International Journal of Advance Research in Science and Engineering
Vol. No. 5, Issue No. 08 , August 2016
www.ijarse.com
IJARSE
ISSN 2319 - 8354

PROTOTYPING OF IMAGE ENHANCEMENT ALGORITHMS USING BEAGLE BOARD FOR RURAL HEALTH MONITORING

Garima Sharma[1], Krishan Kumar[2]

Department of Electronics and Communication Engineering,
Bhagat Phool Singh Mahila Vishwavidyalaya, Khanpur Kalan, Sonipat, Haryana,(India)

ABSTRACT

CT scan, MRI and Ultrasound machine has already been developed and widely used in healthcare sector. These equipments utilize FPGA and other DSP kits which is still a costly solution. Another alternative is to use open source DSP kits. Beagle board is a low cost open source. Enhancement of medical images is very important in order to provide health monitoring. We have designed a cost effective solution for fast image enhancement in real-time using open source DSP kit. This paper is an approach towards healthcare sector in order to provide cost effective and optimum quality framework for rural health monitoring. In this paper several image enhancement algorithms are explored and implemented using Simulink with the computer vision system toolbox and other in-build tools in order to analyze their performance for development of devices used in healthcare industry.

Keywords*: FPGA (Field programmable gate array), DSP (Digital Signal Processing), contrast stretching, spatial domain, simulink, Matlab, Beagle board.***

I. INTRODUCTION

Various healthcare equipments are designed on the basis of image processing algorithms and DSP kits. There are various applications such as microscopy, digital photography, computer vision, whether meteorology etc which require enhancement of images. The implementation of these image enhancement algorithms on various DSP kits has undergone a rapid evolution over past decades [12]. Beagle board is an open source hardware which can be utilized for constructing medical devices in order to meet cost effective constraints [36]. Image enhancement is performed to accentuate the features of image. Algorithms of Image enhancement are application dependent. The enhancement operation is performed to improve the quality of image which includes various techniques. Simulink has built-in support for implementation of images on beagle board [32]. Implementation of image processing algorithms on beagle board is beneficial in order to reduce construction cost of medical equipments [7].

II. ALGORITHMS FOR IMAGE ENHANCEMENT: AN OUTLOOK

Algorithms for image enhancement are required to enhance or improve features of an image to get desired results for a specific application. The aim of image enhancement algorithms is to obtain suitable results for a desired application. To accomplish the task of enhancement certain operations are performed for example if an image consist of noise like salt and pepper noise then the image can be enhanced by performing the operation of noise reduction and if we have a very dark image then its intensity is increased by contrast stretching. Edges of an image can also be highlighted and at the end we get an enhanced image. Algorithms for image enhancement are used to enhance or improve features of an image to get desired results for a specific application. These algorithms are problem oriented for example best algorithm for medical imaging [18] may not be suitable for whether meteorology. So the task of selecting the algorithms for enhancement of image varies with desired application. Classification of image enhancement algorithms is depicted in figure 1.

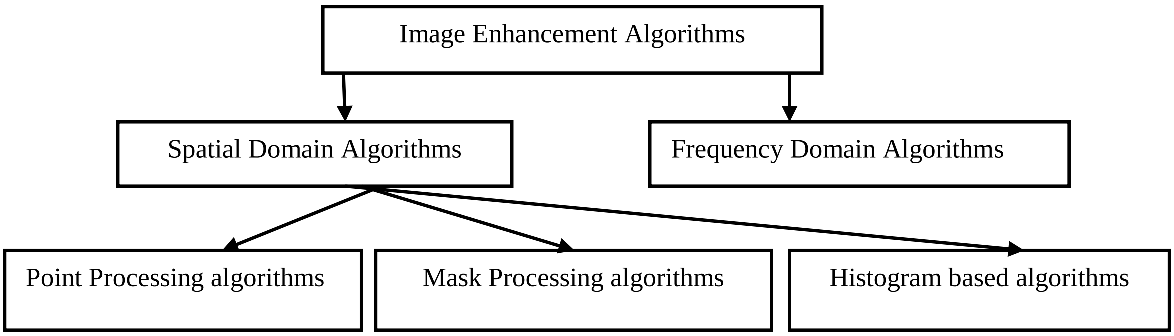

Fig. 1 Classification of image enhancement algorithm

The algorithms of image processing mainly divided into two domains –spatial domain and frequency domain as depicted in table 1.

Table 1: spatial verses frequency domain algorithms

S. No.	Spatial Domain Algorithm	Frequency Domain Algorithm
1	It works directly on image plane	It modify the coefficients of image
2	DFT has no use in spatial domain	DFT is used for enhancement in frequency domain
3	Image pixels are directly manipulated to obtain enhanced image	In this manipulation is done by taking inverse Fourier Transform(IFT) to obtain enhanced image

The spatial domain algorithm enhance the images directly by transforming the image and there is no preprocessing required for this purpose while the Frequency domain algorithms require some operations by using Discrete Fourier Transform(DFT) on the coefficients of image. These operations require use of various filters like low pass and high pass filters [37].

2.1 Spatial Domain Algorithm

The spatial domain algorithms perform the task of enhancement by transforming the pixels from original image to the enhanced image. For the purpose of enhancement a transformation function is used.

(i)For one dimensional image the transformation function is defined as follows:

$$g(x)=T[f(x)]$$

Where T is the transform operator, g is Processed image at a point x and f is original image at point x.

(ii)For two dimensional images the transformation image is given as follows:

$$g(x,y)=T[f(x,y)]$$

Where g is a processed image at a location (x,y). Hence T works on f at a location (x,y) by considering neighborhood to determine processed pixels value in g . The spatial domain algorithms are further divided into following categories:

2.1.1 Point processing algorithm

In point processing algorithm the operator T operates on x,y by considering the neighborhood size of 1x1.In point processing T determines the intensity and corresponding location for processed image g by considering the pixel at single location and there is no need for consideration of neighborhood value for processed image[8]. The transformation operator for point processing is given as follows:

$$s=T(r)$$

Where T operator operates on original image r to give processed image s for corresponding location. These s and r are independent to each other at different locations. If a graph is plotted between processed image s and original image r and the slope of image gives the transformation operator T as shown in figure 2.

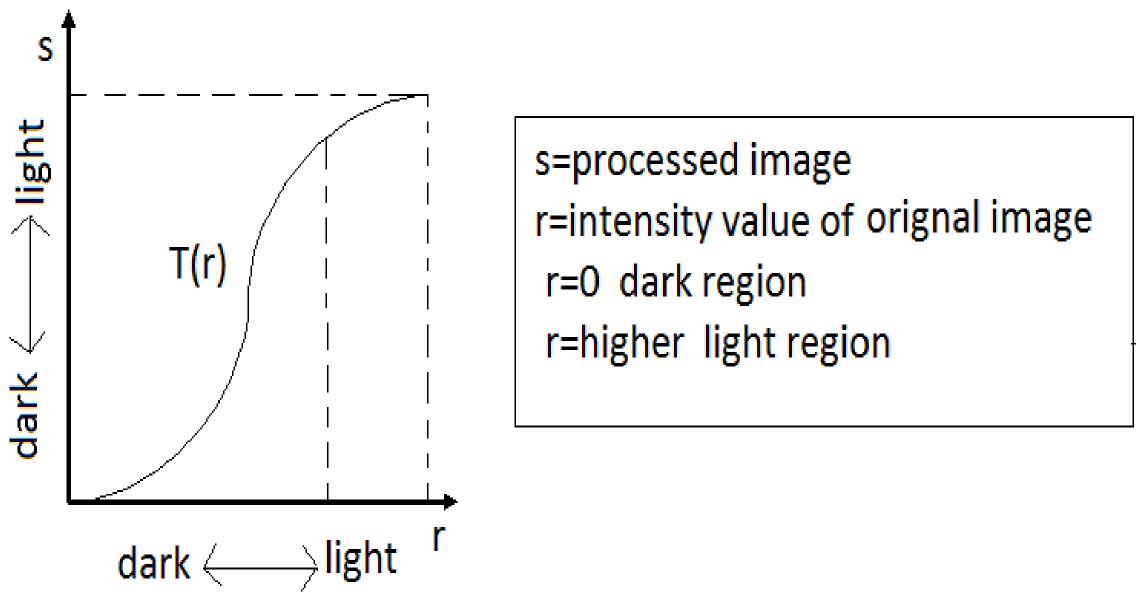

Fig. 2 Transformation function for point processing [35]

The point processing algorithms mainly focus on enhancement of intensity of a particular region. It does not consider the overall appearance to be highlighted and only enhance values within a given range .There are various types of point processing algorithms for image enhancement as shown in figure 3.

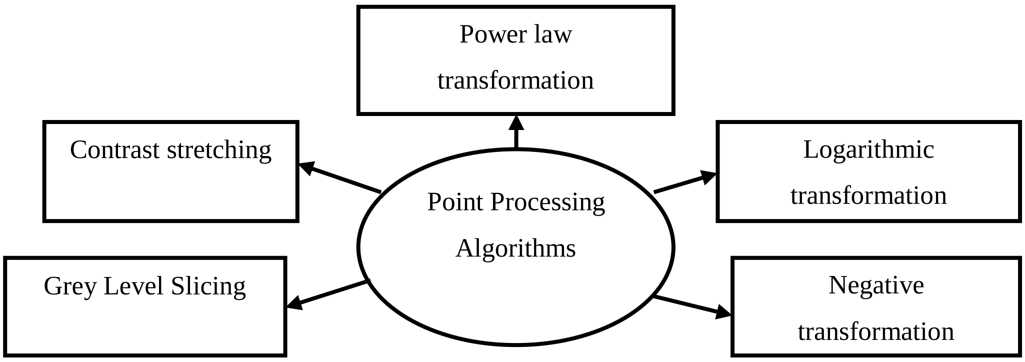

Fig. 3 Classification of point processing algorithm [39]

The point processing algorithms are classified on the basis of required application. For example the power law transformation algorithms are useful for the applications which require in display of image, image acquisition devices and image printing devices because these devices themselves transform the images using the power law transformation to obtain enhanced image whereas grey level slicing is useful to enhance the value of desired grey levels by enhancing all the intensity values within a range and the outside intensity value either remains unchanged or suppressed [38]. In negative transformation algorithms, input image is inverted and this scheme is efficient for those images in which all information is stored in grey and white pixels which are embedded in huge region of dark pixels. Hence in order to obtain that information the image is inverted .To enhance the dark images, the algorithm used is contrast stretching. The dynamic range compression algorithms are useful for those images which have to be displayed on display devices but due to their large dynamic range these images are failed to be displayed. Hence their dynamic range is compressed so that the display devices can handle that kind of images. It is also known as logarithmic transformation algorithm.

2.1.2 Mask processing algorithm

In mask operation algorithm the operator T operates on x, y by considering the neighborhood size of 3x3. In point processing T determines the intensity and corresponding location for processed image g by considering the neighborhood around a pixel (x, y). For mask operations the intensity value of pixel around a point or in neighborhood is required. All the neighborhood pixels contribute in calculating the intensity of processed image. There are some values shown inside the mask known as coefficients. The value of these coefficients helps in deciding the kind of image enhancement operation such as averaging or sharpening. These mask coefficients are shown in figure 4.

W (-1,-1)	W (-1, 0)	W (-1,-1)
W (0,-1)	W (0, 0)	W (0, 1)
W (1,-1)	W (1, 0)	W (1, 1)

Fig. 4 Mask coefficients of 3x3 mask

Mask processing operations are classified on the basis of type of filters used such as spatial filters, median filters and sharpening filters. Apart from these, masking algorithms also classified as unsharp masking and high boost filter processing. There are different types of filters used for mask processing operations such as linear smoothing, median and sharpening filter.

(i) Linear Smoothing Filter Processing Algorithm

Linear smoothing filters use a spatial low pass filter. In this a box filter is used which enhance the image by reducing noise but at the size of masking used is increases then the noise is reduced at the cost of increasing blurredness in the image. For example a processed image having masking 7x7 is more blurred as compare to the image having masking 5x5.

(ii)Median Filter processing Algorithm

It is a type of nonlinear filter which works on the bases of statistical ordering. The response is based on the order of the values of neighborhood. In this a specific value is set then the half of values is set to less than the zero and half values are set to greater than zero.

(iii) Sharpening Filter Processing Algorithm

These filters maintain sharpness of an image and also enhance the contents of image by using laplacian operators. Sharpening filters should contain the differential operator. The sharpening filter is classified into two categories- First order derivative filter and second order derivative filter. First order derivative filters basically produce thicker edges for a processed image. Second order derivative filters are more suitable for enhancement of algorithms as compare to the first order derivative sharpening filters in terms of stronger response for thin lines and isolated points for an image.

2.1.3 Histogram based algorithm

Histogram based algorithms are used to provide global description for appearance of an image to get desired processed image. It does not deal with content of image and deals only with the global description of image. Histogram based algorithms enhance the contrast of image by modifying the histogram. Histogram of dark image consists most of the pixels having intensity value near to minimum while the histogram of bright image shows most of the pixels near to the maximum. The histogram of low contrast image consist pixels in between

IJARSE
ISSN 2319 - 8354

dark and bright image whereas for high contrast image the intensity vary from low to high which is ideal for visualization. There are two types of algorithms for histogram processing as shown in figure 5.

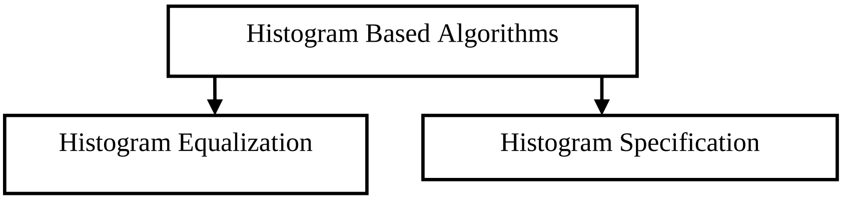

Fig. 5 Classification of histogram based algorithm

(i) Histogram Equalization

In histogram equalization, the histogram is used in such a way that a histogram of processed image contains a uniform probability density function (PDF). But in practical consideration the histogram does not contain uniform PDF. This technique has a drawback of single processed image generation.

(ii) Histogram Specification

In histogram specification, the histogram is modified to enhance the image. This algorithm is also known as histogram modification or histogram matching algorithm. It consist a target histogram and the input image has to be processed in such a way that the histogram of processed image comes out to be same as target histogram.

2.2 Frequency Domain Transformation Algorithm

In frequency domain transformation algorithms Fourier transformation is applied on input image f at point (x, y). The Fourier transform (FT) modify the coefficients of image. The modified coefficients then go through the operation of filtering. For this purpose generally Gaussian filter is used as it gives a desired shape. Also the Fourier transforms (FT) and inverse Fourier transform (IFT) are also the Gaussian function. Then the inverse Fourier transform (IFT) is applied on modified coefficient to obtain enhanced image.

III. Implementation using Matlab/Simulink

Simulink provides a built in support for implementing image enhancement algorithms using beagle board [23]. Image enhancement algorithms can be designed using various methods [40]. Image enhancement using histogram equalization on beagle board is depicted in figure 6.

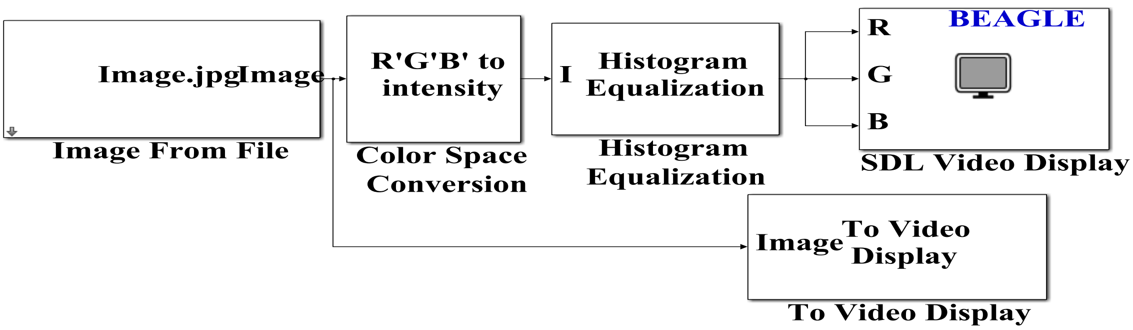

Fig. 6 Simulink model for image enhancement using histogram equalization

Fig. 7 Input image

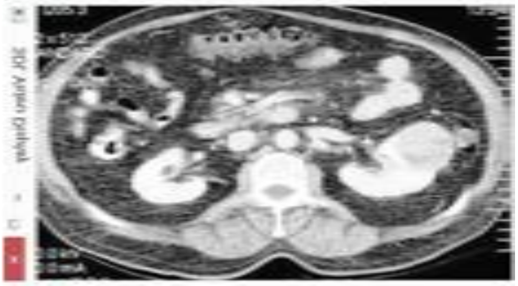

Fig. 8 Output image

Image enhancement can also be achieved using adder block which enhance quality of image as depicted in figure 9.

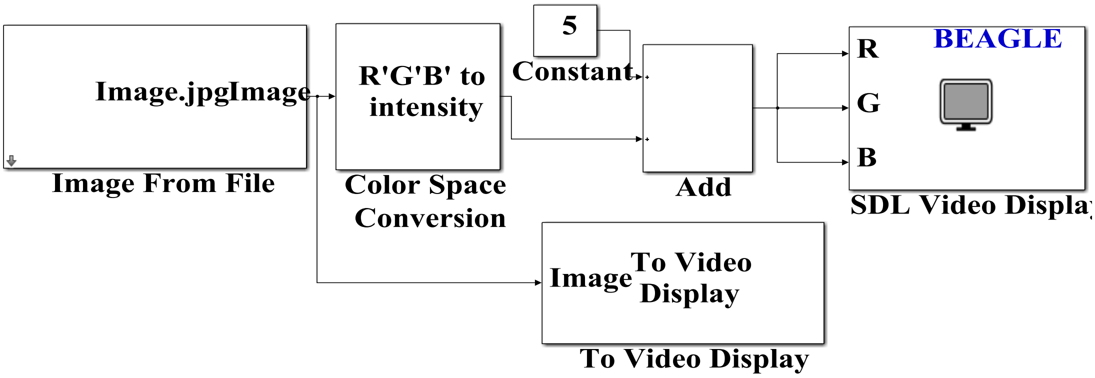

Fig. 9 Simulink model for image enhancement using adder block

Fig. 10 Input image

Fig. 11 Output image

There are various types of filters used in order to improve quality of images. Image enhancement using median filter is depicted in figure 12.

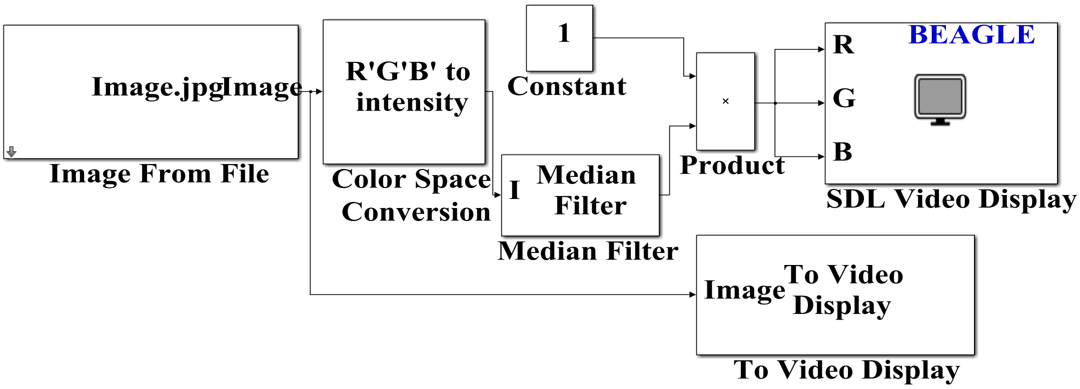

Fig. 12 Simulink model for image enhancement using median filter

Fig. 13 Input image

Fig. 14 Output image

Images can also be enhanced by adjusting its contrast. Image enhancement using contrast adjustment is depicted in figure 15.

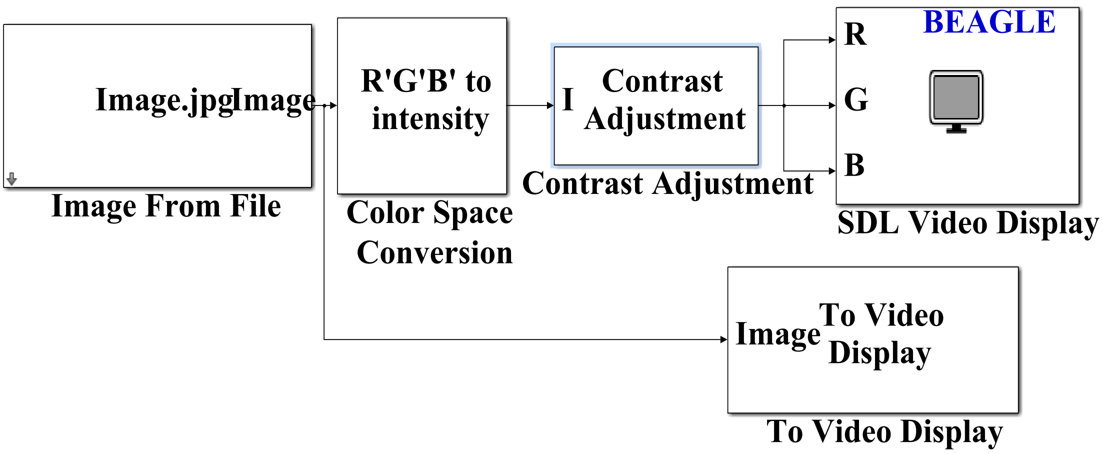

Fig. 15 Simulink model for image enhancement using contrast adjustment

International Journal of Advance Research in Science and Engineering
Vol. No. 5, Issue No. 08 , August 2016
www.ijarse.com
IJARSE
ISSN 2319 - 8354

Fig. 16 Input image

Fig. 17 Output image

Image enhancement algorithms can be analyzed by visualizing the images as well as by calculating image statics. Hence in order to check quality of images, statistical analysis is done as depicted in table 2.

Table2. Statistical analysis of image enhancement algorithms

Sr. no.	Image enhancement algorithm	Mean	Median	Standard Deviation	Variance	PSNR
1	Histogram Equalization	0.501	0.5098	0.2919	0.085	12.73
2	Image enhancement using adder block	0.324	0.2431	0.2076	0.0431	29.54
3	Median Filter	0.303	0.2196	0.2053	0.04216	32.64
4	Contrast Adjustment	0.304	0.2235	0.2059	0.0431	42.42

The quality of image is analyzed by visualizing the images as well as by calculating its statistical parameters [11]. The Mean gives average value of each column or row and median gives median value along each column or row. The standard deviation and variance can also be calculated along an entire column or row. Quality of image can be checked by analyzing psnr (peak signal to noise ratio) as depicted in figure 10.

.

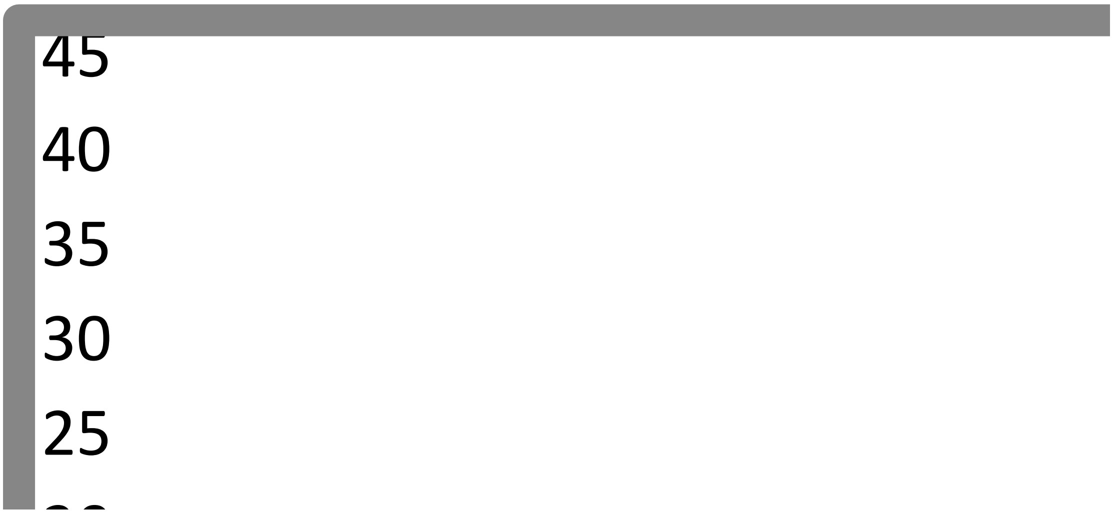

Fig. 10 PSNR analysis of image enhancement algorithms

More psnr indicates more improvement in image quality. Contrast adjustment algorithms on raspberry pi gives best image quality as it has highest psnr.

IV. CONCLUSION

In summary, we have explored various image enhancement algorithms for healthcare sector and implement these algorithms on open source hardware i.e. beagle board. Contrast adjustment algorithm gives better quality image due to its high PSNR value. Hence we have concluded that contrast adjustment algorithm using beagle board provide optimum quality along with cost effective constraints which is very beneficial for monitoring health of rural and economically backward people.

REFERENCES

1. Parth V. Parikh, Bhinjan A. Dalwadi, Ghanshyam D. Zambare, Sobel edge detection using FPGA-Artix®-7, International Journal of Scientific & Technology Research, 5 (6), June 2016, 250-253.
2. Siddarth Sharma, k. Pritamdas, FPGA based efficient median filter implementation using Xilinx System Generator, International Journal of Innovative Research in Science , Engineering and Technology, 5(5), May 2016, 8946-8952.
3. Durga Joshi, Richa Tiwari, A study of VHDL implementation of fast sobel edge detection algorithm, International Journal of Innovative Research in Computer and Communication Engineering, 4(5), May 2016, 9775-9777.
4. Swami Gururaj M., Naveen J., Identification of counterfeit currency and denomination using Raspberry pi, International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering, 4(2), April 2016,142-146.

5. Prof. Mangesh. T. Nikam, Mr. Jitendra. A. Patil and Mr. Vishal S. Patil, Pedestrian Counting System Using Raspberry-Pi and OpenCV, International Journal of Innovative Research In Electrical, Electronics, Instrumentation and Control Engineering (IJIREEICE), 4(3), March 2016, 94-96.
6. Jyoti Yadav, Mohammed Firash Khanna, Muhammed Shahan K. K, Sreedevi p, Sumayya K, Manju V. M, Raspberry pi based gesture photography, International Journal of Advanced Research in Computer and Communication Engineering, 5(3), March 2016, 412-416.
7. K. Horak and L. Zalud, Image Processing on Raspberry Pi in Matlab, Advances in intelligent systems and computing, 4 November 2015.
8. M. Ali Altuncu, Taner Guven, Yasar Becerikli, Suhap Sahin, Real-time system implementation for image processing with hardware/software co-design on the Xilinx Zynq platform, International Journal of Information and Electronics Engineering, November 2015, 473-477 .
9. Nirmal T. M.,K. R. Joy, Rajeev K., Implementation and optimization of connected component labeling in Raspberry Pi, ARPN Journal of Engineering and Applied Sciences, 10(17), September 2015, 7670-7677.
10. S. R. Dixit, Dr. A. Y. Deshmukh, Realization of canny edge detection algorithm using FPGA, International Journal of Engineering Sciences & Research Technology (IJESRT), 4(9), September 2015, 608-618.
11. Shikha Maheshwari, Krishan Kumar, Comparative analysis of lung cancer using different medical modality , International Journal of Advanced Research in Computer and Communication Engineering, 4 (9), September 2015, 332-336.
12. Samar D. Gajbhiye, Pooja P. Gundewar, Object Tracking Using Embedded Platform for Video Surveillance, International Journal of Innovative Research in Computer and Communication Engineering, 3(7), July 2015, 6791-6798.
13. Kaji Ahmed Asif Fuad, Shahriyar Masud Rizvi, Hardware software co-simulation of Canny edge detection algorithm, International Journal of Computer Applications, 122(19), July 2015, 7-12.
14. K. Dinesh Kumar, A. V. karthik, K. Shravan Kumar, M. Koteswara Rao, V. Nancharaiah, Implementation of sobel and prewitt edge detectors using Xilinx System Generator, International Journal of Advanced Engineering and Global Technology, 3(7), July 2015, 901-905.
15. J. Manasa, J.T. Pramod, Dr. S. A . K. Jilani, Mr. S. Javeed Hussain, Real Time Object Counting using Raspberry pi, International Journal of Advanced Research in Computer and Communication Engineering (IJARCCE), 4(7), July 2015, 540-544.
16. Yogesh V. Raut, Charudatta V. Kulkarni, FPGA Based Face Detection System using Xilinx System Generator, International Journal of Advanced Research in Computer and Communication Engineering, 4(6), June 2015, 423-426.
17. Dushyant Mankar, Prof. S. S. Mungona, Models for Matlab and XSG Simulink based edge detection operations, International Research Journal of Engineering and Technology (IRJET), 2(3), June 2015, 1254-1257.

18. K. S. Shilpashree, Lokesha H , Hdimani Shivkumar, Implementation of Image Processing on Raspberry Pi, International Journal of Advanced Research in Computer and Communication Engineering (IJARCCE), 4(5), May 2015, 199-202.
19. Nazia Abdul Majeed, Satheesh Rao, FPGA Based Design Implementation for Detection of Exudates Using XSG, International Journal of Innovative Research in Computer and Communication Engineering (IJIRCCE), 3(4), April 2015, 2818- 2825.
20. Kalyani A. Dakre, Prof. P. N. Pusdekar , Image Enhancement using Hardware co-simulation for Biomedical Applications, International Journal on Recent and Innovation Trends in Computing and Communication (IJRITCC), 3(2), February 2015, 869-877.
21. V. Kamatchi Sundari and M. Manikandan, Implementation of Multi Target Tracking Algorithm on Beagle Board-Xm, Paripex-Indian Journal of Research, 4(7), July 2015, 31-33.
22. Swati R. Dixit and Dr. A. Y. Deshmukh, Sobel Edge Detection Implementation using Spartan 3 FPGA and Xilinx System Generator, International Journal of Engineering Research and General Science, ISSN 2091-2730, 3(4), July-August 2015, 221-227.
23. Dr. S.A.K. Jilani, P. Mohammad Gouse, Motion Detection Alert System using Beagle Bone Black, International Journal of Engineering Research & Technology (IJERT), 3(9), September-2014, 1249-1252.
24. Dr. S. A. K. Jilani , G.S.A. Manasa, Raspberry Pi Based Color Speaker, SSRG International Journal of Electronics and Communication Engineering (SSRG-IJECE), 1(7), September 2014, 28-32.
25. Mohammed Yousuf Khan, Masarath Nayeem Tayyaba, M. A .Raheem, Ayesha Siddiqua and Syed Sameena, Image Enhancement and Hardware Implementation of Edge Detected Vascular Images using Simulink Model, International Journal of Advanced Research in Computer and Communication Engineering, 3(4), April 2014, 6385-6388.
26. Indrajeet Kumar, Jyoti Rawat and Dr. H.S. Bhadauria, A Conventional Study of Edge Detection Technique in Digital Image Processing, International Journal of Computer Science and Mobile Computing, 3(4), 328-334, April 2014.
27. Pankaj Bhandari, Pankaj K Gupta, Karthik U. S Goutham Reddy, Jeeva. B, Analysis of face recognition based on edge detection algorithm with hardware interfacing, International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, 3(3), April 2014 ,114-121.
28. Pradeep Kumar M and Lokesha H, Real Time Implementation of Computer Vision Algorithms on Beagle board, IOSR Journal of VLSI and Signal Processing (IOSR-JVSP), 4(2), March-April 2014, 1-6.
29. Hong Nguyen T. K., Cecile. Belleudy, Tuan. V. Pham, Performance and Evaluation Sobel Edge Detection on Various Methodologies, International Journal of Electronics and Electrical Engineering, 2(1), March 2014, 15-20.
30. Md. Maminul Islam, Md. Sharif Uddin Azad, Md. Asfaqul Alam, Nazmul Hassan, Raspberry Pi and image processing based Electronic Voting Machine (EVM), International Journal of Scientific & Engineering Research, 5(1), January 2014, 1506-1510.

31. Parashar Dhakal, Nabin Sharma Rijal, Amar Mani Aryal, Ashutosh, Shrey Pratik, Development of Real Time Area Based and Particle Filter Based Tracking on Panda Board, International Journal of Advanced Computer Engineering and Communication Technology (IJACECT), 3(1), 2014, 30-36.
32. G. Johny and P. Vijay Daniel, Real Time Embedded Implementation of Face Recognition Using Beagle Board, International Journal Of Engineering Sciences & Research Technology (IJESRT), 2(12), December 2013, 3452-3456.
33. H. P. Narkhede, Review of image segmentation technique, International Journal of Science and Modern Engineering (IJISME), 1(8), July 2013, 370-372.
34. Adhyana Gupta, Hardware software co-simulation for traffic load computation using Matlab Simulink model blockset, International Journal of Computational Science and Information Technology (IJCSITY), 1(2), May 2013, 1-12.
35. S.S. Bedi and Rati Khandelwal, Various Image Enhancement Techniques- A Critical Review, International Journal of Advanced Research in Computer and Communication Engineering (IJARCCE), 2(3), March 2013, 1605-1609.
36. S. N. Gaikwad, P. H. Bhagat, A Review Of Face Recognition System Using Wavelet Transform On Beagleboard-Xm, International Journal of Innovative Research & Development, 2(2), February 2013, 478-487.
37. Priyanka Saini, Adesh Kumar, Neha Singh, FPGA Implementation of 2D and 3D Image Enhancement Chip in HDL Environment, International Journal of Computer Applications, 62(21), January 2013, 24-31. [38] A. Radha, R. Priyakanth, Performance Efficient FPGA Implementation of 2D Image Filtering Using Xilinx System Generator (XSG), International Journal of Electronics & Communication Technology (IJECT), 3(4), Oct-Dec 2012, 373-377.
38. Snehal O. Mundhada, Prof. V. K. Shandilya, Image Enhancement and Its Various Techniques, International Journal of Advanced Research in Computer Science and Software Engineering (IJARCSSE), 2(4), April 2012, 56-61.