FRACTAL VIDEO CODING TECHNIQUE A HYBRID APPROACH USING PARALLEL COMPUTING

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Abstract— Picture speaks more than words but picture needs more space to get stored. For last almost three decades lot of research has been going in video compression. The term Fractal video coding is a technique which provides many advantages such as fast decoding as well as resolution independence also good compression ratio, but the encoding time is very high hence the technique is lagging behind. So, To minimize the encoding time, there is a need of new technique which is proven to be better with respect to time. The proposed system combines fractal encoding with Discrete Wavelet Transform to reduce the time taken for the encoding. The proposed hybrid algorithm which is going to be executed in parallel, hence it will again reduced the encoding time and also gives good increase in speed up when compared with the previous original algorithm which is sequential in nature. As we have just focus on to the encoding time factor so this hybrid technique will definitely degrade the quality of the video but the encoding time will be very much less.

Keywords— Discrete Wavelet Transform , Parallel Computing, video coding techniques, Hybrid video coding, Fractal Video Coding.

I. INTRODUCTION

As observed in the past decades, the video compression technology have become popular in the audio video streaming sector. It gives the way we create, generate also communicate and consume visual information. There are Many applications such as broadcast services by using satellite, digital video storage and the other services which uses digital video communication in their implementation. The amount of data i.e. quantity of the digital video is very high it means the storage of videos is more and the memory required for the storage devices as well as the bandwidth of the transmission channel are limited and finite in nature, so if the amount of data needed by the system to reproduce the given video is reduced then storage space is saved and it increases access speed and it is the only way to achieve motion video on digital computers. Encoding techniques that are generally used reduce redundancy within an image under consideration and video so that the amount of data sent through and over a channel can be minimum. The Fractal Video encoding technique is based on the term self-similarity in real-world images , where an image can be viewed as the model of unique fixed point of a contractive operator which is on space of images.

Fractal video coding technique can be compared with classical techniques like Discrete Cosine Transform (DCT) and newly developed techniques like wavelet & wavelets transform. The Only drawback of Fractal video decoding is very high encoding time(on to the opposite side decoding is very fast) when compared to transform coding. But the fractal video coding technique provides good image quality after reconstruction of the fractal image. Hence To overcome the drawback of fractal coding technique we can go by two ways which are developed over the time .First way says, how Discrete Wavelet Transform (DWT) technique is combined with fractal coding and the second way says how encoding part is executed in parallel. As both the techniques have their own advantages and disadvantages so we can combine these techniques to utilize and enhance the advantages.

II. FRACTAL IMAGE COMPRESSION

To proceed with this hybrid approach one should know the term Fractal . A Fractal is nothing but a structure that is made up of similar forms and patterns that has occur in many different sizes which are to be map. The Fractals can also be defined as an objects with fractional dimension. The term fractal is a mathematical set that typically displays self similar patterns. The Fractals may exactly same at every scale of evaluation or they may be nearly the same at different scales of evaluation which are under consideration. It uses the concept known as an attractor. An Attractor is a set of physical properties with which a system tends to evolve, regardless of the starting conditions of the system. Fractal uses following concepts,

1. Contractive transformation : The given transformation is contractive if it is applied to any two points in the input to the system must bring them closer together in the output

2. Iterated Function System(IFS): An IFS is a collection of contractive transformations which can be represented by {wi : R2 -> R2 | i = 1,..., n} which map the plane R2 to itself and 3. Fixed Point.

This collection of transformation defines a map (1). The map W is not applied to the given plane , it is applied to sets – The set is nothing but the collections of points in the plane.

Consider , Given input set termed as S, in which we can compute the "wi" for each ith iteration , where we can apply the union of these sets and get a full new set W(S). As real time images are not exact self

similar, so the images which are partitioned into a non overlapping blocks known as range blocks.

These non overlapping blocks are mapped to another category of blocks known as overlapping blocks which are exactly double the size of range blocks and which is also called as domain blocks. By using metrics like RMS, the error between two blocks say(range and domain) and contrast and brightness values are calculated. For this error calculation process , each range block is compared with all domain blocks which are under consideration. The domain block for which the minimum RMS error is calculated , it is getting stored along with contrast as well as brightness in the encoded file of a particular range block. Hence to find the matching domain block the time required is large, so there are no. of researchers had been working on it.

So, Here is the use of hybrid and parallel techniques comes into picture. While decoding the image , the basic image is considered, the image to be considered can be blank or it can be any other image.The Encoded details of each block is fetched from encoded file and applied to particular domain block. This procedure is followed until the image converges. The decoding process of Fractal is very fast.

III. PROPOSED PARALLEL HYBRID FRACTAL VIDEO CODING TECHNIQUE

The Proposed algorithm is in four dependent stages.

A. Discrete Wavelet Transform (DWT):

In DWT we have two types of coefficients approximate and detailed. When we actually apply DWT on an image, an approximate and detailed coefficients both are separated using sub band coding and the image is divided into four integral parts which are LL, LH,HL and HH.The LL part gives approximate values of whole image.The HH part give detailed part of the image.In addition to this LL part gives us low frequency components of the image and HH part gives high frequency components. Out of these two LL and HH Which part is more important for processing it is depends on the application for which this part is going to be used and image data.The DWT algorithm uses special kinds of coding functions called as sub band coding functions. In sub band coding low pass and high pass filters are used. After we applied DWT, we consider LL part of the image which contains approximate values. The function for subband coding of an image is going to work on average and difference. It is implemented by following process , applying the average function along rows and then along columns. The other way it is implemented is by taking the average of 2x2 block of the given image and detailed coefficients are calculated by calculating the average of 2x2 blocks difference.

In this project idea we have considered only one kind of coefficients called as approximate coefficients. After applying Dwt the size of image is decreased by 4. While applying Inverse DWT, we are going to copying the value of a pixel to the 2x2 block.

B. Proposed Sequential Hybrid Fractal+ DWT Video Coding:

In the fractal video coding, each frame in a given video has two categories of blocks 1. Overlapping Blocks & 2. Non-Overlapping blocks. The overlapping blocks are also known as domain blocks and non overlapping blocks are also known as range blocks.

Domain blocks are double the size of range blocks. For simplicity in calculating the RMS proposed method uses a special concept known as domain pool concept.In Domain pool, instead of fetching each domain block for each range block, we are going to fetch all domain blocks which are created before the mapping of range and domain starts. Which reduced the encoding time by some milliseconds.

For example If we consider an image of size 256x256 and range block size as 8 then No of range blocks = (256/8)* (256/8) =1024 and No of domain blocks = (256-16+1)* (256-16+1) = 58081(with step size = 1)and each domain block 8 affine transformations are applied. So total number of domain block = 58081*8= 464648.

For each block out of 1024 range blocks, 464648 domain blocks are searched to get the best domain block match. Because of this the encoding time of fractal video coding is very much high. So To reduce this time complexity there are no. of methods which are proposed and used like domain classification. But if we reduce the number of domain blocks to cover the whole image and the time required to find best match. So in proposed solution method the important factor is step size so here step size is considered to be greater than 1, which ultimately reduces the number of domain blocks to a very large extent.

For example: we consider the step size =16. No of range blocks = (256/8)* (256/8) =1024 and No of domain blocks = (256/16)* (256/16) = 256 . Hence for 8 transformations, the Total number of domain block = 256*8=2048.This results in very high speed up, and at the same time it does not affect much on the quality of the frame.

1) Modified Fractal Video Encoding Accept a video as input
2) Extract frames from the video
3) Set a threshold value for rms calculation
4) Apply DWT on each frame
5) Take range size and step size as input from the user
6) Partition each frame into range blocks(non overlapping).
7) Here ranges (r) and domains (d = 2*r)
8) Generate Domain pool (step size provided by the user)
9) Apply spatial contraction on each domain.

10) Apply affine transformation on each contracted domain.
11) Store all transformations of each domain block.
12) Search for most suitable domain block. Compute (s, o, rms).
13) If the value is less than threshold then store the domain information, If the value is greater than threshold then domain with minimum or least value of rms is the best matching block for that range block, then Store the fractal code for the same
14) End

Modified Fractal Video Decoding Read range and domain mapping in encoded file:
1) Take a blank image
2) Get the locations of domain and range by placing the coordinates from encoded file.
3) Then shrink this domain to the size of range.
4) Multiply scaling and add offset to this shrunken domain.
5) Replace this shrunken domain to the range, which maps to it. First iteration
6) Again repeat this by multiplying scaling and adding offset to the same till some predefined number of iterations say 25. Apply inverse DWT
7) Calculate PSNR between this image and original image.
End

C. Proposed Parallel Hybrid Fractal+ DWT Video Coding:

The implementation of Parallel programming/ Computing for proposed algorithm is implemented in OpenCL structure. The OpenCL is chosen as it is open source, cross platform language which is used for heterogeneous computing. The OpenCL application can be execute on CPU as well as one or more GPUs.

As the principle of parallel computing says, The tasks which can execute faster when executed in sequential manner should be deployed and assigned to the CPU and the tasks which are computationally i.e. with respect to time and space complexity as well as iteration, more expensive should be executed on the GPU. The selection of the device whether CPU or GPU will be such that each process in the system should be busy in the execution of the task which is assigned to it.

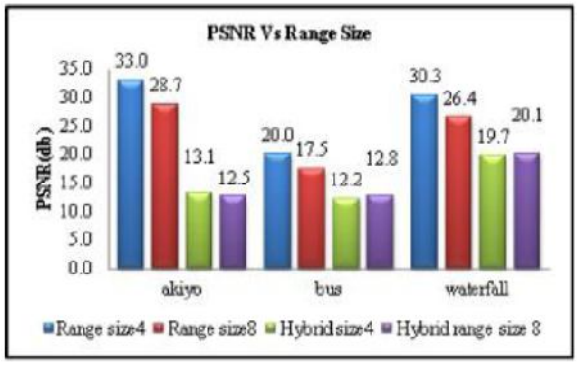
The Data required for processing should be transferred from host processor to device processor for execution. For some applications transfer time is very significant portion of total execution time. So the applications should be designed to minimize this time. Algorithm for proposed system can be explained as follows :

Parallel Hybrid Fractal+ DWT Video Encoding:

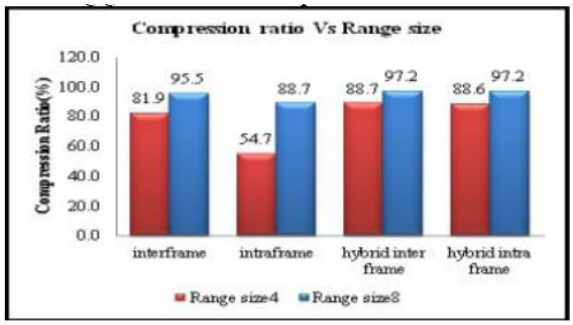
- Accept a video as input.
- Apply DWT on each frame.
- Take range size and step size as input from the user.
- Partition each frame into range blocks(also known as non overlapping) , called as range pool. Here ranges (r) and domains (d =2*r). Generate Domain pool (With Step size provided by user)
- Send this domain and range pools to device.
- Set number of work items = number of range blocks
- Search for most suitable domain block. Compute (s, o, rms).
- If value is greater than threshold then domain with least value of rms is the best matching block for the range. Copy the stored values to host.
- Store the fractal code.
- End

Experimental Results:

Consider 20 frames of a video of size 256x256. The category considered here is interframe videos. Simple fractal encoding with range size 4 gives best quality. Hybrid structure does not give good PSNR for both range sizes 4 and 8.



Higher the range size higher the compression ratio. Simple fractal Intra frame encoding gives a lower compression ratio. Hybrid inter frame encoding gives the highest compression ratio. Sequential and parallel encoding gives the same compression ratio.



for simple fractal encoding the parallel processing gives good performance gain But for parallel hybrid fractal video coding performance gain is not achieved.

This occurred because of the data transfer overhead. Also some part of the code (ex. calculating minimum

RMS between all domain blocks) is inherently sequential. This part of code will take the same time in sequential as well as in parallel execution.

Total encoding time required using parallel structure is very good as compared original fractal encoding algorithm.

Speed up can be tested on NVIDIA GeForce GTX 660/610. Speedup is calculated by executing the program sequentially and then in parallel.

Number of cores launched are 256 , 1024 and 4096 respectively. as we increase the number of work items the speed up is increased. Speedup is directly proportional to the number of work items launched.

CONCLUSION

The high computational time complexity of fractal encoding technique can be successfully reduced by using Discrete Wavelet Transform combined with traditional fractal coding.

Making execution of domain, range mapping in parallel also helped to reduce the time complexity.

Using threshold value encoding time is reduced to a very large extent and quality is degraded to a very small extent.

Using lattice spacing also encoding executed very faster. If we take lattice spacing of domain size then the encoding time required is minimized and quality is degraded to a very small extent. Applying dwt gives a very good speedup, but quality is degraded at very large extent.

Making the proposed system gives better speedup and each frame is encoded as an average 0.7 sec which is very good compared to traditional fractal encoding. Using more powerful GPU can give more good speed up

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