AN APPROACH OF CONTRAST ENHANCEMENT USING GENETIC ALGORITHM

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Declaration

We, hereby, declare that the work presented in this thesis is the outcome of the investigation performed by me under the supervision of Dr.Taskeed Jabid, Assistant Professor, Department of Computer Science and engineering, East West University. I also declare that no part of this thesis has been or is being submitted elsewhere for the award of any degree or diploma. This thesis complies with the regulations of this University and meets the accepted standards with the respect to originality and equality. We hereby release this thesis to the public. We also authorize the university or other individuals to make copies of this thesis as needed for scholarly research.

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Abstract

Contrast enhancement plays a fundamental role in image/video processing. Histogram Equalization (HE) is one of the most used method for image contrast enhancement. However, there is a chance that after HE we can get unreal looking image. This may cause problem in various sector. So to solve this problem we proposed an efficient method of contrast enhancement using genetic algorithm in this paper. This proposed method takes simple chromosome structure as input and perform crossover and mutation on the chromosome. For performing crossover and mutation we used a fitness function to determine which operation is preferred for the chromosome. Experimental results showed that this method makes real image especially when the dynamic range of input image is high. Also, it has been shown by simulation that genetic algorithm works better on image and it also help to enhance image contrast.

Acknowledgements

As it is valid for everybody, We have additionally landed now of accomplishing an objective in our life through different connections with and assistance from other individuals. In any case, composed words are regularly slippery and harbor differing understandings even in one's mother language. Consequently, we might not want to make effort to find best words to express my appreciation other than just posting those individuals who have added to this postulation itself in a basic way. This work was completed in the Department of Computer Science and Engineering at East West University, Bangladesh.

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CHAPTER 1
INTRODUCTION

1.1 Image Enhancement

Image enhancement is basically the method of manipulating or improving an image where the visual appearance of output image is more compatible than original image for a specific or dynamic application. The main objective of image enhancement is to make an image more suitable for a specific task or dynamic task for observer by changing the properties of an image. There are so many image enhancement techniques to enhance an image. Image can be enhanced by modifying brightness, sharpness, contrast, edges, boundaries of an image. Different type of techniques is used for different kind of enhancement where contrast enhancement plays the fundamental role in image processing.

1.1.1 Goal of Image Enhancement

Images in medical, satellite, ethereal images and even our daily life photographs suffer from poor contrast and noise. So, it is essential to remove the noise and enhance the contrast to improve the image quality. One of the most significant stages in medical images detection and resolution is image enhancement techniques which improves the quality of images for human viewing, removing noise, enhancing contrast and exposing details are instances of enhancement actions.

1.1.2 Real Life Applications of Image Enhancement Techniques

Image enhancement techniques have been contributed to exploration development in a numerous fields. A number of the areas in which image processing has a vast utility are as follows.

In medical sector, usage of image processing techniques for noise discount in addition to sprucingthe visual representation and details of an photograph. Considering the fact , that minute details perform a crucial position inward prognosis and treatment related to disorder, it's miles vital to spotlight important capabilities spell showing clinical snap shots. This this way image processing strategies will become an important assisting device for MRI, echo-graphy and x-rays photos.

Astrophotography faces challenges as a consequence of mild and noise contamination that may be lessened through image enhancement. For real-time sharpening and comparison enhancement several cameras have during-constructed image enhancement capabilities. Moreover, several software program which permit editing such photos to offer better and vivid final consequences.

In atmospheric sciences, as an example is used to gradual up the consequences of haze, fog, mist and turbulent climate conditions for meteorological observations. It is able to help in detecting form and additionally structure of remote objects in environment sensing. An artificial photograph from satellites needs photo restoration, enhancement and other filtering process to put off noise.

In the field of marine, the study of pics exhibits thrilling highlights of water go with the flow, slit density and geomorphology behavior to name more than one. These functions are to a greater volume truly observable in photographs which might be digitally boosted to conquer the problem of shifting goals, shortage of mild and difficult to understand surround.

In forensics, for example is used for designation, proof collecting and monitoring. Images received from finger-print detection, protection motion images analytic thinking and crime scene inspections are superior to help out with identity of criminals together with protection of victims.

Some of other fields along with regulation enforcement,microbiology,bio medicine,bacteriology and so on which achieve the benefits of numerous image enhancement techniques [3][4].

1.2 Genetic Algorithm

A genetic algorithm (GA) is extraordinary for exploring solutions for complex search issues. They're frequently utilized in fields like engineering for building to make fantastically quality items on account of their capacity to search through an enormous combination of parameters to locate the best match. For instance, they can search through various combination of elements and diagram to locate the ideal combination of both which could bring about a more dynamic, lighter and overall, better final item. They can also be utilized to sketch computer algorithms, to scheme tasks and to solve other optimization issues. Genetic algorithm emerged on the procedure of development by natural determination which has been seen in nature. They

basically recreate the route in which life utilizes evolution to discover solutions for real world issues. Surprisingly, genetic algorithm can be utilized to discover solutions for incredibly complex issues but they are themselves entirely not so hard to utilize and get it [1].

1.2.1 Working Procedure of Genetic Algorithm

The fundamental procedures for a genetic algorithm are:

Initialization - Defining an initial population which can be generated randomly or through a user defined process.

Fitness Function - Every individual from the populace is then evaluated and calculating a 'fitness' for that person. The fitness value is determined by how well it fits with desired prerequisites.

Selection - Targeting to be always enhancing populaces general fitness. Selection is just for keeping the best people in the populace and discarding bad people.

Crossover - Creating new people by combining perspective of selected people. The expectation is that by combining certain attributes from at least two people we will make a much 'fitter' child which will acquire the best characteristics from each of its' parents.

Mutation - By including a little bit randomness into the populaces' genetic qualities otherwise every combination of determinations can create initial populace. Mutation generally works by rolling out little improvements at arbitrary to a persons' genome.

Termination

There are a couple of reasons why it is needed to terminate genetic algorithm from proceeding its quest to a solution. General reason for terminating is that the algorithm has found a solution which is adequate and meets a predefined criteria. Some other purposes behind terminating might a chance to be imperatives.

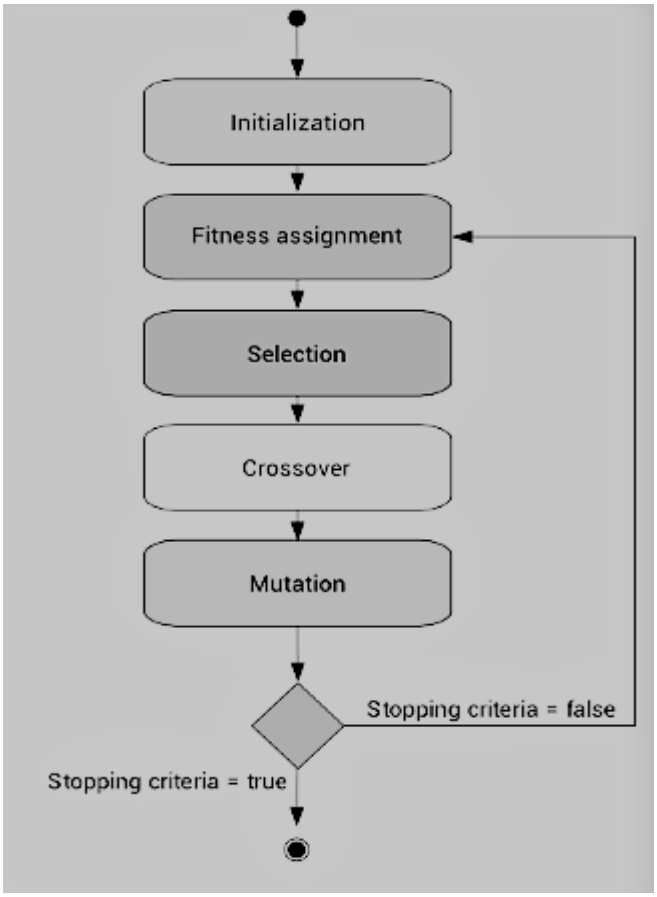


Fig. 1.2.1: Fundamental procedures for a genetic algorithm

We are going to perform contrast enhancement process based on this genetic algorithm. The principle of this method is using a simple chromosome composition and genetic operators to enhance the visible properties and contrast of low illumination photos particularly with high dynamic limit. In this procedure maps every gray level of input image to another one like output image with more contrast. Simulation output displayed that this method significantly worked well and it could generate more natural looking photos than some other related work. Experiments exhibited that the improved photos are compatible for application in dynamic field like real life photography, astrophotography etc.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

In this chapter, we will discuss about previous work in image enhancement field and then the theory of genetic algorithm. Enhancing image can be done by many ways. There are so many image enhancing techniques but in our work we used genetic algorithm to enhance the image. Our work is inspired form Sara Hashemi, Soheila kiani, Navid Noroozi, Mohsen Ebrahimi, Moghaddam who worked on image enhancement using genetic algorithm. In this work each image is compared as chromosome. Then use crossover and mutation on the chromosome to improve the result.

2.2 Histogram Equalization

Histogram equalization is a process in image processing for contrast coordination while using the histogram of image. This method usually enhances the global contrast of uncounted images, particularly when the data in use with the image is represented by nearest contrast values. By performing this coordination, the intensities is generally better distributed within the histogram.

This provides for component of lower local contrast to achieve an enhanced contrast. Histogram equalization performs this by successfully expanding the most dense intensity values [2].

2.3 Dynamic Histogram Equalization

The Dynamic Histogram Equalization technique accept control over the effect related with consecutive HE so it can make the improvement of image without performing virtually any loss of properties inside it. DHE partitioning the stimulant histogram into number of sub con texture histograms till it ensures in which no dominating part happens in any of this recently created sub-histograms. After that, each sub-histogram is distributed a operative GL which generally can be mapped by HE further. This is accomplished by distributing total available dynamic range of limp levels among the sub-histograms based on their ethical force limit in input graphical and cumulative ordination of histogram values. This ordination involving extending range of distinction restricts short features from the input image from getting dominated and washed away, and ensures a average contrast enhancement of every portion of the total image. At last, for each sub-histogram a separate transformation perform is calculated based for the traditional HE method in addition to gray levels of stimulation image are allocated for the output image accordingly. The complete technique can be divided in three parts categorized histogram, distributing GL ranges for every single sub-histogram and applying HE along each of them [2].

2.4 Theory of Genetic Algorithm

First, an image is converted to gray level image where the value is between 0 to 255. Then remove the duplicate value form chromosome and create a new chromosome. Then generate a random chromosome of same size. Then put this value on the chromosome to see how the image looks like. After that several iterations have been done on the image and crossover and mutation have been done on the image to get a better image [1].

2.4.1 Detailed Procedure of Genetic Algorithm

As we now know they're emerged on the procedure of natural determination, this implies they take the major properties of natural choice and apply them to whatever issue it is we're attempting to solve.

2.4.1.1 Creating chromosome structure

This method uses a simple chromosome structure. First, generate a chromosome form the input image. If the for working procedure we only work on gray level image.The intensity value of this gray level image is between 0 to 255. Then remove the duplicate value from the chromosome and generate an array without duplicate value. Then short the chromosome value in assenting order. The size of this chromosome is n. Then we generate a random array of the

same size. Then replace the chromosome value random array value. But before we sort the random array in ascending order.

17	25	13	11	29	17	21	25	31	91
1	2	3	4	5	6	7	8	9	10

Fig 2.4.1.1: An array generated from image with index.

11	13	17	21	25	31	29	91
1	2	3	4	5	6	7	8

Fig 2.4.1.2: First chromosome generated from the image.

To evaluate each chromosome as mentioned earlier. We use a function that do thisremapping between input chromosome and random chromosome, it is mentioned below.

$$T(G(K))=C_i(K) \quad (1)$$

Where, K=1,2,3,.....n

Where T is the function that used for changing the original image gray level. G is the available gray levels in the input image in ascending order, k stands for indexes of G. Therefore, G(K) represents input image gray level value at k^{th} position. C_i represents the value of k^{th} cell.

Now the function will do as follows:

T(26)=0, T(33)=49, T(38)=56, T(91)=109, T(157)=203

The function will replace the value of input chromosome intensity in the value random array position. The function will replace the value of input chromosome intensity in the value random array position. The intensity value of the input image will be replaced in the random array position.

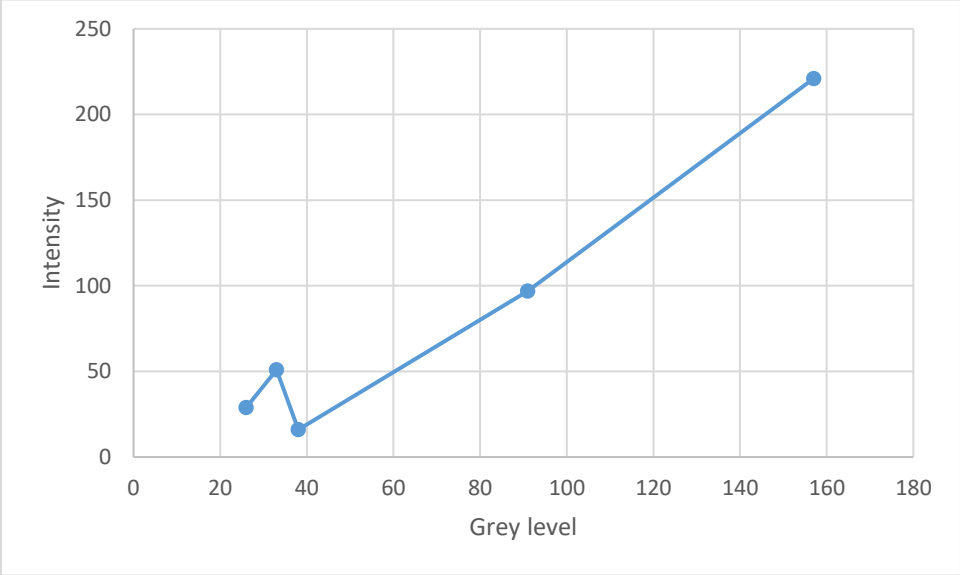


Fig 2.4.1.3: Representation of input array with gray level value.

Fig 2.4.1.4: Random array with intensity value

0	52	91	151	153	202	221	255
1	2	3	4	5	6	7	8

Fig 2.4.1.5: The array of chromosome structure generated randomly.

After the random array is generated put the random array value in the image array and generate the chromosome. Then sort the array in ascending order.

17	25	13	11	29	17	21	25	31	91
1	2	3	4	5	6	7	8	9	10

Fig 2.4.1.6: The image array

0	51	91	151	153	0	202	52	221	225
1	2	3	4	5	6	7	8	9	10

Fig 2.4.1.7: The image array after putting random value

After the initial population is generated and for each individual we will calculate the fitness value.

2.4.1.2 Calculating the fitness

In the proposed method the fitness of each chromosome is calculated in the following function:

$$fitness(x)=\log(\log(E(I(x)))) * n\_edges(I(x)) \quad (2)$$

Where fitness(x) refers to the fitness of chromosome of x. I(x) represents the enhanced image. n_edges(I(x)) represents the number of detected edge in the enhanced image. For detecting edge we used canny edge detector where the canny edge detector takes the output of sobel edge detector as input. The sum of the intensity of enhanced image is represented by E(I(x)) which is calculated by the following equation:

$$E(I(x)) = \sum_x \sum_y \sqrt{\delta h_1(x,y)^2 + \delta v_1(x,y)^2} \quad (3)$$

Where,

$$\delta h_1(x,y) = g_1(x+1,y-1) + 2g_1(x+1,y) + g_1(x+1,y+1) - g_1(x-1,y-1) - 2g_1(x-1,y) - g_1(x-1,y+1) \quad (4)$$

and

$$\delta v_1(x,y) = g_1(x-1,y+1) + 2g_1(x,y+1) + g_1(x+1,y+1) - g_1(x-1,y-1) - 2g_1(x,y-1) - g_1(x+1,y-1) \quad (5)$$

In equation (2) a log-log measure of edge intensity is used to prevent producing unnatural images.

2.4.1.3 Selection process

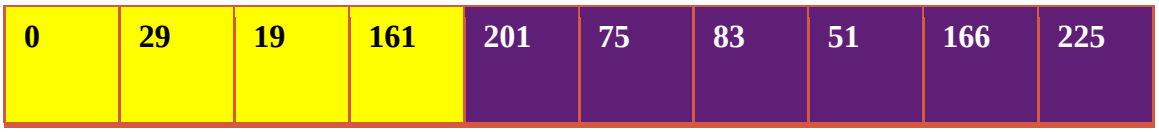
Selection of individual is based on their fitness value. The individual which have more fitness value than other have more chance of going to the next generation. The main idea of this process is to crate stronger generation than previous based on fitness value. So the individual which have grater fitness value than other have grater possibility of survival. On the contrary the weaker individual have less possibility of survival. If the crossover rate is P_C and number of individual is P_S. The number of individual that have passed to the next generation is PS – (PS * PC). So the number of individual that are selected for next generation is $P_S * P_C$. The process is preformed until the terminating condition is meet.

2.4.1.4 Crossover and Mutation process

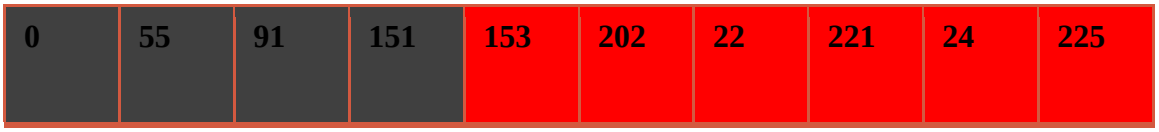
For crossover two have selected randomly and crossover operation is proceeded.Form the crossover operation two child have created. Therefore $P_S * P_C$ individual have selected for selection process. As $P_S * P_C$ new individuals are needed for selection process and two points have selected randomly from them. Finally, each new individual is sorted in ascending order. For crossover a random number is generated in randomly and the crossover operation starts from that position.

Before crossover:

Random value: 4

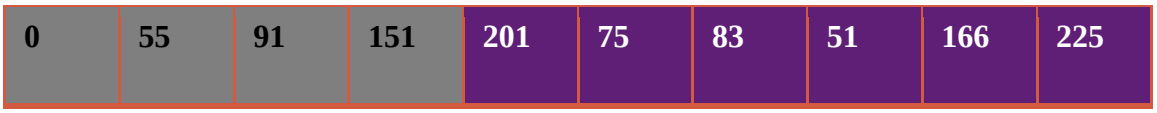


(a)

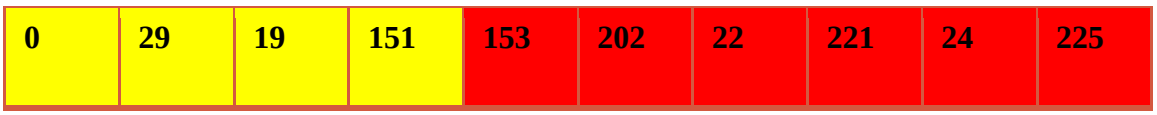


(b)

Fig 2.4.1.8 : Before crossover (a) and (b) chromosome



(a)



(b)

Fig 2.4.1.9 : After crossover (a) and (b) chromosome

For mutation a random number is selected and the number of element is selected for mutation. If fitness value is less than mutation constant, mutation process will be preceded. Five

percent of the individual elements are selected randomly for mutation. For each element a random integer number that should be less than or equal to the next element value and more than or equal to the previous element value is generated. This random number is replaced by element and sort the chromosome in the ascending order.

Before Mutation:

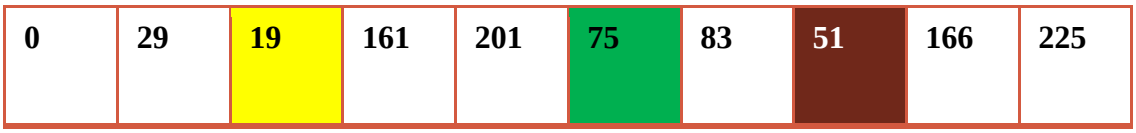


Fig 2.4.1.10: Chromosome before mutation where the value is selected randomly

After mutation and sorting in ascending order:

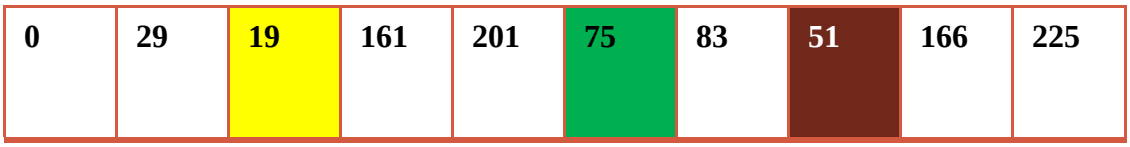


Fig 2.4.1.11: Chromosome after mutation and sorting

2.4.1.5 Terminating Condition

In genetic algorithm the number of iteration is infinity. So a terminating condition is used to stop this process and iteration.

(1) When the iteration meet the maximum number of iteration.

(2) When the difference of best fitness in two consecutive generation is less than ϵ. The value of ϵ has been considered as 0.02 * best_fitness.This random number is replaced by element.

CHAPTER 3
SYSTEM DESCRIPTION

3.1 Introduction

For better understanding our work, in this section, we will discuss our system and the design will be over viewed. We have used C++ language, Visual Studio 2017 IDE and Open CV as our image enhancement visualization library for implementation.

3.2 Open CV

OpenCV (Open Source Computer Vision Library) is free for both academic and commercial use which supports Windows, Linux, Mac OS, iOS and Android. It has also C++, C, Python and Java user interfaces. OpenCV is used for numerical efficiency and with a strong focus on real-time applications which is accepted all over the world. For interactive art, adjusting maps on the web, to mines review or through advance level robotics this library is widely used.

OpenCV deals with image pixels that are often encoded in a compact, 8- or 16-bit per channel, form and thus have a limited value range as it is a computer vision library. Moreover, certain operations on photos, like color space mutation, brightness/contrast coordination, sharpening,

complicated interpolation (bi-cubic, Lanczos) can generate values out of the available limit. If it just stores the lowest 8 (16) bits of the result, this output in visual artifacts and can affect a further image analysis.

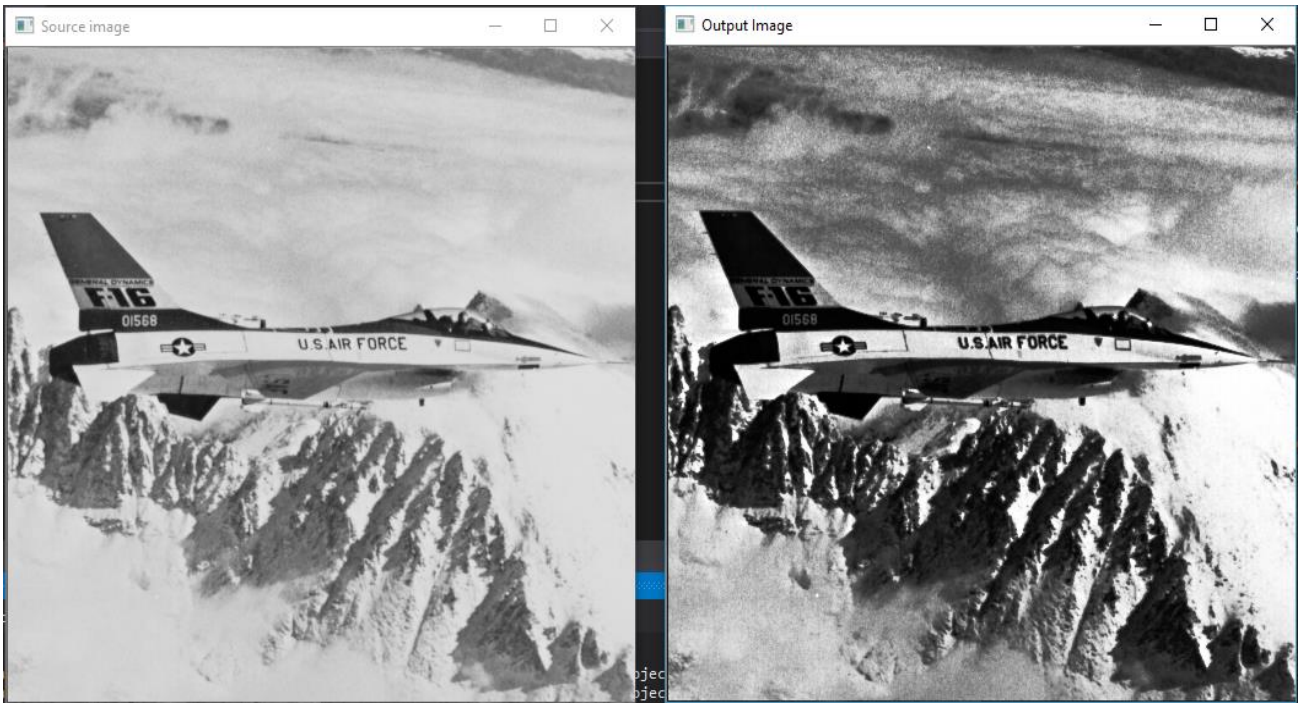
CHAPTER 4
CONCLUSION

4.1 Overall Conclusion

So, we found genetic algorithm for image contrast enhancement especially when input image has low dynamic range. This method works on simple chromosome structure to enhance the image. Some iteration has done on the process to get the enhanced image. To confirm the result is compared to some standards. The experiment result is satisfactory though it consumes a lot processing time. Besides, experiment results demonstrated that the enhanced images are suitable for different application field.

4.2 Experimental Result

Some experimental results after applying Genetic Algorithm where we can see left one is the input image and right one is the output (enhanced) image. We see clearly how effectively genetic algorithm works here.


Source image
Output Image
F-16
01568
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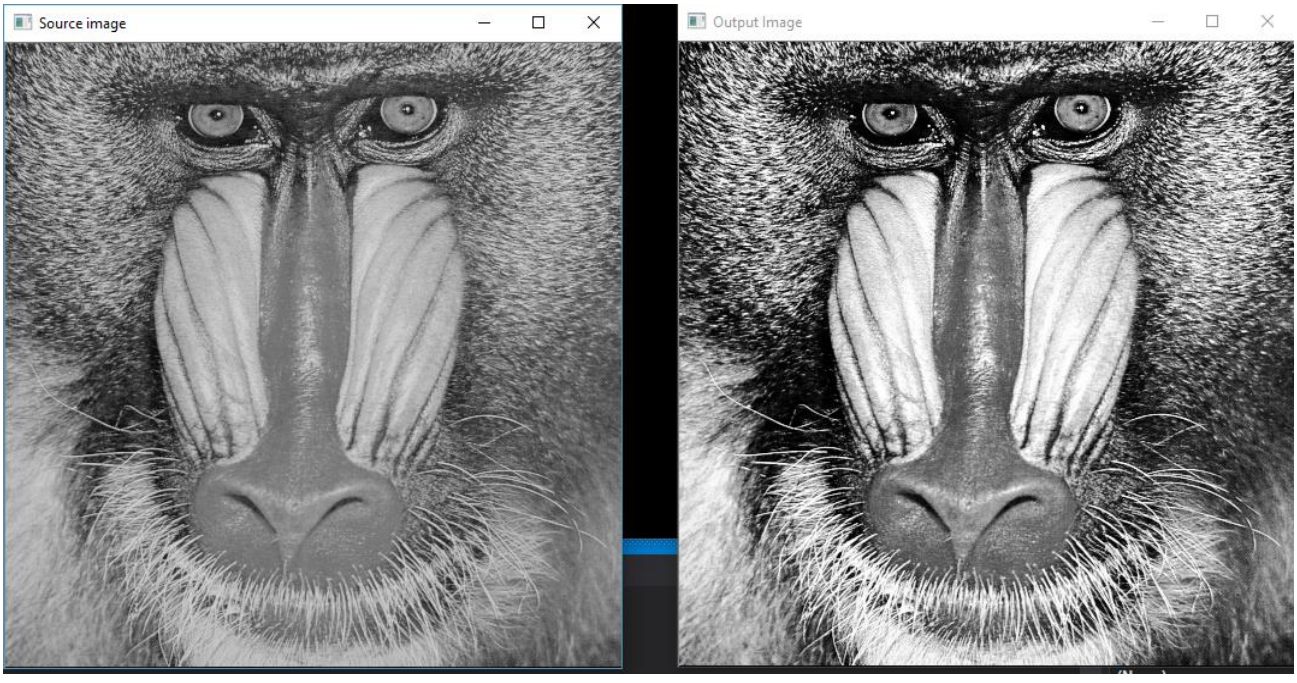
(a)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Output Image

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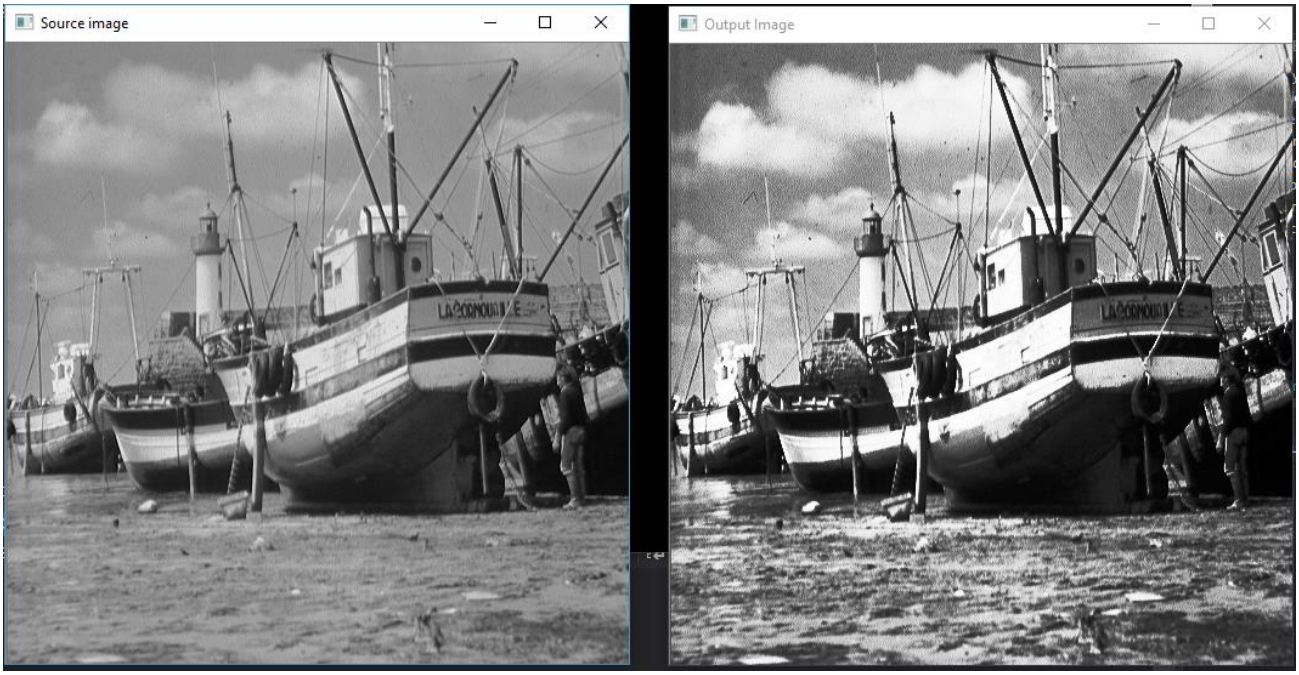

(c)

Fig 4.2.1: Experimental results

4.3 Future Work

Here we see just visual comparison. Later, we will represent this comparison in statistical way. Moreover, in future, we were going to combine some other algorithm and to compare those result with this one. We would like to include other method like swarm intelligence or ant colony method to improve the result.

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APPENDIX A LIST OF ACRONYMS

GE	Genetic Algorithm
HE	Histogram Equalization
DHE	Dynamic Histogram Equalization
GL	Gray Level
MRI	Magnetic Resonance Imaging