Analytical Adjustment of Image Contrast

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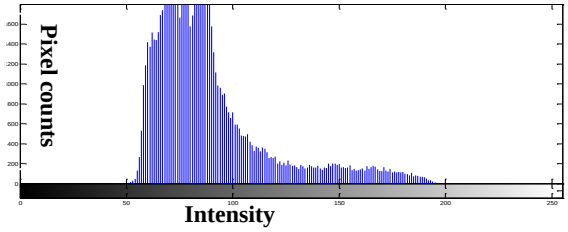
ABSTRACT
Detailed analysis based on histogram stretching for image contrast adjustment has been performed. However unprocessed image includes unwanted noise which needs to be reduced for performing the stretching accurately. The level of noise reduction greatly effects the contrast adjustment and varies from images to images depending on the intensity of noise itself. This paper discusses about image contrast adjustment technique along with the algorithm. Results are analyzed corresponding to images of different quality based on histogram stretching considering different level for the noise reduction.

General Terms
Histogram stretching, Visual quality, Image contrast

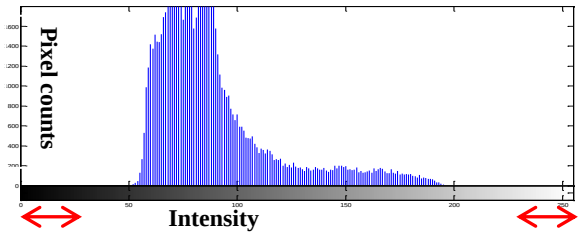
Keywords
Intensity histogram, Underwater image, Medical image, Contrast adjustment

1. INTRODUCTION
Contrast adjustment is an important part of image processing [1]. Contrast of an image can be determined by the ratio between the brightest and the darkest pixel intensities [2]. Unprocessed images having very low contrast are not suitable for human eyes to read. By improving the image contrast, images can be made more suitable for human vision [3]-[6]. This sort of image processing can play a vital role in digital photography, medical images and LCD display images. Adjusting contrast means simply making light colors lighter and dark colors darker simultaneously. It can be done by setting all color components below a specified lower bound to zero, and all color components above a specified upper bound to the maximum intensity (that is, 255)[7]. An efficient method is used here that is called histogram stretching [8]. A histogram can be defined as the probability distribution of the pixel values in an image. It represents the frequency of occurrence of all the gray levels in an image [9]. It is broken into three histograms of the three component channels for RGB images. Two operations affecting the pixel values are used in the stretching method. They are- i) Adding a value to all the pixels adds that amount to the histogram, visually this shifts the histogram ii) Multiplying all the pixel values by a certain amount of scales where the histogram data appears, visually this stretches the histogram. The rest of the paper is ordered as- Section 2 describes about the detailed methodology that has been used to perform the analysis. Section 3 is the result and analysis part. A comparison is shown by varying the amount of pixel removal for an underwater image that has been captured in an adverse environment in section 3.1. It also shows that effect of excessive amount of pixel removal can result an unnatural image. Section 3.2 includes the histogram stretching effects on images of different categories including a medical image. Experimental results are shown in section 3.3. Discussion and Conclusion are included in Section 4 and 5 respectively.

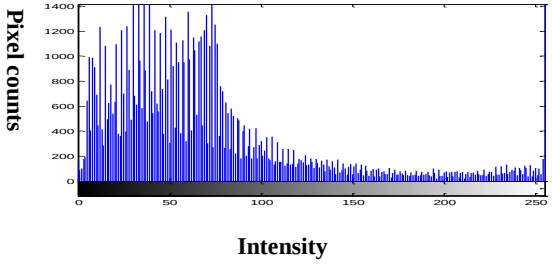
2. METHODOLOGY
To extract maximum information from an image it is necessary to distinguish between different objects and the background. Contrast adjustment is a conventional method to meet up the purpose which can be performed efficiently by appropriate histogram stretching. Unfortunately, raw images, specially captured at adverse environment, suffer from noises that can affect the further stretching which is needed for the purpose of contrast adjustment. Therefore, noise reduction should be carried out before the stretching technique. The detailed method can be summarized as follows-



Step-I: Plotting Intensity histogram of an image



Step-II: Selecting portions to remove/shift (over red arrow)



Step-III: Stretching the remaining pixels

The described method results in a contrast variation of the image. The noise removal (step II) helps for a better adjustment of the image contrast.

3. RESULTS AND ANALYSIS

The effect of histogram stretching considering different amount of pixels removal (based on intensity) has been analyzed using several images.

3.1 Underwater Oceanic Image:

For the considered underwater image, the amount of pixels removal (shift) has been varied from 0% to 100%. The corresponding results reflect that for 0% to about 5%, the increased contrast of various object and background creates better visualization. After 7%, the increase of contrast rather degrades the visualization producing noises. An illustration has been provided with the help of images along with histogram plots considering several of pixels removal cases.

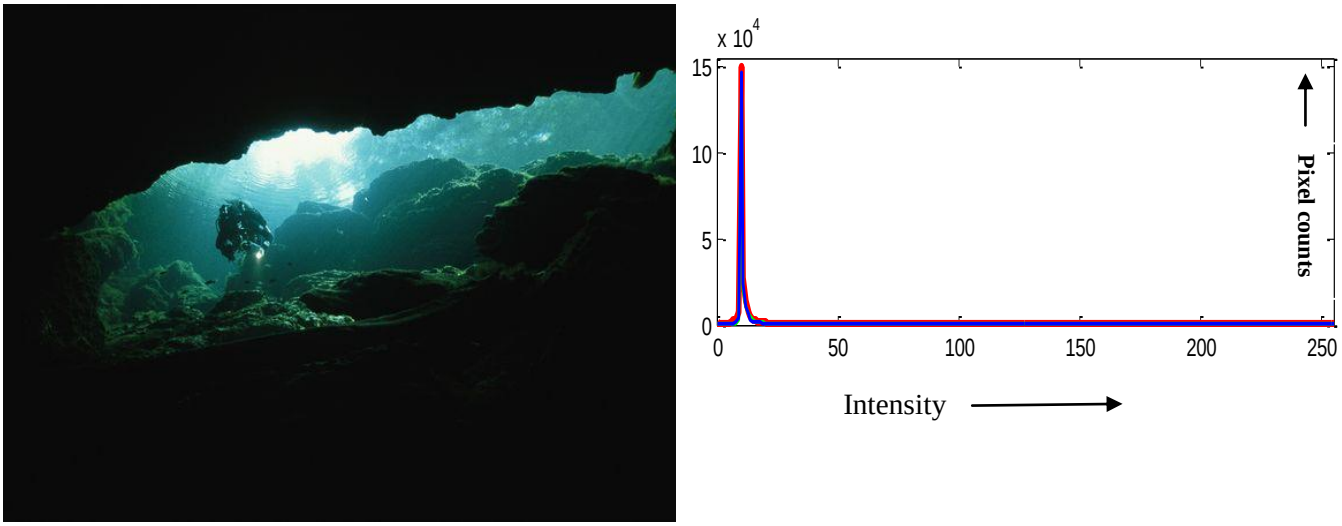


Fig 1a: Original Underwater image with corresponding histogram plot of RGB channels at the right

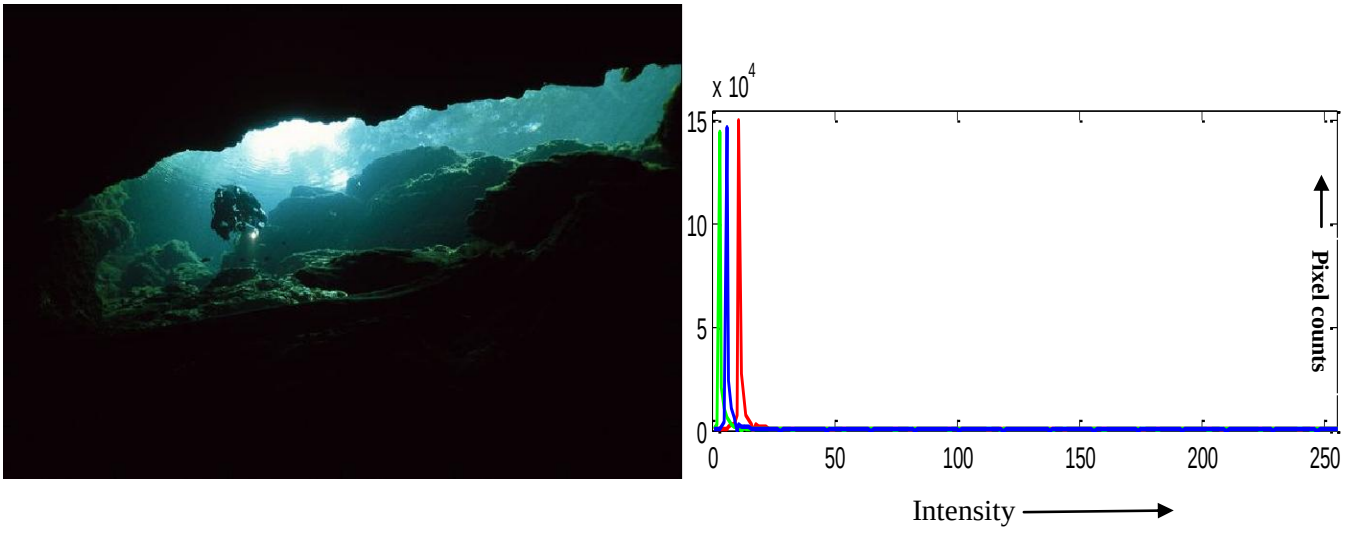


Fig 1b: The effect of histogram stretching considering 0.1% pixels removal from original image

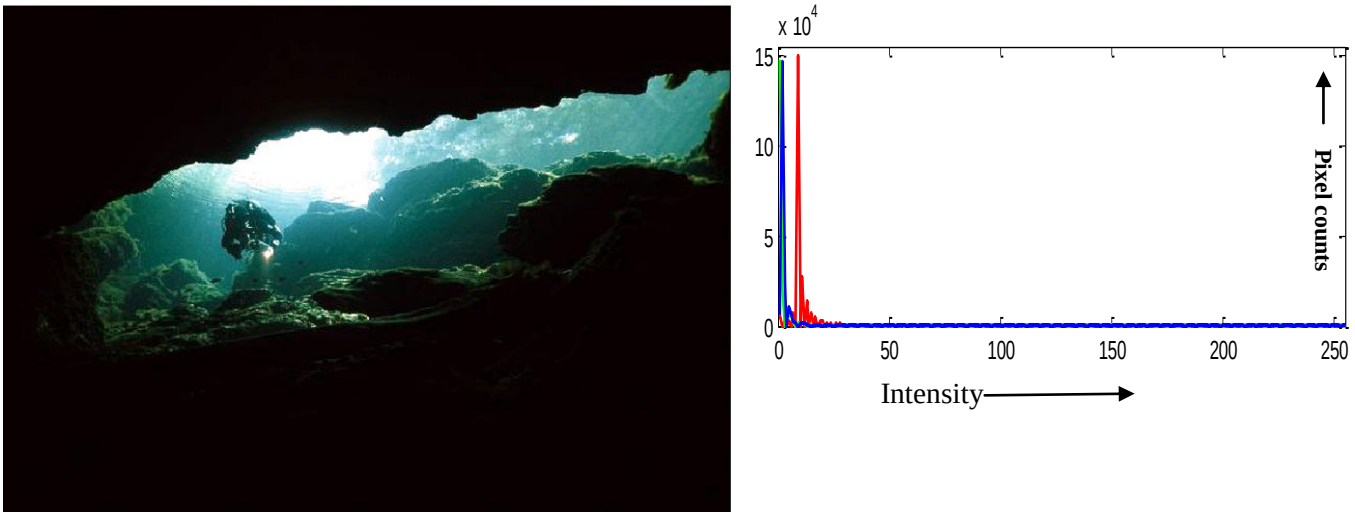


Fig 1c: The effect of histogram stretching considering 2% pixels removal from original image

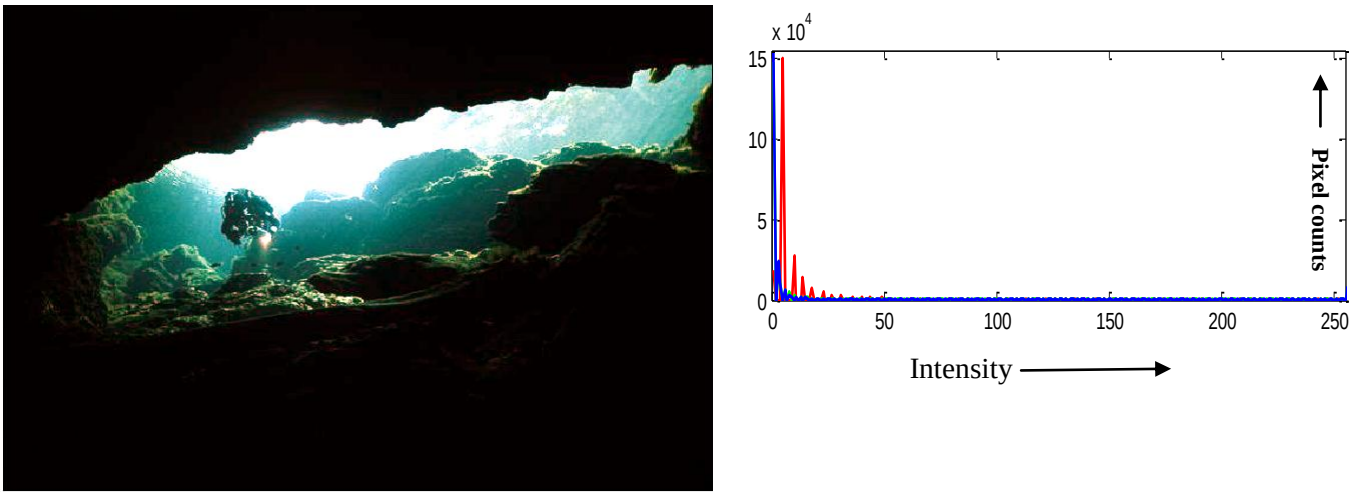


Fig 1d: The effect of histogram stretching considering 5% pixels removal from original image.

The original image has been taken from web link:

http://environment.nationalgeographic.com/environment/photos/wes-skiles-photography/

Analysis:

The histogram plots of Red, Green and Blue channels corresponding to original image are mostly dominant at left side revealing the lower intensity or darkness of the image.

All the channels existence on similar intensity points gives the image lower contrast which causes degraded visual quality. Distribution of Blue channel along most of the intensity level informs about the bluish environment of the image.

Application of histogram stretching causes the congested pixels channels to distribute, creating difference in intensity levels. This creates a visual individualization of object and environment's different portions. It is also a clear observation that clipping off more percentage of pixels (around maximum and minimum intensity levels) before stretching, causes more separation between the Red, Green and Blue channels resulting more contrast.

Excessive pixel removal creates an unnatural image due to unequal distribution of the RGB components. It has been described with the help of images as follows-

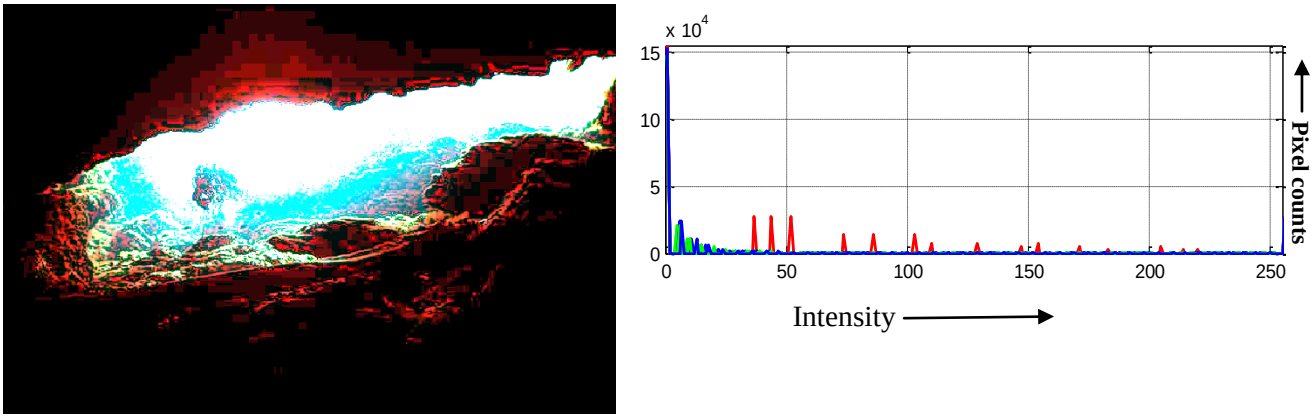


Fig 2: Effect of 17% pixel clipping. The corresponding histogram shows Red channel to dominate throughout most of the intensity levels. Causing excessive reddish effect which can be considered as noise. So, it has rather degraded the visualization quality than upgrade.

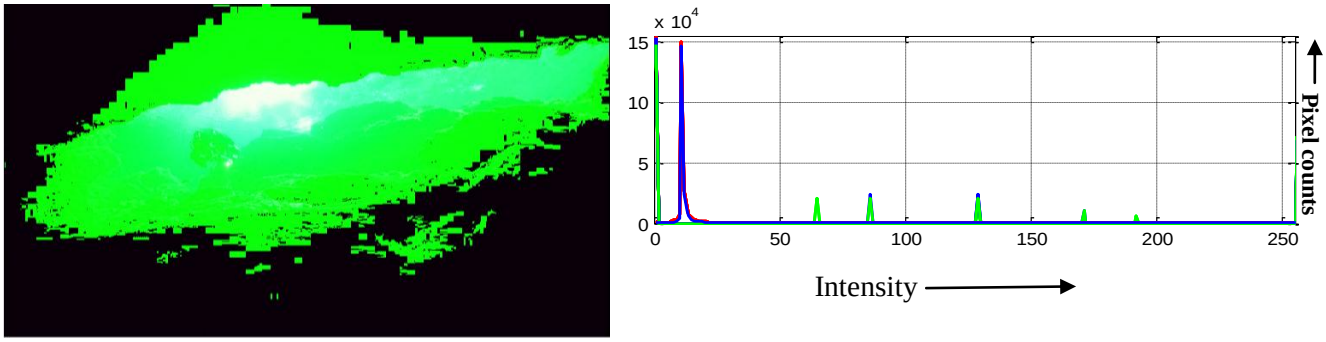


Fig 3: Effect of 45% pixel clipping. Excessive distribution of green channel throughout most intensity level emerges noises.

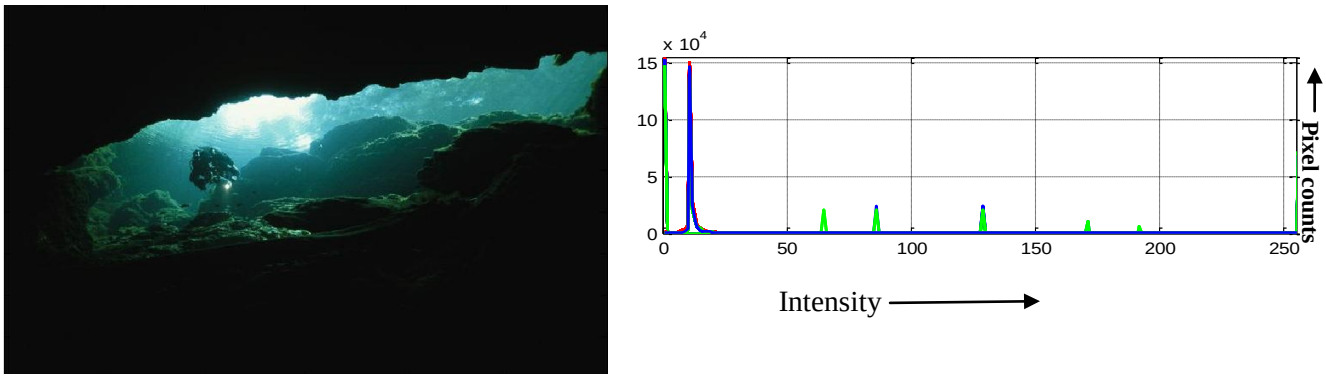


Fig 4: Effect of 87% pixel clipping. The bluish effect is less noticeable as noise because the original image contains maximum blue pixel information itself.

To measure the quality of the images [fig. 1 to 4], contrasts per pixels have been calculated. Contrasts per pixels defined as the average intensity difference between a pixel and its adjacent pixel.

Table 1: Contrast Per Pixel for underwater image

Pixel clipping percentage	Contrast Per Pixel (CPP)
0	3.7714
0.1	20.0726
2	20.2158
5	20.5749
17	21.8860
45	22.8022
87	20.2878

3.2 Implementation of Histogram Stretching on Images of Different Aspects:

Impact of histogram stretching has been checked on images of several categories like- medical image, scenery and an architectural monument. Best visual quality has been found at 5% pixel removal for all of these images that have been examined.

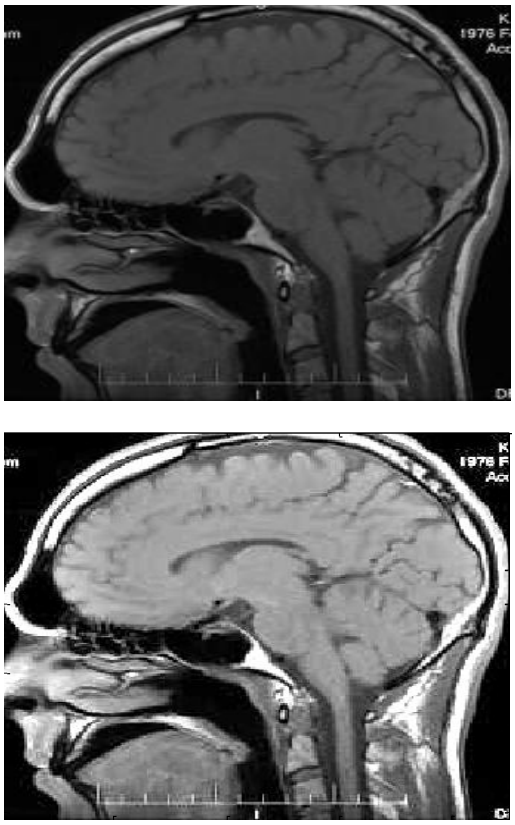


Fig 5: The effect of histogram stretching considering 5% pixels removal from medical image.

Fig 6: The effect of histogram stretching considering 5% pixels removal from scenery.

Fig 7: The effect of histogram stretching considering 5% pixels removal from an architectural monument.

3.3 Experimental Results

An experiment was performed by capturing an image of a red rectangular file at about 3 feet distance in a swimming pool. For this experimental image, around 19% pixel clipping produced best visual quality.

Due to the poor quality camera and polluted water type, the existence of the red file was quite unnoticeable. Applying histogram stretching considering different pixel clipping percentage in prior, the image contrast has been increased.

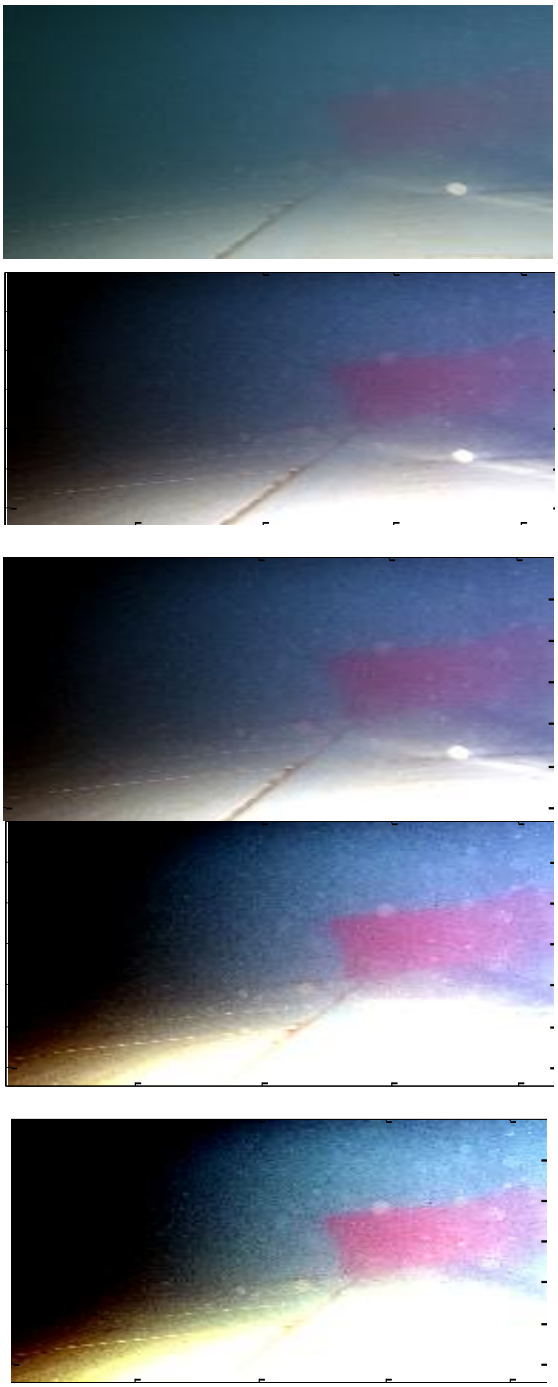


Fig 8: Effect of 6%, 8%, 19% and 23% pixel clipping respectively. The first image is the original one.

Table 2: Contrast per Pixel for experimental result

Pixel clipping percentage	Contrast Per Pixel (CPP)
0	11.5642
6	20.3069
8	20.5669
19	22.4774
23	23.0851
46	22.9269

4. DISCUSSION

Contrast adjustment can be a great help in image processing as it improves the quality of an image and makes it more suitable for human vision. This paper includes the performance analysis of the contrast adjustment technique taking different amount of pixel clipping into account. Simulation results as well as experimental results have been shown and analyzed.

5. CONCLUSION AND FUTURE WORK:

This paper includes improving the quality of an image by adjusting image contrast. This improvement will be used in image pre-processing for submerged object detection. This contrast adjustment will also be used in pre-processing of medical images for diagnosis by detecting affected cells from normal cells.

6. REFERENCES

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