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Losseless Image and Video Compression Technique

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ABSTRACT: Images are being used in many fields of research. One of the major issues of images is their resolution. In this paper we are studying different image resolution enhancement techniques that use Wavelet Transform (WT). Basis functions of the WT are small waves located in different times. They are obtained using scaling and translation of a scaling function and wavelet function Therefore, the WT is localized in both time and frequency. In this method is used to improve the image resolution for different type of images. In this paper we are comparing different image resolution enhancement techniques those using Wavelet Transform. The increasing demand to incorporate video data into telecommunication series, the corporate environment the entertainment industry, and even at home as made digital video technology a necessity. A problem however is that still image and digital video data rates are very large typically in the range of 150Mbits/sec. Data rates of this magnitude would consume a lot of the bandwidth, storage and computing resources in the typical personal computer. For this reason Video summarization standards have been developed to eliminate picture redundancy, allowing video information to be transmitted and stored in a compact and efficient manner.

I. INTRODUCTION

Image resolution enhancement is a usable preprocess for many satellite image processing applications, such as vehicle recognition, bridge recognition, and building recognition to name a few. Image resolution enhancement techniques can be categorized into two major classes according to the domain they are applied in: 1) image-domain; and 2) transform-domain. The techniques in image-domain use the statistical and geometric data directly extracted from the input image itself [1], [2],while transform-domain techniques use transformations such as decimated discrete wavelet transform to achieve the image resolution enhancement [3]–[6].

The decimated discrete wavelet transform (DWT) has been widely used for performing image resolution enhancement [3]–[5]. A common assumption of DWT-based image resolution enhancement is that the low-resolution (LR) image is the low-passfiltered subband of the wavelet-transformed high-resolution (HR) image. This type of approach requires the estimation of wavelet coefficients in subbands containing high-pass spatial frequency information in order to estimate the HR image from the LR image.

In order to estimate the high-pass spatial frequency information, many different approaches have been introduced. In [3], [4], only the high-pass coefficients with significant magnitudes are estimated as the evolution of the wavelet coefficients among the scales. The performance is mainly affected from the fact that the signs of estimated coefficients are copied directly from parent coefficients without any attempt being made to estimate the actual signs. This is contradictory to the fact that there is very little correlation between the signs of the parent coefficients and their descendants. As a result, the signs of the coefficients estimated using extreme evolution techniques cannot be relied upon. Hidden Markov tree (HMT) based method in [5] models the unknown wavelet coefficients as belonging to mixed Gaussian distributions which are symmetrical about the zero mean.

HMT models are used to determine the most probable state for the coefficients to be estimated. The performance also suffers mainly from the sign changes between the scales. The decimated DWT is not shift-invariant and, as a result, suppression of wavelet coefficients introduces artifacts into the image which manifests as ringing in the neighbourhood of discontinuities [6]. In order to combat this drawback in DWT-based image resolution enhancement, cycle-spinning methodology was adopted in [6]. The perceptual and objective quality of the resolution enhanced images by their method compare favorably with recent methods [3], [5] in the field.

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Dual-tree complex wavelet transform (DT-CWT) is introduced to alleviate the drawbacks caused by the decimated DWT [7]. It is shift invariant and has improved directional resolution when compared with that of the decimated DWT. Such features make it suitable for image resolution enhancement. In this letter, a complex wavelet-domain image resolution enhancement algorithm based on the estimation of wavelet coefficients at high resolution scales is proposed. The initial estimate of the HR image is constructed by applying cycle-spinning methodology [6] in DT-CWT domain. It is then decomposed using the one-level DT-CWT to create a set of high-pass coefficients at the same spatial resolution of the LR image. The high-pass coefficients together with the LR image are used to reconstruct the HR image using inverse DT-CWT. The letter is organized as follows. Section II gives a brief review of the DT-CWT. Section III describes the proposed DT-CWT domain satellite image resolution enhancement algorithm. Section IV provides some experimental results of the proposed approach and comparisons with the approaches in [1], [2], [4], and [6]. Section V concludes the letter.

Resolution has been frequently referred as an important property of an image. Images are being processed in order to obtain super enhanced resolution. One of the commonly used techniques for image resolution enhancement is Interpolation. Interpolation has been widely used in many image processing applications. Interpolation in image processing is a method to increase the number of pixels in a digital image. Traditionally there are three techniques for image interpolation namely Linear, Nearest Neighbor and cubic. Nearest Neighbor result in significant ―Jaggy‖ edge distortion. The Bilinear Interpolation result in smoother edges but somewhat blurred appearance overall. Bicubic Interpolation look's best with smooth edges and much less blurring than the bilinear result .By applying the 1-D discrete wavelet transform (DWT) along the rows of the image first, and then along the columns to produce 2-D decomposition of image.DWT produce four sub bands low-low(LL),low-high(LH),high-low(HL)and high-high(HH).By using these four sub bands we can regenerate original image.

II. LITERATURE SURVEY

NEW ENHANCEMENT APPROACH FOR ENHANCING IMAGE OF DIGITAL CAMERAS BY CHANGING THE CONTRAST

There are four well-known traditional interpolation techniques namely nearest neighbor, linear, and Lanczos. In [4] using bilinear, bicubic method the PSNR values for Lena's image are 26.34 and 26.86. W. Knox. Carey, Daniel. B. Chuang, and S. S. Hemami in [5] presented the regularity-preserving interpolation technique for image resolution enhancement synthesizes a new wavelet subband based on the known wavelet transform coefficients decay. Which gives PSNR (db) value for Lena's Image as 31.7 [5]. Xin. Li and Michael. T. Orchard in [6] presented a hybrid approach produced by combining bilinear interpolation and covariance-based adaptive interpolation called New Edge-Directed Interpolation Which gives PSNR(db) value for Lena's Image as 28.81 [4]. Alptekin. Temizel and Theo. Vlachos in [7] presented technique named "Wavelet domain image resolution enhancement using cycle-spinning and edge modelling ", which improves PSNR (db) values for Lena's image up to 29.27 [4]. Hasan. Demirel and Gholamreza. Anbarjafari in [8] presented an approach DT- CWT based image resolution enhancement which gives PSNR (db) value for Lena's Image as 33.74 [4]. Gholamreza. Anbarjafari and Hasan. Demirel in [9] presented a method named "Image super resolution based on interpolation of wavelet domain high frequency subbands and the spatial domain input image", whichgives PSNR(db) value for Lena's image up to 34.79 [4]. Hasan. Demirel and Gholamreza. Anbarjafari in [4] presented new method named "Image Resolution Enhancement by Using Discrete and Stationary Wavelet Decomposition", which give PSNR(db) value for Lena's image as 34.82 [4].

This paper proposes a new simple method of DCT feature extraction that utilize to accelerate the speed and decrease storage needed in image retrieving process by the aim of direct content access and extraction from JPEG compressed domain. Our method extracts the average of some DCT block coefficients. This method needs only a vector of six coefficients per block over the whole image blocks In our retrieval system, for simplicity, an image of both query and database are normalized and resized from the original database based on the cantered position of the eyes, the normalized image equally divided into non overlapping 8X8 block pixel Therefore, each of which are associated with a feature vector derived directly from discrete cosine transform DCT. Users can select any query as the main theme of the query image. The retrieval images is the relevance between a query image and any database image, the relevance similarity is ranked according to the closest similar measures computed by the Euclidean distance. The experimental results show that our approach is easy to identify main objects and reduce the influence of background in the image, and thus improve the performance of image retrieval. A **discrete cosine transform** (**DCT**) expresses a finite sequence of data points in terms of a sum of cosine functions oscillating at different frequencies. DCTs are important to numerous applications in science and engineering, from loss compression of audio (e.g. MP3) and images (e.g. JPEG) (where small high-frequency components can be discarded), to spectral methods for the numerical solution of partial

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differential equations. The use of cosine rather than sine functions is critical in these applications: for compression, it turns out that cosine functions are much more efficient (as described below, fewer functions are needed to approximate a typical signal), whereas for differential equations the cosines express a particular choice of boundary conditions. In particular, a DCT is a Fourier-related transform similar to the discrete Fourier transform (DFT), but using only real numbers. DCTs are equivalent to DFTs of roughly twice the length, operating on real data with even symmetry (since the Fourier transform of a real and even function is real and even), where in some variants the input and/or output data are shifted by half a sample. There are eight standard DCT variants, of which four are common. The most common variant of discrete cosine transform is the type-II DCT, which is often called simply "the DCT" its inverse, the type-III DCT, is correspondingly often called simply "the inverse DCT" or "the IDCT". Two related transforms are the discrete sine transforms (DST), which is equivalent to a DFT of real and odd functions, and the modified discrete cosines transform (MDCT), which is based on a DCT of overlapping data.

III. SYSTEM ANALYSIS

3.1 PROBLEM DEFINITION:

In this Existing system has most complicated to improve image resolution. In traditionally there are three techniques for image interpolation namely Linear, Nearest Neighbor and Bicubic. Nearest Neighbor result in significant ―Jaggy edge distortion. The Bilinear Interpolation result in smoother edges but somewhat blurred appearance overall. Bicubic Interpolation look's best with smooth edges and much less blurring than the bilinear result. Traditional interpolation methods work in the time domain.

3.2 PROBLEM SOLVED:

In this proposed system we resolved the high frequency components (i.e. the edges) problem by applying ('linear' (default) | 'nearest' | 'spline' | 'pchip' | 'cubic') interpolation. The main loss in image resolution enhancement by using interpolation is on its high frequency components (i.e., edges), which is due to the smoothing caused by interpolation. Edges plays very important role in image. To increase the quality of the super resolved image, it is essential to preserve all the edges in image. It is cleared from the output image values that the image resolution enhancement method using Wavelet Transform and Image Interpolation is giving far better result than any other technique.

3.3 Proposed System

The goals for this thesis have been the following.

One goal has been to compile an introduction to the subject of H.263 encoders and decoders. There exist a number of studies of various parts of the encoder and decoder, but complete treatments on a technical level are not as common. Material from papers, journals, and conference proceedings are used that best describe the various parts.

Another goal has been to search for algorithms that can be used to implement the most demanding components of H. 263 Video summarization standards.

1. Motion compensation & Motion estimation
2. Discrete Cosine Transform (DCT) &Inverse discrete cosine transform(IDCT)
3. Scaling and Quantization
4. Entropy encoding & Decoding

A third goal is to evaluate their performance with regard to speed, memory requirements, and complexity. These properties were chosen because they have the greatest impact on the implementation effort and the computation demands .

A final goal has been to design and implement an H.263 encoder & Decoder. This should be done in matlab . The source code should be easy to understand so that it can serve as a reference on the standard for designers that need to implement a encoder. The proposed system should be compatible such way it has high summarization rate which can be used for (DVB) digital video broadcasting. This system can be enhanced to implement in video conferencing and video –on- demand applications. The files SUMMARIZATION using H.263 encoder are smaller than MPEG files which is faster to download. This advantage motivate us to begin the projectn .where we begin to modify the discrete cosine transform to adaptive DCT.

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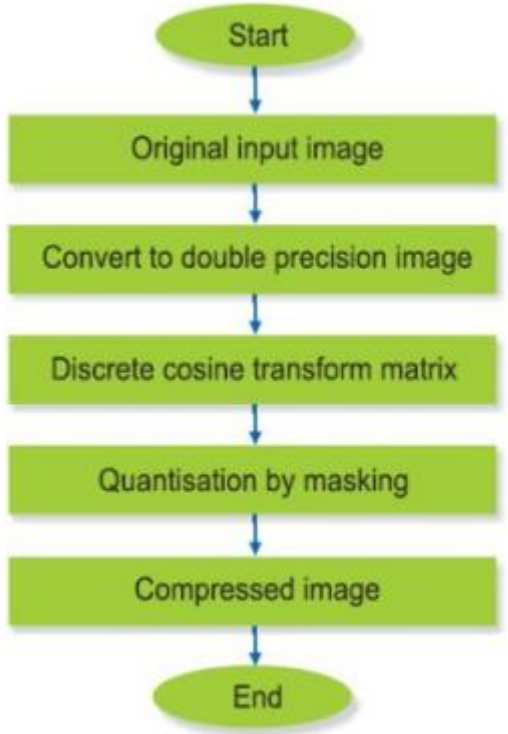
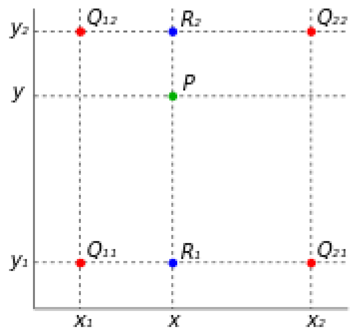
3.4 Architecture

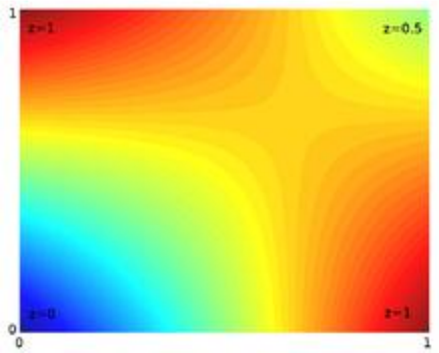


IV. RESULT AND DISCUSSION

Bilinear interpolation



The four red dots show the data points and the green dot is the point at which we want to interpolate.



Example of bilinear interpolation on the unit square with the z-values 0, 1, 1 and 0.5 as indicated. Interpolated values in between represented by color.

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In mathematics, **bilinear interpolation** is an extension of linear interpolation for interpolating functions of two variables (e.g., *x* and *y*) on a rectilinear 2D grid.
The key idea is to perform linear interpolation first in one direction, and then again in the other direction. Although each step is linear in the sampled values and in the position, the interpolation as a whole is not linear but rather quadratic in the sample location.

Algorithm
Suppose that we want to find the value of the unknown function *f* at the point (x, y). It is assumed that we know the value of *f* at the four points $Q_{11} = (x_1, y_1)$, $Q_{12} = (x_1, y_2)$, $Q_{21} = (x_2, y_1)$, and $Q_{22} = (x_2, y_2)$.
We first do linear interpolation in the *x*-direction. This yields

$$f(x, y_1) \approx \frac{x_2 - x}{x_2 - x_1} f(Q_{11}) + \frac{x - x_1}{x_2 - x_1} f(Q_{21})$$
$$f(x, y_2) \approx \frac{x_2 - x}{x_2 - x_1} f(Q_{12}) + \frac{x - x_1}{x_2 - x_1} f(Q_{22})$$

We proceed by interpolating in the *y*-direction to obtain the desired estimate:

$$\begin{aligned} f(x,y) &\approx \frac{y_2 - y}{y_2 - y_1} f(x, y_1) + \frac{y - y_1}{y_2 - y_1} f(x, y_2) \\ &= \frac{y_2 - y}{y_2 - y_1}\left(\frac{x_2 - x}{x_2 - x_1} f(Q_{11}) + \frac{x - x_1}{x_2 - x_1} f(Q_{21})\right) + \frac{y - y_1}{y_2 - y_1}\left(\frac{x_2 - x}{x_2 - x_1} f(Q_{12}) + \frac{x - x_1}{x_2 - x_1} f(Q_{22})\right) \\ &= \frac{1}{(x_2 - x_1)(y_2 - y_1)}\left(f(Q_{11})(x_2 - x)(y_2 - y) + f(Q_{21})(x - x_1)(y_2 - y) + f(Q_{12})(x_2 - x)(y - y_1) + f(Q_{22})(x - x_1)(y - y_1)\right) \\ &= \frac{1}{(x_2 - x_1)(y_2 - y_1)}\begin{bmatrix} x_2 - x & x - x_1 \end{bmatrix}\begin{bmatrix} f(Q_{11}) & f(Q_{12}) \\ f(Q_{21}) & f(Q_{22}) \end{bmatrix}\begin{bmatrix} y_2 - y \\ y - y_1 \end{bmatrix} \end{aligned}$$

Note that we will arrive at the same result if the interpolation is done first along the *y*-direction and then along the *x*-direction.

Algorithm Working Process
An alternative way to write the solution to the interpolation problem is

$$f(x, y) \approx a_0 + a_1 x + a_2 y + a_3 xy$$

Where the coefficients are found by solving the linear system

$$\begin{bmatrix} 1 & x_1 & y_1 & x_1 y_1 \\ 1 & x_1 & y_2 & x_1 y_2 \\ 1 & x_2 & y_1 & x_2 y_1 \\ 1 & x_2 & y_2 & x_2 y_2 \end{bmatrix}\begin{bmatrix} a_0 \\ a_1 \\ a_2 \\ a_3 \end{bmatrix} = \begin{bmatrix} f(Q_{11}) \\ f(Q_{12}) \\ f(Q_{21}) \\ f(Q_{22}) \end{bmatrix}$$

If a solution is preferred in terms of *f(Q)* then we can write

$$f(x, y) \approx b_{11} f(Q_{11}) + b_{12} f(Q_{12}) + b_{21} f(Q_{21}) + b_{22} f(Q_{22})$$

Where the coefficients are found by solving

$$\begin{bmatrix} b_{11} \\ b_{12} \\ b_{21} \\ b_{22} \end{bmatrix} = \left(\begin{bmatrix} 1 & x_1 & y_1 & x_1 y_1 \\ 1 & x_1 & y_2 & x_1 y_2 \\ 1 & x_2 & y_1 & x_2 y_1 \\ 1 & x_2 & y_2 & x_2 y_2 \end{bmatrix}^{-1}\right)^T \begin{bmatrix} 1 \\ x \\ y \\ xy \end{bmatrix}$$

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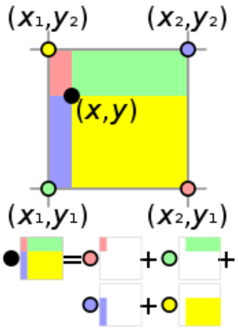
Unit Square

If we choose a coordinate system in which the four points where *f* is known are (0, 0), (0, 1), (1, 0), and (1, 1), then the interpolation formula simplifies to

$$f(x,y) \approx f(0,0)(1-x)(1-y) + f(1,0)x(1-y) + f(0,1)(1-x)y + f(1,1)xy.$$

Or equivalently, in matrix operations:

$$f(x,y) \approx \begin{bmatrix} 1-x & x \end{bmatrix} \begin{bmatrix} f(0,0) & f(0,1) \\ f(1,0) & f(1,1) \end{bmatrix} \begin{bmatrix} 1-y \\ y \end{bmatrix}.$$



In this geometric visualisation, the value at the black spot is the sum of the value at each coloured spot multiplied by the area of the rectangle of the same colour, divided by the total area of all four rectangles.

Nonlinear

Contrary to what the name suggests, the bilinear interpolant is *not* linear; but it is the product of two linear functions. Alternatively, the interpolant can be written as

$$f(x,y) = \sum_{i=0}^{1}\sum_{j=0}^{1} a_{ij}x^i y^j = a_{00} + a_{10}x + a_{01}y + a_{11}xy$$

where

$$\begin{aligned} a_{00} &= f(0,0) \\ a_{10} &= f(1,0) - f(0,0) \\ a_{01} &= f(0,1) - f(0,0) \\ a_{11} &= f(1,1) + f(0,0) - (f(1,0) + f(0,1)) \end{aligned}$$

In both cases, the number of constants (four) corresponds to the number of data points where *f* is given. The interpolant is linear along lines parallel to either the *x* or the *y* direction, equivalently if *x* or *y* is set constant. Along any other straight line, the interpolant is quadratic. However, even if the interpolation is *not* linear in the position (*x* and *y*), it *is* linear in the amplitude, as it is apparent from the equations above: all the coefficient *bj, j=1..4*, are proportional to the value of the function *f(,)*.

The result of bilinear interpolation is independent of which axis is interpolated first and which second. If we had first performed the linear interpolation in the *y*-direction and then in the *x*-direction, the resulting approximation would be the same.

The obvious extension of bilinear interpolation to three dimensions is called trilinear interpolation.

Application in image processing

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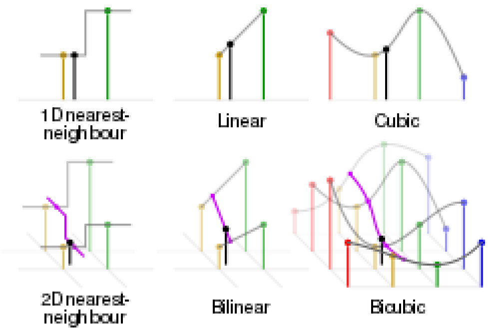


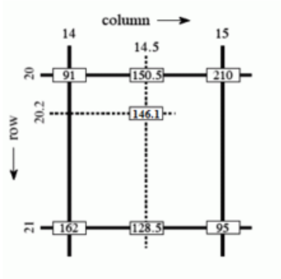
Comparison of *Bilinear interpolation* with some 1- and 2-dimensional interpolations. Black and red/yellow/green/blue dots correspond to the interpolated point and neighbouring samples, respectively. Their heights above the ground correspond to their values.

In texture mapping, it is also known as bilinear filtering or *bilinear texture mapping*, and it can be used to produce a reasonably realistic image. An algorithm is used to map a screen pixel location to a corresponding point on the texture map. A weighted average of the attributes (color, alpha, etc.) of the four surrounding texels is computed and applied to the screen pixel. This process is repeated for each pixel forming the object being textured.

When an image needs to be scaled up, each pixel of the original image needs to be moved in a certain direction based on the scale constant. However, when scaling up an image by a non-integral scale factor, there are pixels (i.e., *holes*) that are not assigned appropriate pixel values. In this case, those *holes* should be assigned appropriate RGB or grayscale values so that the output image does not have non-valued pixels.

Bilinear interpolation can be used where perfect image transformation with pixel matching is impossible, so that one can calculate and assign appropriate intensity values to pixels. Unlike other interpolation techniques such as nearest-neighbor interpolation and bicubic interpolation, bilinear interpolation uses only the 4 nearest pixel values which are located in diagonal directions from a given pixel in order to find the appropriate color intensity values of that pixel.

Bilinear interpolation considers the closest 2x2 neighborhood of known pixel values surrounding the unknown pixel's computed location. It then takes a weighted average of these 4 pixels to arrive at its final, interpolated value. The weight on each of the 4 pixel values is based on the computed pixel's distance (in 2D space) from each of the known points.



Example of bilinear interpolation in grayscale values.

As seen in the example on the right, the intensity value at the pixel computed to be at row 20.2, column 14.5 can be calculated by first linearly interpolating between the values at column 14 and 15 on each rows 20 and 21, giving

$$I_{20,14.5} = \frac{15-14.5}{15-14} \cdot 91 + \frac{14.5-14}{15-14} \cdot 210 = 150.5$$
$$I_{21,14.5} = \frac{15-14.5}{15-14} \cdot 162 + \frac{14.5-14}{15-14} \cdot 95 = 128.5$$

and then interpolating linearly between these values, giving

$$I_{20.2,14.5} = \frac{21-20.2}{21-20} \cdot 150.5 + \frac{20.2-20}{21-20} \cdot 128.5 = 146.1$$

This algorithm reduces some of the visual distortion caused by resizing an image to a non-integral zoom factor, as opposed to nearest-neighbor interpolation, which will make some pixels appear larger than others in the resized image.

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V. CONCLUSION

The proposed adaptive Video codec is mainly meant for mobile communication and ownership protection. This algorithm can be extended to work with 3D video images. Since the codec eliminates particular insignificant subbands that saves the computations required to calculate a subband it can be implemented in areas where the battery constraints and the resources should be dealt economically. It has a high summarization ratio if the parameter values applied are increased and enables to minimize the number of bits transmitted. Though the proposed algorithm has advantages it has some limitations. Since the high pass sub bands are eliminated it incurs a heavy loss of information, when the elimination is performed for higher levels of decomposition. Also, since the bands are eliminated entirely without considering any significant bits in that band, the video obtained after summarization is distorted. These drawbacks can be overcome by performing elimination of subbands only at lower levels of transform. Since there is only a minimal degradation in video quality, the adaptive and energy efficient multiwavelet codec presents a potential solution to the problem of high energy and bandwidth requirements that cannot be fulfilled by limited growth in battery technologies or the projected growth in available cellular bandwidth. The energy efficient wavelet combined with the watermarking scheme used for digital copyright protection and management.

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