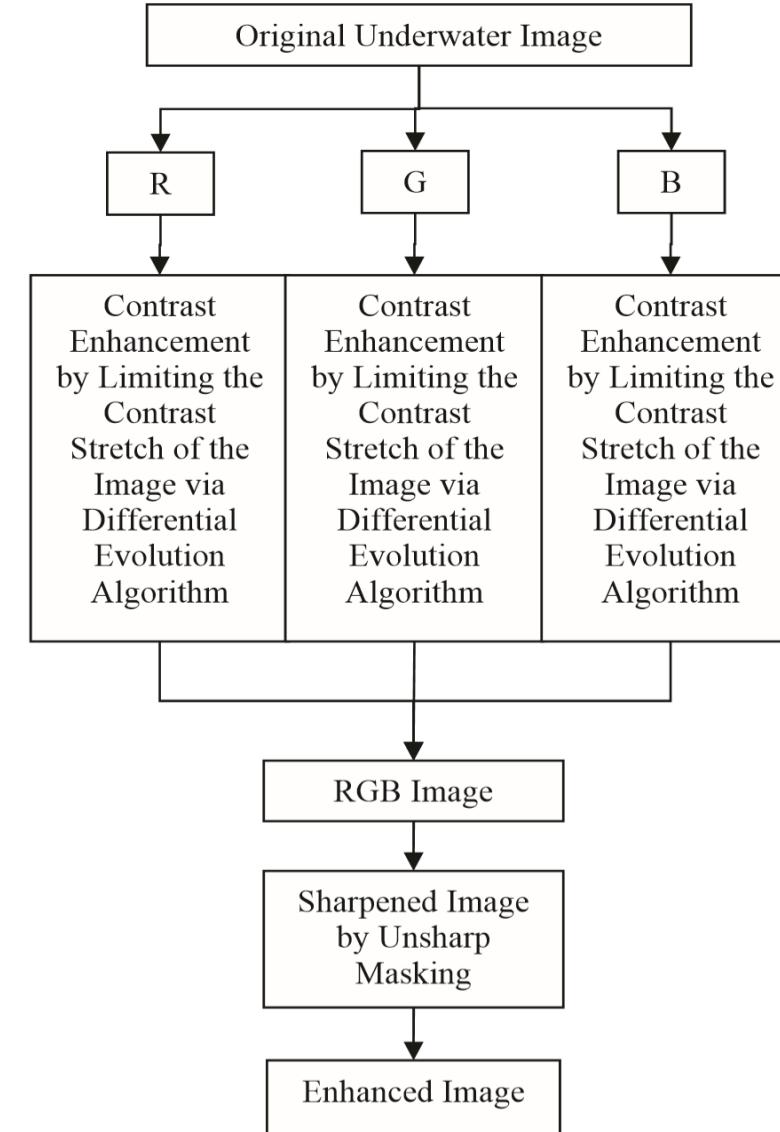


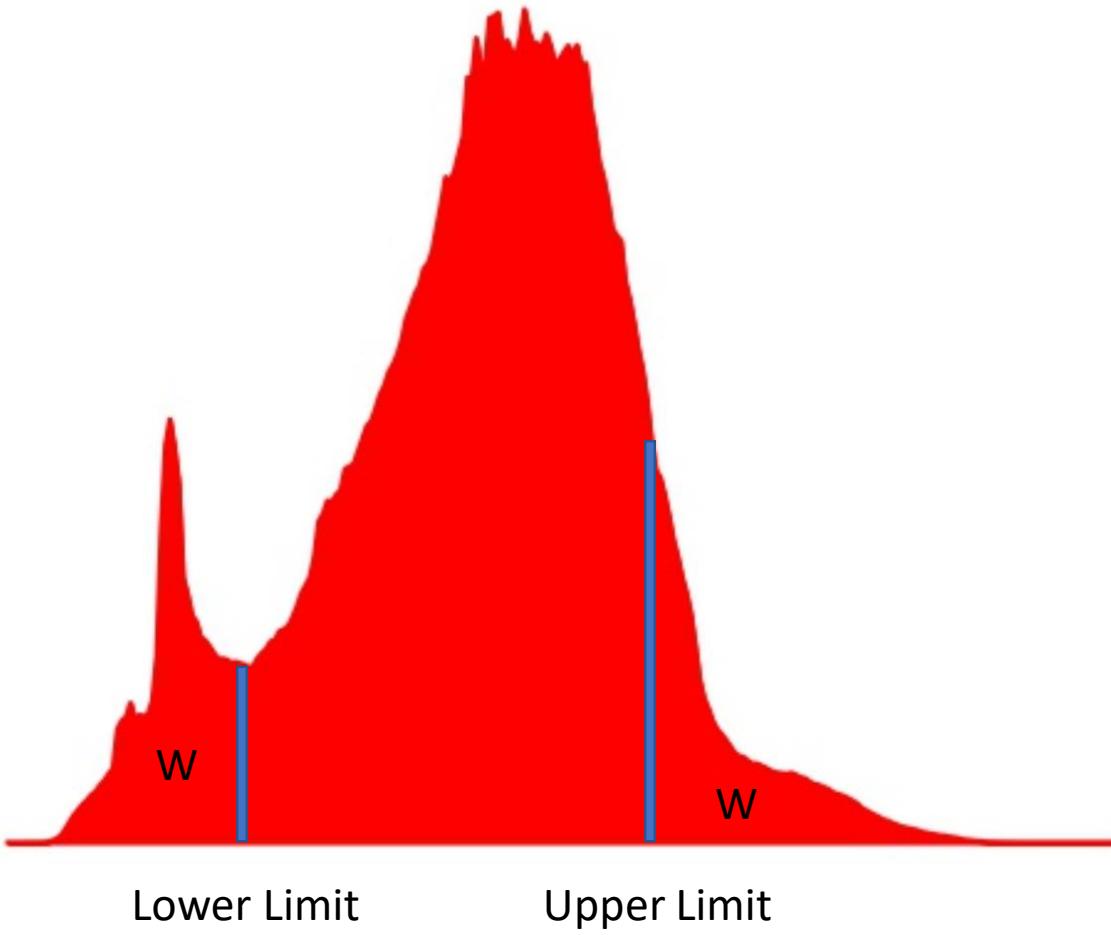
Underwater Image Enhancement Based On Contrast Adjustment via Differential Evolution Algorithm

Team Name	:kvl
Team Members	: 1.2018801010 - Karnati Venkata Kartheek - PhD CSE 2.2018900014 - Arun Kumar Subramaniam - PGSSP
Title Of Project	:Underwater Image Enhancement Based On Contrast Adjustment via Differential Evolution Algorithm
Mentor TA	:Prathyakshun
Repo URL	: https://github.com/Kartheek77/DIP-Monsoon2019-Project

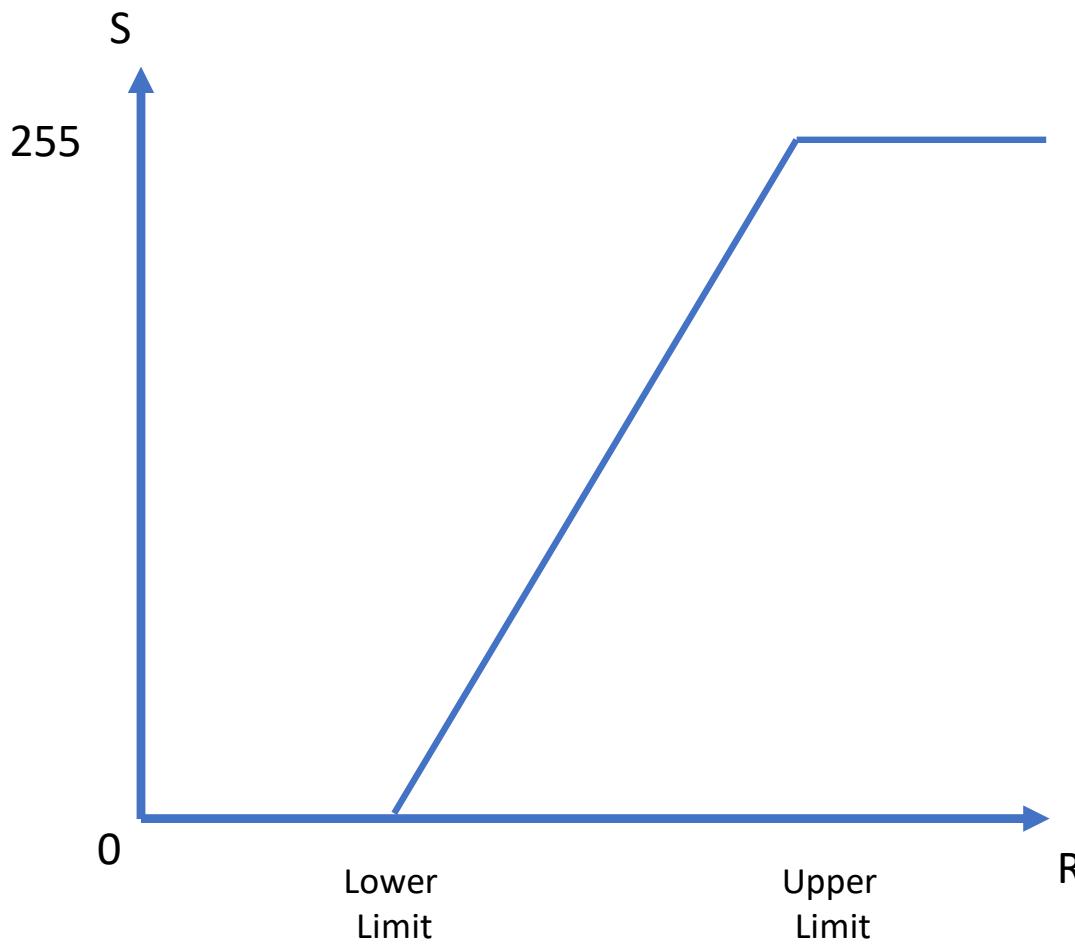
Algorithm



Histogram



Transformation Function



Objective Function

Entropy(H) + Average Gradient(grad_avg)

$$H = - \sum_{l=0}^{L-1} P_l \log_2 P_l$$

$$grad_avg = \frac{1}{WxH} \sum_{i=1}^W \sum_{j=1}^H \sqrt{\left(\frac{\partial I(i, j)}{\partial i} \right)^2 + \left(\frac{\partial I(i, j)}{\partial j} \right)^2}$$

DE_Algo(Mutation,CrossOver,Selection)

$$x_{j,i,G} = x_{j,low} + rand(0,1).(x_{j,high} - x_{j,low});$$
$$j = 1, 2, \dots, D; \quad i = 1, 2, \dots, N_p; \quad G = 0$$

$$V_{i,G} = x_{r1,G} + F \times (x_{r2,G} - x_{r3,G}) \quad r1 \neq r2 \neq r3 \neq i$$

$$U_{j,i,G+1} = \begin{cases} V_{j,i,G+1} & \text{if } (rand_j[0,1] \leq C) \text{ or } (j = j_{rand}) \\ x_{j,i,G} & \text{otherwise} \end{cases}$$

Grid Search

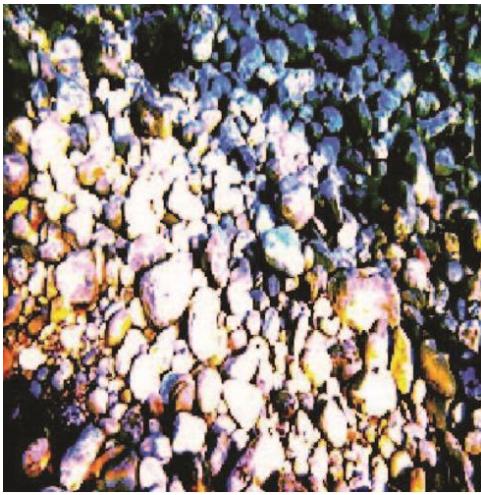
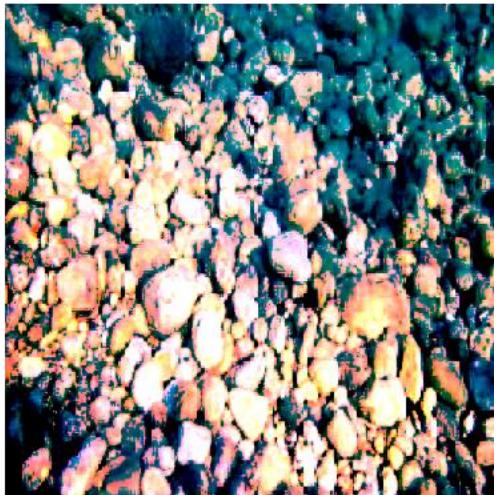
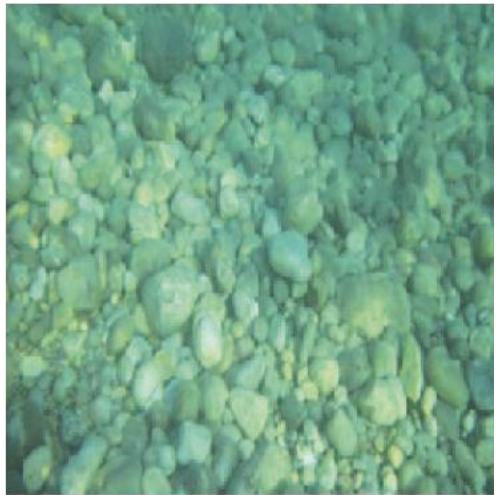
F

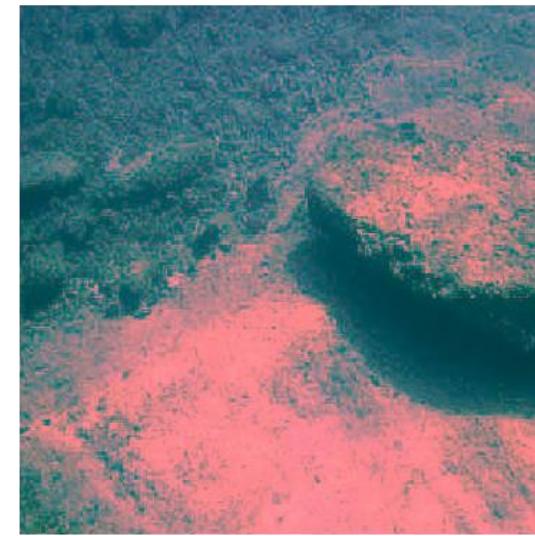
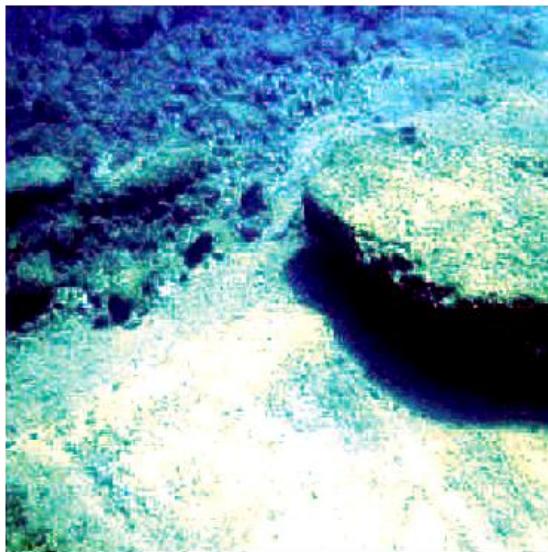
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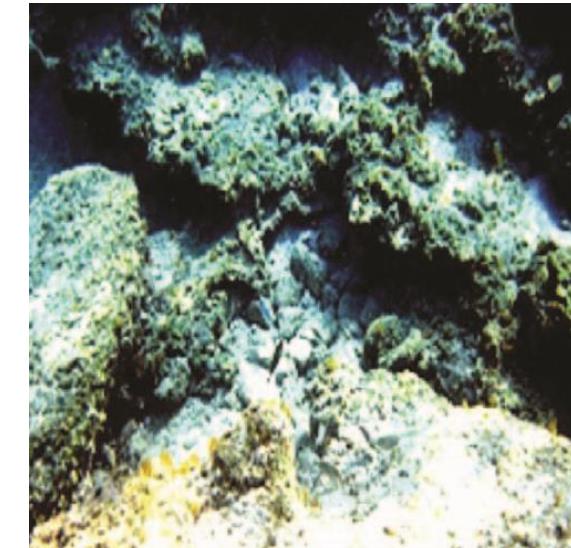
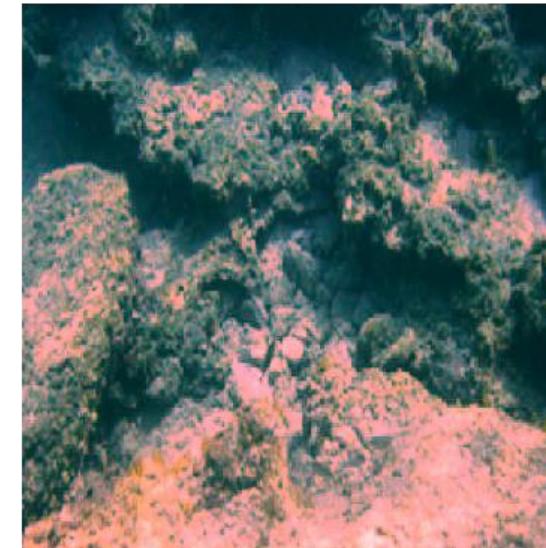
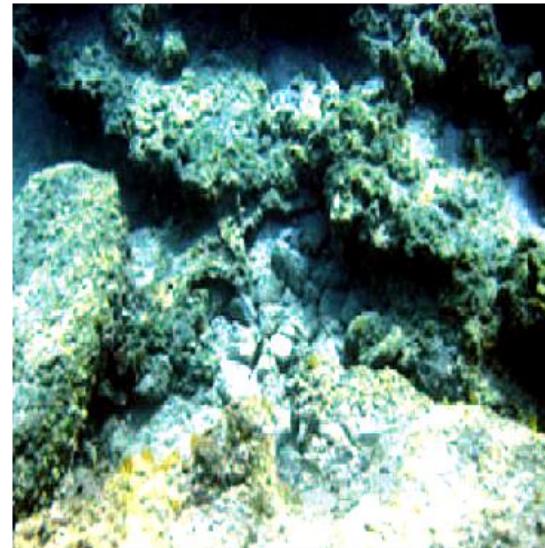
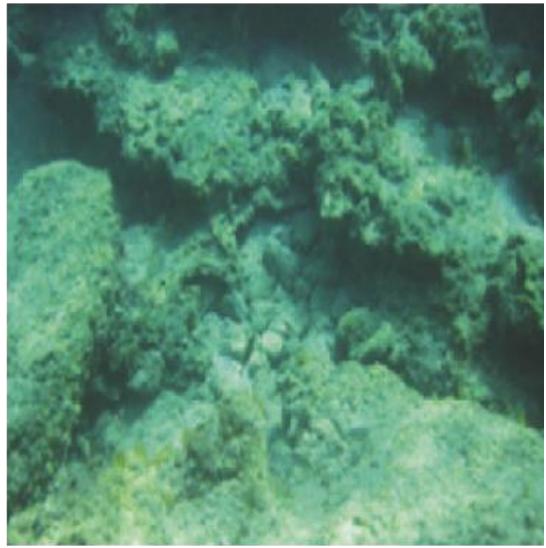
	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90
0.10	23.7991	22.9760	24.3076	24.3929	21.3713	23.9701	21.4565	23.7991	24.3076	
0.20	24.3076	19.9517	23.8126	19.4446	24.3929	23.7139	24.3076	22.9581	23.7991	
0.30	21.3713	21.6275	22.9581	23.7139	23.5518	23.2189	23.7991	23.7139	21.3713	
0.40	23.7139	23.7139	22.9581	23.7991	21.3713	23.2189	23.7139	24.5638	24.3076	
0.50	24.3076	21.6098	24.3929	23.7991	24.3076	23.7991	23.9701	22.9581	23.7991	
0.60	23.7991	24.3076	22.9581	23.7991	24.3929	22.9581	24.3076	20.8762	20.8762	
0.70	23.5518	24.3076	24.3929	21.3713	23.7139	23.7991	23.7139	23.7991	20.8762	
0.80	23.7991	21.3713	23.7991	21.3713	22.9760	22.2943	23.5518	24.3929	21.4565	
0.90	23.2189	23.7991	21.3713	22.8880	23.7139	22.9581	24.3076	24.3929	22.0101	

Images given In Paper





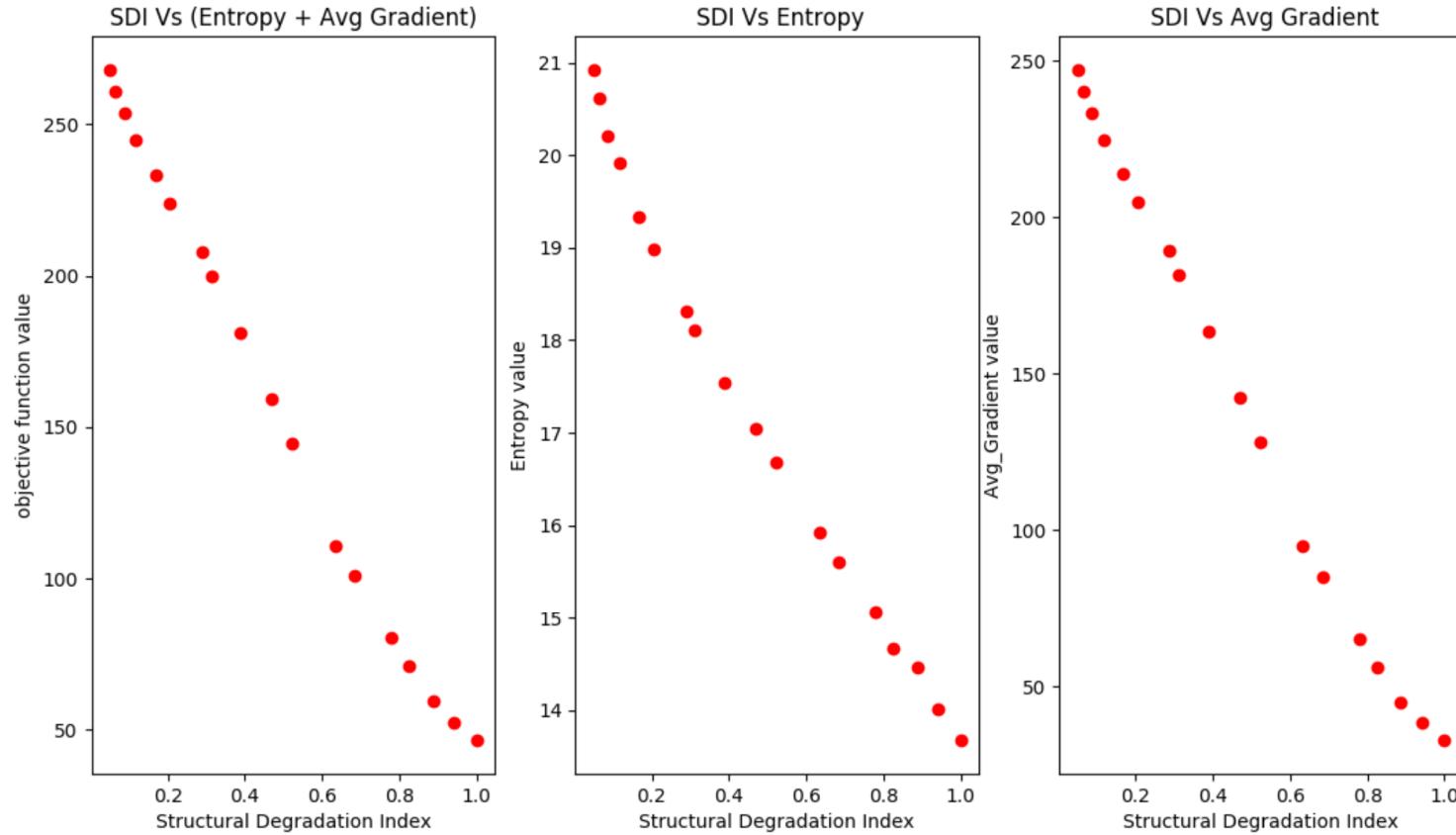




Turbidity Dataset



Obj Fun On This Dataset



Given Image



Enhanced Image



Given Image



Enhanced Image



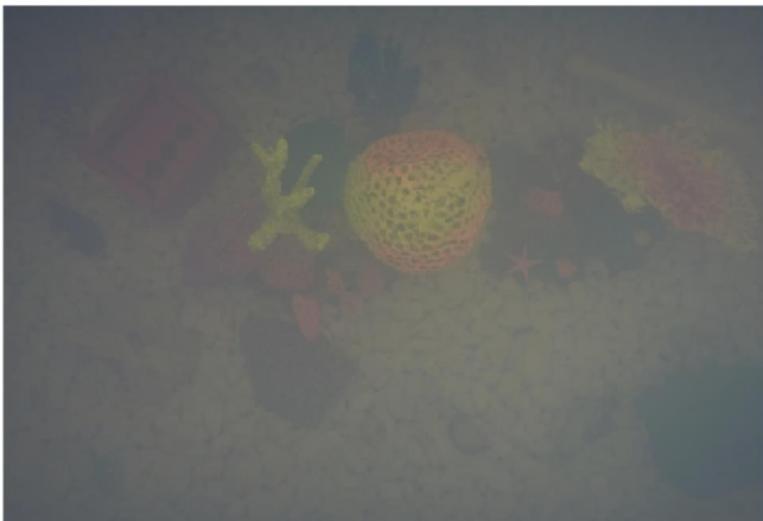
Given Image



Enhanced Image



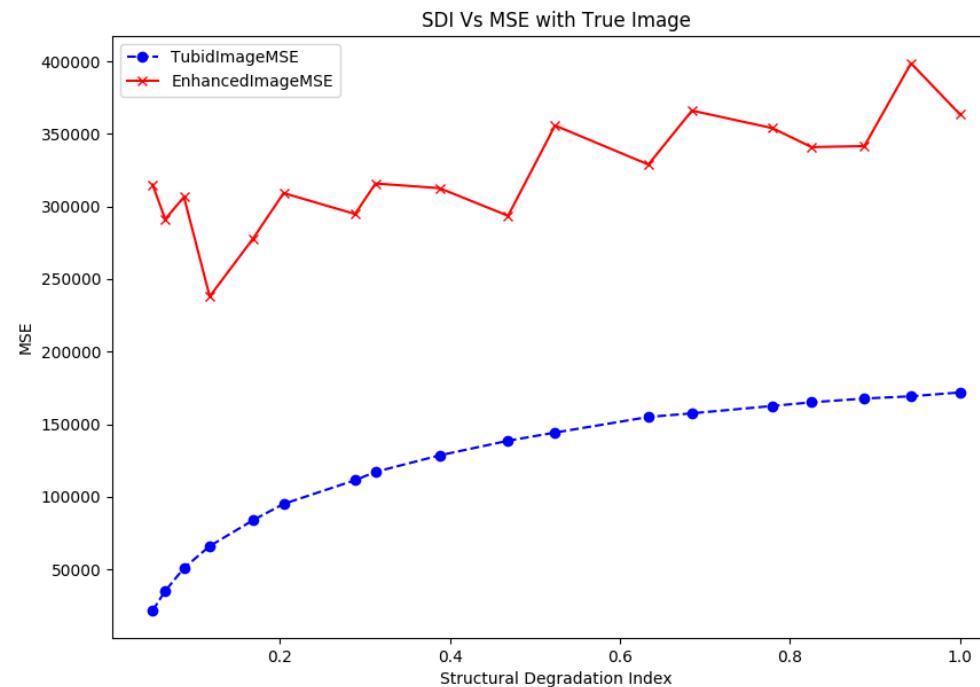
Given Image



Enhanced Image



Results On This Dataset



Intuition for changed Obj Fun

$$\sum (I(k + 1) - I(k))^2$$

$$E(X-Y)^2$$

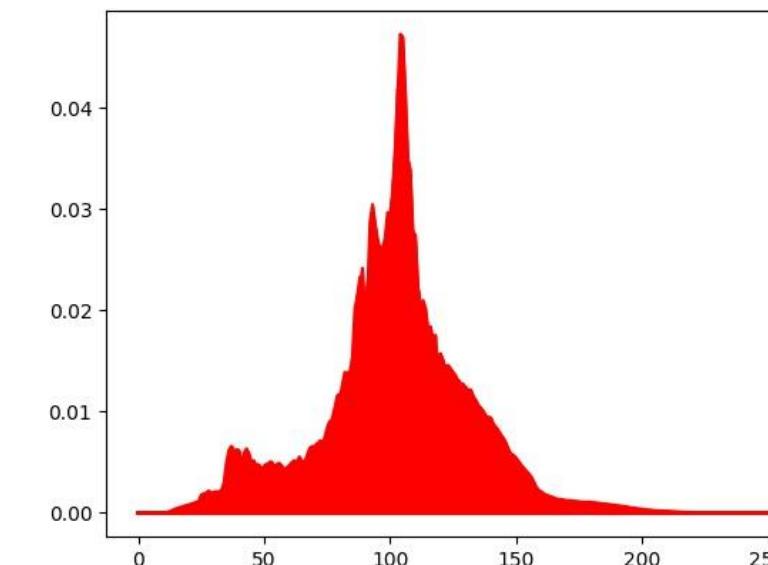
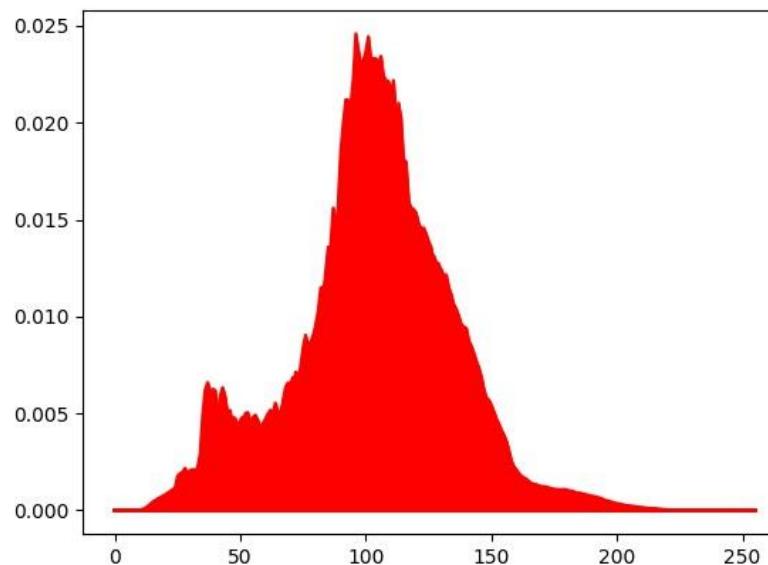
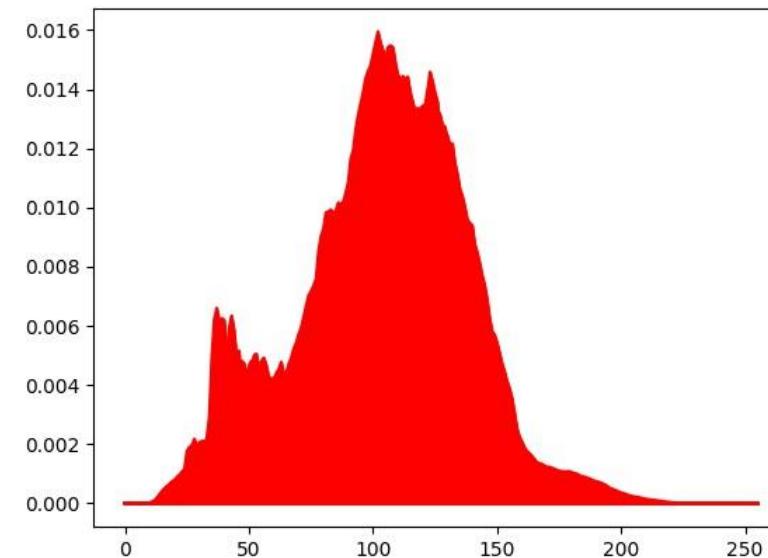
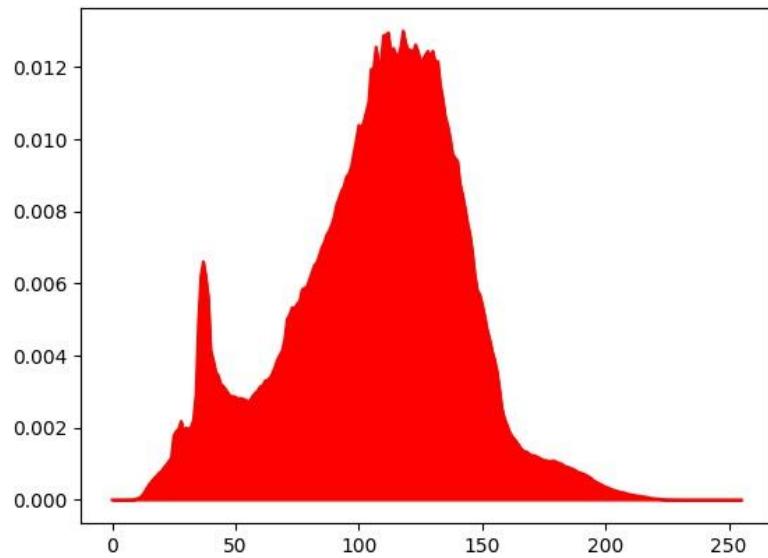
$$E(X^2+Y^2-2XY)$$

$$E(X^2)+E(Y^2)-2E(X)E(Y)$$

Assuming X,Y are Independent and Identically Distributed

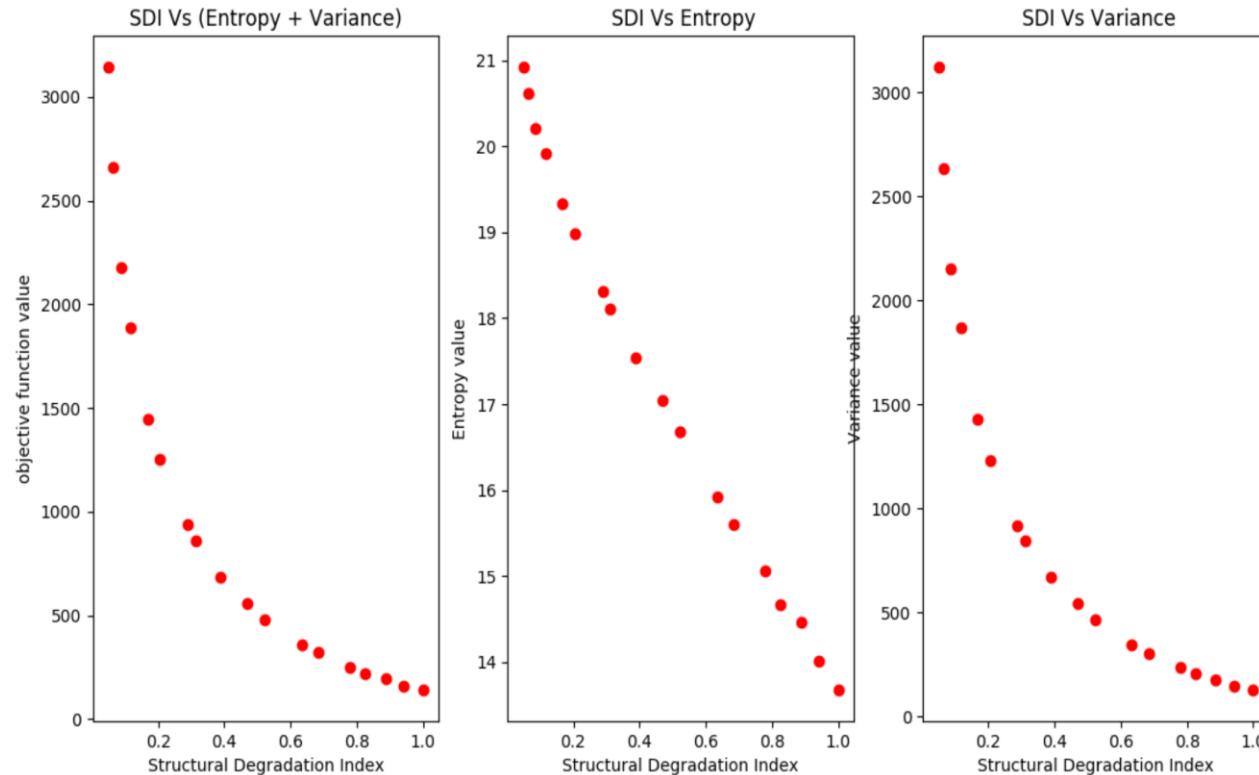
$$2(E(X^2)-E(X)^2)$$

$$2\text{Var}(X)$$



Changed Obj Fun On This Dataset

Entropy(H) + Variance



Given Image



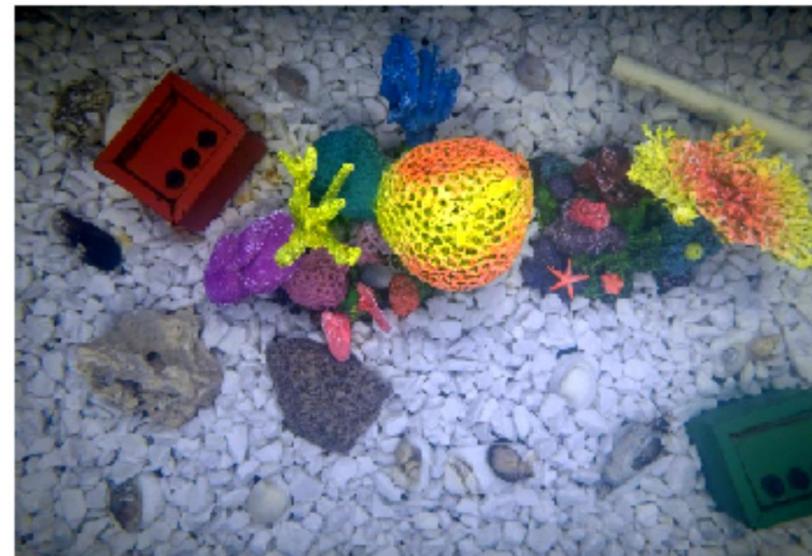
Enhanced Image



Given Image



Enhanced Image



Given Image



Enhanced Image



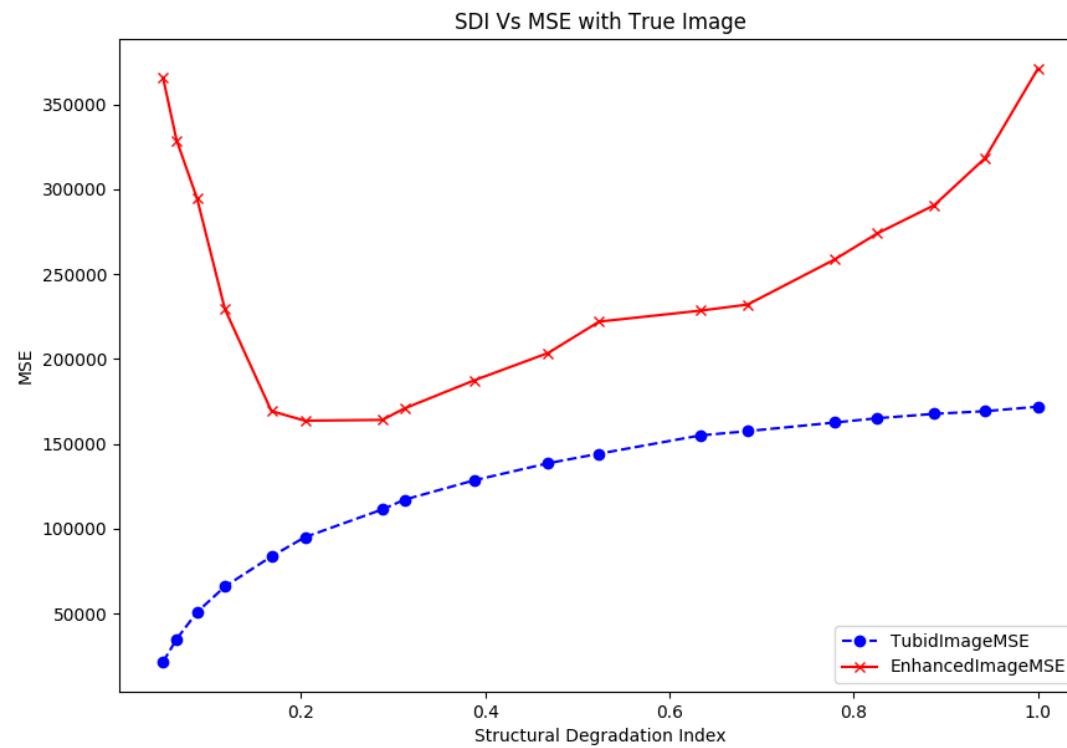
Given Image



Enhanced Image

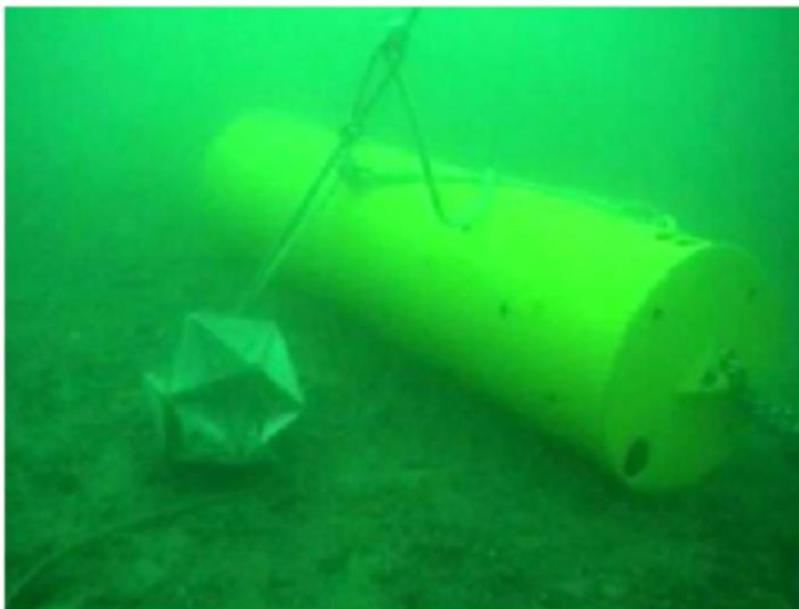


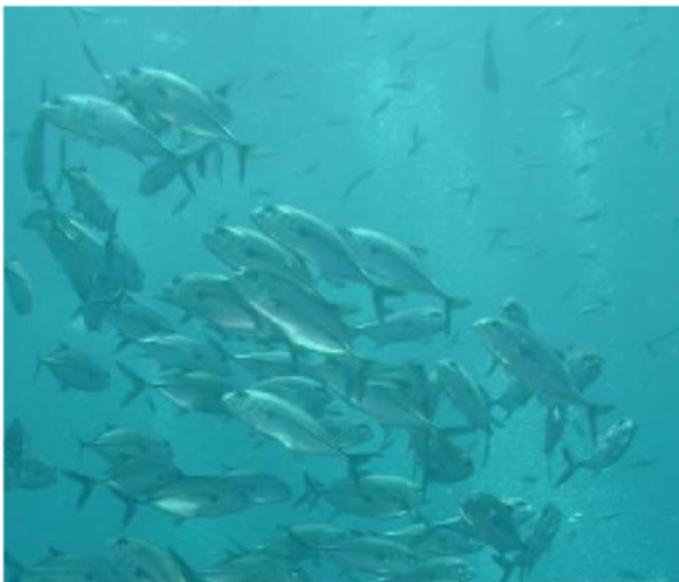
Results On Changed Obj



Other Images







```
SubjectiveRating.append(np.array([1,2,0,1,2,2,-1,1,-1,-1,1]))
```

```
SubjectiveRating.append(np.array([2,2,-1,2,2,2,-2,1,0,-2,2]))
```

```
SubjectiveRating.append(np.array([2,1,0,2,2,2,-1,0,0,-1,2]))
```

```
SubjectiveRating.append(np.array([1,2,0,1,2,2,0,0,-1,-2,1]))
```

```
SubjectiveRating.append(np.array([2,1,-1,1,2,2,0,1,-1,-2,1]))
```

```
meanSubjectiveRating
```

```
array([ 1.6,  1.6, -0.4,  1.4,  2. ,  2. , -0.8,  0.6, -0.6, -1.6,  1.4])
```

```
np.array(PSNRValues)
```

```
array([12.82558578, 12.79996919,  9.1618457 , 10.14653735,  9.9433969 ,  
      9.44017774,  9.3224674 , 11.68315867, 12.57669018, 11.82280706,  
     13.3956042 ])
```

```
np.correlate(PSNRValues,meanSubjectiveRating)
```

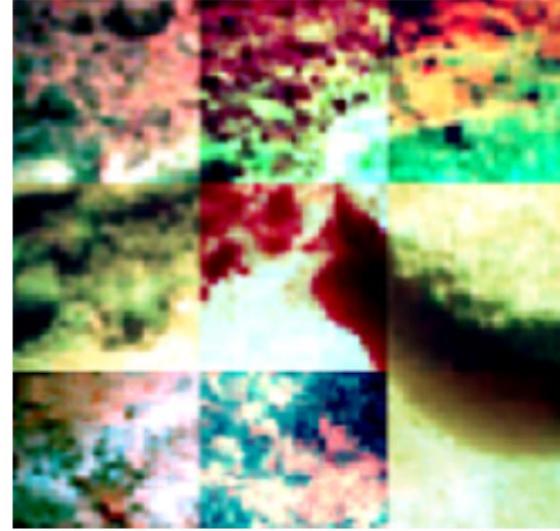
```
array([82.15171303])
```

Attempt related trying DE on local patches

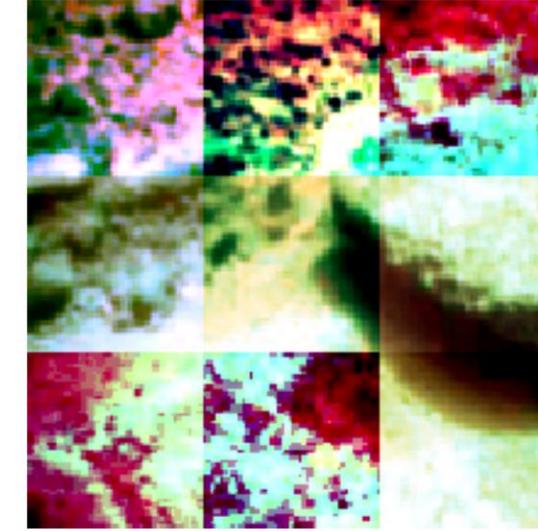
An attempt was made to try on local patches of different resolutions. An output of one such resolution below (two random optimization attempts):



Input Image



First attempt



Second Attempt

Division Of Work

2018801010 - Karnati Venkata Kartheek - PhD CSE

1. Implementation of Given Research Paper. Written Code and produced enhanced images similar to images in paper.
2. Tried different approach by including more number of variables in optimization problem.
3. Performed Grid Search to get the best parameter values.
4. Applied the Algorithm on new data set.
5. Proposed changes the existing method to make it better for new dataset.
6. Compared Original method vs modified method on this dataset.
7. Collected five subjective ratings for each of 11 images and calculated the PSNR, subjective ratings correlations.
8. Made Documentation.
9. Made Presentation

2018900014 - Arun Kumar Subramaniam - PGSSP

1. Implemented DE On Local Patches
2. Tested Histogram Equalization If it works
3. Made Slides for my part in presentation
4. Built google form to collect user rating for Images
5. Acquired Images from Different Sources to try Algo On.
6. Made Documentation related to my part, checked errors.
7. Implemented own version the research paper taking valid input from colleague on a critical implementation detail