IRREVERSIBLE COMPRESSION OF MRI BRAIN IMAGE WITH HEVC

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***Abstract:*Currently many superior image compression strategies have been proposed in response to the increasing demands for medical image to store at very excessive quality and for efficient compression. Instead of lossless compression we used diagnostically suited lossy compression (Irreversible Compression) to lessen facts length for garage, coping with and transmitting content. At present JPEG 2000 is normally used compression format for medical images shared using DICOM (Digital Imaging and Communication in Medicine) general. However JPEG 2000 isn't always efficiently used for storing series images and 3D images. So we choose new format HEVC with the intention to offer better compression efficiently as compared to JPEG 2000. HEVC is a maximum current standardized video compression generation that is evolved by way of Joint Collaborative Team on Video Coding (JCT-VC).Generally for medical images consisting of CT, CR, MR, and Digital Radiography the bit intensity is 1024 or 4096. HEVC range is appropriate for scientific photos programs. It offers more bit rate reduction while maintaining the identical subjective image excellent relative to its predecessor H.264/AVC. With HEVC, intra encoding complexity can be reduced with negligible increase in file length.**

IndexTerms
Medical Image, Irreversible Compression, DICOM, JPEG 2000, HEVC, MRI

Introduction

Emergence of cloud based healthcare offerings necessitates medical provider carriers to proportion the medical pictures generated by using extraordinary systems and gadget. These images are considered on heterogeneous platforms such as net and cell clients. The need of interoperability between the medical

programs and gadget has caused the usage of DICOM widespread. However the bandwidth and garage constraints would possibly require better compression of big medical pics. In addition to this requirement the cloud based healthcare situation requires an efficient and uniform lossless and lossy compression widespread. The project in the usage of the consumer gadgets to access scientific images .The High Efficiency Video Coding (HEVC) general supports lossless and lossy compression with bit intensity of as much as sixteen bits . Normally medical pics are of diverse modalities ranging from Computed Tomography (CT), Computed Radiography (CR), Magnetic Resonance (MR), PET-CT and, Ultrasound (US).Medical take a look at of a patient may additionally require a series of research and every look at generates a series of pix. The record length of the consequent photo collection might be big. For instance: Full Body PET may have six hundred images according to set, wherein the scale of one set may be 1.2 GB and typically in one observe there are 4 units. Thus general record size shall be 4.8 GB.

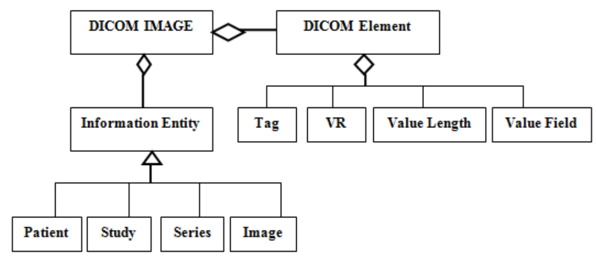

Fig.1**:** Relationship between DICOM Information Entities and Elements

The Medical images used in this study were DICOM images. DICOM is a medical imaging standard which enables interoperability between heterogeneous medical applications and devices . The core part of the standard includes information entities, modules, file format, and a networking protocol. A DICOM medical image file normally contains medical image data and meta data included as Information Entities (IE) describing attributes such as patient, study, series, and image. IE is an aggregation of several DICOM elements or DICOM attributes. Each DICOM element is an aggregation of four fields: a tag, a data type called value representation (VR), value length, and the value field. The relationship diagram depicting the association between DICOM objects is shown in Fig. 1. A DICOM tag is made up of group and element number fields; for example, the tag with group number 0028 is an image pixel group. These group tags are used to obtain the image configuration information that is required for image compression. A few commonly used image pixel group tags are defined in Table I. The second goal of this paper is complexity reduction for high bit-depth medical images. The proposed model for computational complexity reduction is evaluated for medical images of more DICOM modalities.

Table 1

DICOM IMAGE PIXEL GROUP TAGS

DICOM Image Tags	Description
Samples per pixel (0028,0002)	Number of color channels.

Photometric interpretation (0028,0004)	Monochrome1 / Monochrome2. Defines whether zeroes be interpreted as black or white
Planar configuration (0028,0006)	Shows how color channels are arranged in the pixel data buffer
Bits Allocated (0028,0100)	Defines how much space in bits is allocated in the buffer for every sample.
Bits Stored (0028, 0101)	Defines how many of the bits allocated are actually used.
High Bit (0028, 0102)	Defines how the bits stored are aligned inside the bits allocated.
Number of Frames (0028,0008)	Defines the total no. of frames in the image

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II.LITERATURE SURVEY

A. High Efficiency Video Coding (HEVC) Text Specification: HEVC (H.265) standard is the latest enhanced video coding standard which was planned to improve the rendered specifications of its preceding standard MPEG-4 (H.264). The main goal of the HEVC standardization effort is to enable significantly improved compression performance relative to existing standard H.264. For similar video quality, HEVC bit streams consume only about half of the bit rate compare to previous standard H.264. HEVC gives higher compression comparing with previous standard H.264 because of its new features like quad tree structure, more directional intra-prediction modes. In this paper, intra-prediction for equal block sizes and variable block size are implemented for luminance component of different video sequences. Luminance component is important for brightness information. For variable block size canny edge detection method is used. HEVC gives better PSNR compare to H.264. HEVC suitable for resolutions up to Ultra High Definition (UHD) video coding in the future.

B. Evaluation of HEVC compression for high bit depth medical images : We evaluate the performance of HEVC Intra and Inter coding of Digital Imaging and Communications in Medicine (DICOM) standard based medical images in both lossless and lossy mode compared to JPEG 2000 (JP2). Prior studies have used Main Still Profile to evaluate lossless HEVC Intra coding whereas we have used HEVC Range extension Profiles. Besides lossless Intra coding, our study evaluates lossless Inter prediction of DICOM based medical image series. The results show that HEVC Inter Prediction achieves reduction in file size up to 39% for the lossless inter mode and up to 94% for lossy mode in case of images with low loss accepted in some medical imaging (PSNR greater than 50 dB). This reduction of file size is significant and can be used to reduce transmission and storage cost especially in a cloud based e-healthcare scenario.

C. Content dependent intra mode selection for medical image compression using HEVC: This paper presents a method for complexity reduction in medical image encoding that exploits the structure of medical images. The amount of texture detail and structure in medical images depends on the modality used to capture the image and the body part captured by that image. The proposed approach was evaluated using Computed Radiography (CR) modality, commonly known as x-ray imaging, and three body parts. The proposed method essentially reduces the number of **CU** partitions evaluated as well as the number of intra prediction modes for each evaluated partition. Evaluation using the HEVC reference software (HM) 16.4 and lossless intra coding shows an average reduction of 52.47% in encoding time with a negligible penalty of up to 0.22%, increase in compressed file size.

D.Lossy and lossless intra coding performance evaluation: High Efficiency Video Coding (HEVC), the latest international standard of video coding under development, has shown a major breakthrough with regards to compression efficiency. But most of the currently published studies were intended to evaluate the overall R-D performance of HEVC in comparison to prior H.264/AVC video coding standard. In this paper, we present sufficient rate-distortion performance comparisons of image coding between the HEVC and previous image and intra-only video coding standards, including JPEG 2000, JPEG LS and H.264/AVC intra high profile. In addition, some recently reported performances of HEVC are also reviewed and compared. The coding simulations are conducted on a set of recommended video sequences during the development of the HEVC standard. Experimental results show that HEVC can offer consistent performance gains over a wide range of bitrates on natural video sequences as expected. Besides, we also present the comparison results of all these standards in the scenario of lossless image coding.

III.PROPOSED TECHNIQUE

The main steps involved in our algorithm is,

1. Firstly we have to take DICOM series of images as the input.
2. For the number of DICOM series we have to perform the HEVC operation for every image.
3. Next for every image we have to take JPEG 2000 format images i.e., lossy compression.
4. At finally, by varying compression ratios like 5 to 20 we can observe performance by using PSNR and SSIM for the HEVC and JPEG 2000.

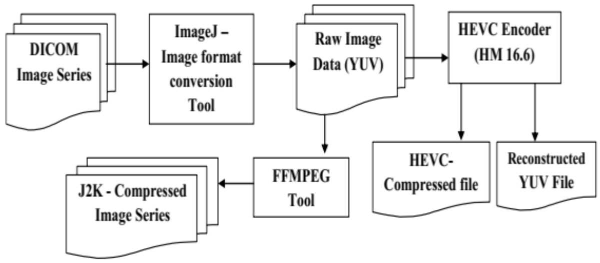


Fig.2 : Overview of the proposed method

A) HEVC (H.265) Using MATLAB:

HEVC (H.265) standard is the latest enhanced video coding standard which was planned to improve the rendered specifications of its preceding standard MPEG-4 (H.264).

An overview of the main features in intra-frame prediction of H.265 could be written as follows: ƒ

- A quad-tree block division structure with respect to amount of details in an image. ƒ
- 33 Angular modes in angular prediction (just 8 different modes in H.264) ƒ
- Planar prediction for smoothing the sample surfaces.

It's worth mentioning that the quad-tree structure of H.265 intra normally uses square block with sizes in range 4, 8, 16, 32 and 64 (different block sizes based-on the level of granularity in the image), while in H.264 the processing units are up to macro-blocks of 16x16 samples.

Moreover, while this video coding standard splits images to one luma and two chroma parts, thesis focuses only on the implementation of intra-prediction on luma part of an image.

This thesis aims at implementation of the intra-frame prediction of HEVC using MATLAB. All the steps of implementation process are listed as follows:

- Converting RGB images to YUV colour-space and working on the luma part (or Y)
- Splitting images to square blocks ranging from 4 to 64 pixels ƒ
- Implementing intra-frame prediction algorithm ƒ
- Comparing intra-prediction output of H.264 and H.265 in square blocks with size 4 and 16 pixels

The considered set of images for this thesis was organized in 3 different resolutions (*VGA*: 480x640, *HD720*: 720x1280, *HD1080*: 1080x1920) to implement and evaluate the HEVC intra-frame prediction outcomes.The performance of our algorithm can be evaluated by usingPSNR and SSIM.

Finally in the last step, it's time to merge all predicted small blocks (separate matrices of a cell) to a single matrix and also remove the zero-padding added in the first step (block decomposition) and the output would be the decoded picture (predicted) with HEVC intra-frame prediction algorithm.

For intra encoding, high-throughput-RExt profile was used and "Intra period" encoder parameter was set to 1. In this case, all the frames were encoded as Intra (I) frames. HEVC Inter coding was used to evaluate the benefits of temporal predictive coding for medical image series, which is not supported in Motion JPEG and J2K. For inter encoding, main- RExt profile was used and the "Intra period" parameter was set to -1. This configuration results in the first frame being directionally predicted B-frames. The HEVC lossy encoding of high bit depth medical images was carried out by varying the quantization parameter, in order to match the PSNR and SSIM values of HEVC with J2K. The above mentioned experimental method is depicted in Fig

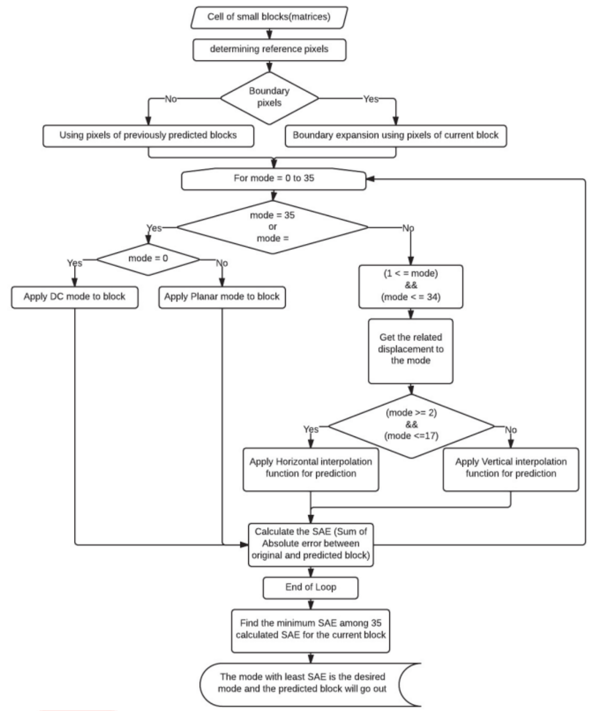


Fig3**:** HEVC Intra-frame prediction function process flowchart

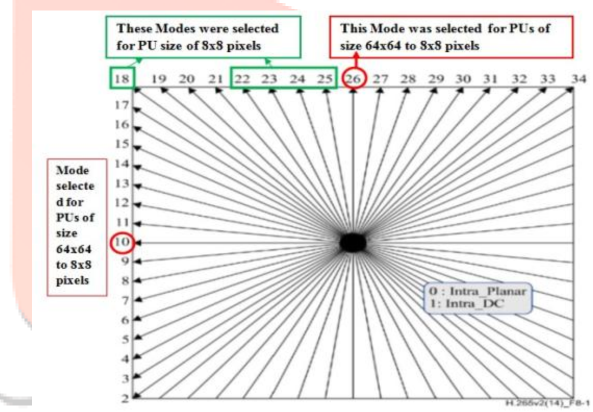
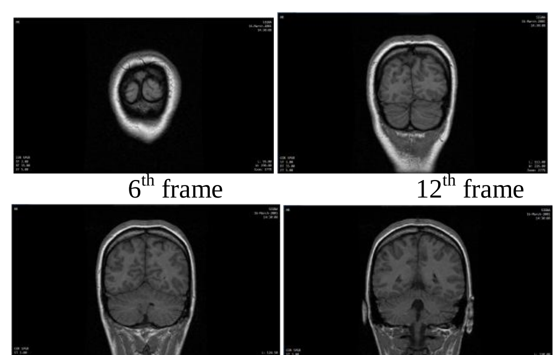


Fig4: Set of Angular Directional Intra Prediction modes that were selected for 95% times

IV.RESULTS:

Input Images:



6th frame 12th frame

18th frame 22nd frame

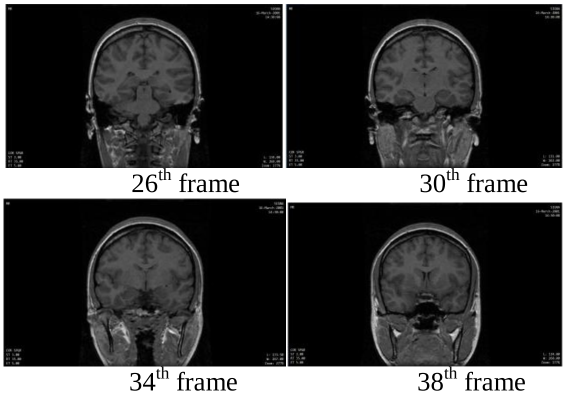


Fig4: Medical Images of DICOM Modalities and body parts used in this study.

Output Images:

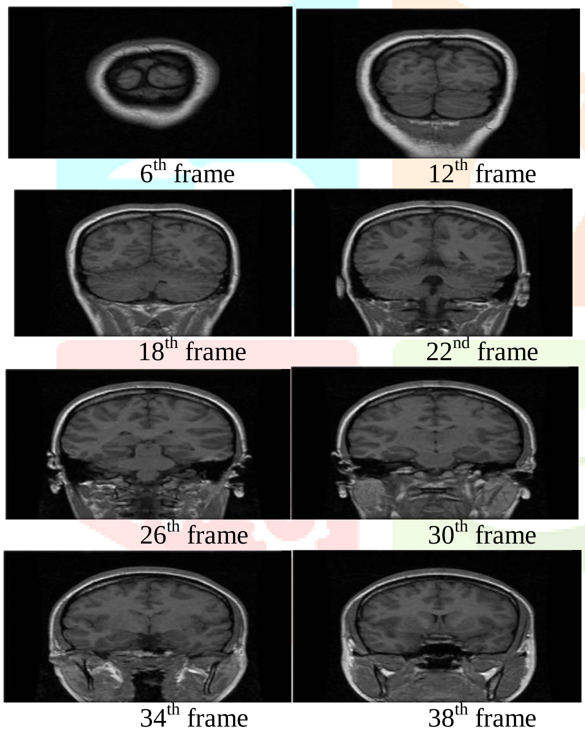


Fig5: Compressed HEVC images

GRAPHS:

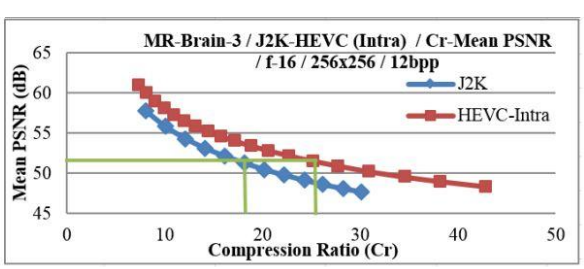


Fig.5: Graph of medical images of various modalities showing correlation between HEVC-Intra and J2K for equivalent PSNR quality.

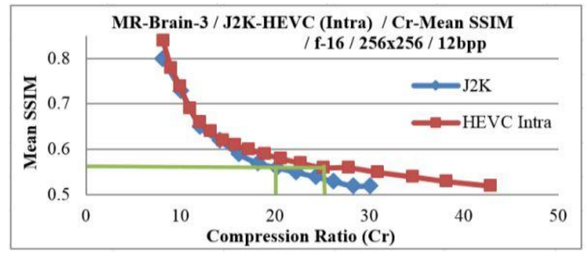


Fig.6: Graph of medical images of various modalities showing correlation between HEVC-Inter and J2K for equivalent SSIM quality.

ADVANTAGE

The J2K compression ratios which fall within the irreversible compression range are used to establish the compression comparison with HEVC and the irreversible compression performance of J2K and HEVC are compared for equivalent quality measured using Structural Similarity Index (SSIM) and Peak Signal to Noise Ratio (PSNR).

V. Conclusion

In this paper shows that using HEVC for medical image compression can reduce storage and bandwidth uptto 54% compared in comparison to J2K. The evaluation was limited to the diagnostically acceptable compression ranges established in prior studies. Even HEVC-Inter shows similar gains in terms of % reduction in file size. The ICR bounds established for HEVC are based on equivalent objective metrics and subjective assessments are necessary to determine subjective equivalence for the same objective distortion.
The study also developed a method for computational complexity reduction in lossless Intra HEVC compression. Results show 55% reduction in computational complexity with negligible increase in file size. Using such complexity reduction approaches reduces the cost of HEVC encoding while retaining the compression benefits..

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