ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

Compression of Monochrome Stereoscopic 3D Images with Minimal Quantization Error

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Abstract:

Stereoscopy (also called stereoscopics) is a technique for creating or enhancing the illusion of depth in an image by means of stereopsis for binocular vision. Stereoscopy creates the illusion of three-dimensional depth from given two-dimensional images. Human vision, including the perception of depth, is a complex process, which only begins with the acquisition of visual information taken in through the eyes; much processing ensues within the brain, as it strives to make sense of the raw information. JPEG 2000 (JP2) is an image compression standard and coding system. It was created by the Joint Photographic Experts Group committee in 2000 with the intention of superseding their original discrete cosine transform-based JPEG standard with a newly designed, wavelet-based method.

In this paper we implement a Compression of Monochrome sterescopic 3D Images with minimal quatization error. To dodge a huge number of measurements in the course of subjective experiments, a model for visibility thresholds is established. The left image and right image of a stereo pair are then compacted together by means of the visibility thresholds attained from our method to confirm that quantization errors in each image are unnoticeable to both eyes. The subsequent images are visually lossless when showed independently as 2D images, and also when demonstrated in stereoscopic 3D mode.

Keywords:

Compression, Stereoscopy, JPEG 2000, Quatization error, 2D & 3D Images.

Introduction:

The word stereoscopy derives from Greek (stereos), meaning "firm, solid", and meaning "to look, to see". Any stereoscopic image is called a stereogram. Originally, stereogram referred to a pair of stereo images which could be viewed using a stereoscope. Most stereoscopic methods present two offset images separately to the left and right eye of the viewer. These two-dimensional images are then combined in the brain to give the perception of 3D depth. This technique is distinguished from 3D displays that display an image in three full dimensions, allowing the observer to increase information about the 3-dimensional objects being displayed by head and eye movements.

Stereoscopy is the production of the illusion of depth in a photograph, movie, or other two-dimensional image by the presentation of a slightly different image to each eye, which adds the first of these cues (stereopsis). The two images are then combined in the brain to give the perception of depth. Because all points in the image produced by stereoscopy focus at the same plane regardless of their depth in the original scene, the second cue, focus, is not duplicated and therefore the illusion of depth is incomplete.

There are also mainly two effects of stereoscopy that are unnatural for human vision: (1) the mismatch between convergence and accommodation, caused by the difference between an object's perceived position in front of or behind the display or screen and the real origin of that light; and (2) possible crosstalk between the eyes, caused by imperfect image separation in some methods of stereoscopy.

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Although the term "3D" is ubiquitously used, the presentation of dual 2D images is distinctly different from displaying an image in three full dimensions. The most notable difference is that, in the case of "3D" displays, the observer's head and eye movement do not change the information received about the 3-dimensional objects being viewed. Holographic displays and volumetric display do not have this limitation. Just as it is not possible to recreate a full 3-dimensional sound field with just two stereophonic speakers, it is an overstatement to call dual 2D images "3D". The accurate term "stereoscopic" is more cumbersome than the common misnomer "3D", which has been entrenched by many decades of unquestioned misuse. Although most stereoscopic displays do not qualify as real 3D display, all real 3D displays are also stereoscopic displays because they meet the lower criteria also.

IMAGE PROCESSING

In imaging science, image processing is any form of signal processing for which the input is an image, such as a photograph or video frame; the output of image processing may be either an image or a set of characteristics or parameters related to the image. Most image-processing techniques involve treating the image as a two-dimensional signal and applying standard signal-processing techniques to it.Image processing usually refers to digital image processing, but optical and analog image processing also are possible. This article is about general techniques that apply to all of them. The acquisition of images (producing the input image in the first place) is referred to as imaging.

Closely related to image processing are computer graphics and computer vision. In computer graphics, images are manually made from physical models of objects, environments, and lighting, instead of being acquired (via imaging devices such as cameras) from natural scenes, as in most animated movies. Computer vision, on the other hand, is often considered high-level image processing out of which a machine/computer/software intends to decipher the physical contents of an image or a sequence of images (e.g., videos or 3D full-body magnetic resonance scans). In modern sciences and technologies, images also gain much broader scopes due to the ever growing importance of scientific visualization (of often large-scale complex scientific/experimental data). Examples include microarray data in genetic research, or real-time multi-asset portfolio trading in finance.

PROBLEM DEFINITION

Notations and Preliminaries

- A simple approach to this problem might be to compress each of the component images of a stereoscopic pair in a visually lossless manner.
- To avoid numerical problems, any zero valued variance is replaced by the arbitrarily chosen value $\alpha = 10{-}4$. The values of $I\theta,k,l$, $I\theta,k,r$, and $\sigma 2\ \theta,k,l$ are then used to compute ˆ $t\theta,k,l$ for each sub-codeblock. Finally, the VT for a codeblock is chosen as the minimum ˆ$t\theta,k,l$ over all sub-codeblocks in the codeblock.
- Since the crosstalk effect is an inherent perceivable problem in current 3D display technologies, the measurement of VTs in this work considered not only the factors characterized for 2D images in , but also the various combinations of luminance values in both the left and right channels of stereoscopic images.

IMPLEMENTATION

Implementation is the stage of the project when the theoretical design is turned out into a working system. Thus it can be considered to be the most critical stage in achieving a successful new system and in giving the user, confidence that the new system will work and be effective.The implementation stage involves careful planning, investigation of the existing system and it's constraints on implementation, designing of methods to achieve changeover and evaluation of changeover methods.

MODULES

Modules

1. User Registration
2. Upload Image
3. Stereoscopic images,
4. Discrete cosine transform
5. JPEG QUANTIZATION NOISE ANALYSIS

   A. Notations

   B. Quantization Noise

   C. General Quantization Noise Distribution

   5. Specific Quantization Noise Distribution

   6. Identification of decompressed jpeg images based on quantization noise

   Analysis

A. Forward Quantization Noise
B. Noise Variance for Uncompressed Images
C. Noise Variance for Images With Prior JPEG Compression

   8. PERFORMANCE EVALUATION

A. Evaluation on Gray-Scale Images With Designated Quality Factor
B. Evaluation on Color Images
C. Evaluation on JPEG Images From a Database With Random Quality Factors

Modules Description

Stereoscopic images:

- we investigate here the visually lossless compression of 3D stereoscopic images. To this end, we consider the contrast sensitivity function (CSF) for stereoscopic 3D images in the presence of crosstalk.
- Three stereoscopic images are shown on the display concurrently.
- One is placed at the top center of the screen, and the other two are arranged at the bottom left and bottom right, respectively.
- The other two stereoscopic images contain no noise. the three stereoscopic images are displayed for 20 seconds.
- stereoscopic images is adapted from the coding method of . In JPEG2000, a subband is partitioned into rectangular codeblocks.
- The coefficients of each codeblock are then quantized and encoded via bit-plane coding.The results reported in Table IV are for the latter VTs.
- Evidently, larger bitrates are required to achieve visually lossless coding for 3D stereoscopic images than for 2D images for the display and viewing conditions employed.
- but also the various combinations of luminance values in both the left and right channels of stereoscopic images.
- The VTs obtained via the proposed model were then employed in the development of a visually lossless coding scheme for monochrome stereoscopic images.

Visually lossless coding:

- The proposed coding method for visually lossless compression of 8-bit monochrome stereoscopic images is adapted from the coding method of .

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- In JPEG2000, a subband is partitioned into rectangular codeblocks. The coefficients of each codeblock are then quantized and encoded via bit-plane coding.

- The actual number of coding passes included in a compressed code stream can vary from codeblock to codeblock and is typically selected to optimize mean squared error over the entire image for a given target bit rate.

- Rather than minimizing mean squared error, the method proposed in includes the minimum number of coding passes necessary to achieve visually lossless encoding of a 2D image.

- This is achieved by including a sufficient number of coding passes for a given codeblock such that the absolute error of every coefficient in that codeblock is less than the VT for that codeblock. Evidently, larger bitrates are required to achieve visually lossless coding for 3D stereoscopic images than for 2D images for the display and viewing conditions employed.

Discrete wavelet transform

- More recently, the CSF has been modeled using the discrete wavelet transform . In that work, uniform noise was added to each wavelet subband (one at a time) of an 8-bit constant 128 grayscale image to generate a stimulus image.

- The method of was extended to a more realistic noise model in and . Specifically, a quantization noise model was developed for the dead-zone quantization of JPEG2000 as applied to wavelet transform coefficients.

- For the 5 level wavelet decomposition employed here, k = 3 represents the median transform level.

- The nominal thresholds Tθ,3,l(Iθ,3,l , Iθ,3,r) attempt to model the effect of crosstalk caused by different intensities in the left and right images for different orientations, but fixed variance and transform level.

- The inverse wavelet transform is performed, and the result is added to a constant gray level image having all pixel intensities set to a fixed value Iθ,3,l between 0 and 255.

- After the addition, the value of each pixel in this stimulus image is rounded to the closest integer between 0 and 255.

JPEG2000:

- Specifically, a quantization noise model was developed for the dead-zone quantization of JPEG2000 as applied to wavelet transform coefficients. Then, rather than adding uniform noise to a wavelet subband as in , stimulus images were produced by adding noise generated via the dead-zone quantization noise model.

- Appropriate VTs derived from this model are then used to design a JPEG2000 coding scheme which compresses the left and right images of a stereo pair jointly.

- The performance of the proposed JPEG2000 coding scheme is demonstrated by compressing monochrome stereo pairs.

- The resulting left and right compressed image files can be decoded separately by a standard JPEG2000 decoder.

- To facilitate visually losslessly compression via JPEG2000, VT models are developed in this section, for both the left and right images of stereo pairs.

- JPEG2000 codeblock of a 2D image is defined as the largest quantization step size for which quantization distortion remains invisible.

- visually lossless JPEG2000 for 2D images and our proposed visually lossless JPEG2000 for stereoscopic 3D images.

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
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- Compressed codestreams created via the proposed encoder can be decompressed using any JPEG2000 compliant decoder.

Identification of Decompressed Jpeg Images Based On Quantization Noise Analysis   From above, we know that the quantization noise distributions are different in two JPEG compression cycles. In the following, we first define a quantity, call forward quantization noise, and show its relation to quantization noise. Then, we give the upper bound of its variance, which depends on whether the image has been compressed before. Finally, we develop a simple algorithm to differentiate decompressed JPEG images from uncompressed images.

Evaluation on JPEG Images From a Database With Random Quality Factors

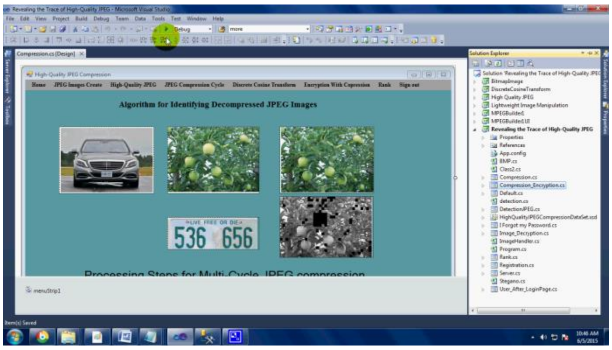
- Since the decompressed JPEG images encountered in daily life are coming from different sources, and thus having been compressed with varying quality factors. We conduct the following experiment to show the performance on random quality factors.

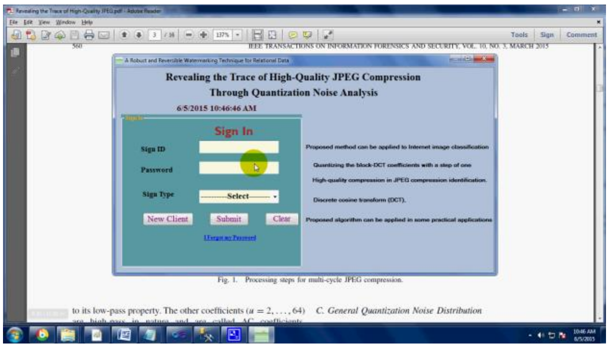
- Test Image Set: To increase the amount and the diversity of images for testing, and also to test whether the thresholds of the methods heavily rely on image database, we use the test image set composed of 9,600 color JPEG images created by Fontani et al.

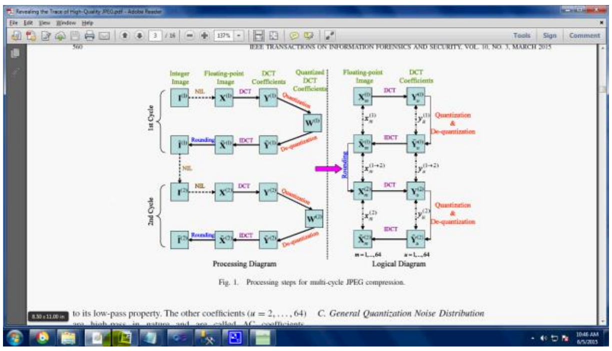
A. Internet Image Classification

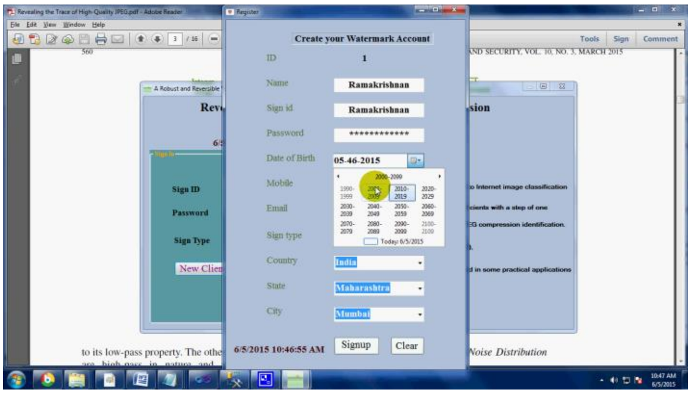
The first application of our JPEG identification method is Internet image classification. Internet search engines cur gently allows users to search by content type, but not by compression history. There may be some graphic designers who wish to differentiate good-quality decompressed images from uncompressed images in a set of images returned by Internet search engines. In this case, searching images by compression history is important. In this section, we show the feasibility of such an application.Image Classification Algorithm: We first convert color images into gray-scale images. Then we divide each image into non-overlapping macro-blocks of size B × B (e.g., B = 128, 64, or 32). If the dimension of the image is not exactly the multiple times of B, the last a few rows or columns are removed from testing. Next, we perform JPEG identification on each macro-block. We can use the threshold as given in Table I for each macro-block size. For a test image I, suppose it contains a total number of N(B) macro-blocks, and assume a number of D(B) macro-blocks are identified as decompressed. We use a measuring quantity, called block hit (BT), to assess the proportion of macro-blocks being identified, i.e.,

SCREENSHOTS





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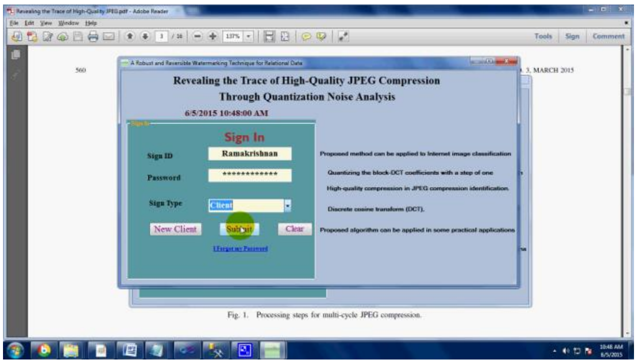
Revealing the Trace of High-Quality JPEG Compression
Through Quantization Noise Analysis
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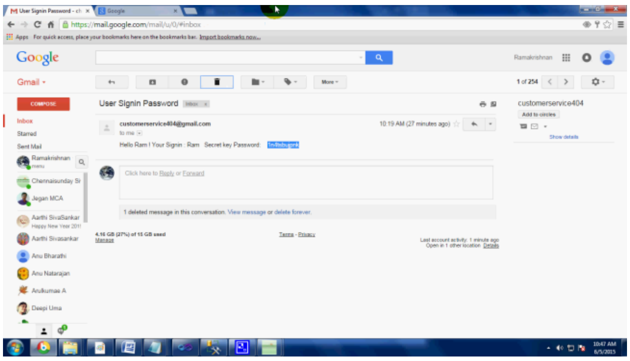

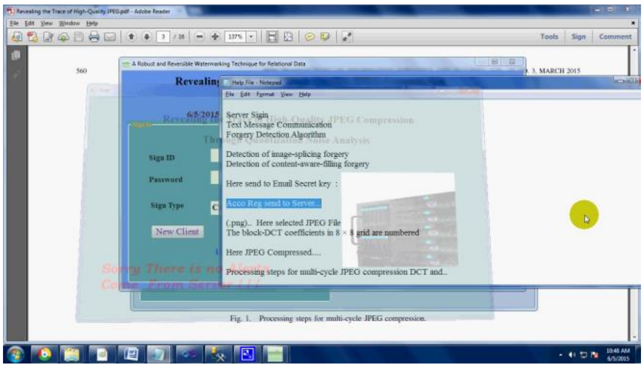

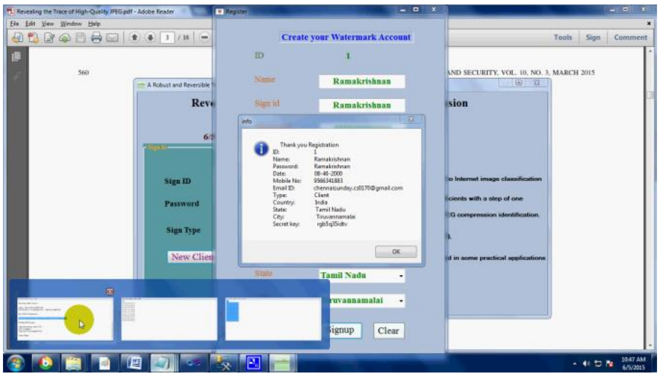
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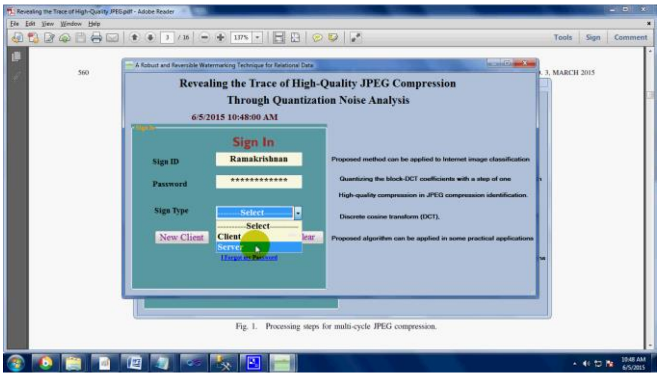
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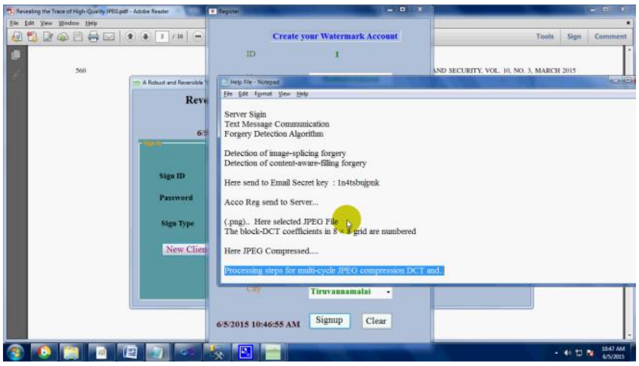
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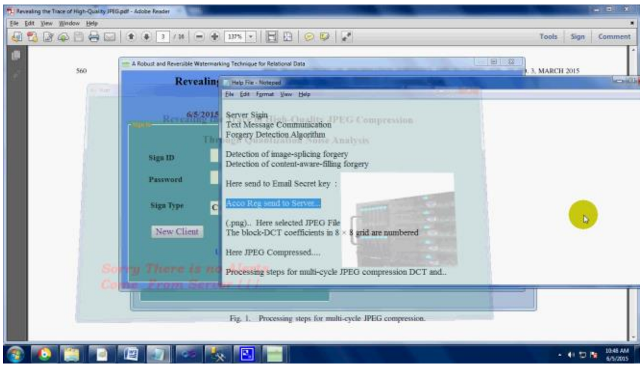

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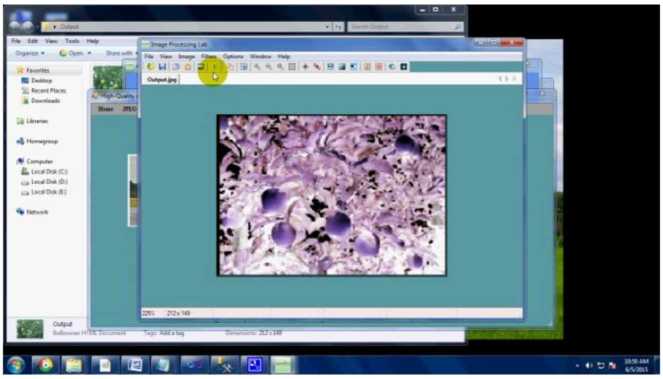

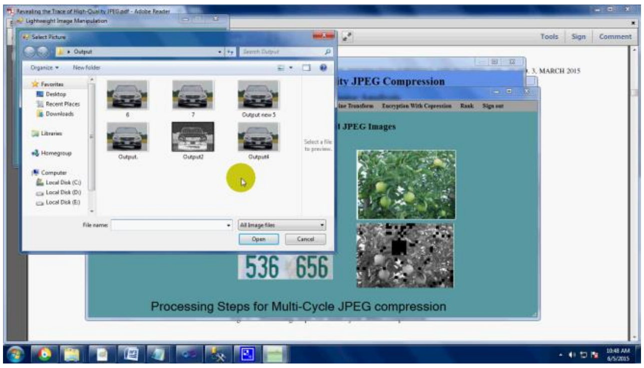

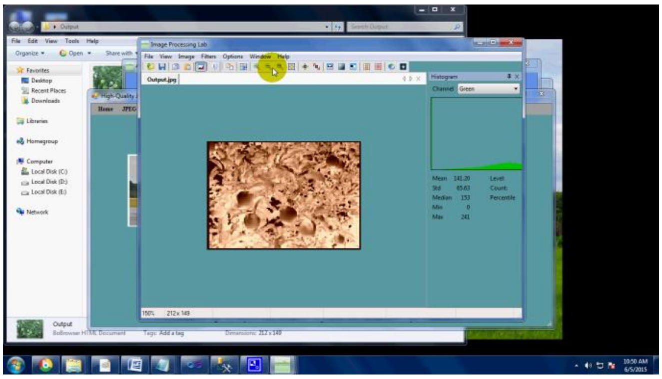

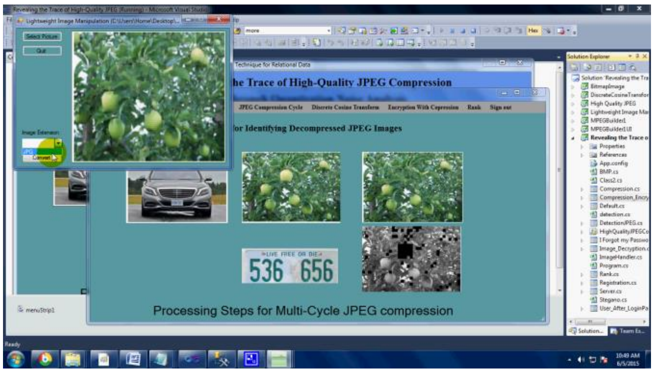

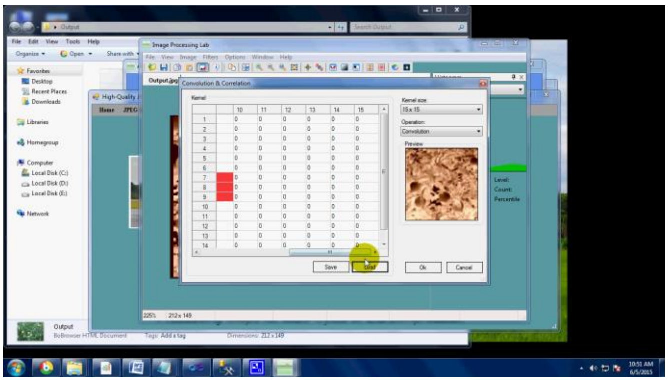

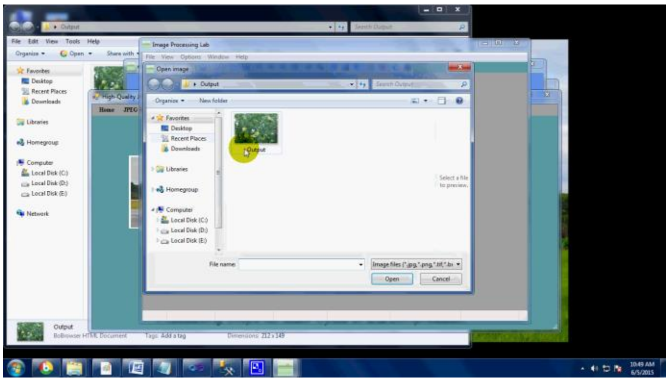

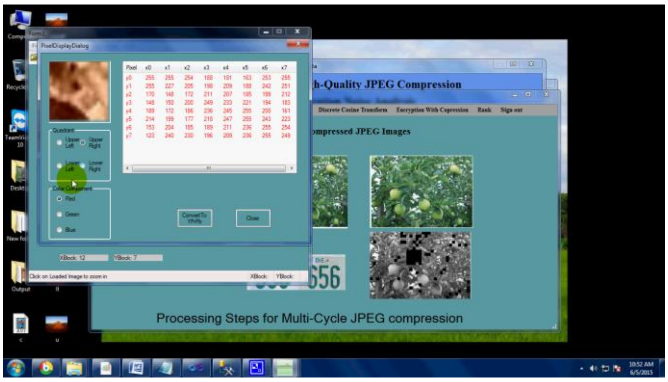

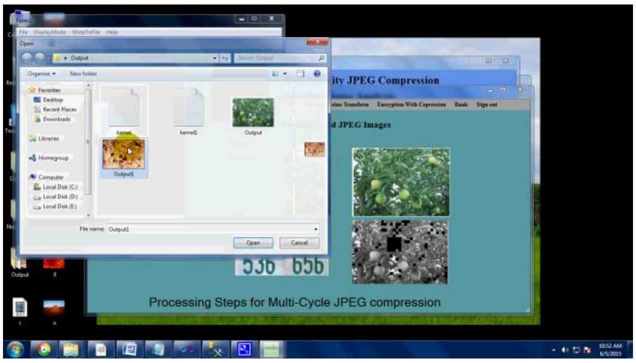

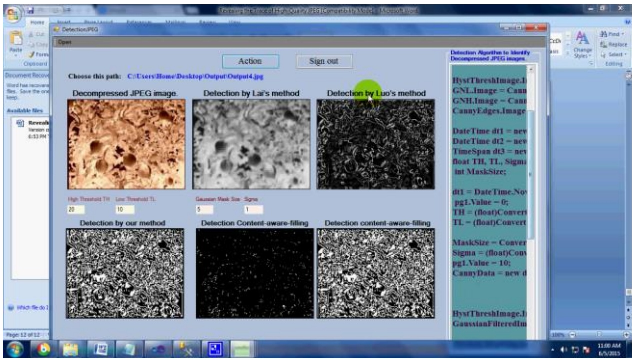

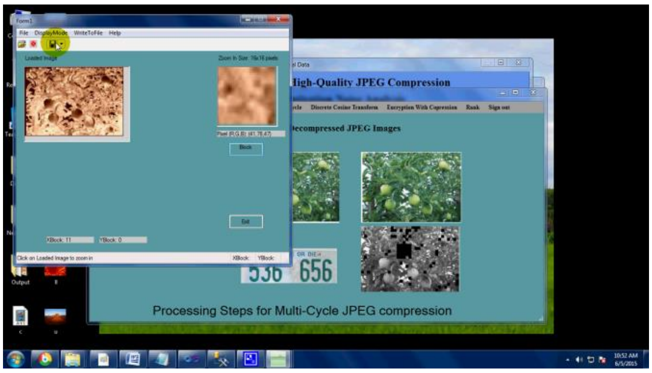

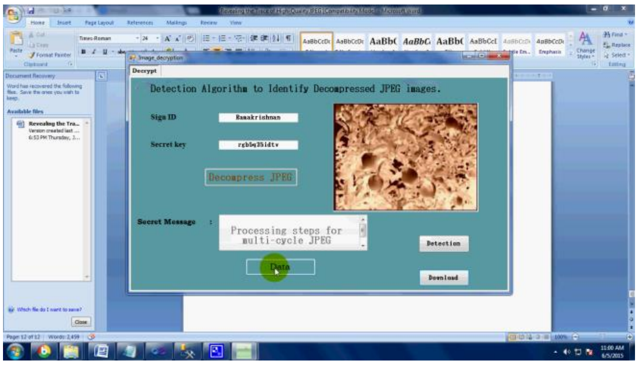

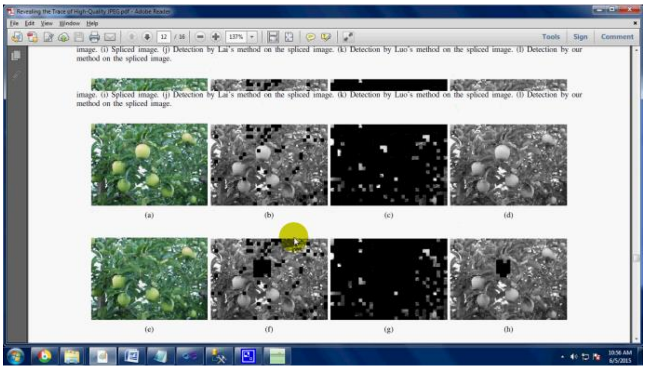

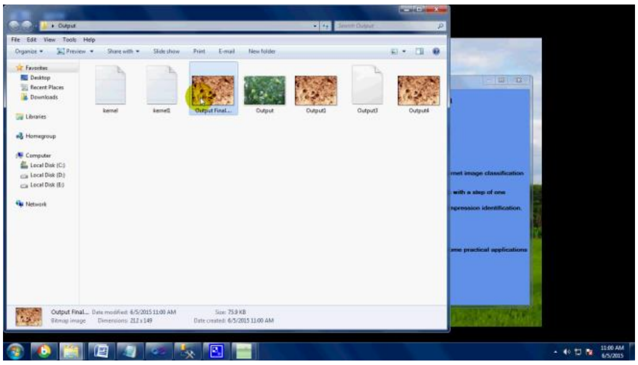

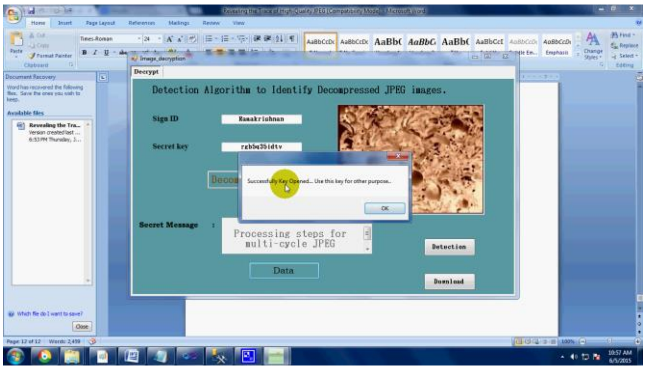

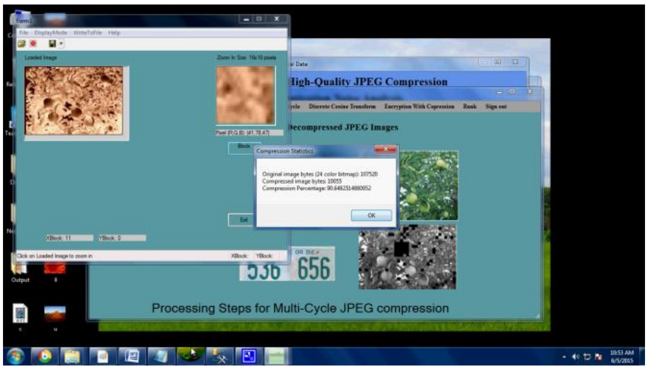

CONCLUSIONS

- A methodology for visually lossless compression of monochrome stereoscopic 3D images was provided.

- Since the crosstalk effect is an inherent perceivable problem in current 3D display technologies, the measurement of VTs in this work considered not only the factors characterized for 2D images in , but also the various combinations of luminance values in both the left and right channels of stereoscopic images.
- To ensure that neither eye can perceive quantization errors when crosstalk occurs, the final VT for the left image is taken as the minimum between the VTs of the left eye and the right eye for distortion introduced in only the left image.
- The same considerations apply to the right image, simply reversing the roles of left and right.
- It is prohibitive to measure VTs for all possible combinations of coefficient variance and left/right image gray levels.
- Thus, a separable model for VTs was proposed. The VTs obtained via the proposed model were then employed in the development of a visually lossless coding scheme for monochrome stereoscopic images. Compressed codestreams created via the proposed encoder can be decompressed using any JPEG2000 compliant decoder.

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