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AREA EFFICIENT RELIABLE 2D BI-CUBIC INTERPOLATOR USING RAIDX-16 BOOTH

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ABSTRACT: This concept proposes a new edge-directed image interpolation method. This method is an extension of the classical cubic convolution (BC) interpolation. BC interpolates indiscriminately the missing pixels in the same direction (horizontal or vertical) and typically results in blurring, blocking, ringing or other artifacts in interpolated. The proposed bicubic architecture is based on state-of-the-art VLSI architectures for performing square and cube operations. All the adders used in the proposed design are judiciously developed to increase the speed retaining an acceptable area and power consumption. Further, as an extension of this concept raidx16 modified booth encoding algorithm used to reduce area and timing constrains.

***KEYWORDS*:** cubic convolution, Bi-cubic, Vedic multiplication, Carry save addition, Radix-16, Modified booth encoding.

INTRODUCTION: An approach to improve digital image quality which has attracted large interest in the past decade is super resolution reconstruction (SRR). One of the major issues regarding SRR algorithms is their dependence on an accurate modeling of the SRR problem[1]. Outliers are defined as data points with different distributional characteristics than the assumed model, so this kind of reconstruction algorithm is highly dependent on the data outliers. We focus on thenon-Gaussian outliers in this paper, and concentrate on reducing the effects of salt and pepper outliers. In image processing, non-linear filter has been studied widely because it can not only remove outlier effectively but also keep details of the image sufficiently. At present, there are many typical nonlinear filter algorithms such as Median filter[Morphology filter[3], Stack filter[4], some improvedfilter algorithms based on the Median filter and so on. Based on the studies of the cat's visual cortex, the Pulse Coupled Neural Networks (PCNN) becomes a mathematical model based on the mammal's visual nerve nets. PCNN is different from the traditional multilayer neural networks in that it is a single layer model, which is suited to real-time image processing. This is a neural network that without any training needed, generates a sequence of binary images for theinput digital image. To simplify the PCNN, Kinser introduced the Intersecting Cortical Model (ICM), earlier called the Unified Cortical Model (UCM) [5]. Image scaling is the process of resizing a digital image which has been widely used in many fields from consumer electronics to medical fields. Scaling is a non-trivial process that involves a trade-off between efficiency, smoothness and sharpness. In the fields of digital imaging devices, image scaling has a very important role [1], [2]. An important application of image scaling is to scale down the high-quality pictures or video frames to fit to the application such as the mini size liquid crystal display panel of the mobile phone or tablet PC etc. An image size can be scaled in two ways; up scaling and down scaling. Up scaling is an image enhancement process in which the size of the image is enlarged to fit to the desired application. It is the process of highlighting certain features of interest in an image. Down scaling is the process of image compression which reduces the amount of data needed to represent a digital image. This is done by removing the redundant data from the image. The objective of image compression is to decrease the number of bits required to store and transmit image without any measurable loss of information. Common interpolation algorithms can be grouped into two categories: adaptive and non-adaptive. Adaptive methods change depending on what they are interpolating (sharp edges vs. smooth texture), whereas non-adaptive methods treat all pixels equally. Non adaptive algorithms include: nearest neighbor, bilinear, bicubic, spline, sinc, lanczos and others. Nearest neighbor algorithm is the simplest method in which the scaled images are full of blocking and aliasing effects. Bilinear interpolation algorithm [3] is the most widely used scaling method, where the target pixel is obtained by the linear interpolation in both horizontal and vertical directions. Another popular non-adaptive method is bicubic interpolation algorithm [4], which is an extension of cubic model. These are some of the polynomial- based methods. Image interpolation is a technique of producing a highresolution (HR) image from its low-resolution (LR) counterpart, which is often required in many image processing applications because a HR image can offer more details and a better view. The classical image interpolation methods are nearest neighbor (NN) interpolation, bilinear (BI) interpolation, bicubic convolution (BC) interpolation [1], and cubic spline (CS) interpolation [2], [3], etc. The classical methods attempt to turn discrete data into a continuous function and resample the function, which have very good interpolation effects for the pixel intensity smooth images. In fact, the intensity surfaces of almost all natural images are highly irregular. They are only smooth along edge directions while abrupt discontinuity might happen across edge directions. Therefore, resampled images obtained by the classical methods incur typically common artifacts [4] such as blurring, blocking and ringing etc. in the edge regions. Bicubic interpolation is one of the efficient methods to find unknown pixels in digital image processing.

LITERATURE SURVEY: One of the definitions of image interpolation is that it's a technique to transform low-resolution images into a high-resolution image. It is very useful in many image processing tasks. An edge directed bicubic interpolation has been done by zhou dengwen. The main objective of this paper is that it can adapt to the varying edge structure of an image. And he has successfully reduced common artifacts like blocking, ringing, and blurring [1]. When we scan some old images for restoring, the scanned image is not as good as the original image. There are some removing objects and scratches in the scanned image. From that point of view, Mehram motmaen and his co-worker tried to build an improved algorithm of Image that can be used 1-D bicubic and 2-D hyperbolic interpolations. For better preservation of corner pixel, they have used hyperbolic formation in neighboring pixels [2]. Another definition of image interpolation is that it is a technique to scale up and scale down the image pixels. On that basis, sekar.k and his co-worker presented a paper that will do bicubic interpolation based on Discrete Wavelet Transform (DWT). They have done DWT interpolation on a greyscale image. Then they performed bicubic interpolation [3]. One of the zhang xiang-guang paper, he has designed an algorithm that can perform super-resolution reconstruction efficiently [4]. Watchara ruangsang and his co-worker have done the same type of work. But their main motivation is to increase the resolution of the CCTV cameras. Most of the time, CCTV cameras produce a lowresolution image due to the camera field of view or lightening. From that degraded image, it is impossible to extract valuable information. So, they have tried to build a super-resolution algorithm based on the overlapping of the bicubic interpolation [5]. In any TV program, it uses a 2x2 scale factor to enlarge the image. Auangkun rangsikunpum and his co-worker tried to describe how this real-time expansion of sign language images work on any TV. Here they have used bicubic interpolation, and the 2x2 scale factor helps them to simplify the bicubic interpolation formula [6].Yunshan zhang and co-workers have tried to improve the bicubic interpolation algorithm on hardware. Where they have used scratch table method to avoid floating number multiply and cubic operation. Based on the parallel processing capability of the hardware, they have performed bicubic interpolation [7].Adaptive algorithms include many proprietary algorithms in licensed software such as: Qimage, PhotoZoom Pro, Genuine Fractals and others. Many non-polynomial-based methods have been proposed in recent years, such as curvature interpolation [5], and autoregressive model [6].

BICUBIC INTERPOLATION

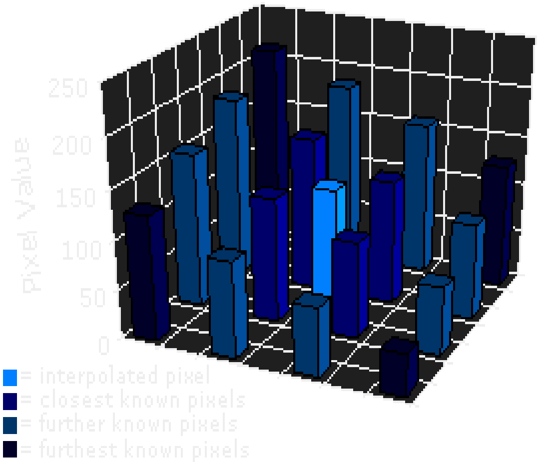

Fig1: **BICUBIC INTERPOLATION Population**

Bicubic goes one step beyond bilinear by considering the closest 4x4 neighborhood of known pixels — for a total of 16 pixels. Since these are at various distances from the unknown pixel, closer pixels are given a higher weighting in the calculation. Bicubic produces noticeably sharper images than the previous two methods, and is perhaps the ideal combination of processing time and output quality. For this reason it is a standard in many image editing programs (including Adobe Photoshop), printer drivers and in-camera interpolation. the original data set, and interpolated values in both the x and y dimensions to create a smooth surface. **An important note**: Notice how the interpolated dataset is smooth in the x-direction, y-direction, and the xy-direction (ie: along the diagonals). This means that for any point in our interpolated data set, we should be able to compute not only the intensity (ie: height/grayscale) value, but also it's derivative in ANY direction along x, y, or xy. This is equivalent to us having the following data available to us (assume $f(a,b)$ =the grayscale intensity value from the source image, X, at $X(a,b)$, and that we are trying to calculate the interpolated grayscale value in the target/output image, Y, at $Y(J,K)$)

The bicubic interpolation method is used in the context of finding out of unknown distinctive pixel values. In constant interpolation, any unknown pixel value is substituted by locating the nearest adjacent pixel. But it introduces blocking artifact. In bilinear interpolation, the unknown pixel value is substituted depending on the four nearest neighbours. But both of them fail to give a precise result. So, in this context bicubic interpolation has been opted . The function for obtaining unknown pixel value using bicubic interpolation function is

$$F(p',q') = \sum_{m=1}^{2} \sum_{n=-1}^{2} F(p+m,q+n) R_c\{(m-a)\} R_c\{-(n-b)\}$$

Where a=p'-p, b=q'-q and Rc(x) is the bicubic interpolation function. The general form of bicubic interpolation function is

$$R_c(x) = A_1|x|^3 + B_1|x|^2 + C_1|x| + D_1 \quad for \;\; 0 \le |x| \le 1$$

From the above pixel function represented in , it is evident that the overall architecture needs adder, subtractor, square circuit, cube circuit, and delay elements . For the implementation of bicubic interpolation function (Rc), the different components required are adder, counter, SAM, memory, and delay elements.

PROPOSED TECHNIQUE:
RADIX-16 MODIFIED BOOTH ENCODING:
BOOTH MULTIPLIER:

Booth's Multiplication Algorithm is a Multiplication algorithm that multiplies two signed binary numbers in two's complement notation. The algorithm was invented by Andrew Donald Booth in 1950 while doing research on crystallography at Birkbeck college in Bloomsbury, London. Booth used desk calculators that were faster at shifting than adding and created the algorithm to increase their speed. Booth's algorithm is of interest in the study of computer architecture.

BOOTH ALGORITHM:

Booth's algorithm examines adjacent pairs of bits of the N-bits multiplier Y in signed two's complement representation, including in implicit bit below the least significant bit,y1=0.For each bit yi , for i running from 0 to N-1,the bits yi and yi-1 are considered. Where these two bits are equal, the product accumulator P is left unchanged. Where yi=0 and yi-1=1, the multiplicand times 2i is added to P; and where yi=1 and yi-1=0, the multiplicand times 2i is subtracted from P. The final value of P is the signed product. The representation of multiplicand and product are not specified; typically, these are both also in two's complement representation, like the multiplier, but any number system that support addition and subtraction will work as well. As stated here, the order of the steps is not determined. Typically, it proceeds from LSB to MSB, starting at i= 0; the multiplicand by 2i is then typically replaced by incremental shifting of the P accumulator to the right between steps; low bits can be shifted out, and subsequent additions and subractions can then be done just on the highest N bits of P[1]. There are many variations and optimizations on these details. The algorithm is often describes as converting strings 1s in the multiplier to a highorder +1 and a low-order -1 at the ends of the string. When a string runs through the MSB, there is no high-order +1, and the net effect is interpretation as a negative of the appropriate value. The number of partial products rows that must be added to give the multiplication"s result can be reduced by using Booth decoding. In Booth multiplier, the numbers of reduced partial products rows are depend on the grouping done at multiplier bits . These groups of multiplier perform the selected operation on multiplicand. In booth multiplier grouping is done by 2 bits, 3 bits, 4 bits and so on. Higher order booth decoding reduces the number of partial product rows by a greater by decoding larger groups of multiplier bits. This multiplication process is completed in 3 steps. First step: multiplier bits are divided in groups then these groups are fed to decoder at where it will indicate that which operation is to perform on multiplicand. Second step: here indicated operation performs on the multiplicand and it will generate the partial products. Third step: Now generated partial products are adding with adders.

RADIX16 MODIFIED BOOTH ENCODING ALGORITHM: Booth recoding was originally introduced when multiplication was implemented using a series of shift-add operations. By recoding, the number of 1's in the multiplier could be reduced, and thereby the number of additions. The core idea is as follows:

Multiplier: $B=-b_{n-1}2^{n-1}+\sum_{i=0}^{n-2} b_i 2^i$

- Introduce new variables: $\hat{b}_i=-b_i+b_{i-1}$ for $i=0\ldots n-1$ (assume $b_{-1}=0$).
- Compute $P=\sum_{i=0}^{n-1}(\hat{b}_i\times 2^i\times A)$

 Although this looks very similar to the normal product, note that any time $b_i = b_{i-1}$ there is no addition to be performed as the partial product will be zero. In the case of serial addition, these steps can be skipped, thus saving computation.

To reduce the number of partia l products added while multiplying the multiplicand higher radix Booth Encoding algorithm is one of the most well known techniques used .Radix 16 Booth algorithm which scan strings of five bits with the algorithm given below:
(1) Extend the sign bit 1 p osition if necessary to ensure that n is even.
(2) Append a 0 to the right of the LSB of the multiplier.
(3) According to the value of each vector,each Partial Product will be 0,y,+2y,+3y,+4y,+5y,+6y,+7y,+8y, -8Y, - 7y, - 6y, - 5y, - 4y, -3y, - 2Y, - Y. The multiplicati on of y is done by shifting y by one bit to the left. Thus, in any case, in designing n bit parallel multipliers, only n/4 partial products are generated

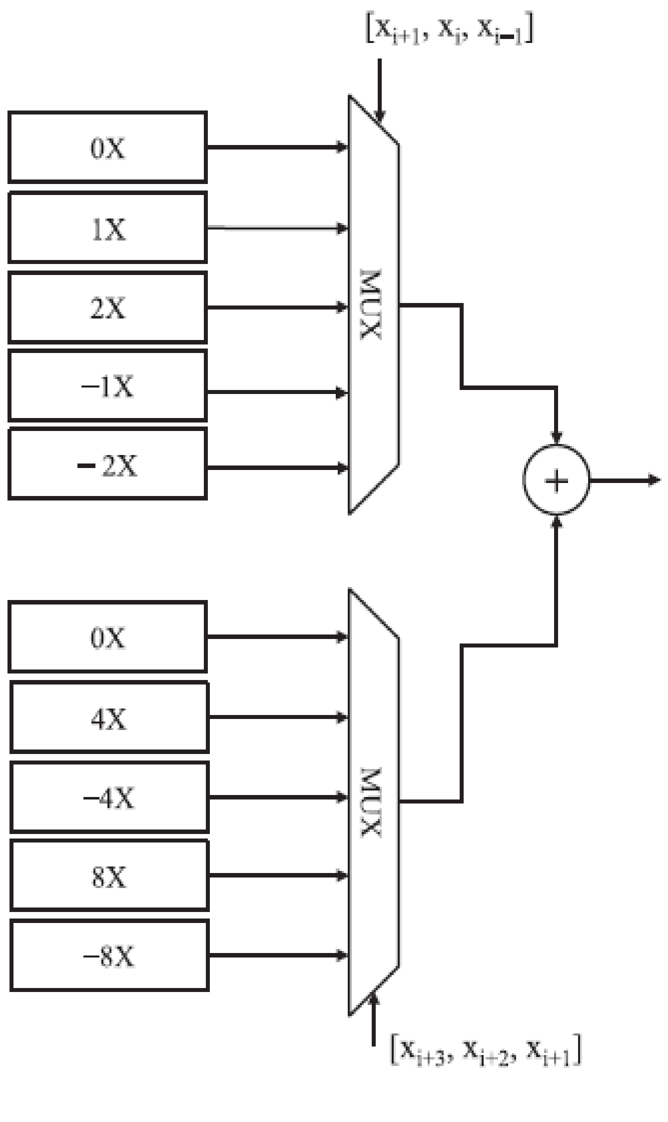

Fig2: Radix16 modified booth encoder

X_{i+3}	X_{i+2}	X_{i+1}	X_i	X_{i-1}	PP
0	0	0	0	0	0Y
0	0	0	0	1	1Y
0	0	0	1	0	1Y
0	0	0	1	1	2Y
0	0	1	0	0	2Y
0	0	1	0	1	3Y
0	0	1	1	0	3Y
0	0	1	1	1	4Y
0	1	0	0	0	4Y
0	1	0	0	1	5Y
0	1	0	1	0	5Y
0	1	0	1	1	6Y
0	1	1	0	0	6Y
0	1	1	0	1	7Y
0	1	1	1	0	7Y
0	1	1	1	1	8Y
1	0	0	0	0	-8Y
1	0	0	0	1	-7Y
1	0	0	1	0	-7Y
1	0	0	1	1	-6Y
1	0	1	0	0	-6Y
1	0	1	0	1	-5Y
1	0	1	1	0	-5Y
1	0	1	1	1	-4Y
1	1	0	0	0	-4Y
1	1	0	0	1	-3Y
1	1	0	1	0	-3Y
1	1	0	1	1	-2Y
1	1	1	0	0	-2Y
1	1	1	0	1	-1Y
1	1	1	1	0	-1Y
1	1	1	1	1	0Y

Table: Radix16 modified booth encoding table

RESULT:

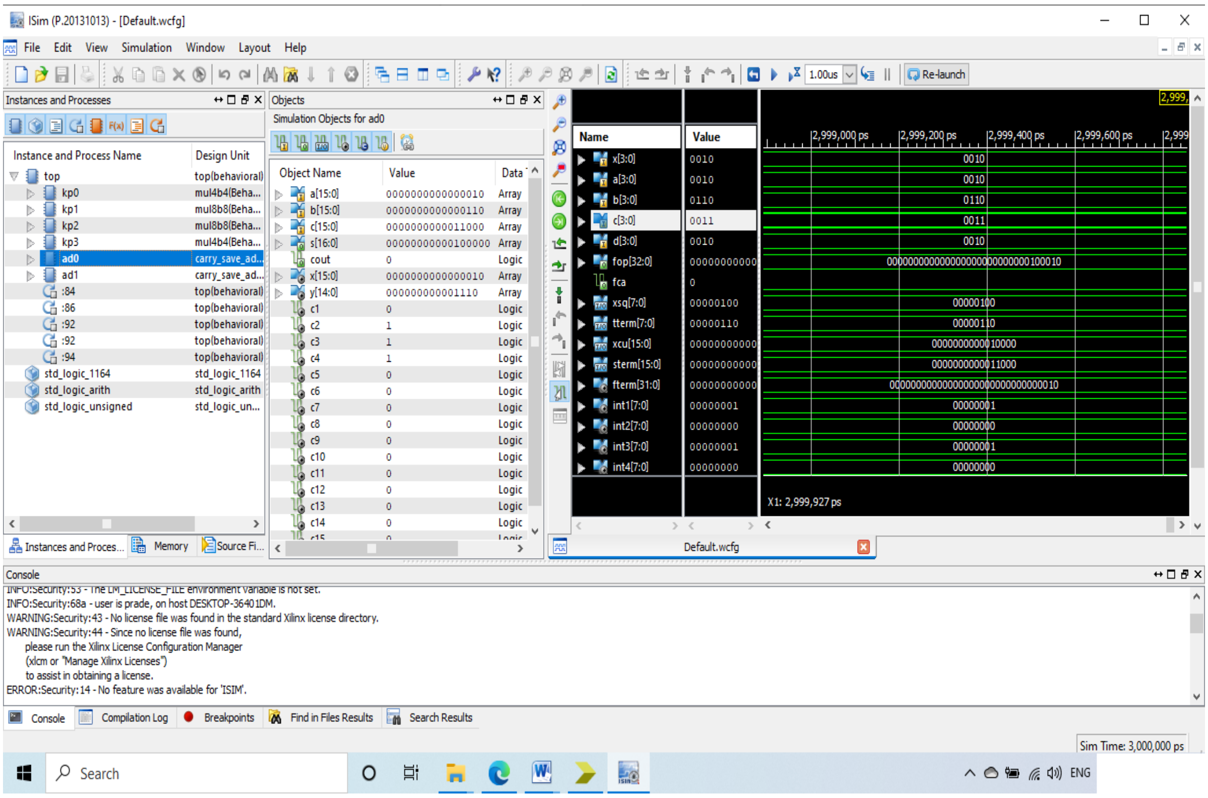

Fig: Existing Simulation output taken in XILINXISE 14.7

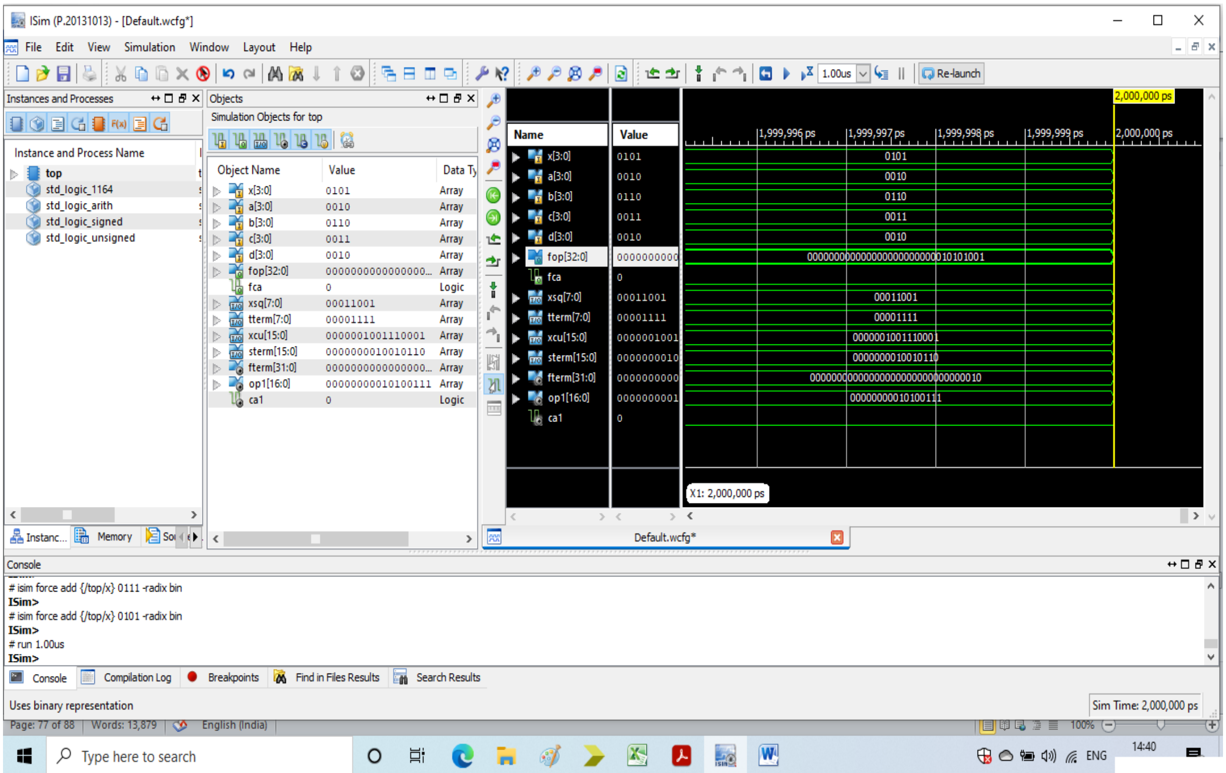

Fig: Proposed Simulation output taken in XILINXISE 14.7

CONCLUSION AND FUTURE SCOPE:

The bicubic architecture has been designed from the base level using proposed architecture yields an efficient implementation. designing CLA based CSA, a rigorous analysis of the quality of the proposed design has been done. The design has been synthesized, followed by post routing simulation using xilinxise 14.7. So, proposed CSA, modified booth encoding based bicubic interpolation function architecture can be effectively utilized in high-speed applications. The future of image processing will involve scanning the heavens for other intelligent life out in space. Also new intelligent, digital species created entirely by research scientists in various nations of the world will include advances in image processing applications. Due to advances in image processing and related technologies there will be millions and millions of robots in the world in a few decades time, transforming the way the world is managed. Advances in image processing and artificial intelligence6 will involve spoken commands, anticipating the information requirements of governments, translating languages, recognizing and tracking people and things, diagnosing medical conditions, performing surgery, reprogramming defects in human DNA, and automatic driving all forms of transport. With increasing power and sophistication of modern computing, the concept of computation can go beyond the present limits and in future, image processing technology will advance and the visual system of man can be replicated.

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