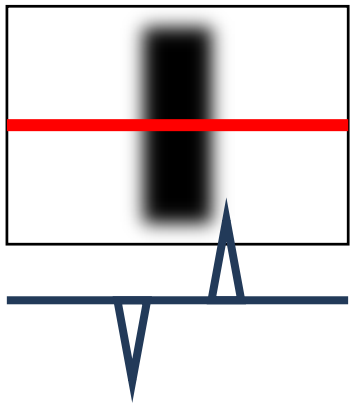
Problem

- 밝기 기반의 경계 검출





- 영상에서 말하는 경계(Gradient)



- 거품 영상의 특징

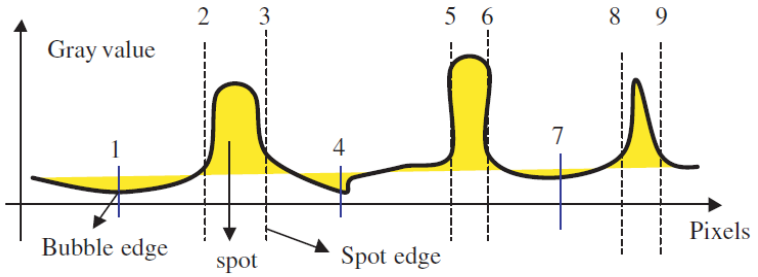
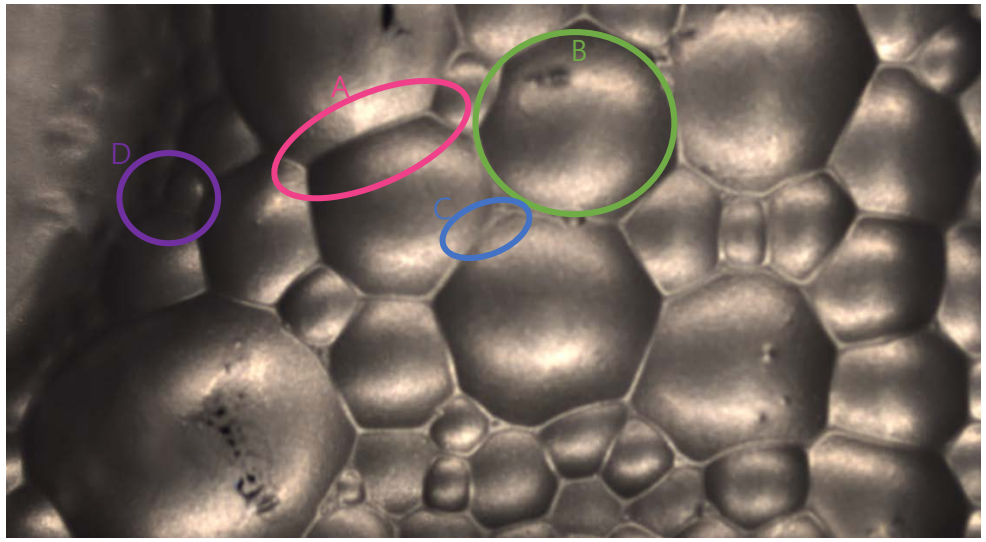
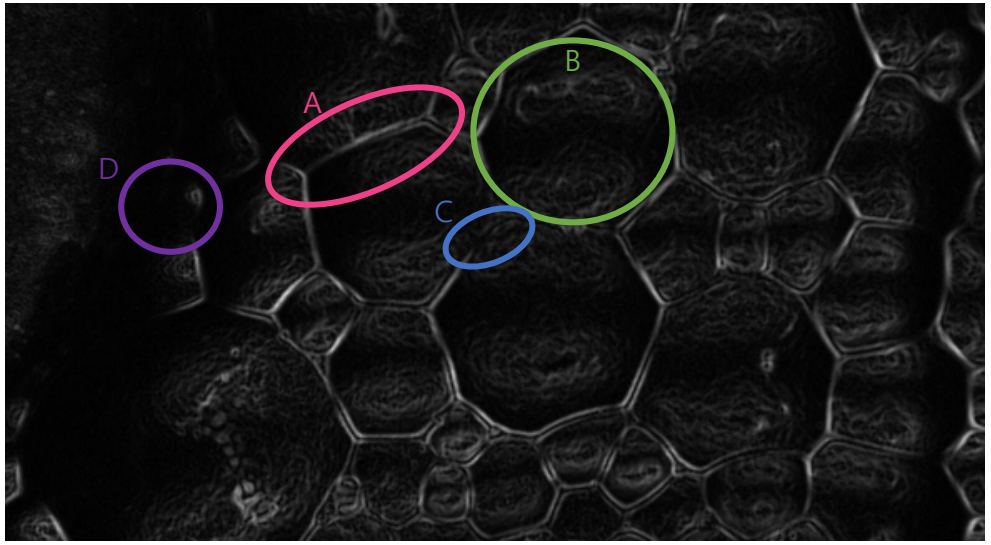


Fig. 6. Gray value versus pixels of a cross-section of a froth image.

- 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.

- 거품 영상과 Sobel operation 예시 영상





Intro

Local normalization

- Local normalization

획득 영상 $I(x,y) = p(x,y)n(x,y)s$ 표면 방향(Surface normal direction)

광원(Light source)

반사율

$$I'(x,y) = A \cdot I(x,y)$$

$$A = \frac{n(x,y)s'}{n(x,y)s}$$: illumination ratio

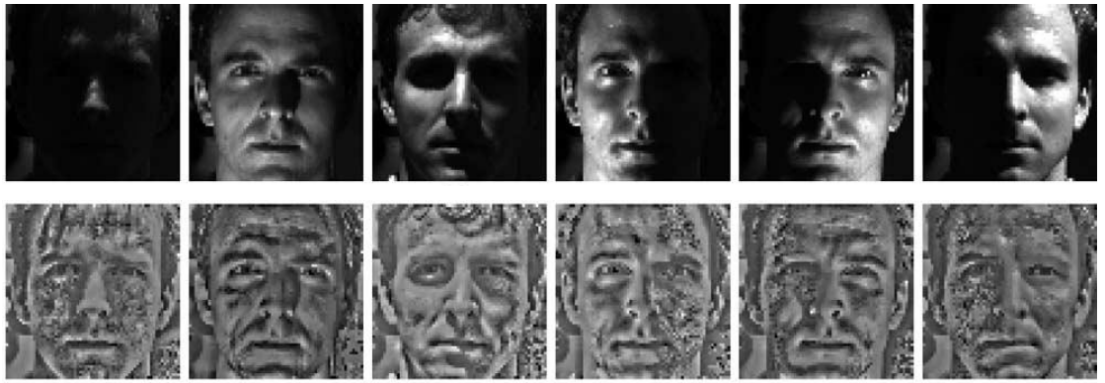
원하는 광원이 사용된 이미지 $I'(x,y) = p(x,y)n(x,y)s'$

원하는 광원

$$I'(x,y) = A \cdot I(x,y) + B$$

노이즈 성분

- Local normalization 결과



$$I'(x,y) = A \cdot I(x,y) + B$$

Intensity value : $$I_p'(x,y) = \frac{I'(x,y) - E(I'(x,y))}{Var(I'(x,y))}$$

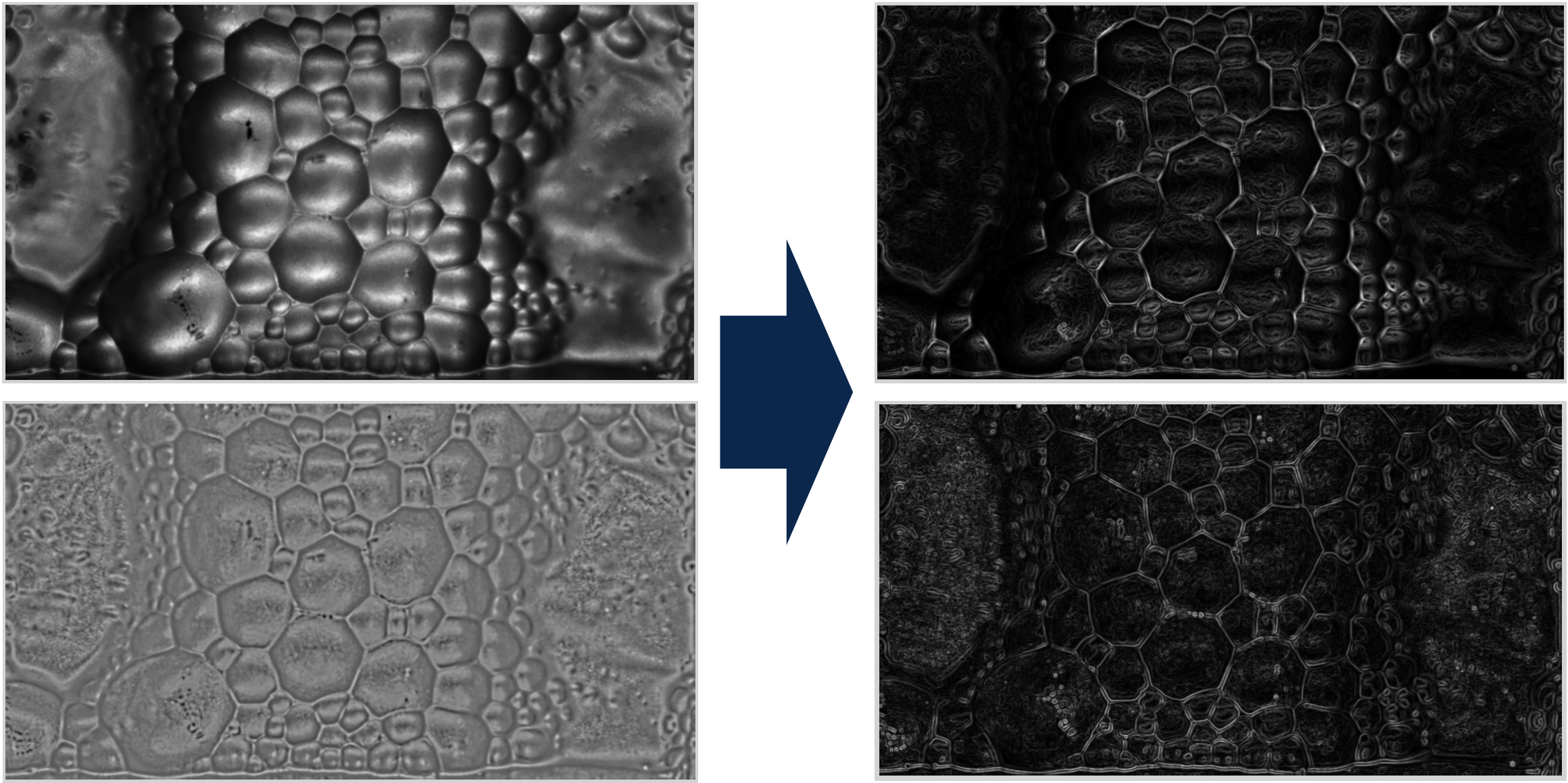
$$\begin{cases} E(I'(x,y)) = 0 \\ Var(I'(x,y)) = 1 \end{cases}$$

$$\begin{cases} E(A \cdot I(x,y) + B) = A \cdot E(I(x,y)) + B = 0 \\ Var(I'(x,y)) = \sqrt{\frac{\sum (I'(x,y) - E(I'(x,y))^2}{N}} = A \cdot \sqrt{\frac{\sum (I(x,y) - E(I(x,y))^2}{N}} = A \cdot Var(I(x,y)) = 1 \end{cases}$$

$$I_p'(x,y) = \frac{A \cdot I(x,y) + B - (A \cdot E(I(x,y)) + B)}{A \cdot Var(I(x,y))} = \frac{I(x,y) - E(I(x,y))}{Var(I(x,y))}$$

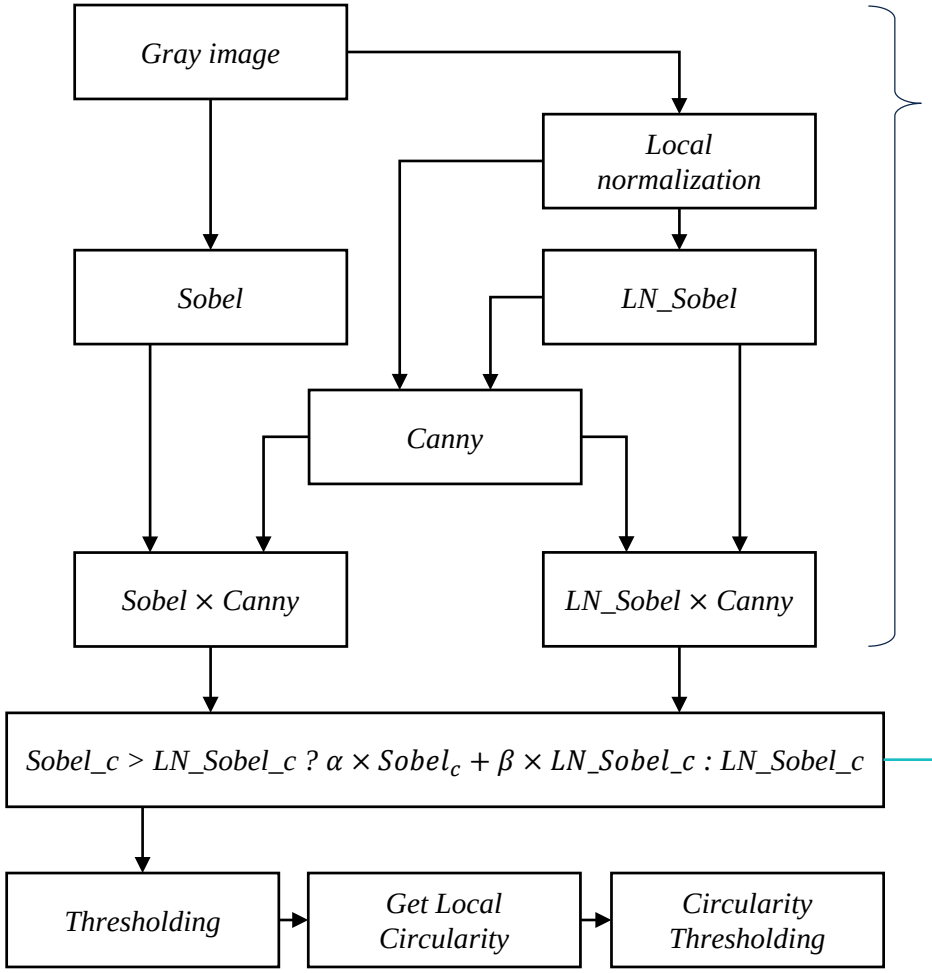
Intro

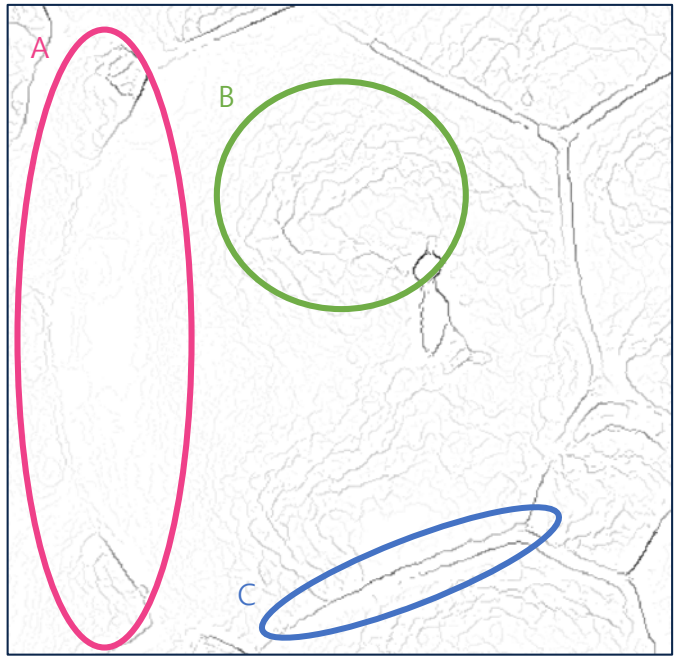
Local normalization 결과



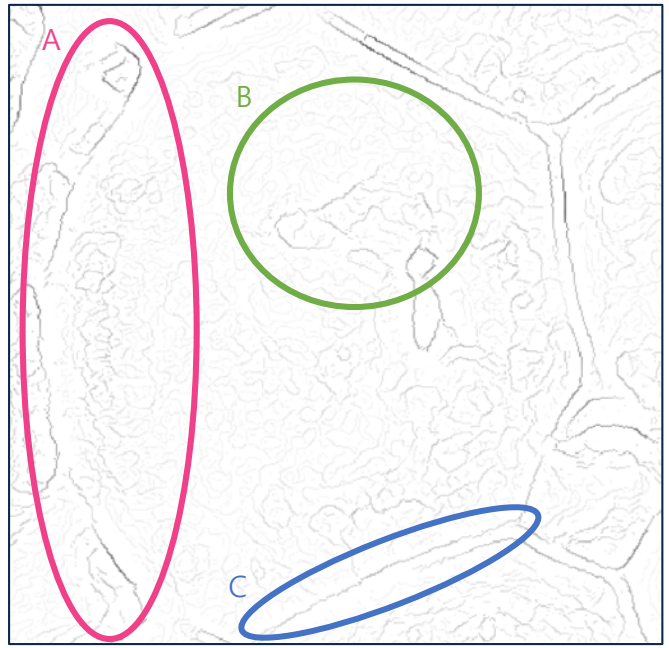
Edge Enhancement

Edge Enhancement#1





Sobel



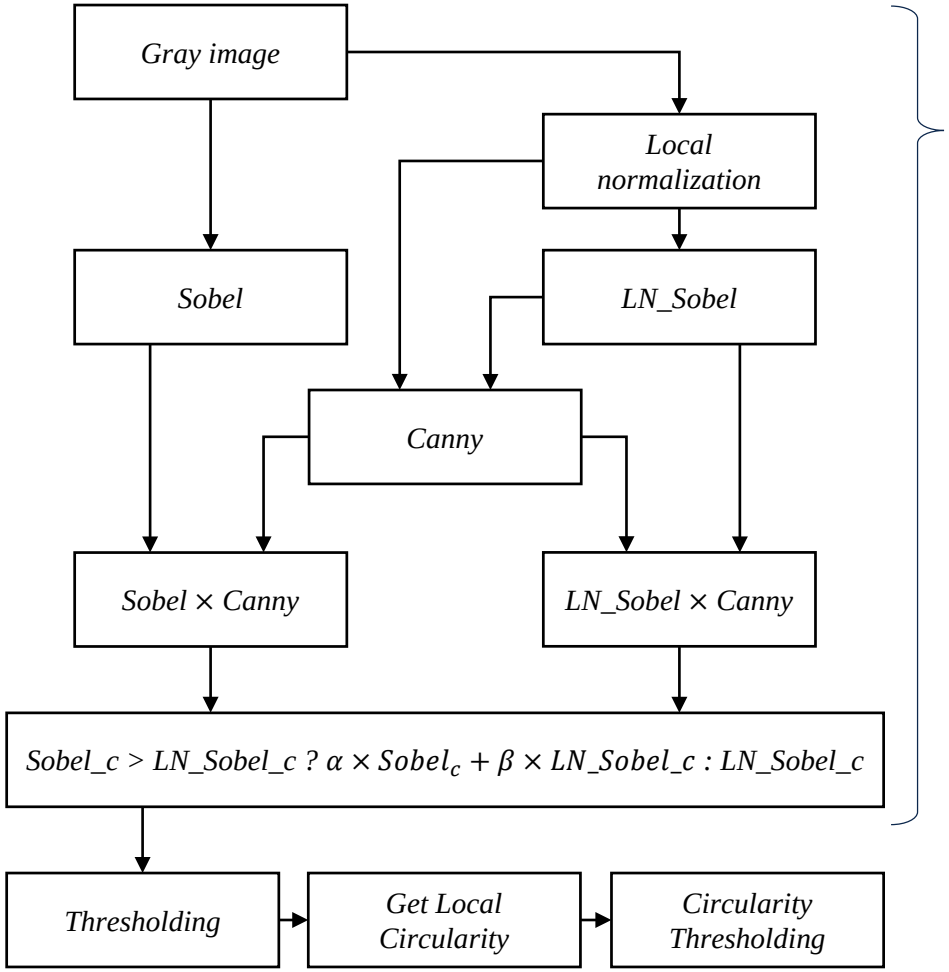
LN & Sobel

- A : Local normalization으로 살아난 경계
- B : 조명(High-light) 영역의 경향 차이
- C : 거품 경계 부분의 경향 차이

- A : 살아난 경계 유지
- B : 조명 영역 값 완화
- C : 경계 영역 강화

Edge Enhancement

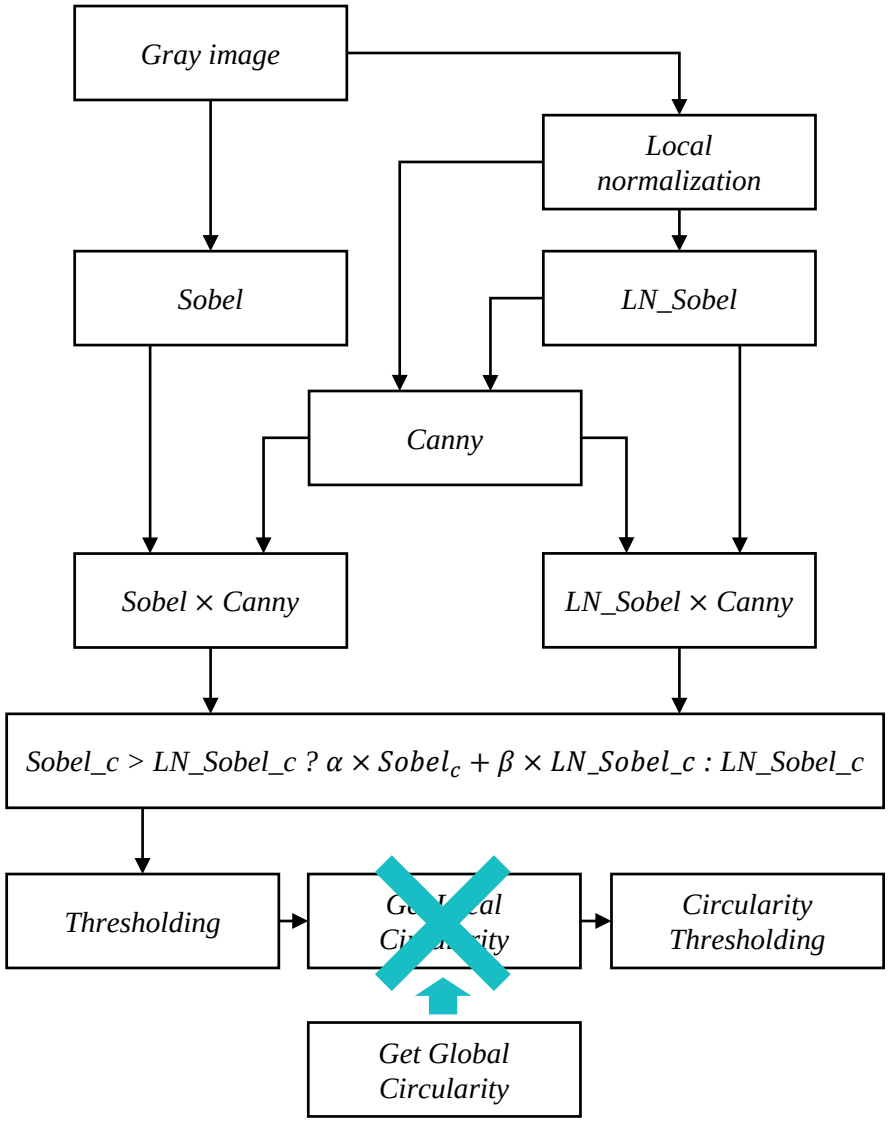
Edge Enhancement#1



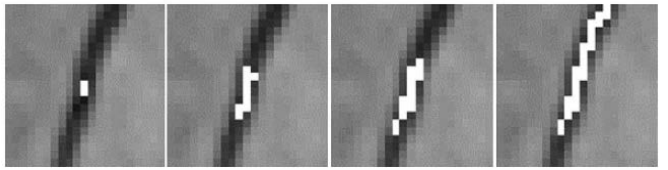
- 목표에 근접한 결과를 얻을 수 있었다.
- 하지만 아직 내부 여러 노이즈 요소(조명, 거품 갈라짐)에 의한 영향이 남아있다.

Edge Enhancement

Edge Enhancement#1



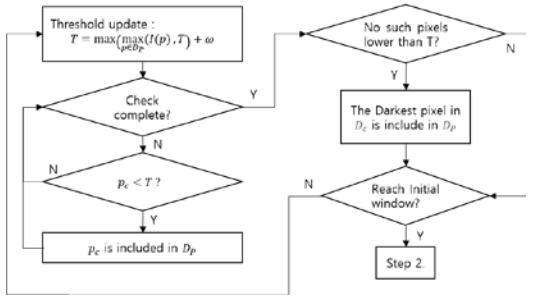
- Get Local Circularity(Percolation)



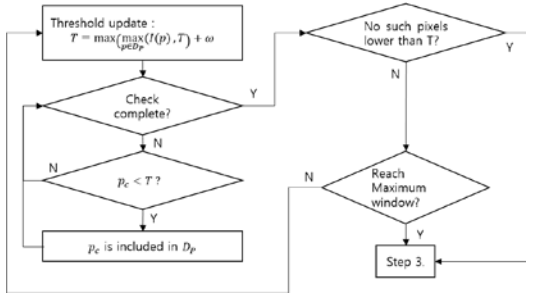
(1) Iteration 1 (2) Iteration 5 (3) Iteration 10 (4) Termination

- 생각보다 효과가 미미
- Circularity를 이용해 구분하기에는 Local 하게 보는 영역이 너무 작아 발생하는 현상으로 추측.

- Step 1 – 영역 확장 과정#1



- Step 2 – 영역 확장 과정#2



- Step 3 – 확장 영역의 형태 확인 과정

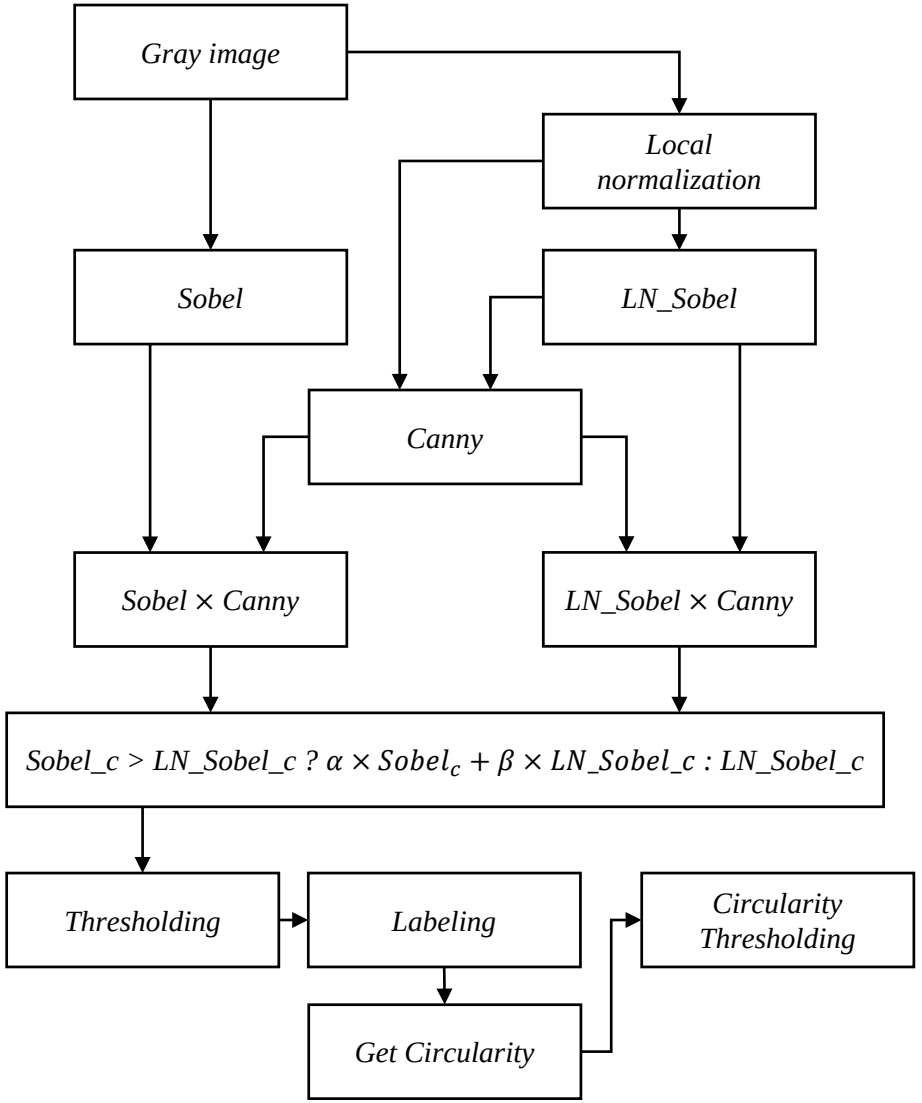
Circularity : $F_C = \frac{4 \cdot C_{count}}{\pi \cdot C_{\max}^2}$

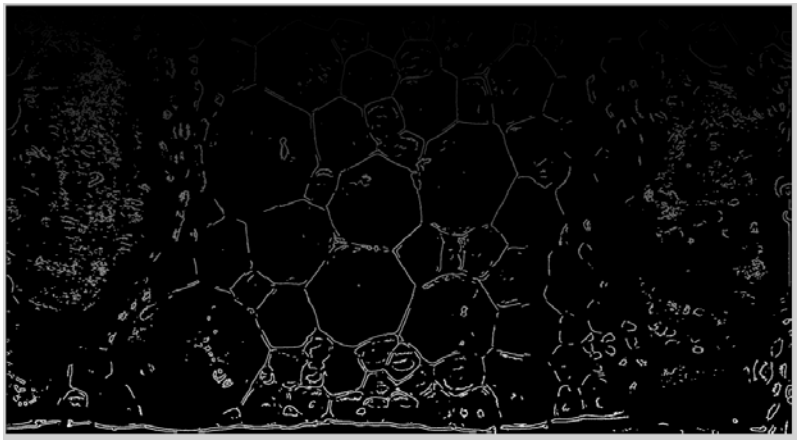
C_{count} : The number of pixels in D_P

C_{max} : Maximum length of D_P

Edge Enhancement

Edge Enhancement#2



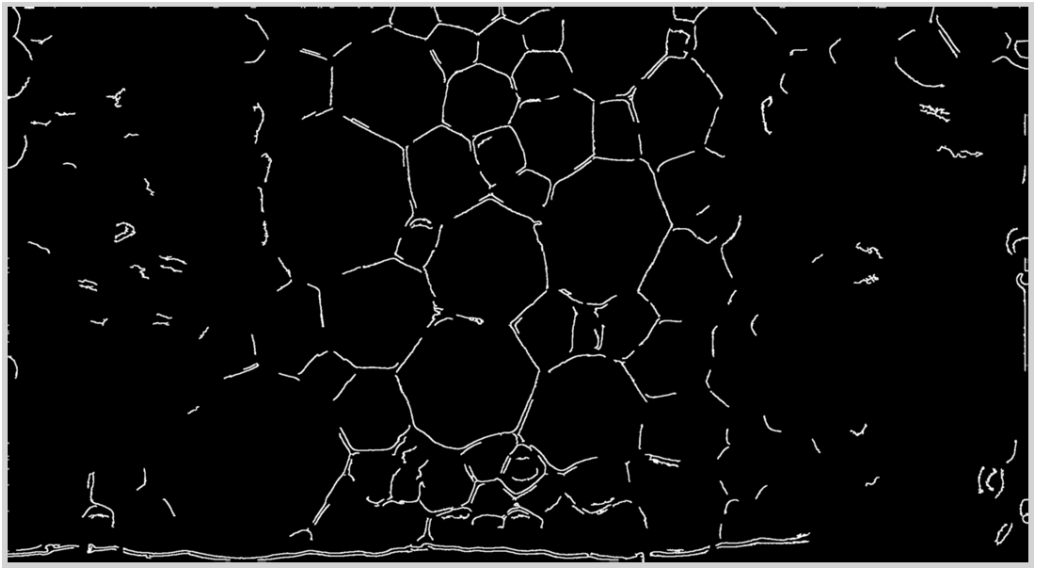


- Get Circularity

Circularity : $F_C = \frac{4 \cdot C_{count}}{\pi \cdot C_{\max}^2}$

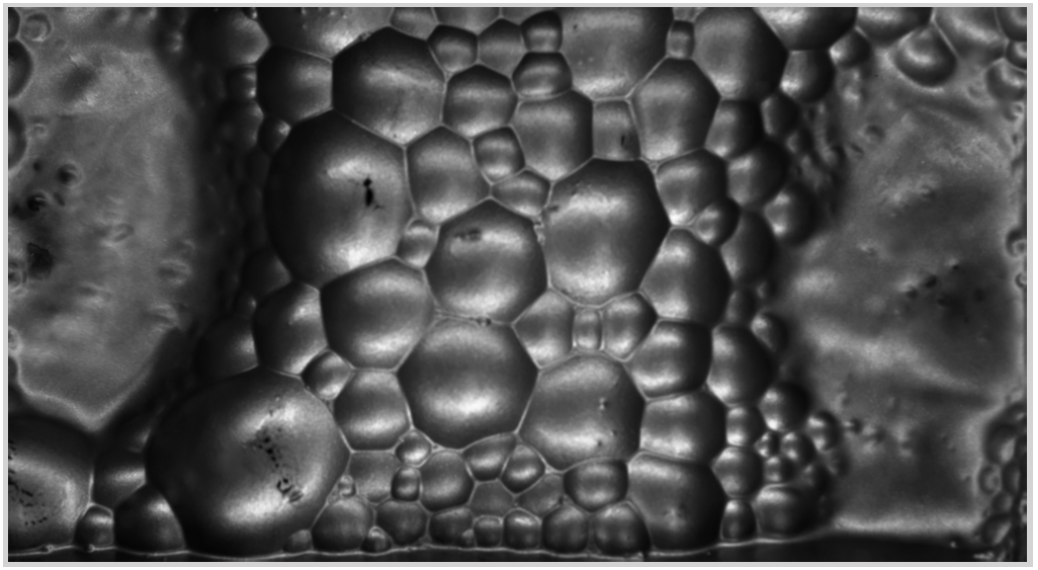
C_{count} : The number of pixels in D_P

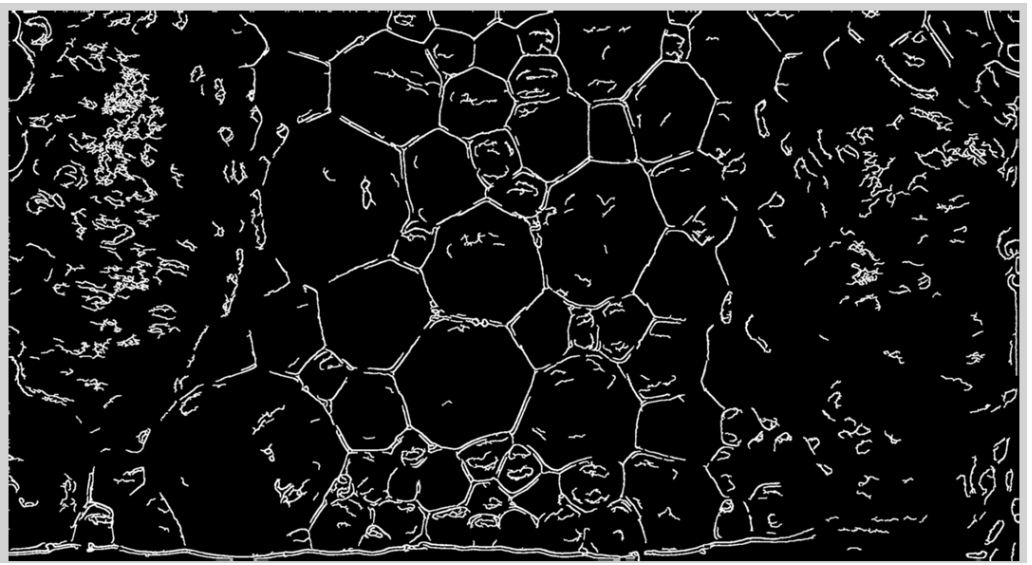
C_{max} : Maximum length of D_P

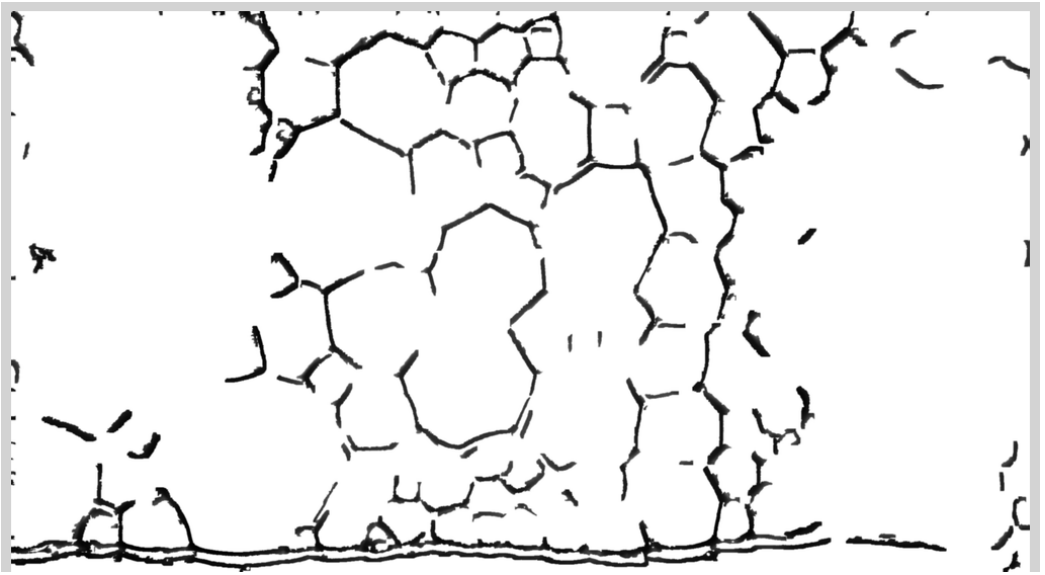


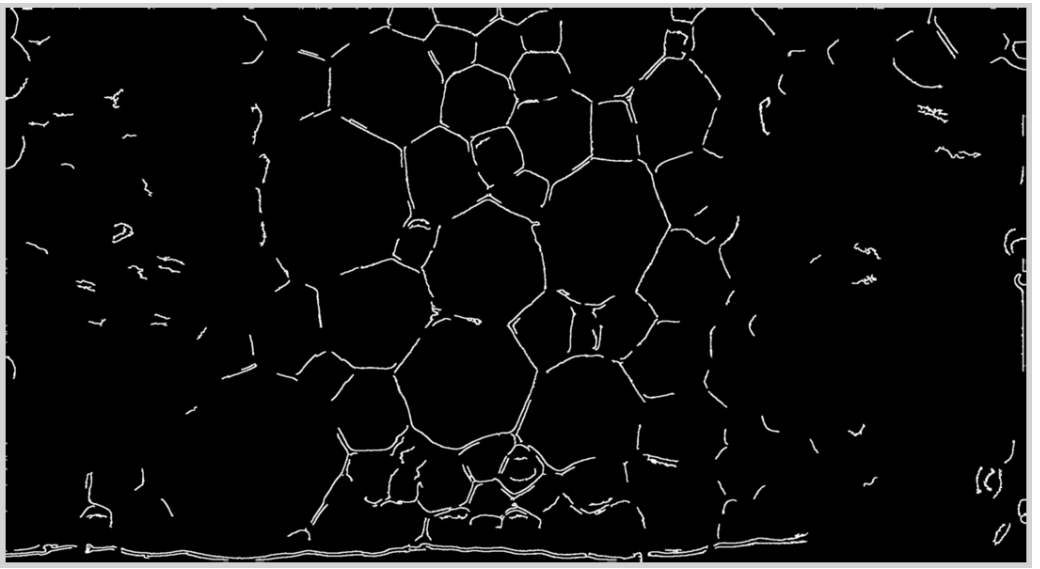
Result

Edge Enhancement Result



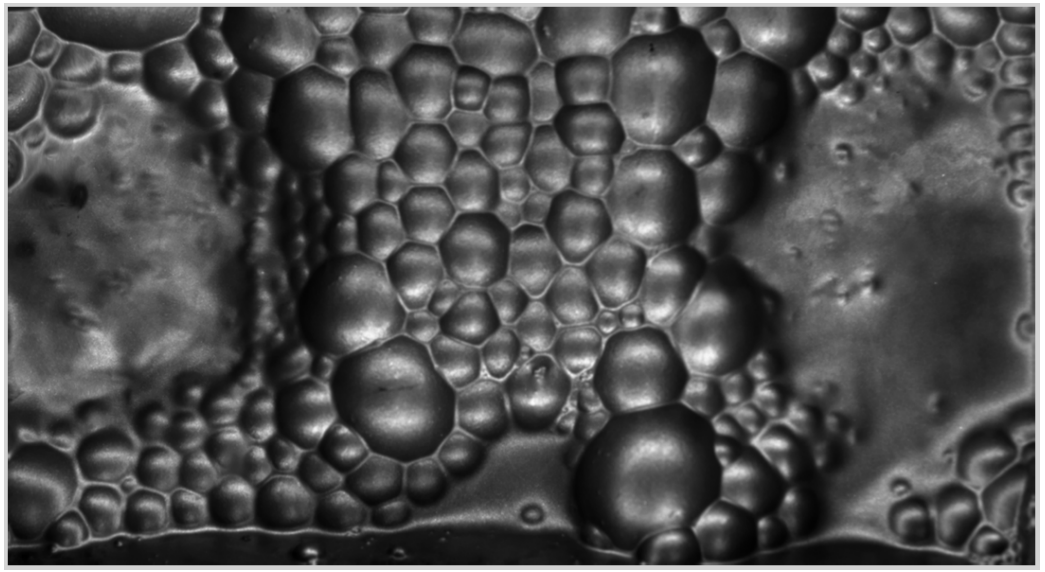


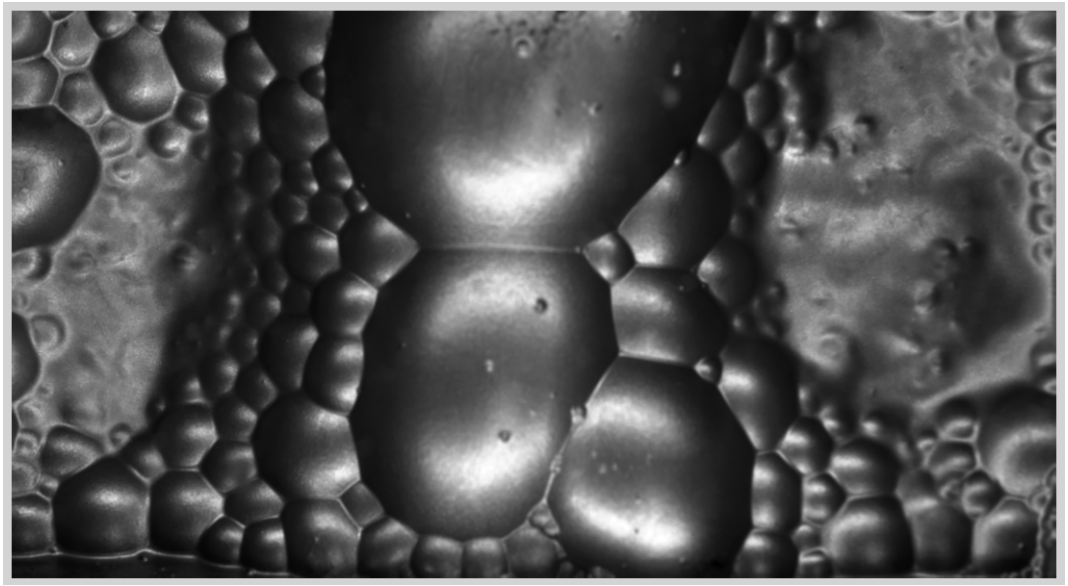


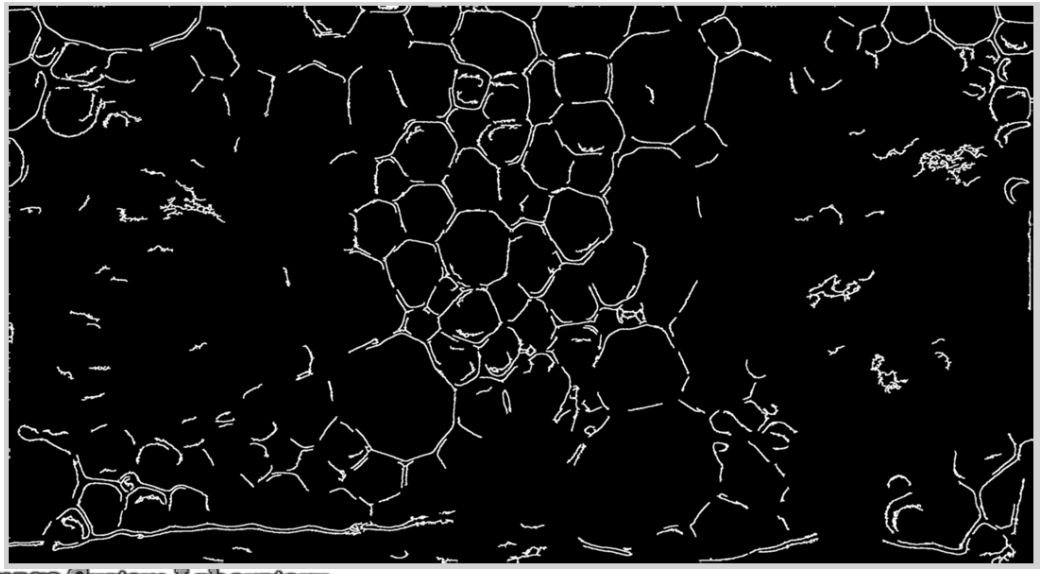


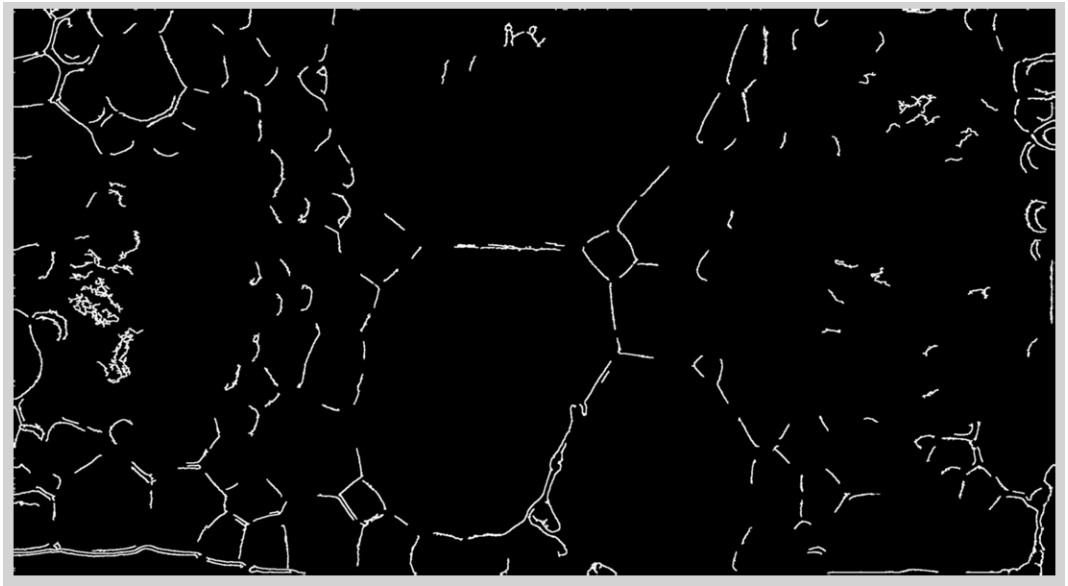
Result

Edge Enhancement Result







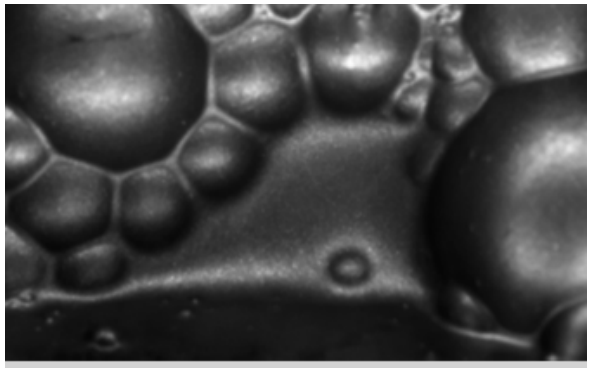


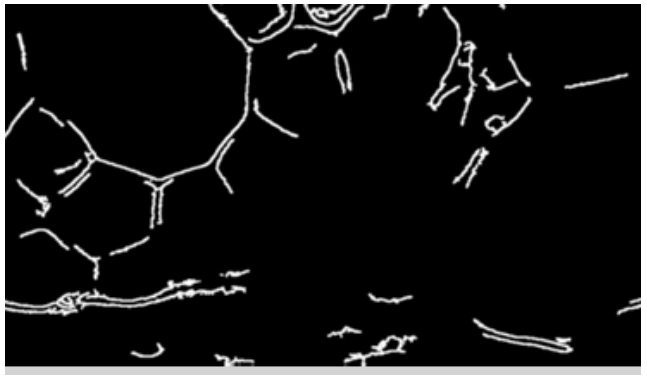
Conclusion

Future work

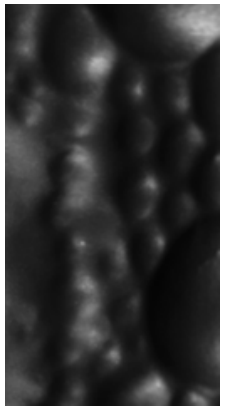
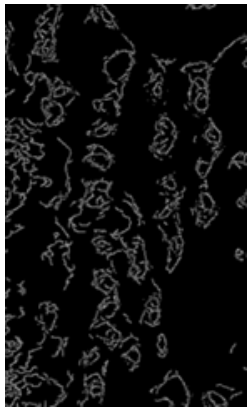
- Local normalization을 기반으로 기존의 결과보다 향상된 경계 검출 결과를 얻었다.
- 검출된 경계 결과를 기반으로 거푸 분할을 진행할 계획이다.

- Smooth하게 조명 변화가 보이는 거품의 경계는 거품 내부의 조명 성분 주변과 비슷한 경향을 갖기 때문에 경계 검출에 어려움이 있다.





- Local normalization영상을 거치면, 입력 영상의 어두운 영역의 거품이 더 잘 보이지만, 경계 검출 과정에서 둥글게 보이기 때문에 Circularity를 이용한 이진화 과정에서 제거 되는 문제가 있다.


Q & A