

PJ : Cold Brew Machine

조원 : 홍기화

[프로젝트 목적]

Cold Brew Coffee Automation System

주 목적

←---- optional
←----- mandatory

1 Ground Coffee Analysis

DSP(OpenCV)

Camera USB 3.0 1920 x 1280

Data 1 : Color(RGB)

Data 2 : Size(mm²)

Under Dark Room and LED light

Under Dark Room and LED light

Filter all but the ground coffee
-> Average the color of the dots

Laplacian Filter -> Contour ->
Size data -> graph(size, count)

2 Sensor Data Processing(Digital Filter)

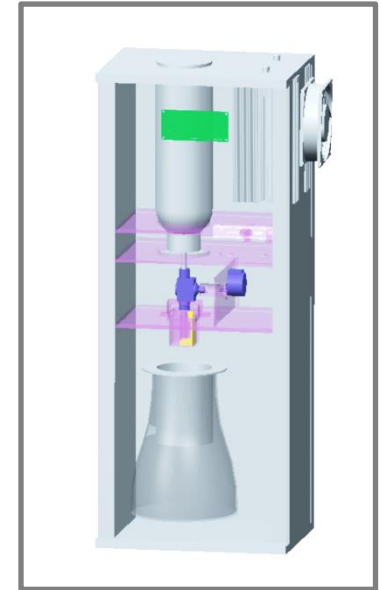
Weight Sensor Data -> ADC(<=3mV Change)

ADC -> DFT

DFT -> Digital Filter(LPF)

Where 1 : Weight Sensor

Where 2 : Temperature Sensor



[프로젝트 목적]

Cold Brew Coffee Automation System

주 목적

←---- optional
←—— mandatory

3 Drop Display On Web

WebGL

Water Drop Visualization

Display Data

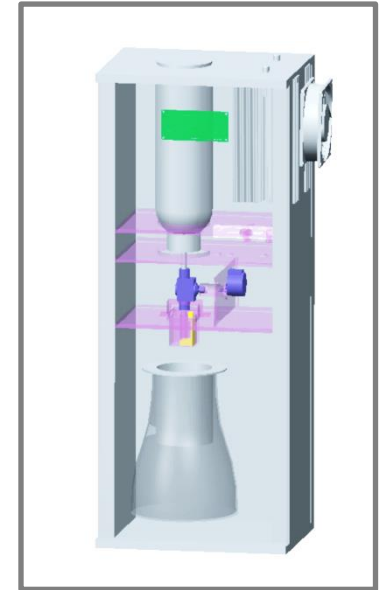
IR Remote -> Web

Ground coffee (size)

Display data

Ground coffee (color)

Select settings



4 Interrupt List(Priority)

1. Remote Control

2. Drop Count

3. Weight Sensor

4. LCD Display

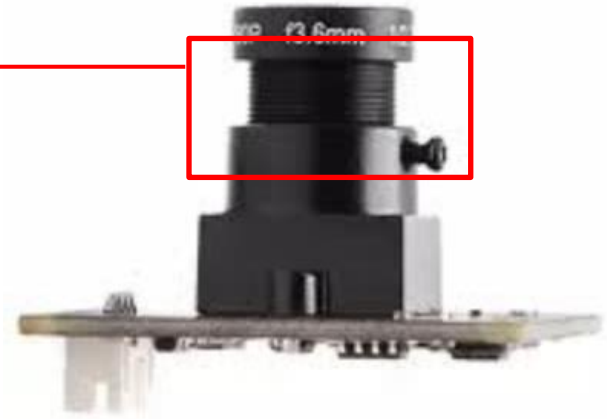
[PJ CBM : BOM]

대분류	소분류	품명	수량(ea)	단위가격(원)	총액(원)
electronic parts	MCU	TI tms570 launchpad	1	37570	37570
	LCD	LC1621 LCD	1	7700	7700
	Weight Sensor	Load cell BND-611N 1kg	2	25300	50600
	Weight Sensor	Load cell BND-611N 2kg	1	14500	14500
	Weight sensor adc IC	HX711 Module (24bit AD)	1	1540	1540
	Drop Sensor	photo interrupter	1	1760	1760
	Temperature sensor	ETH-01DV	1	8910	8910
	UV-LED	uv-c 4545 smd led 5mW	3	5000	15000
	IR receiver + control board	(chinese)	1	2000	2000
	step motor controller	ULN2003 Module	1	1300	1300
	step motor for valve control	28BYJ-48	1	1200	1200
	FAN		1	17500	17500
	TEC Module	TEC-12705	2	5400	10800
	Relay		2	2000	4000
	Camera	usb3.0	1	75000	75000
Mechanical parts	door switch	ramps 1.4 limit switch	3	2400	7200
	펄티어 단열스폰지	펄티어 단열스폰지	1	600	600
	Peltier heatsink	Peltier-Heatsink-Set(협신전자)	1	16500	16500
	LED PCB	smd led 기판	1	1800	1800
	투명 튜브	에어호스 6mm	1	800	800
	electric wire	0.35Q x 12C 10color 1m	1	1300	1300
	wire mold	wire duct PVC 사각몰드 밤색 1호	3	300	900
	문 경첩	경첩	2	1000	2000
	문고리	문고리	1	1000	1000
	문자석	문 자석	1	1200	1200
	case	플라베니아 5T 회색	1	4950	4950
	단열재	압축스티로폼 20mm	1	2000	2000
	물병	물병 티보틀	1	5000	5000
	실리콘마개	SL.Sto6105 (싸이랩코리아)	1	4500	4500
	Water valve	FSC0600 호스6mm 미세조절	1	2600	2600
	Water tank	daiso 1001333	2	1760	3520
	Li-po 2800mAh 35C	Li-po 2800mAh 35C	1	51900	51900
	3D Printer	Ender 3	1	230000	230000
	3d print 필라멘트	PLA 필라멘트 1kg	2	17500	35000
	볼트너트	m3,m4,m5 볼트 너트 와셔 세트(은색)	1	6100	6100
	더치기구	더치기구	1	19500	19500
합계 총액					647,750

[PJ CBM : 진행 상황]

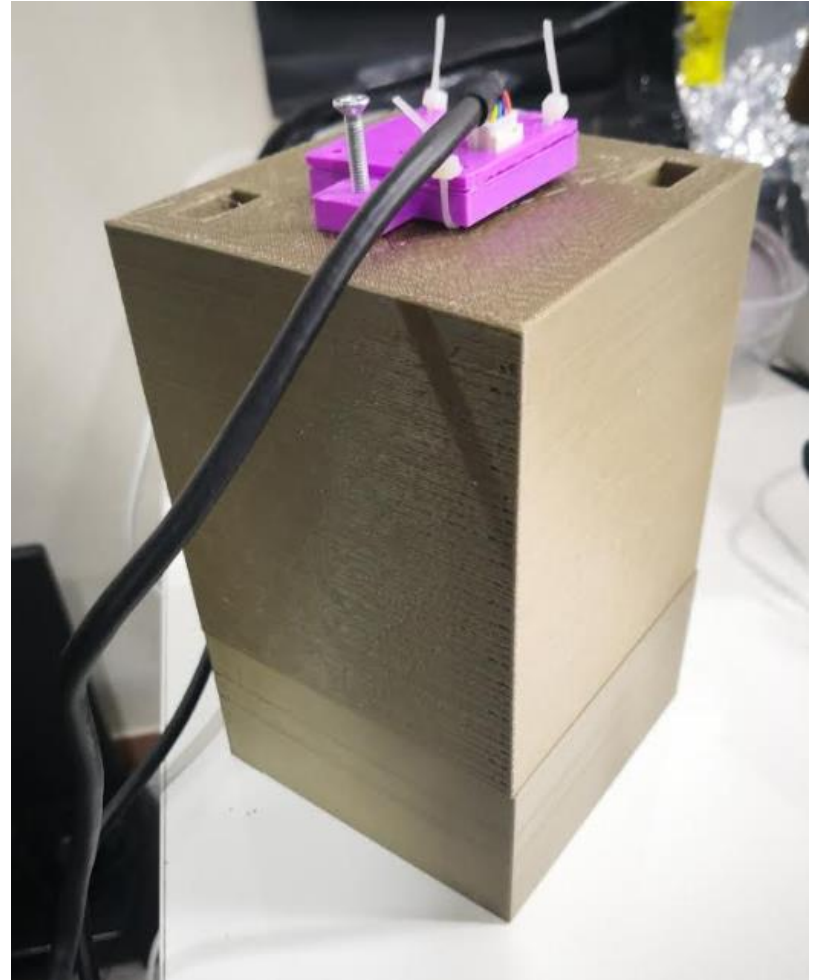
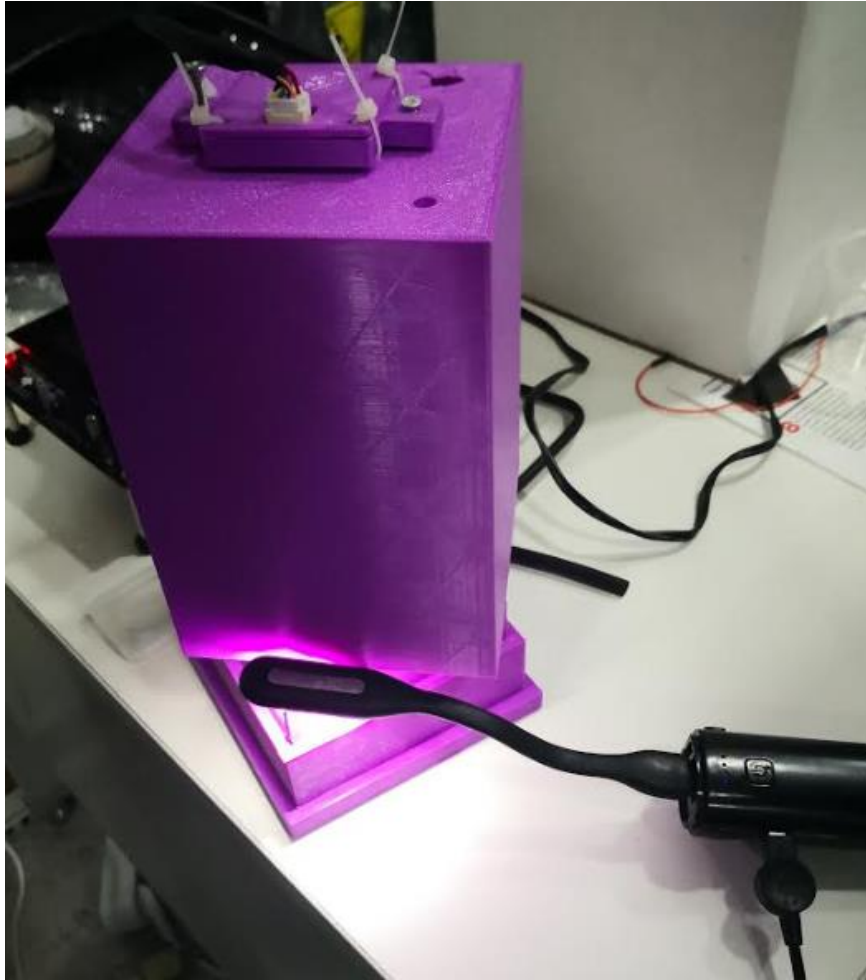
❑ Camera Focus

175mm 위치에 초점을
수동으로 맞춘다. ←



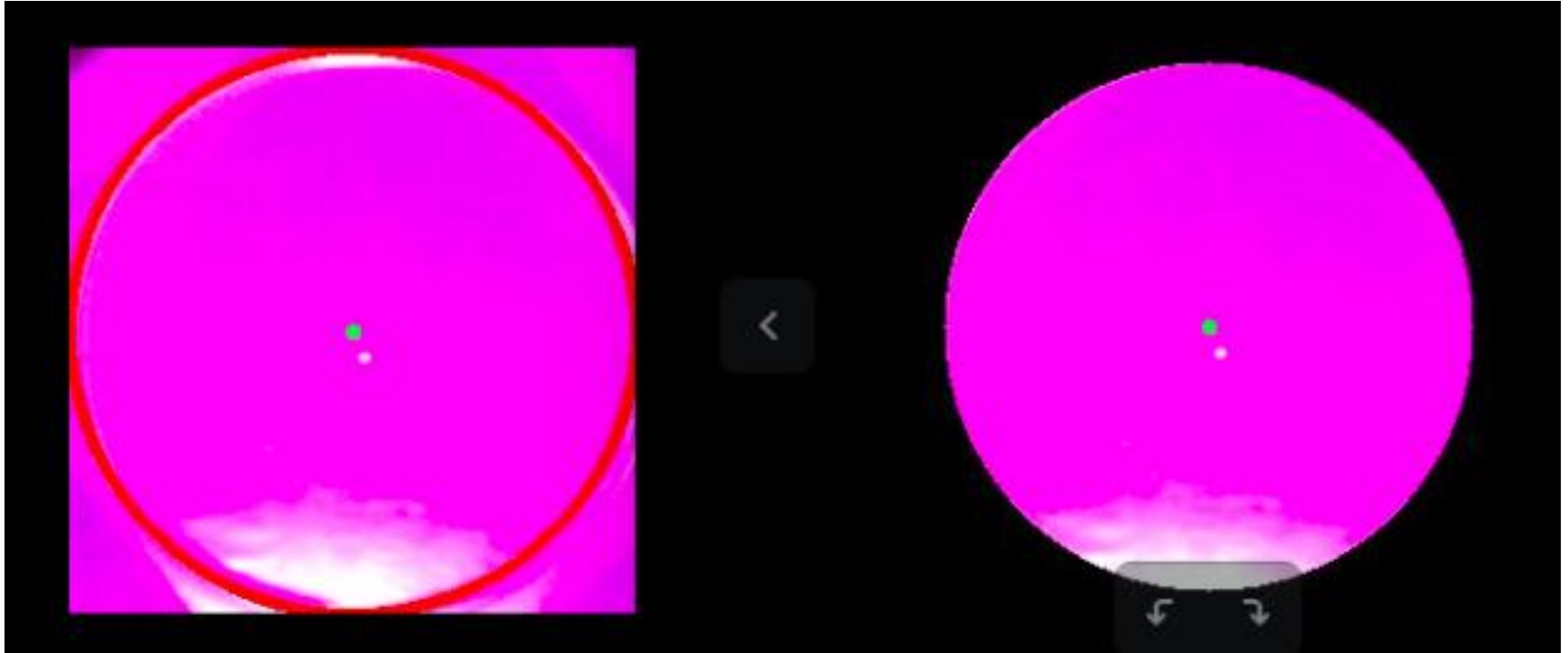
[PJ CBM : 진행 상황]

☐ Dark House 3D Print



[PJ CBM : 진행 상황]

□ ROI 추출 (Hough Circle)



< Hough Circle Detection >

< Radius, Center filtering >

[PJ CBM : 진행 상황]

❑ Color Average (with Black and White Filter)

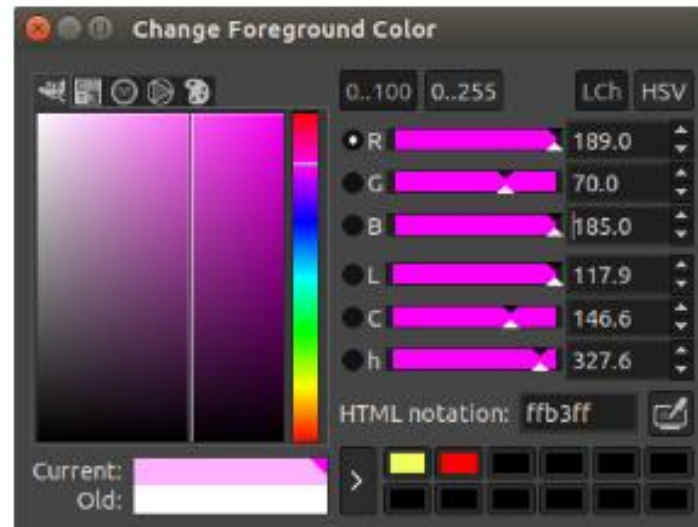
< 가운데 쪽 한 점 색상 분석 >

```
r : 124  
center : 326,236  
limit = 2111111111  
center r = 255, g = 95, b = 255
```



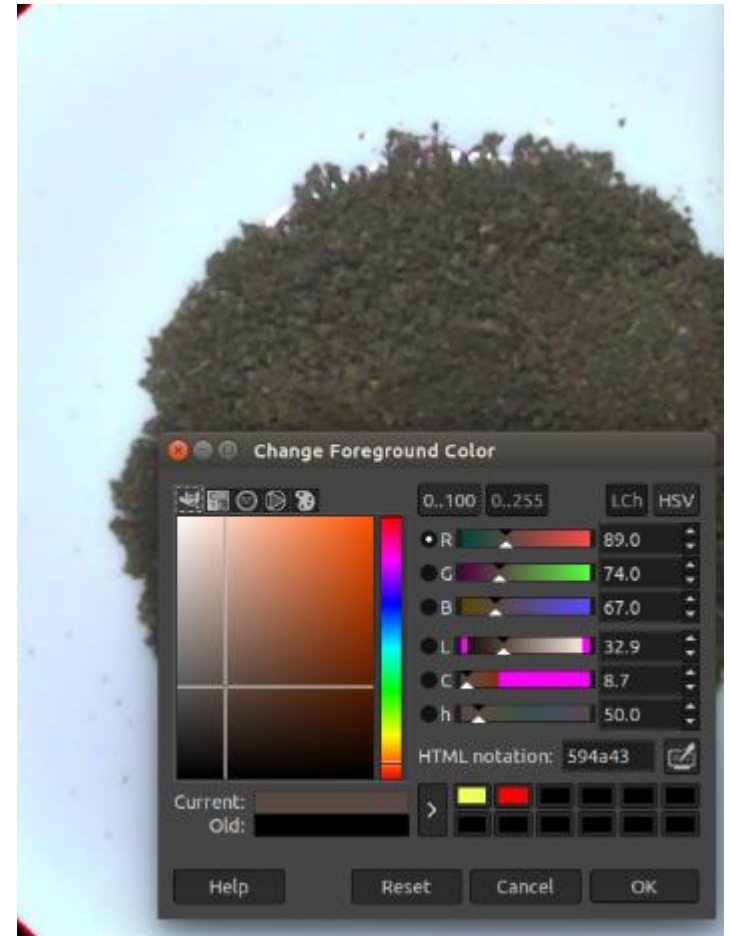
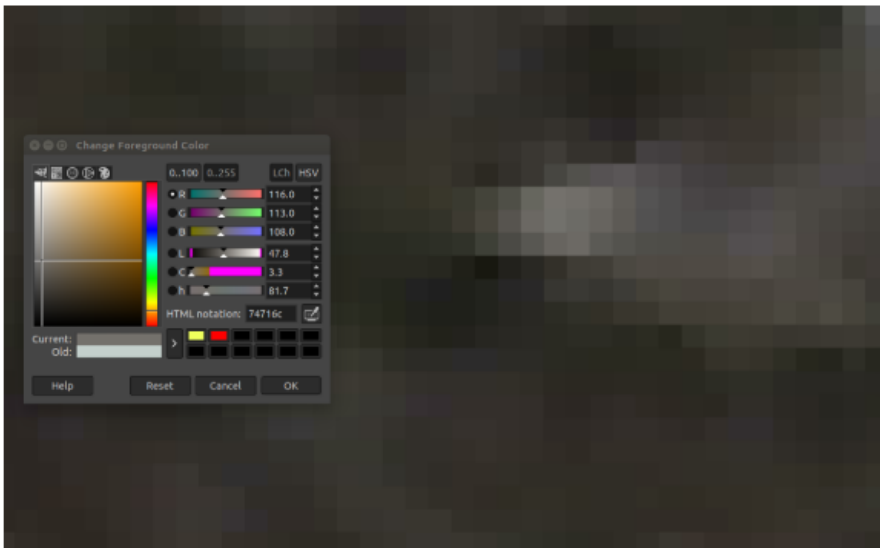
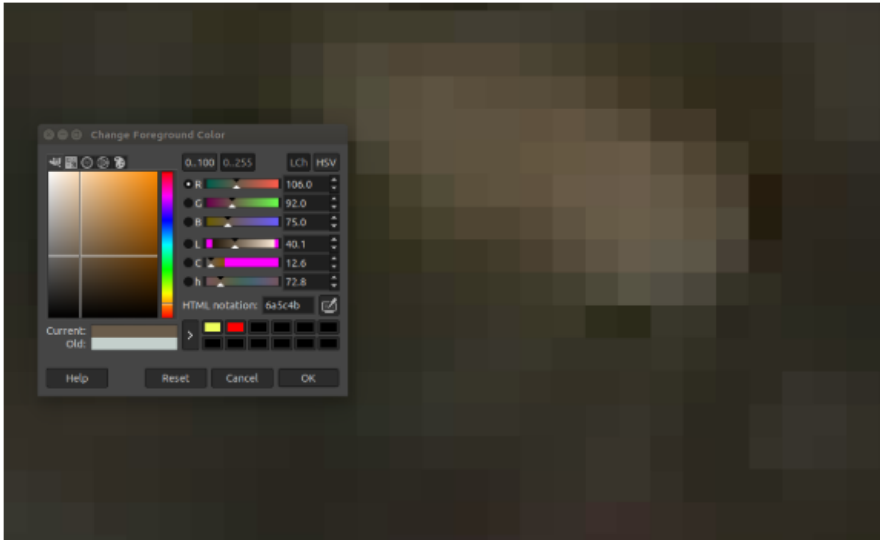
< 전체 색 평균 >

```
r : 118  
center : 330,238  
avg r = 189, g = 70, b = 185
```



[PJ CBM : 진행 상황]

- ❑ Color Average (with Black and White Filter) -> Applied to Ground Coffee Beans

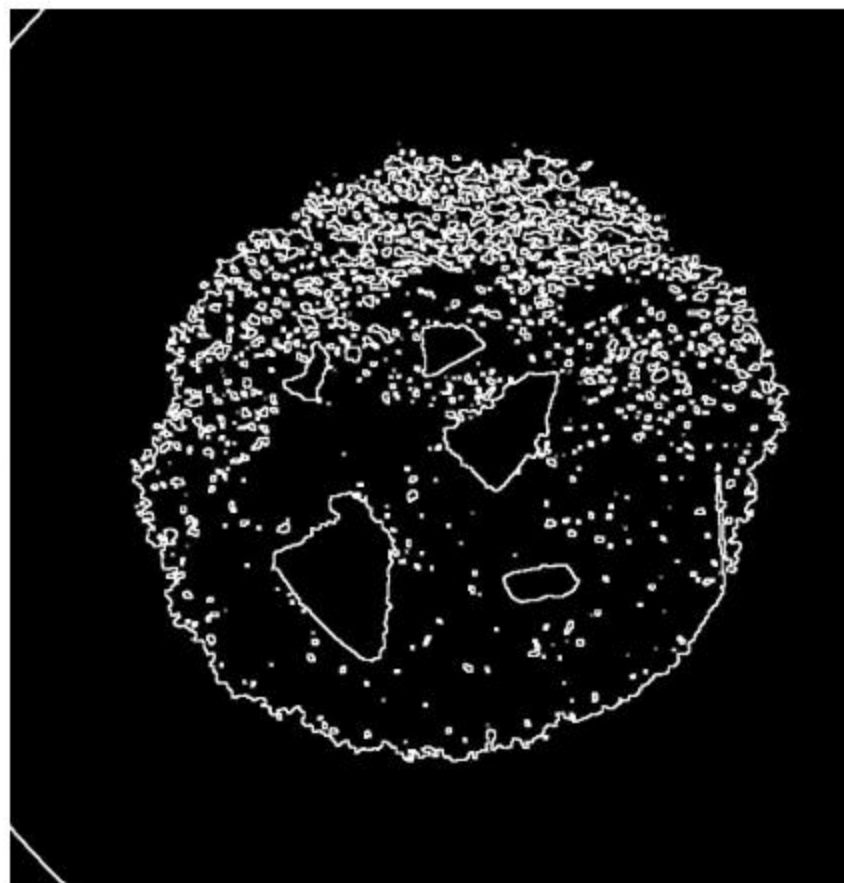


[PJ CBM : 진행 상황]

- Ground Coffee Size Analysis : threshold change to get particle lines

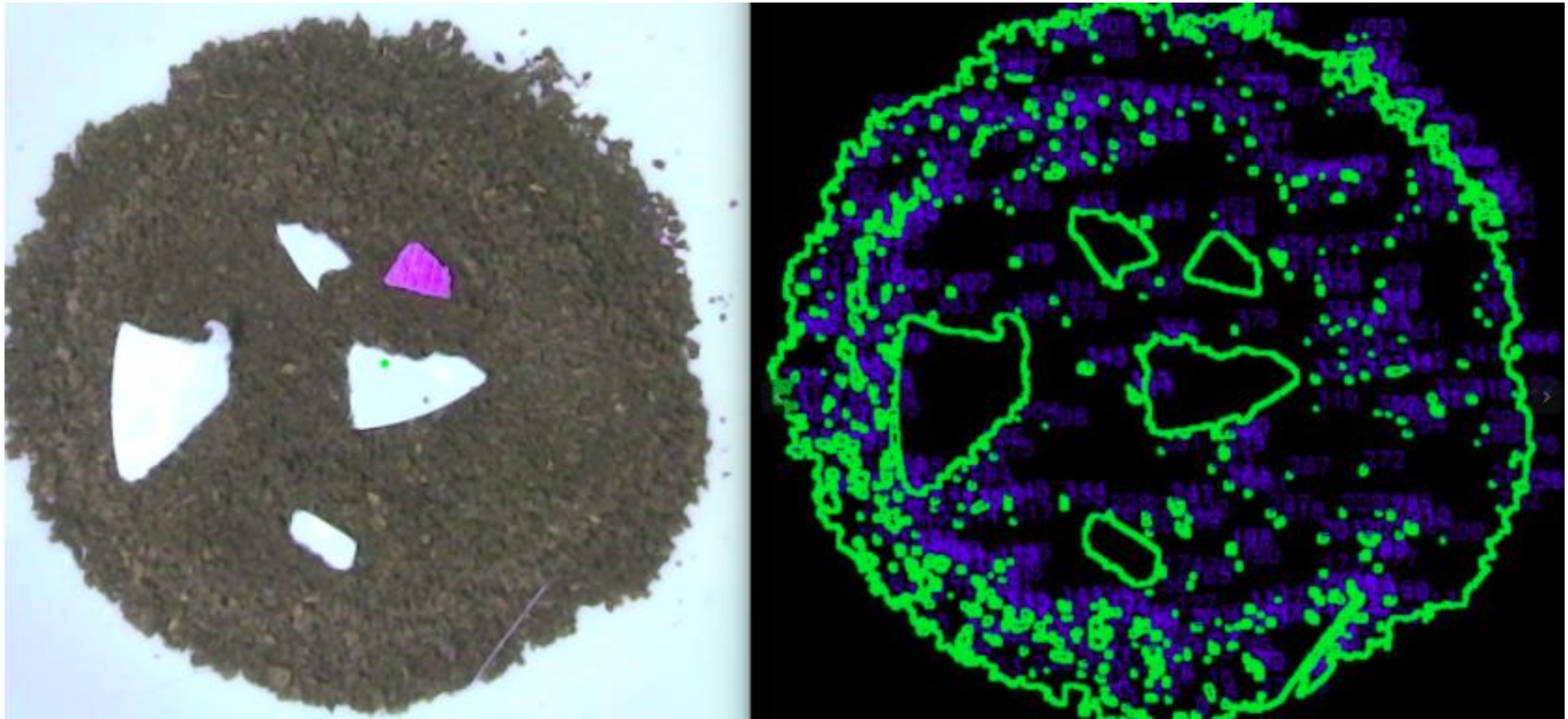
```
GaussianBlur(croi, croi, cv::Size(3, 3), 0, 0);  
cvtColor(croi, croi, COLOR_RGB2GRAY);  
threshold(croi, croi, 120, 255, THRESH_BINARY);  
Laplacian(croi, dst, CV_16S, 3, 1, 0, BORDER_DEFAULT);  
convertScaleAbs(dst, abs_dst);
```

```
GaussianBlur(croi, croi, cv::Size(3, 3), 0, 0);  
cvtColor(croi, croi, COLOR_RGB2GRAY);  
threshold(croi, croi, 100, 255, THRESH_BINARY);  
Laplacian(croi, dst, CV_16S, 3, 1, 0, BORDER_DEFAULT);  
convertScaleAbs(dst, abs_dst);
```



[PJ CBM : 진행 상황]

- Ground Coffee Size Analysis : Area Display on Contours

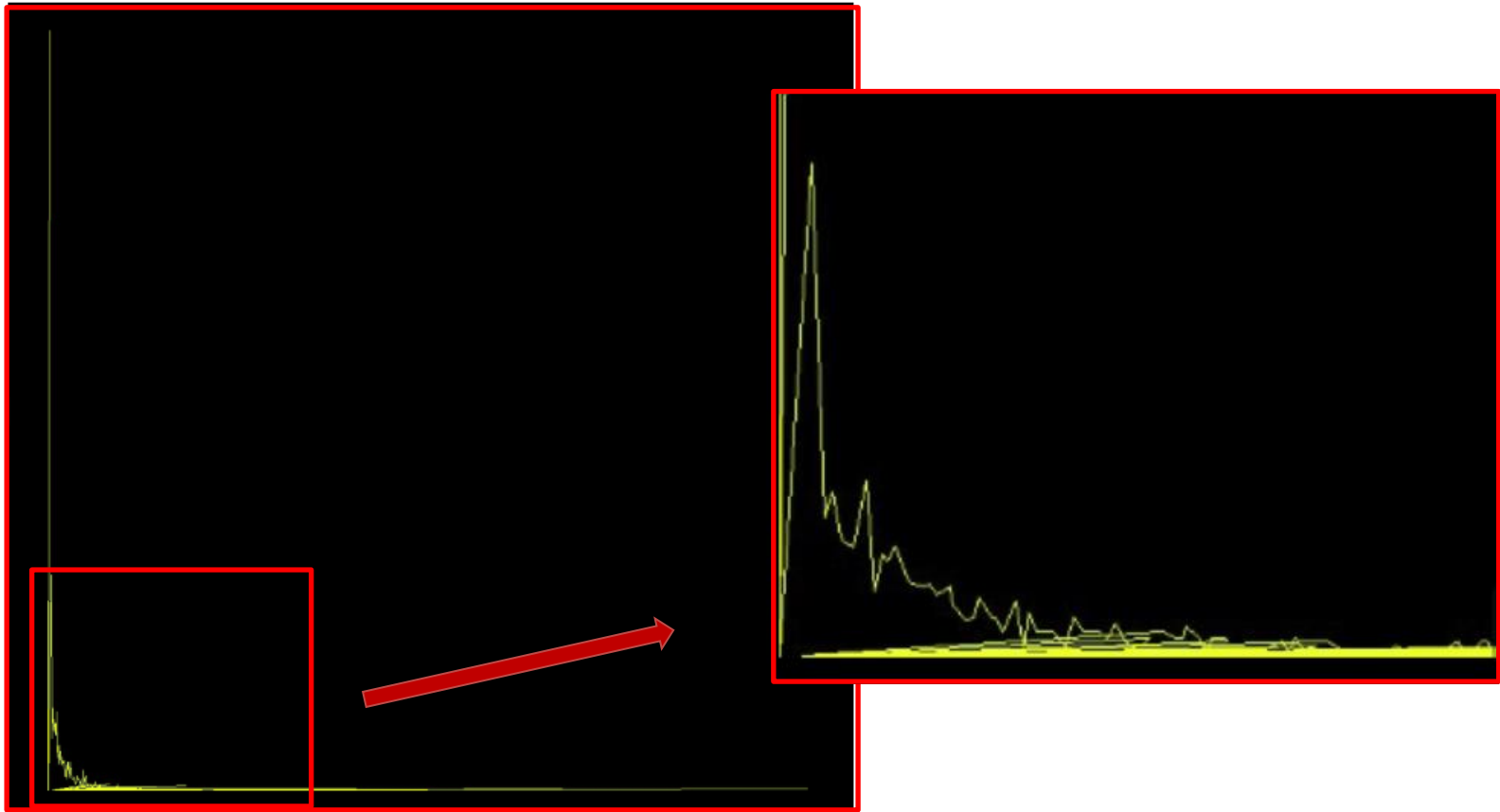


[PJ CBM : 진행 상황]

☐ Ground Coffee Size Analysis : Area Display on Contours

x = blob area data (0~1000)

y = data count ++; (0~1000)



[WEEK 5 : 상세 진행 상황, 문제 & 해결방안]

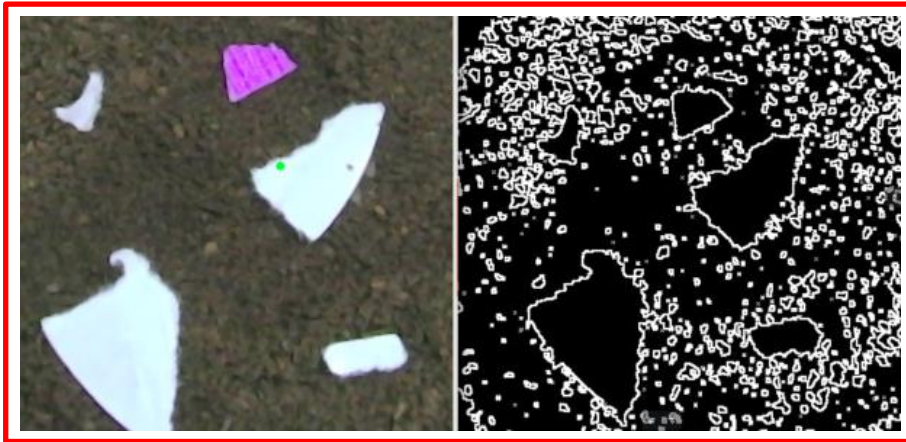
발생문제

□ Contour 인식을 다양한 상황에서 사용하기 어렵다.

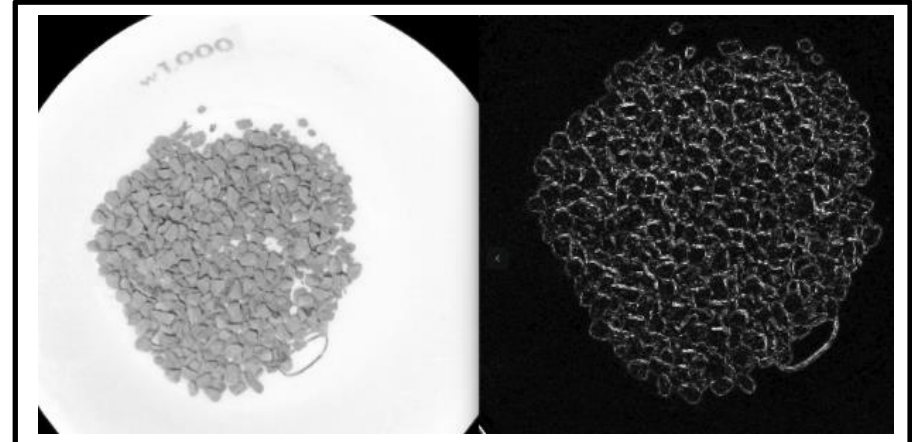
-> blob 인식 한계

해결방안

□ 필터링을 통해 인식 정확도를 향상한다.



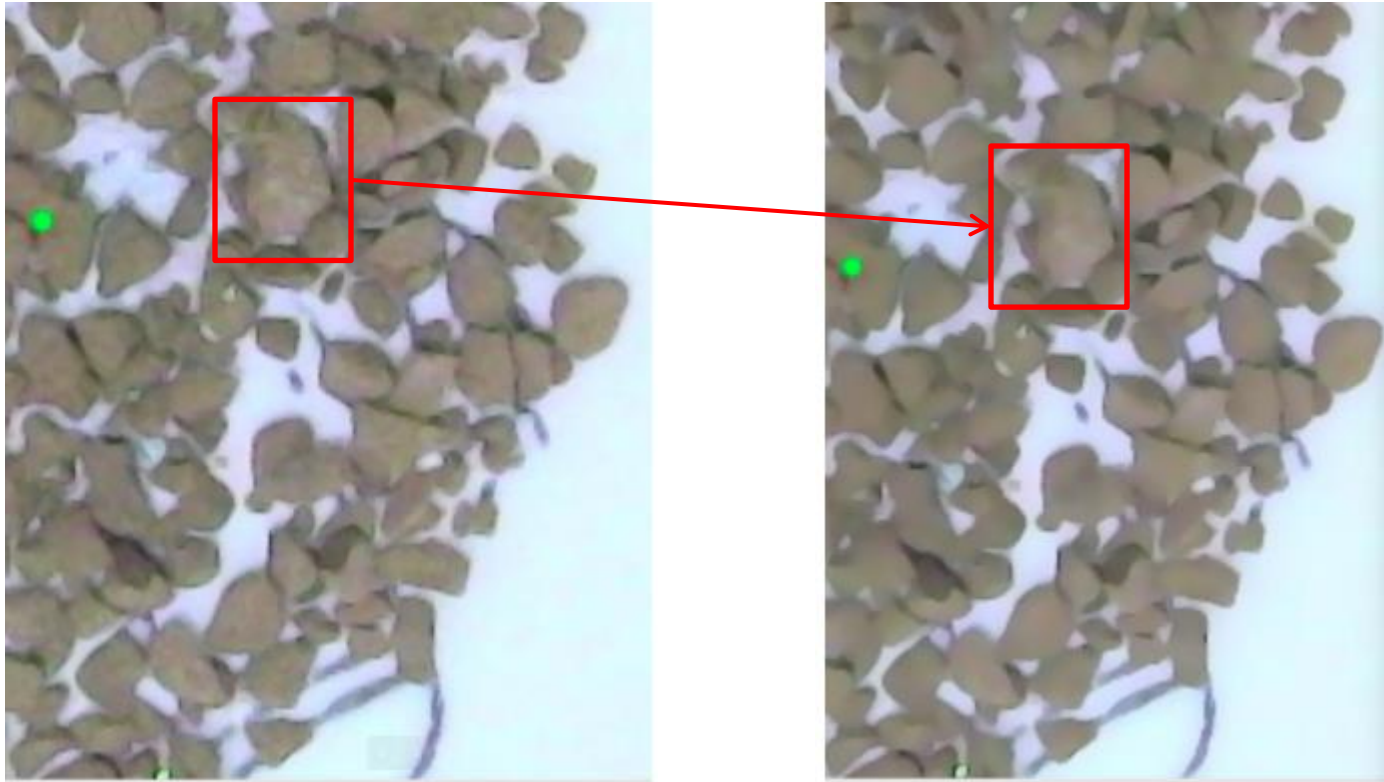
인식이 잘 되는 경우



인식이 잘 안 되는 경우

[PJ CBM : 진행 상황]

- 해결방법 1 : Bilateral (contour라인은 유지하며 색 blur)

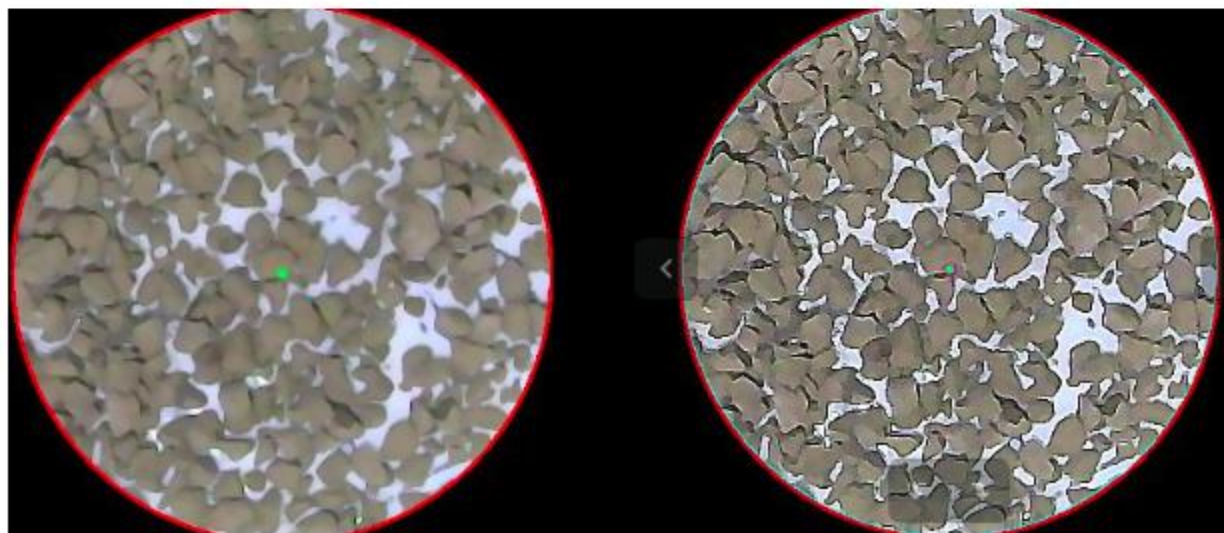


[PJ CBM : 진행 상황]

□ 해결방법 2 : Sharp image

<sharpened 결과>

```
cvtColor(croi2, croi2, COLOR_BGR2GRAY);  
  
Point anchor = Point (-1,-1);  
Mat kernel = Mat(3,3,CV_32F);  
  
kernel.at<float>(0,0) = -1;  
kernel.at<float>(0,1) = -1;  
kernel.at<float>(0,2) = -1;  
kernel.at<float>(1,0) = -1;  
kernel.at<float>(1,1) = 9;  
kernel.at<float>(1,2) = -1;  
kernel.at<float>(2,0) = -1;  
kernel.at<float>(2,1) = -1;  
kernel.at<float>(2,2) = -1;  
  
filter2D(croi2, croi2, -1, kernel, anchor, 0, BORDER_DEFAULT);  
imwrite("after sharpened.jpg", croi2);
```



[PJ CBM : 상세 진행 상황, 문제 & 해결방안]

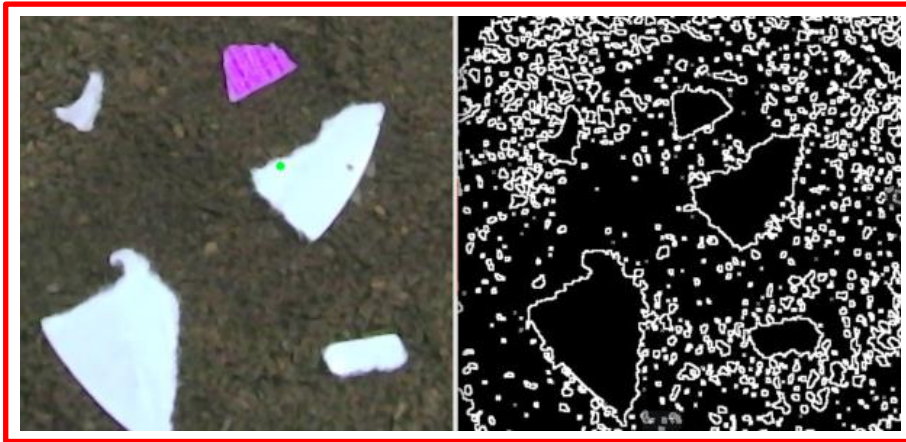
발생문제

- Contour 인식을 다양한 상황에서 사용하기 어렵다.

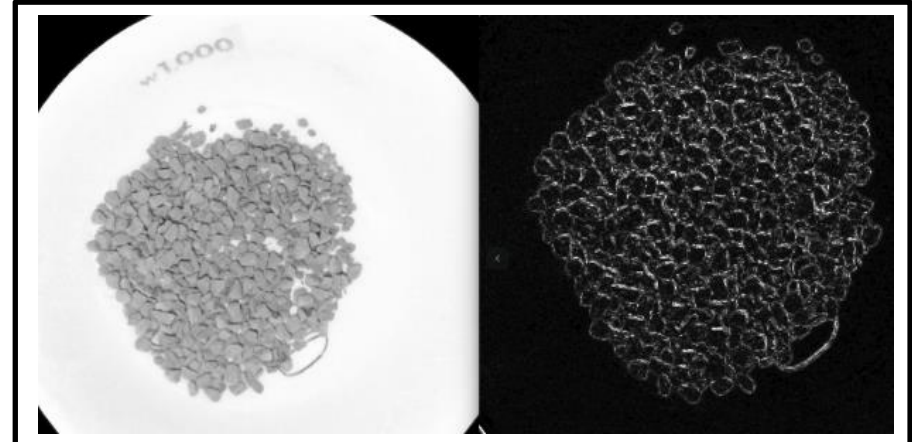
-> blob 인식 한계

해결방안

- DCT(Discrete Cosine Transform)



인식이 잘 되는 경우



인식이 잘 안 되는 경우

[PJ CBM : 진행 상황]

□ 해결방법 : DCT

< dct_out2 (dct 하고 난 결과 matrix) 의 성분 분석 >

```
channel num : 1
type : 5
```

: type 5 는 opencv 문서상에 CV_32F 로 되어있다. 따라서 실수 1 채널 임을 알 수 있다.

아래는 매트릭스 시작부분(5x5) 값 출력 확인 정보.

```
164914, -986.93, -27611.8, 885.382, -25399.8, -342.662
1070.79, -376.439, -392.989, 749.378, -1019.16, -456.593
-29700.1, 602.148, -54508.5, -627.298, 7064.51, 325.642
62.864, 112.199, -1335.56, -595.616, 1772.05, 542.122
-23684.8, 220.209, 5651.07, -499.911, 21854.6, 616.836
```

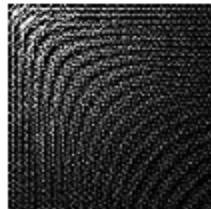
아래는 매트릭스 끝부분 일부의 값 출력 확인 정보.

```
, -7.2127733, -0.41208896, -4.430706, 0.33321682, -0.4084633, -0.35603428, 5.1039228, 0.17
050008, 1.1738181, -2.3127103, -3.3720632, 3.7254994, -4.0751104, -2.5469992, 2.3778839, -
```

Dc 값 (dct_out2.at<float>(0,0) = 163763~~~ 이런식으로 나오고 나머지 멀리 떨어진 ac 값들은 위와 같은 값이 나온다.

< 125x125 ROI 코드 + (0,0)=0; >

```
dct_out2.at<float>(0,0)=0;
dct_125 = dct_out2(Range(0,125),Range(0,125));
meanStdDev(dct_125, mean, stddev);
imwrite("after_dct_roi.jpg", dct_125);
cout << " 125x125 : " << dct_125 << endl;
cout << " mean : " << mean << endl;
cout << " stddev : " << stddev << endl;
```



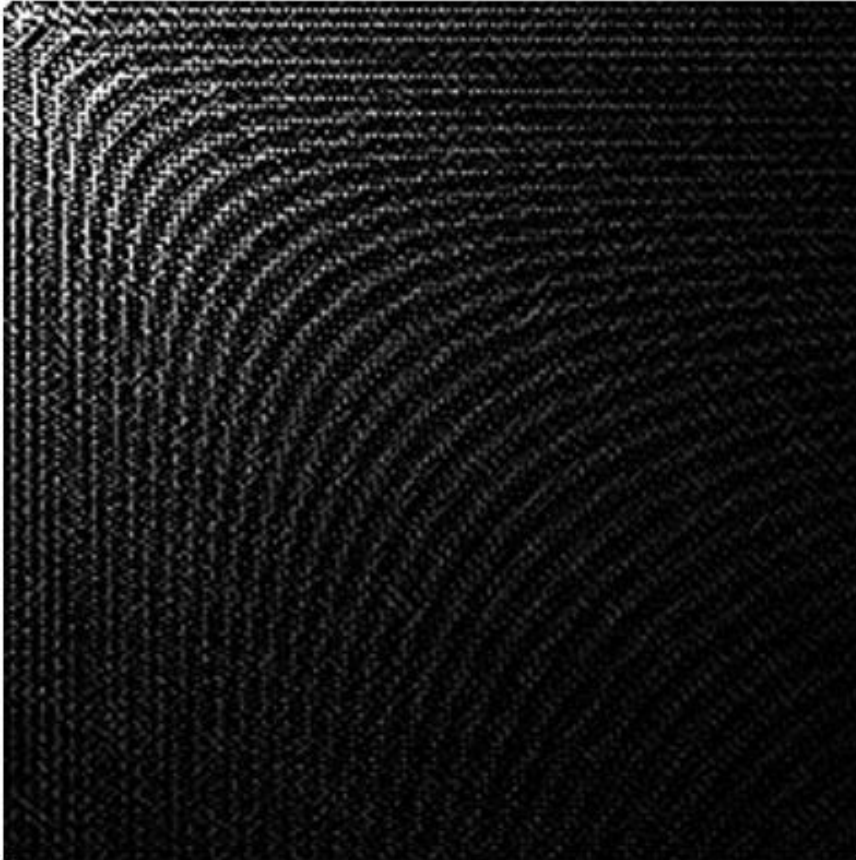
after_dct_roi.jpg

< DCT 변환 후 이미지 >

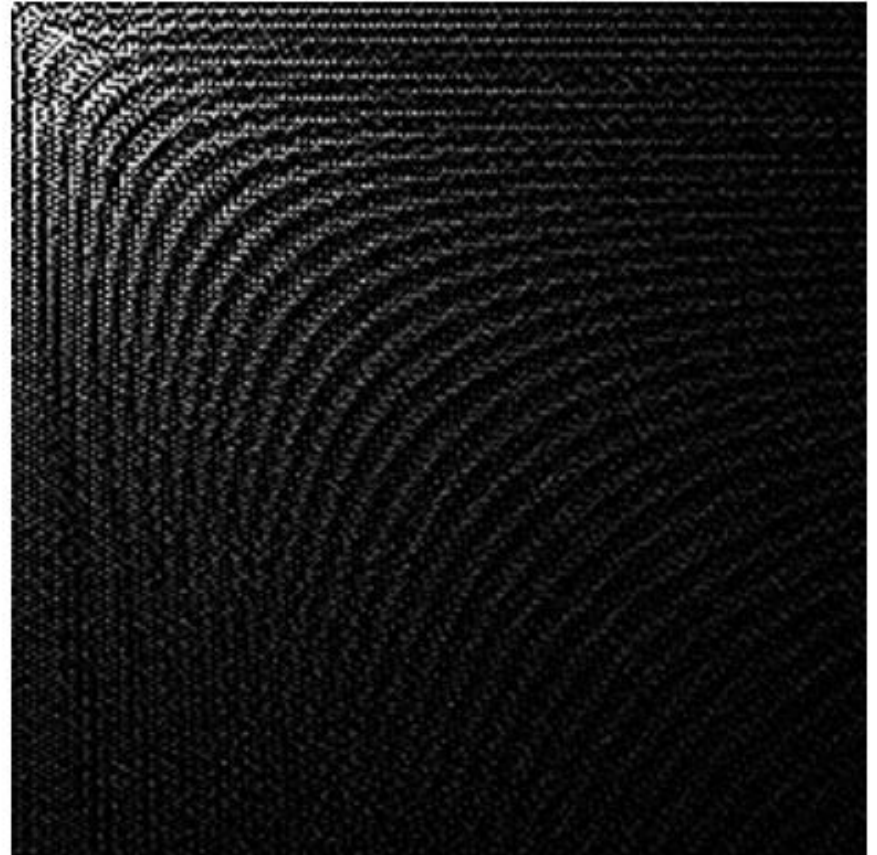
[PJ CBM : 진행 상황]

□ 해결방법 : DCT

알갱이가 클 때

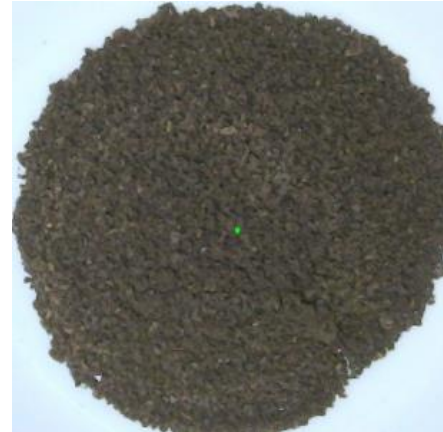
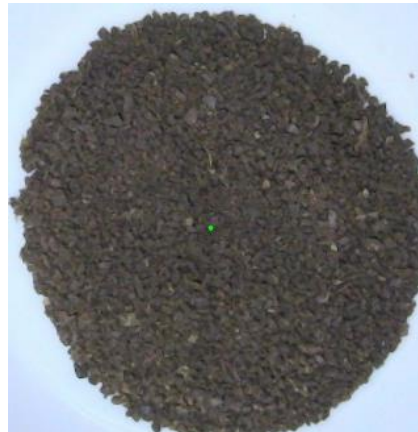


알갱이가 작을 때



[PJ CBM : 진행 상황]

□ 해결방법 : DCT



mean : [-9.60]674664283038]
stddev : [772.0268123370257]

mean : [-8.40]592419734717]
stddev : [779.4965161821599]

mean : [-8.51]483561628818]
stddev : [787.9079488896617]

mean : [-7.77]5558051560401]
stddev : [748.0032626638935]

mean : [-9.427824454484044]
stddev : [758.5713192324557]

mean : [-8.363238039486468]
stddev : [784.1948357911308]

mean : [-8.783586014666199]
stddev : [806.7052165413548]

mean : [-8.318526640209436]
stddev : [791.8764773190211]

mean : [-9.603626961376845]
stddev : [767.0692896284687]

mean : [-8.52400558482492]
stddev : [788.6245738515271]

mean : [-8.858097348047494]
stddev : [808.5567838862721]

mean : [-7.936445702630787]
stddev : [765.1635316026013]

[프로젝트 일정]

6/10~7/11



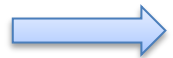
DSP(Camera)



Sensor fix(고장 수리)



DFT, LPF



WebGL



Interrupt Priority check



Debug

Mon	Tue	Wed	Thu	Fri
10	11	12	13	14
	Sensor fix(고장 수리)			
	DSP(Camera)			
17	18	19	20	21
DSP(Camera)				
24	25	26	27	28
DFT, LPF				
		WebGL		
1	2	3	4	5
Interrupt Priority check				
DFT, LPF				
8	9	10	11	
Debug				