IMAGE ENHANCEMENT USING ADAPTIVE HISTOGRAM EQUALIZATION FOR MEDICAL IMAGE PROCESSING

[1]Dr.N.Nandhagopal (nandhaphd@gmail.com), [2]S.Navaneethan (jssnavi.37@gmail.com),

[3]M.Ramesh (amramesh@gmail.com), [4]R.Kandasamy (mrkandasamy1983@gmail.com)

[1]Associate Professor, [2]Research scholar, [3]Assitant Professor, [4]Assitant Professor
[1, 3,4]Electronics and Communication Engineering, Excel Engineering College, Namakkal, India
[2]Anna University, Chennai.

Abstract: Medical image processing is a challenging field of research since the captured images suffers from the noise and poor contrast. The efficiency of the medical image processing depends on the quality of the captured medical images. Major factors for the low contrast medical images are age of capturing equipments, poor illumination conditions and inexperience of medical staff. Thus, contrast enhancement methods are used for improving the contrast of medical images before being used. Contrast enhancement algorithms are powerful tool to reveal details on a low contrast image hidden in a very small range of grey/colour levels. There are various ways to enhance the contrast of an image. One of the most popular algorithms is Histogram Equalization (HE), which has several variants that add some improvements like Adaptive Histogram Equalization (AHE) or Contrast Limited Adaptive Histogram Equalization (CLAHE).These kinds of algorithms are usually implemented using standard programming languages like C, C++, Java or Matlab to give just some examples, and are executed on top of regular general purpose processors. The main objective of this work is to implement an Adaptive Histogram algorithm with selective noise filtering using Verilog as the hardware description language and simulated output is verified with Matlab.

***Index Terms* – CLAHE, AHE, Histogram, FPGA**

I. Introduction

Good contrast is an essential property in most image processing tasks. However, the conditions in which images are taken are not always optimal. Various factors such as the environment, the sensor limitations, lighting or the photographed object itself influence the final result in ways that are not always desirable, leading to a lack of visible detail and limited color range. In these situations, contrast enhancement becomes a good preprocessing tool for a wide range of image processing cases. However, HE and its variants not only increase the contrast of the real detail, but also the imperfections introduced during the acquisition of the picture, as they have no way to differentiate between both cases. This can be troublesome in some contexts such as when the image's contrast is extremely low or when the relevant data can be easily confused with the noise. For this reason, some designing efforts in that field are now concentrated on reducing the apparition of that undesired data. There are mainly two points where the problem can be faced: right before or right after the equalization. If the noise reduction treatment is done before or during the equalization, relevant information can be lost together with the removed noise, and thus it cannot be detected and enhanced during the equalization. On the other hand, if the noise reduction takes place after the equalization, it is harder to remove because the enhancement makes it more visible and relevant.

II. Related Work

IMAGE contrast enhancement is important in medical applications. This is due to the fact that visual examination of medical images is essential in the diagnosis of many diseases. In applications such as chest radiography and mammography [1], [2], the image contrast is inherently low due to the small differences in the X-ray attenuation coefficients. Linear contrast stretching and histogram equalization are two widely utilized methods for global image enhancement [3]–[4].In diagnostic medical images, local details may be more important than global contrast. Adaptive histogram equalization (AHE) [5]–[6] and adaptive contrast enhancement (ACE) [7]–[8] are two well-known local enhancement methods. AHE algorithms map the gray values of pixels using the relationships obtained from the local histograms. Although this improves image contrast, it requires intensive computations [9]. The bilinear interpolation technique was developed [10], [11] to reduce the computational burden. It first divides images into blocks, and then calculates the mapping functions of those blocks.

III. Histogram equalization

Adaptive histogram equalization (AHE) and contrast limited histogram equalization (CLAHE) are more complex, improved versions of the standard histogram equalization. The standard histogram equalization algorithm has the problem that the contrast enhancement is based on the statistics of the entire image. Because of that, some levels will be used to depict parts of the image of low interest. Adaptive histogram equalization tries to minimize this problem by using a different histogram for each pixel in the image, calculated using a window with the intensity values immediately surrounding that pixel called contextual region. This produces an image in which the objects with different intensity values which lie in different intensity subranges are simultaneously visible. However, it must be noted that it does not guarantee that in case pixel a value is greater than pixel b value this relationship will be preserved after the equalization. Moreover, in practical terms, computing a histogram for each pixel is not viable because of its computational cost. As a consequence, in most cases this approach is scrapped and instead [12], the image is divided in a limited number of tiles, and for each of them a histogram is computed. In order to prevent the apparition of the boundaries of the tiles when applying the transformation to the different pixels, bilinear interpolation is used to make the transitions in the final picture smoother. CLAHE is useful to limit the appearance of certain noise content in zones of low gray level variability by limiting its enhancement. However, the reduced contrast enhancement in certain zones of this alternative could hide the presence of some significant data in the image.

Figure 1a) original image

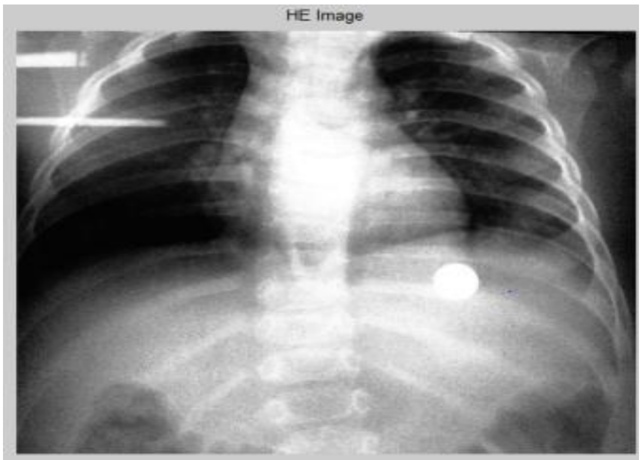

Figure 1b) Contrast Enhanced image

IV Proposed System

AHE is different from the normal HE method because HE gives only one histogram but AHE method generates several histograms corresponding to different area of the image and by using that it redistributes the intensity values of the image. In proposed method, we apply AHE method for contrast enhancement on modified after that use median filtering for image sharpening and then to minimize the difference between input and processed image mean brightness. The method has the ability to control the level of contrast enhancement in the output image. In this proposed method we use “adapthisteq‟ to adjust the contrast in a grayscale image. The original image has low contrast, with most values in the middle of the intensity range. “adapthisteq‟ produces an output image having values evenly distributed throughout the range. Figure 2 shows noise introduced image in which high frequencies noise presents in noise image where as additive noise, such as Gaussian noise present noise image.

Implementation Steps Involved in the Proposed Algorithm

• Step 1: Read the input image.

• Step 2: Convert input image into gray scale image if it is color image.

• Step 3: Calculate Intensity values of each pixel

• Step 4: Calculate Histogram Equalization.

• Step 5: Determine Cumulative Density function .

• Step 6: Calculate output of modified AHE function.

• Step 7: Output image

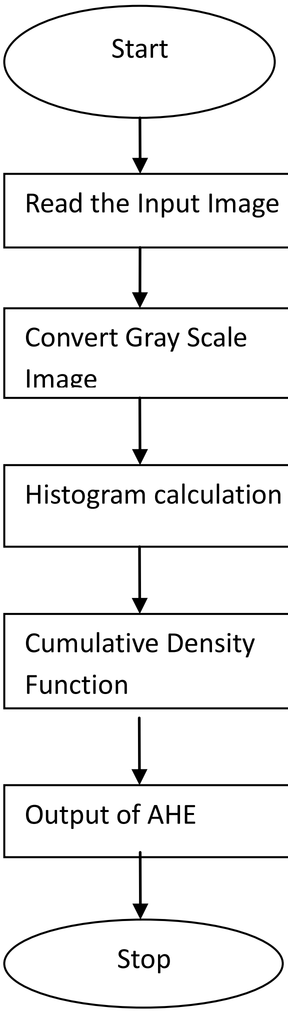

Figure 2: Flow chart of AHE

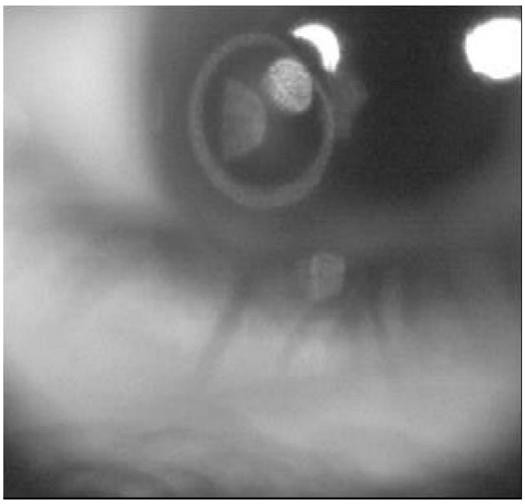

Figure 3: Noisy Human Eye Image

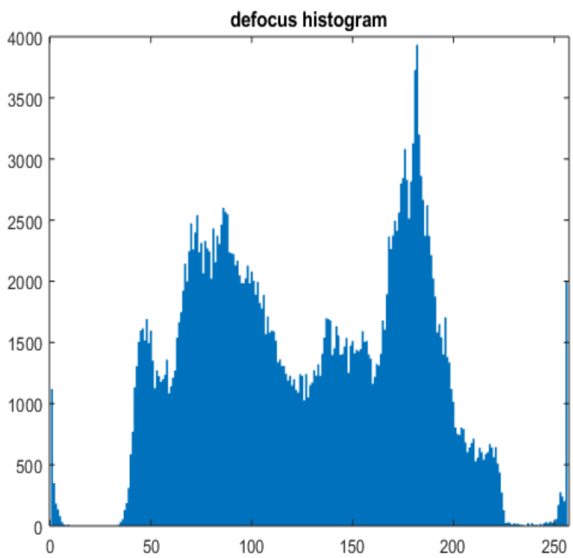

Figure 4: Histogram of Noisy Image

V Results

Simulation of proposed algorithm is done by Modelsim and output is viewed through Matlab.

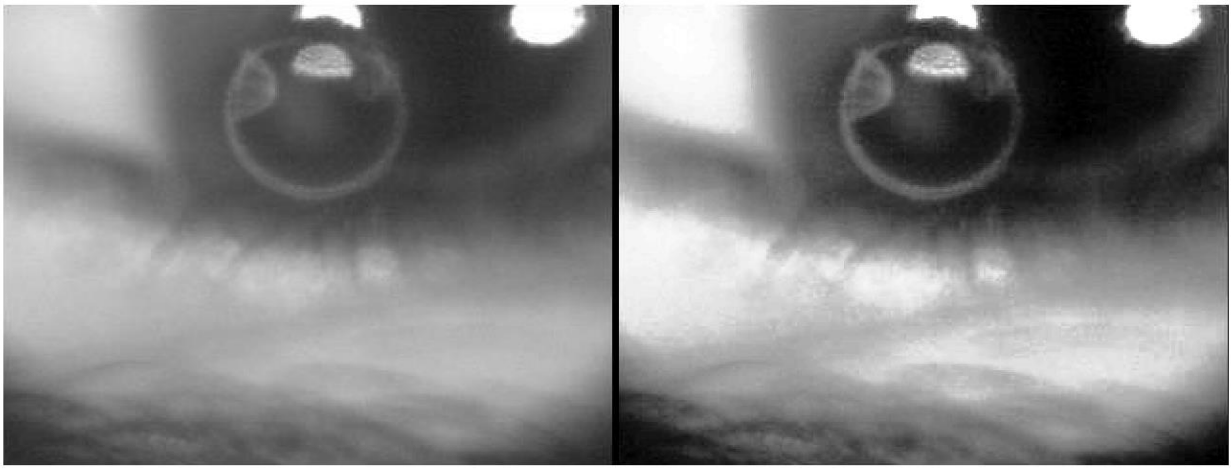

Figure 5a) Input Eye Image Figure 5b) AHE output Image

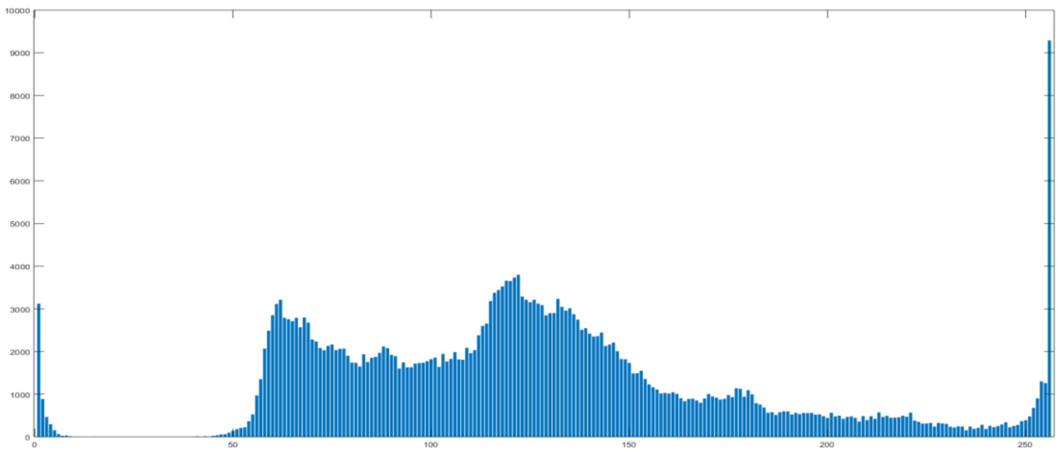

Figure 6) Histogram for AHE output Image

VI Conclusion

A novel approach of image enhancement technique using Adaptive histogram modification algorithm. The proposed framework employs carefully designed penalty terms to adjust the various aspects of contrast enhancement. Hence, the contrast of the image/video can be improved without introducing visual artifacts that decrease the visual quality of an image and cause it to have an unnatural look. The experimental results show the effectiveness of the algorithm in comparison to conventional contrast enhancement algorithms. Obtained images are visually pleasing, artifact free, and natural looking. The proposed method is applicable to a wide variety of images and video sequences. It also offers a level of controllability and adaptivity through which different levels of contrast enhancement, from histogram equalization to no contrast enhancement, can be achieved.

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