

VLSI IMPLEMENTATION OF IMAGE SCALING ALGORITHM-RESEARCH DIRECTIONS

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Abstract-The growing interest in image scaling is mainly due to the availability of the digital imaging devices such as digital video cameras, high definition monitors etc. Scaling a digital image is a demanding and very important issue in image processing. The literature on digital image scaling is quite rich involving many methods with each approach providing tradeoffs between various factors. This paper investigates mainly on the various types of image scaling algorithms that are existing and putting it all together for a literature survey. Scope of this study focuses on the different available image scaling algorithms with their performance results.

Keywords -VLSI, AMLE, MTF, OPD, SRAM, IAVQ, HR, LR, VGA, IA, VQ, LMMSE, VO, FDGA, CMOS, FPD, LCD, VHDL, CT, HDTV,CNN

1 INTRODUCTION

The image scaling algorithms can be separated into polynomial-based and non polynomial-based methods. The simplest polynomial-based method is a nearest neighbor algorithm. It has the benefit of low complexity, but the scaled images are full of blocking and aliasing artifacts. The most widely used scaling method is the bilinear interpolation algorithm, by which the target pixel can be obtained by using the linear interpolation model in both of the horizontal and vertical directions. Another popular polynomial based method is the bicubic interpolation algorithm, which uses an extended cubic model to acquire the target pixel by a 2-D regular grid. In recent years, many high-quality non polynomial-based methods have been proposed. These novel methods greatly improve image quality by some efficient techniques, such as curvature interpolation, bilateral filter, and autoregressive model. The methods mentioned earlier efficiently enhance the image quality as well as reduce the artifacts of the blocking, aliasing, and blurring effects. However, these high-quality image scaling algorithms have the characteristics of high complexity and high memory requirement, which is not easy to be realized by VLSI technique. Thus, for real-time applications, low-complexity image processing algorithms are necessary for VLSI implementation.

2 LITERATURE SURVEY OF VLSI IMPLEMENTATION OF IMAGE SCALING ALGORITHM

2.1 Spline Interpolation Technique

In 1978,Hsiehs.Hou and Harry.C.Andrews proposed spline interpolation technique. The theory of B-spline is briefly reviewed by discussion on B-spline interpolation and B-spline filtering. The Cubic B-spline which can give smooth interpolation for the given discrete data and spline filtering for smoothening the data is discussed. This has been implemented by both software and hardware for image processing applications. Both the methods are iterative procedures which are particularly suited for digital design. Image magnification and image minimization are presented for comparison. B-spline function local support and shift invariant properties offer very attractive computational procedures. The cubic B-spline interpolation is superior to other interpolation methods.[1]

2.2 Image Resampling Technique

In 1983,AnthonyParker ,Robert.V.Kenyon and Donald.E.Troxel proposed image resampling technique.Resampling is the process of

transforming a discrete image which is defined at one set of coordinate locations to a new set of coordinate points. Resampling can be divided into two processes: interpolation of the discrete image to a continuous image and then sampling the interpolated image. Resampling is used to increase the number of points in an image to improve its appearance for display. To preserve image quality the interpolating function used for the resampling should be an ideal low pass filter. Various interpolation methods such as nearest neighbor, linear, cubic B-spline, high resolution cubic Spline were compared and the best response was obtained with the high resolution cubic spline functions. [2]

2.3 Resistive Grid Image Filtering Method

In 1992, Cellular Neural network frame developed by Bertram E. Shi and Leon O. Chua to analyse the image filtering operation performed by the linear resistive grid. The use of frequency domain techniques to characterize the I/O finite size. The operation is used by 'folk' theorems, that was used in the presence of variations in the values of the resistors. The CNN framework is used to provide an input-output analysis of the processing performed by resistive grids. The resistive grids are robust in the presence of parameter variations in the array. Finally, it has an application to edge detection. In particular, the filtering performed by the grid is similar to the exponential filter in the edge detection algorithm. [3]

2.4 Nonlinear Interpolation Scheme

In 1995, K. Jensen and D. Anastassiou proposed a nonlinear interpolation scheme for still image resolution enhancement. Edge directed interpolation techniques employ a source model that emphasizes the visual integrity of the detected edge and modify the interpolation to fit the source model. The technique is proposed to explicitly estimate the edge orientation and accordingly tune the interpolation coefficients. In the technique, the edges are detected and localized in the lower resolution pictures to impart high frequency detail information to the interpolations. With the proposed algorithm, certain high frequency image components around detected edges are predicted and replaced, yielding a lower error reproduction in such areas. The algorithm does not model the diversity of textual characteristics found within most images. The inclusion of an edge texture source assumption can be used to enhance the

quality of an image in the interpolation process. A model-based algorithm for application to the spatial interpolation of still images was presented. [4]

2.5 Absolute Minimal Lipschitz Extension model

In 1998, V. Caselles, J. M. Morel, and C. Sbert discussed possible algorithms for interpolating scalar data. A set of basic assumptions to be satisfied by the interpolation algorithms were also proposed. The Absolute Minimal Lipschitz Extension model (AMLE) is studied. Experiments show that the restoration of images with poor dynamic range is possible [5].

2.6 Convolution with symmetrical method

In 1999, Erik H.W. Meijering, Karel J. Zuiderveld, and Max A. Viergever proposed convolution with image symmetrical method for image reconstruction. In order to be able to obtain an acceptable reconstruction, both in terms of computational speed and mathematical precision, it is required to design a kernel that is of finite extent and resembles the sinc function as much as possible. The applicability of the sinc - approximating symmetrical piecewise n th -order polynomial kernels is investigated in satisfying these requirements. The reconstruction of images, which are in general n -dimensional signals, is an important operation in many applications. Operations such as magnification, sub pixel translation, rotation, deformation, or warping of images cannot be carried out without reconstructing the image under consideration. Many interpolation schemes have been devised for that purpose. This includes the very simple nearest neighbor and linear interpolators as well as the more computationally expensive cubic convolution and window sinc interpolation schemes. [6]

2.7 Medical Image Interpolation Technique

In 1999, T. M. Lehmann, C. Gonner, and K. Spitzer proposed a comprehensive survey of existing image- interpolation methods in medical image. They are expressed using a standardized terminology. The interpolation techniques used are truncated and windowed sinc, nearest neighbor, linear, quadratic, cubic B-spline, cubic, Lagrange and Gaussian interpolation. Various interpolation

methods as well as their parameters and variations are presented and discussed. The comparison is done by spatial and fourier analyses, computational complexity as well as run time evaluations and quantitative and qualitative interpolation error determinations for particular interpolation tasks which were taken from common situations in medical image processing. Relative performance and task-specific dependencies likewise are examined with regard to variations between image types and transform parameters. [7]

2.8 Image sharpening technique - JPEG Domain

In 1999, Konstantinos Konstantinides, Vasudev Bhaskran Proposed a new technique for Image Sharpening using JPEG standards. In the Image sharpening is achieved by suitably scaling each element of the encoding quantization table. Experimental results of the scanned images shows the improved image quality without affecting additional computational cost, compressibility. An unprocessed color text images, have very poor visual quality due to limited Modulation Transfer Function (MTF) and misregistration. An important cost for the MTF degradation is the lens. In most scanners and cameras an object is imaged on the sensor through the lens. If a lens is not perfect then the light wave emerging from the lens is not a perfect sphere. This is known as Optical Path Difference (OPD). To observe the OPD appear in the image as a blur of image points. Finally the image is obtained using the technique called sharpening image which is simple and cost effective manner in the compression domain.[8]

2.9 IAVQ Algorithms

In 2000, S.Ridella, S.Rovetta and R.Zunino proposed an algorithm for both training and runtime use of interval arithmetic vector quantization (IAVQ). Intervals arithmetic (IA) can enhance vector quantization (VQ) in image compression applications. VQ encodes information by means of a set of prototypes in the observed domain. In the IAVQ reformulation of classical VQ, prototypes assume ranges of admissible locations instead of being clamped to specific space positions. This provides VQ-reconstruction process with some degrees of freedom, which do not affect overall compression ratio. In image compression, IA attenuates artifacts (such as blackness) brought about by the VQ schema.[9],

2.10 Image improvements using LCD Controller and interpolation algorithm

In 2001, Hee-chul kim, byong-heon kwon and myung-Ryul choi proposed and implementation by FPD (Flat Panel Display) for image interpolation with improvement. The role of display systems connect humans with variable electronic devices. FPD like LCD (Liquid Crystal Display) is the most suitable device to replace the existing CRT monitors, which are bulky and dissipates large power than the LCD. The advantages of LCD is lightweight, high resolution and low power operation. Moreover it can represent high quality image when the length of the digital data is increased. This proposed method is achieved using computer simulation and VHDL. [10]

2.11 Area Pixel Model-Winscale Algorithm

In 2003, C.H.Kim, S.M.Seong, J.A.Lee and L.S.Kim proposed a new scaling algorithm, Winscale, which performs the scale up or down transform using an area pixel model rather than a point pixel model. That is, in the algorithm, the pixel shapes of the original and the scaled image are treated as rectangles and pixel intensity is evenly distributed in rectangle area. Therefore each new pixel of the scaled image is obtained by weighted averaging the pixel values of the original pixels with area coverage ratio. The algorithm uses a maximum of 4 pixels of an original image to calculate one pixel of a scaled image. The hardware architecture of winscale includes coordinate accumulator, pixel orientation unit, area calculation unit, and multiplication addition unit. The coordinate accumulator accumulates the coordinate of pixel to be scaled; it calculates the location of filter window in operation coordinate. After the coordinate of current scaled pixel is obtained, the pixel orientation unit calculates the coordinate of the pixel to be scaled in the original image. All the pixels relate to the scaled point are found in order to read their pixel values from the memory. Afterward, the area calculation unit calculates the weight of area for each pixel. Finally, the value of the scaled pixel is obtained from the multiplication-addition unit. Based on the proposed technique, the high speed VLSI architecture has been successfully designed and implemented. The proposed algorithm has low complexity. The algorithm has good characteristics such as fine edge and changeable smoothness.[11]

2.12 Gaussian Approximation Filter technique

In 2003, S. Schaller, J. E. Wildberger, R. Raupach, M. Niethammer, and K.Klingenbeck-Regn developed a new method that allows online modifications of image sharpness and pixel noise in real time. In computed tomography(CT), selection of a convolution kernel determines the tradeoff between image sharpness and pixel noise. This method has the ability to modify noise and sharpness in image. The method has the potential to eliminate the need for multiple reconstructions using different kernels. Efficiently implementing fourier transform and using Gaussian approximation filter settings are possible and can replace the reconstructed kernels. Phantom measurements have shown that spatial domain filtering produces similar results as additional reconstructions.[12]

2.13 PTZ Based Colour Interpolation.

In 2004, C. Weerasnghe, M. Nilsson, S. Lichman, and I. Kharitonenko described the development of a digital zoom camera with image sharpening and noise reduction. A method of colour interpolation performed on the Bayer pattern Vs Digital zooming is accomplished using a weighted bilinear interpolation scheme. The output video resolution is simply determined by the choice of the intended interpolated pixel locations. Image sharpening is performed using a non linear sharpening filter and a filter with mid frequency amplification. Noise reduction is accomplished using a line based anisotropic diffusion algorithm. The proposed system is implemented using an FPGA based CMOS camera platform. Camera testing indicates superior performance in resolution, sharpness and noise suppression against standard CCTV cameras in zoomx2 and zoomx4 modes. The proposed algorithm for the camera system were implemented on a Xilinx virtex II FPGA based platform.[13]

2.14 An edge-Guided image interpolation algorithm

In 2006, Lei Zhang, and Xiaolin proposed a new edge-guided non-linear interpolation technique through directional filtering and data fusion. The aim of the image interpolation is to reconstruct the High Resolution (HR) image from the associated Low Resolution (LR) capture. It has applications in medical imaging, Remote sensing

and digital photograph etc. The Linear Minimum Mean Square Error Estimation (LMMSE) technique based on Interpolation algorithm is used to reduced computational cost without affecting Interpolation performance.[14]

2.15 Orientation-Adaptive Interpolation Method

In 2007, Qing Wang and Rabab Kreidieh proposed Orientation- Adaptive Interpolation Method. In recent studies on image interpolation, it is agreed that for many application, the main emphasis should be on the perceptual quality of images. These methods, usually known as edge-directed, content-adaptive, or level-set based, form the family of Visually Oriented (VO) interpolation techniques. Two of the most well-known and most widely used traditional interpolation methods are the bilinear and bicubic. These methods suffer from several types of visual degradations, and the Zigzagging artifacts is one of the most noticeable. The Zigzagging artifact and develop effective methods that significantly reduce it. The distinguish between two kinds of Zigzagging. The first happens at image edges, where the image has strong gradient magnitudes. The second happens at ridge lines, where the gradient is almost zero. [15]

2.16 Generic Image Enhancement Algorithm

In 2007, S.Saponara, L.Fanucci, S.Marsi, G.Ramponi, D.Kammler and E.M.Witte proposed a low complexity generic image enhancement algorithm(Retinex like processing).An application specific instruction set processor (ASIP) for real time retinex image and video filtering is presented.The design optimizations are addressed at algorithmic and architectural levels.The main considerations leading to the designed ASIP are algorithmic optimizations ,memorystructure, architecturepipelining,hardware customizations using bypasses,AGU and special looping structures.ASIP stands for its better energy flexibility tradeoff versus reference ASIC and digital signal processing retinex implementations.[16]

2.17 Winscale Algorithm

In 2007, C. C. Lin, Z. C. Wu, W. K. Tsai, M. H. Sheu, and H. K. Chiang proposed an efficient VLSI design of winscale algorithm. A high speed VLSI architecture has been successfully designed and implemented. The VLSI design of winscale that is

able to process image scaling for HDTV in real time is proposed. Winscale has good high frequency characteristics and better image quality than bilinear method. It is suitable for digital display devices in various resolutions.[17]

2.18 Extended Linear Interpolation Algorithm

In 2008, C. C. Lin, M. H. Sheu, H. K. Chiang, W. K. Tsai, and Z. C. Wu proposed an extended linear interpolation, which is an efficient scaling method with reduced computation complexity. A low cost architecture with the interpolation quality compatible to that of bicubic convolution interpolation and architecture of reducing the computational complexity of generating weighting coefficients is proposed. Based on this proposed technique high speed FPGA architecture has been designed and implemented and it is able to process digital image scaling for HDTV in real time. The FPGA hardware architecture includes the SRAM Manager and Controller, Data Buffer and Arbitration, Extended Linear Interpolation Unit, and VGA Controller. The FPGA hardware architecture of the prototype system is implemented. The CMOS Sense Controller controls the CMOS Sensor to input image data through the serial port into the system. The SRAM Manager Controller stores the image data of the source image in the SRAM. Then the Extended Linear Interpolation module will read the image data via the Data Buffer Arbitration and SRAM Manager Controller and process the interpolation procedure according to scale ratio. The interpolated image data will restore into SRAM. Finally, the scaled image data are transmitted to VGA Card through VGA Controller to display on screen. Compared and analyzed the simulation of proposed architecture with Winscale and Nuno-Maganda. The simulation results of test images shows that proposed method presents a quality that is compatible to bicubic convolution interpolation with various scale ratios. The proposed architecture has solved the problem of computation complexity of interpolation and simplified the hardware circuit. Various advantages of this proposed technique are low complexity and improved quality of linear interpolation. [18]

2.19 Adaptive image Stabilization

In 2008, Angelos Amantiadis and Ioannis Andreadis proposed Adaptive image Stabilization in Zooming Operation. The proposed architecture

scheme allows integration for both optical and digital zooming operation scenarios. Zooming ability and the video stabilization are the two features that are considered in recent consumer imaging devices. Camera zooming helps the user to modify the size of the object projected on the sensor surface. The purpose of the video stabilization is to remove the undesirable position fluctuations of the captured video sequence caused by hand shaking or platform movement. These two features can be enabled at the same time in a single imaging device, producing a zoomed and stabilized sequence. Image stabilization systems can be classified into three major categories. The electronic image stabilizer compensates the image sequence by employing motion sensors to detect the camera movement. The optical image stabilizer employs a prism assembly that moves opposite to the shaking of camera for stabilization. Both electronic and optical image stabilizers are hardware dependent. The digital image stabilizer (DIS) does not need any mechanical or optical devices since the image compensation is made through image processing algorithms.[19]

2.20 Bicubic Convolution Interpolation Scheme

In 2008, C. C. Lin, M. H. Sheu, H. K. Chiang, C. Liaw, and Z. C. Wu has put forth a method for low cost VLSI scalar design based on the bicubic scaling algorithm. Based on the proposed technique high speed VLSI architecture is designed. The proposed architecture reduces computational complexity of generating coefficients as well as decreasing number of memory access times. The proposed hardware architecture, includes the Coordinate Orientation hardware, the Coefficient Generator, the Vertical Interpolation Unit, the Virtual Pixel Buffer, and the Horizontal Interpolation Unit. The coordinate orientation architecture is used to calculate the orientations of pixels in horizontal or vertical direction. The coefficient generator creates one kind of coefficients at a time depending on the control signal. To execute interpolation vertical and horizontal interpolation units are used. The virtual pixel buffer is used to store virtual pixels created from vertical interpolation. The proposed method have simple hardware architecture design, low computation cost and easy to implement. Because this widely used bicubic method have high quality image but it needs a lot of computational effort.[20]

2.21 Autoregressive Model

In 2008, X.Zhang and X.Wu proposed an autoregressive model which efficiently enhance image quality as well as reduce the artifact of the blockings, aliasing and blurring effects. The technique estimates a block of missing pixels jointly by imposing an adaptively learnt spatial sample relation not only between known pixels and missing pixels but also between missing pixels themselves. Edges and textures are well preserved and common interpolation artifacts (blurring, ringing, jaggies, zippering etc) are greatly reduced. Various disadvantages of this technique are high complexity, high memory requirement and not easy to be realized by VLSI technique. [21]

2.22 Convolution Based Image Interpolation Method

In 2008, L. Liang designed a kernel function via blending some well known kernels. Blending is a technique widely used in the field of computer-aided geometric design, which can produce curves and surfaces of new types by weighted averaging known curves or surfaces for some specific uses. The new kernel is a better approximation to sinc function both in the space domain and the frequency domain. Based on these kernels, a new convolution based image interpolation method is introduced, whose kernel is a blending of those known ones. Comparing results have shown that the proposed method can improve the visual quality to some extent as well as the PSNR values. [22]

2.23 Distortion Correction Technique

P.Y.Chen, C.C.Huang, Y.H.Shia and, Y.T.Chen proposed a low cost real time pipelined architecture for barrel distortion correction based on the least square estimation method in 2009. The proposed design consist of four main modules; mapping unit, memory bank, linear interpolation unit and a controller. The mapping unit performs the calculation of polar to Cartesian coordinate of target pixel. The memory bank consist of four RAMS, used to provide intensity values of four neighboring pixels around polar to Cartesian coordinate of the target pixel. The interpolation unit linearly interpolates final intensity value. The controller provides control signal of each state to other units and handles the whole correction procedure. The proposed architecture needs less hardware cost but achieves

faster working speed as compared with the previous design. It proves to be a good candidate for low cost high performance distortion correction circuit. Here a 21 stage pipelined architecture is presented for barrel distortion correction. By eliminating the calculation of angle θ and adopting the odd-order back mapping polynomial, the proposed high performance distortion correction design can be implemented with very low cost. The proposed correction circuit can be implemented with a dedicated chip or be integrated with other image processing components such as noise removal and image enhancement, on a single chip for wide angle camera applications. [23]

2.24 Edge Oriented Area Pixel Technique

In 2009, P. Y. Chen, C. Y. Lien, C. P. Lu has jointly proposed an edge oriented area pixel scaling processor. The area pixel scaling method uses an area pixel model instead of the common point model and takes a maximum of four pixels of the original image to calculate one pixel of a scaled image. A simple edge catching technique is adopted to preserve the image edge features effectively by taking into account the local characteristics existed in those available source pixels around target pixel. So as to achieve better image quality. Area pixel scaling technique is approximated and implemented with the proper and low cost VLSI circuit. It requires small amount of memory, i.e., one line buffer. The architecture consists of seven main blocks: approximate module, register bank, area generator, edge catcher, area tuner, target generator, and the controller. The main difficulty to implement the area-pixel scaling with hardware is that it requires a lot of extensive and complex computations. Furthermore, the typical area pixel scaling method needs to calculate six coordinate values for each target pixel's estimation. To reduce the computational complexity, we employ an alternate approach suitable for VLSI implementation to determine those necessary coordinate values efficiently and quickly. [24]

2.25 Bilateral Interpolation Algorithm

In 2010, J.W.Han, J.H.Kim, S.H.Cheon, J.O.Kim and S.J.Ko proposed a novel interpolation method using bilateral filter to handle noisy input image. Since noise deteriorates the interpolation performance in digital images, denoising is employed prior to the interpolation. The bilateral filter decomposes the input LR image into detail

and base layers. Detail layer represent small scale features and base layers represent large scale features. The technique can only deal with the noise in the detail layer which is adaptively smoothed to suppress the noise before interpolation. An edge preserving interpolation method is applied to both layers. Finally base and detail layers are combined to obtain high resolution image. It is empirically proved that the gradient energies in the corresponding region between the detail and base layers have the strong relationship. Depending on this relationship, it may be easy to distinguish texture information from the noise. The proposed method shows subjectively and objectively better performance to generate sharp HR image from LR image even when it contains noise. The proposed method can be used in many portable multimedia applications which may acquire noisy LR image. [25]

2.26 Automatic Fingerprint Based Authentication System(AFAS)

M.Fons, F.Fons and E.Canto proposed a fingerprint based human recognition algorithm in 2010. It's

performance has been evaluated under different processing platforms frequently used in DSP applications. As a result of the evaluation, it is proven that those classical systems based on purely software platforms such as personal computers are able to provide the requested real

Image	Hol es	Len a	Spla sh	Pep per	Clo th	Butterfl y
Bicubic conv	17.7 9	26.3 8	29.8 8	26.8 9	26.5 7	24.59
Bicubic spline	17.8 1	26.4 1	29.9 7	26.9 3	26.6 3	24.73
Method in 8	16.1 6	25.9 6	28.8 2	26.4 6	26.1 1	24.31
Method in 9	17.5 4	26.2 1	29.5 2	26.7 6	26.4 4	24.57
LMMSE_INT R_cubic	18.0 1	26.3 5	29.9 2	26.8 7	26.5 7	24.82
LMMSE_INT R_linear	17.7 3	26.2 2	29.7 1	26.7 4	26.4 1	24.57
OW_INTR_cu bic	17.9 4	26.3	29.9 2	26.8 2	26.5 6	24.72
OW_INTR_lin ear	17.6 4	26.2 1	29.6 7	26.7 2	26.3 6	24.42

time performance at the expense of high system costs. To the best of the authors knowledge, this is the first that implements a complete automatic fingerprint based authentication system (AFAS) application under a dynamically partial self-reconfigurable field programmable gate array (FPGA). The main benefits of this implementation are the acceleration of the processing reached by the parallelism inherent to the hardware design, the high level of integration, the consequent security and reliability improvements provided by the usage of a system on-programmable-chip device that is able to embed the main components of the application in a single chip, and the low cost achieved by the whole system due to the reconfigurability performance featured by the suggested FPGA. All these factors result in an outstanding system that is able to authenticate the

identity of any user by means of those distinctive characteristics available in fingerprints. The key factors to succeed in the development of the embedded AFAS application are the minimization of the reconfiguration overhead by means of the proper sizing of the reconfigurable region in the FPGA and the design of a hardware configuration controller that is able to reach the maximum configuration rates allowed by the technology.[26]

2.27 Curvature Interpolation Algorithm

In 2011, H.Kim, Y.Cha and S.Kim proposed a curvature interpolation method for image zooming which efficiently enhance image quality as well as reduce the artifact of the blockings, aliasing and blurring effects. It is partial differential equation (PDE) based and easy to implement. It has proved to be superior to linear interpolation methods for all synthetic and natural images. In order to minimize artifacts arising in image interpolation such as image blur and the checker board effect, CIM first evaluates the curvature of the low resolution image. After interpolating curvature to the high resolution image by solving a linearized curvature equation, incorporating the interpolated curvature as an explicit driving force. It has been numerically verified that this zooming method can produce clear images of sharp edges which are already denoised and superior to those obtained from linear methods and PDE based methods of no curvature information.[27]

TABLE I

In Table I PSNR (dB) Results of the Recovered HR Images by the Eight Algorithms is shown below.

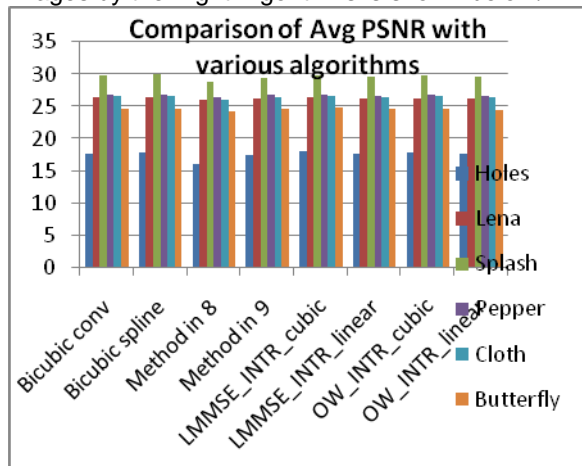


Fig1: Comparison of PSNR

TABLE II

	B L [1]	W in [2]	B C [5]	Ed ge [4]	Ad a [7]	This Work		
						A	B	C
Hal f	27.4	27.3	28.1	27.42	28.49	27.68	27.77	28.27
CIF	27.8	27.7	28.7	27.82	29.25	28.39	27.83	28.22
VG A	28.5	28.5	28.9	28.58	29.44	28.54	28.42	28.60
DI	28.5	28.5	28.9	28.55	29.24	28.56	28.45	28.61
Do ub.	28.5	28.5	28.9	28.58	29.37	27.87	28.80	28.78
HD MI	28.6	26.9	28.9	26.96	29.38	28.72	28.66	28.76
Av e.	28.5	27.9	28.7	27.99	29.2	28.29	28.32	28.54

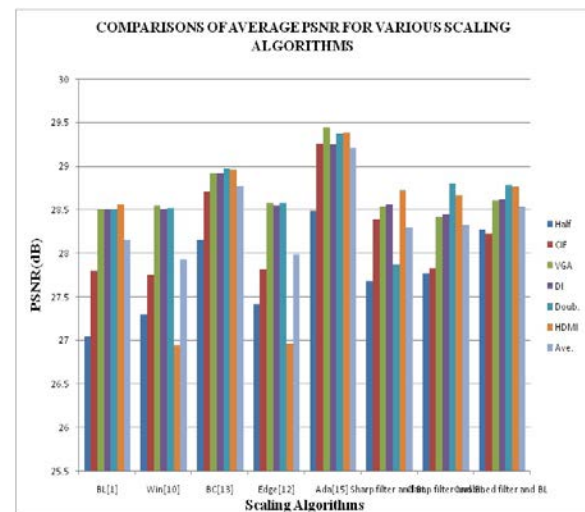


Fig2: Comparison of PSNR

3.Recommendation For Future Work

Review of the various image scaling algorithms lead to a wide research idea.

- VLSI architecture for medical image scaling.
- VLSI architecture for colour image scaling.
- Low power VLSI architecture for image scaling.
- Low power VLSI architecture for image scaling and noise reduction.

4.CONCLUSION

Hence some existing image scaling techniques has been discussed. Image quality of the image after scaling is the main criteria that all the image scaling techniques should hold. To conclude, all the scaling techniques are useful for real time image processing. Each technique is different and gives appropriate results for each technique. Everyday new scaling technique is evolving hence selection of suitable scaling technique will lead to maintain the quality of the image and success in scaling process.

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