

## International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 5, May 2016

# Reversible Image Watermarking Using Modified Reversible Contrast Mapping

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**ABSTRACT:** This paper proposes very large scale integration design of reversible image watermarking using modified reversible contrast mapping algorithmic rule for digital images which will serve the purpose of media authentication in real time surroundings. The use of reversible contrast mapping on pair of pixels in images for reversible watermarking offers a versatile integer transform that shows high embedding rate at low mathematical complexity and without necessitating additional data compression. Mathematically RCM may be explained as a form of flexible linear transformation on pair of pixels that controls distortion and leads to the detainment of the structural data of the watermarked image. The concepts used in modified reversible contrast mapping are M-ary modulation and adaptive distortion control. The M-ary modulation is used for sending two or more data bits at a time instead of sending one data bit at a time. The adaptive distortion control is used to improve data hiding capacity. Performance in robustness against common signal processing operations, namely noise addition, smoothing filtering and some form of geometric operation

**KEYWORDS:** Modified RCM, Reversible Watermarking, Generalized RCM

### I. INTRODUCTION

Digital watermarking is expressed as a knowledge concealing technique that is developed for functions like identification, copyright protection and classification of digital media content. During this technique, a secret information referred to as watermark is embedded into the digital transmission content with in the decoder, watermark information is extracted from the watermarked signal in an exceedingly loss less manner though original signal can't be obtained back. In some necessary applications like military notional, rhetorical law and medical notional, distortion within the original signal might cause fatal results. For instance, a tiny low distortion in an exceedingly medical image might interfere with the accuracy of document identification. Distortion issues which can arise in an exceedingly applications will be fastened in a reversible watermarking technique. Reversible image watermarking algorithms can be divided into five groups. Lossless compression based algorithms, difference expansion based algorithms, and histogram shifting based algorithms, prediction error expansion based algorithms and integer to integer transform based algorithms. Performance of a watermarking algorithm is categorized into three parts. They are visual quality, payload capacity and computational complexity.

### II. LITERATURE SURVEY

A literature survey is survived for various papers which are important to know the previously available techniques and their advantages and limitations. It also includes the various supporting papers for the proposed technique and their advantages. There are many techniques available for reversible image watermarking. The reversible contrast mapping method provides to embed and extract the watermarking. The data of secretly hiding and communicating information has gained immense importance in the two decades due to the advantages in generation, storage, and communication technology of digital content. Watermarking is solutions for tamper detection and protection of digital content. Watermarking can cause damage to the information present in the cover work. At the receiving end, the exact reconstruction of the work may not be possible. In addition there exist certain applications that may not pass even small

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distortions in report work priority to the downstream techniques. In that applications, reversible watermarking instead of other watermarking is occupied. Reversible watermarking of digital image allows full extraction of the watermark along with the complete reconstruction of the cover work. In past years, reversible watermarking process are gaining popularity because of its increasing applications in important and sensitive areas, i.e., military information, health care, and law-enforcement. Due to the rapid evolution of reversible watermarking process, a latest survey of recent research in this field is highly desirable.

In 2001, Honsinger et al was introduced one of the first reversible watermarking method. They utilized modulo addition to achieve reversibility in their watermarking process. Macq developed a reversible watermarking approach by modifying the patchwork algorithm and used modulo addition. Although, proposed reversible techniques are the imperceptibility of their approaches is not magnificent. The watermarked images resulting from these techniques can't tolerate from salt and pepper noise due to the use of modulo addition. A reversible watermarking technique without using modulo addition was then introduced by proposed the concept of compressing the least significant bit plane of cover image to make space for the watermark to be embedded. In 2013 Luo et al reported a reversible watermarking method using interpolation technique. The watermark bits are embedded in the unsampled pixels until no unsampled pixel is left. After that, the remaining of the watermark bits are inserted into the sampled pixels, which are interpolated using nearby watermarked pixels.

### III. LIMITATION IN RCM-RW

Let  $(x, y)$  be the values of pixel pair in an image, then the pixel intensity values are bounded between  $[0, 255]$  for an 8-bits or pixel gray scale image. The forward integer transform for a pair of pixel values is defined. To prevent the overload and the under load problem, the transform pair is restricted within a sub-domain. The inverse transformation can perfectly restored the pixel pair values even if the least significant bits of the transformed pixel pairs are lost, except when both pair of pixels are odd set of values. The occurrence of odd pair of pixels is expected to below with respect to the total possibility of occurrence of other combinations, hence a large set of pair of pixels may be available for data embedding. The limitation is when the set of odd pairs selected and the inverse transformation fails to get back the exact values of the pixel pairs. The forward integer transform is defined as,

$$x^1 = 2x - y, y^1 = 2y - x$$

On the other hand, the inverse transform is defined as,

$$x = \frac{(2x^1 + y^1)}{3}, y = \frac{(x^1 + 2y^1)}{3}$$

### IV. MODIFIED RCM

The modified form of RCM proposed in highlights the usefulness of developing a generalized form of RCM to enable adaptive distortion control-embedding rate-security trade-off in RW. The generalized RCM may be considered as M-ary modulation in communication and is developed. Different RCM functions used in RW change a particular pair of pixel values in different ways due to different transform functions selected. Their combinations allow over embedding on the pair of pixel while visual distortion is maintained to an acceptable limit. The particular combination for the operating points to be chosen is determined by setting the distortion control on each pass/stage of data embedding. The extension includes role of different operating points on data hiding rate, visual distortion, and statistical invisibility of the hidden data through histogram as well as through mathematical analysis. Furthermore, a large set of simulation results on robustness against noise addition, spatial smoothing filtering, cropping and geometric operation. An optimization framework is developed here for maximizing the data hiding capacity while meeting the visual distortion constraint threshold.

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## V. GENERALIZED RCM

Let  $(x, y)$  as a pair of pixel values of an 8-bit/pixel gray scale image. Generalized M-ary RCM forward transform form is given as,

$$x^1 = \left\lfloor \frac{(x + y)}{2} + \frac{N|(x - y)|}{2^M} \right\rfloor$$

$$y^1 = \left\lfloor \frac{(x + y)}{2} - \frac{N|(x - y)|}{2^M} \right\rfloor$$

The symbols 'M' and 'N' are the positive integers. The generalized form of inverse transform is defined as,

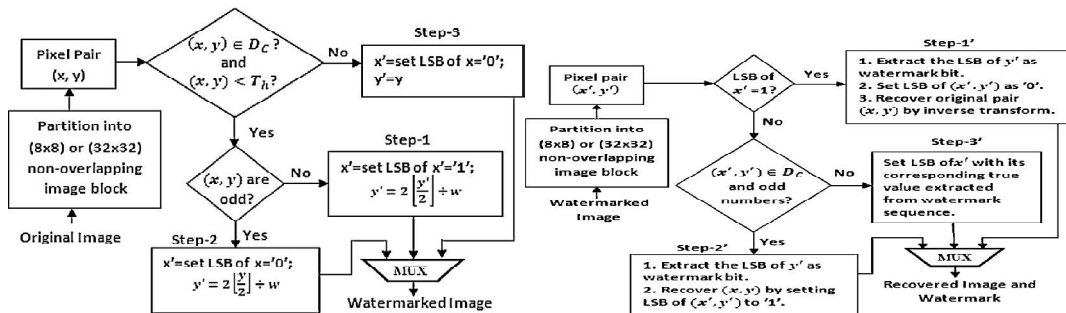
$$x = \left\lfloor \frac{(x^1 + y^1)}{2} + \frac{2^{M-1}|(x^1 - y^1)|}{2N} \right\rfloor$$

$$y = \left\lfloor \frac{(x^1 + y^1)}{2} - \frac{2^{M-1}|(x^1 - y^1)|}{2N} \right\rfloor$$

The respective values of 'M' and 'N', forward transform pairs and inverse transform pairs under lossless communication, the proposed algorithm can perfectly retrieve the original information. Any combinations of integer values for 'M' and 'N' may be used for forming the set of transformation functions. Difference in intensity value between the forward transformed pair and its corresponding original pair of pixels is known as the embedding distortion. Distortion control is necessary in order to reduce the visual artifacts due to data hiding process. In RCM, each pair of pixel embeds one watermark bit. This is due to the fact that LSB of  $x$  contains information whether the pair of pixels is used for transformation, while LSB of  $y$  is available for data embedding. Application of linear sets of transformation functions followed by LSB substitution for data embedding may be reasonably considered as additive signal insertion. It is assumed here that the host image behaves like a Gaussian noise signal to the watermark embedding process.

## VI. WATERMARK EMBEDDING AND EXTRACTION

To realize reversible contrast mapping algorithm, the original image is partitioned into non overlapping groups of pixels pairs following either horizontally or vertically, like any space filling curve.



**Fig 1. Watermark embedding      Fig2. Watermark Extraction**

The steps are similar as in watermark embedding process. Here the watermarked image is partitioned into smaller block size of 8x8 or 32x32 and each block is a gain partitioned into pairs of pixels and using horizontal partitioning method

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as used in embedding. The marked image is partitioned a gain into pairs of pixels. Then any one step is followed subject to two different conditions check as. The process is repeated until it covers all the pixel pairs.

## VII. OUTPUT FOR EMBEDDING AND EXTRACTION



Fig 3. Original image

Hidden Image Thresholded at 70



Fig 4. Secret image



Fig 5. Watermarked Image

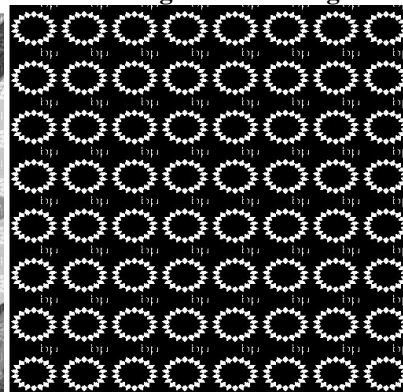


Fig 6. Extracted watermark

Fig 3 shows the original image and fig 4 shows the secret image which is embedded in the original image. Fig 5 shows the watermarked image and fig 6 shows the extracted watermark.

## VIII.PSNR& MSE

The simplest and the most widely used representation to quantify image/video signal quality is the PSNR value. For an 8 bit gray scale image, PSNR is defined by the following expression:

$$PSNR = 10\log_{10} \left( \frac{255^2}{MSE} \right)$$

Where MSE is the mean squared error. For two  $M \times N$  images  $u$  (distorted or watermarked image) and  $v$  (original or host image), MSE is defined as

$$MSE = \frac{1}{MN} \sum_{i=0}^{M-1} \sum_{j=0}^{N-1} (u - v)^2$$

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**TABLE I. COMPARISON OF RCM AND MODIFIED RCM**

	RCM	MODIFIED RCM
MSE	17.9079	16.0725
PSNR	35.6004	36.0700

## IX. CONCLUSION

A generalized form of M-ary RCM is developed for reversible image watermarking under distortion control framework. The optimal set of values for the distortion control is calculated from the optimization framework that improves watermark embedding rate, while meeting the threshold of the embedding distortion. The future work is implemented in FPGA for real time environment.

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