

Lossless Compression Algorithm For Color Image Based on the SHIRCT

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Abstract. This paper studies the wavelet transform domain in low-frequency generation embedded SHIRCT transform complete color image compression algorithm. The results show that this algorithm can be very good to complete image lossless compression, by 12 color international standard test image simulation, JP2, RAR, ZIP ratio, PNG, TGA, PCX, TIF lossless compression results the average increase of: -1%, 12%, 60%, 60%, 32%, 50%, 28%.

Introduction

20 years, image compression technology has made great progress, the most representative of the wavelet transform theory^[1]. Wavelet transform theory can be used to decompose the image signal into many subband signals^[1] with different spatial resolution, frequency characteristic and direction characteristic, and realize the simultaneous processing of low frequency and long time characteristics and high frequency short time characteristics^[2]. The image signal is closer to the requirements of visual perception and data compression. Based on the wavelet transform, these features are widely regarded in the image compression coding technology, and various image compression schemes based on wavelet transform^[3] are presented. Among them, the SPIHT multi-level tree set splitting algorithm^[4] (SPIHT: Set Partitioning In Hierarchical Trees and EZW Embedded Zerotree Wavelets can be considered to represent the highest level of current zerotree wavelet coding^[5]. In addition to selecting the effective wavelet compression algorithm, there is a need to consider the selection of wavelet bases. Different wavelet bases have different characteristics^[6]. Different wavelet bases are used in the same compression algorithm to produce different compression effects. In this paper, the compression algorithm is improved based on the characteristics of wavelet compression combined with SHIRCT algorithm.

SPIHT Algorithms

SPIHT Algorithm Specific Symbols. $O(i, j)$ indicates the node (i, j) a collection of all child coordinates.

$$O(i, j) = \{(2i, 2j), (2i, 2j + 1), (2i + 1, 2j), (2i + 1, 2j + 1)\} \quad (1)$$

$D(i, j)$ represents the set of all the descendant coordinates of node (i, j) .

H denotes the set of transform coefficients of the largest scale of wavelet transform, both LL_J , HL_J , LH_J and HH_J .

$$L(i, j) \text{ means } L(i, j) = D(i, j) - O(i, j) \quad (2)$$

Three lists:

(LIS), important pixel list (LIP), important pixel list (LSP), in LSP, LIP, (i, j) represents a single pixel, in LIS, (i, j) represents set $L(i, j)$ or $D(i, j)$. In order to distinguish between the two types of collections, if it is $D(i, j)$ said LIS table value for the A type, if it is $L(i, j)$ said LIS table value for the B type.

SPIHT Specific Implementation Process. I Initialization:

Output $n = \lfloor \log_2(\max(i, j) \cdot |C_{i,j}|) \rfloor$, set the LSP is empty, the coordinate $(i, j) \in H$ into the LIP, and H in the descendants (high frequency part: HLJ, LHJ, HHJ) into the LIS, as the A value.

II Sorting process:

(1) for each $(i, j) \in LIP$

1) Output $S_n(i, j)$;

2) If $S_n(i, j) = 1$, move $S_n(i, j) = 1$ into the LSP and output the sign of $C(i, j)$;

(2) for each $(i, j) \in LIS$

1) If the value of A, then

① output $S_n(D(i, j))$;

② if $S_n(D(i, j)) = 1$, then for each $(k, l) \in O(i, j)$, as:

• Output $S_n(k, l)$;

• If $S_n(k, l) = 1$, send (k, l) to the LSP and output its symbol;

• If $S_n(k, l) = 0$, send (k, l) to the end of the LIP;

③ If $L(i, j) \neq \emptyset$, move (k, l) to the end of the LIS as the B value; otherwise, remove (i, j) from the LIS.

2) If the value of B, then

① output $S_n(L(i, j))$;

② if $S_n(L(i, j)) = 1$, then

• for each $(k, l) \in O(i, j)$ added to the end of the LIS as an A value;

• Delete (i, j) from LIS.

(3) refinement process: for each $(i, j) \in LSP$ (not including the last splitting process), output the nth most significant bit of $|C_{i,j}|$;

(4) quantization step size refresh: $n = n-1$; return (2).

SHIRCT Transformations

The SHIRCT transform involves three bands of transformations. One advantage of the SHIRCT transform is that the transform can be done entirely by addition and shift, and the operation is fast and hardware is complete.

Positive Transform

$$t = X1 - ((X2 + X3) \gg 1) ;$$

$$Z1 = X2 + X3 + (t \gg 1) ;$$

$$Z3 = -X2 + ((Z1 + (t \gg 3)) \gg 1) ;$$

$$Z2 = t + \eta Z3$$

Inverse Transformation

$$t = Z2 - \eta Z3 ;$$

$$X2 = -Z3 + ((Z1 + (t \gg 3)) \gg 1) ;$$

$$X3 = Z1 - X2 + (t \gg 1) ;$$

$$X1 = t + ((X2 + X3) \gg 1)$$

In the above transformation, the Z2 component can be expressed as:

$$Z_2 = \left(\frac{5}{16} X_1 + \frac{21}{32} X_2 + \frac{11}{32} X_3 \right) \eta +$$

$$X_1 - \frac{X_2 - X_3}{2} = Z_3 \eta + X_1 - \frac{X_2 + X_3}{2}$$

Considering the actual effect of image compression, it is desirable that $|Z_2|$ be as small as possible, since Z_2 is a parameterized expression, and $Z_3, X_1 - (X_2 + X_3) / 2$ are both fixed values, so the choice of η . The effect is very large, different η represents a different reversible transformation, theoretically such a reversible transformation has an infinite number, but always want to find the best one.

In order to facilitate the hardware implementation, the transformation is completely composed of addition and shift, η can be written $\eta = k / 2^l$ ($k \neq 0, l \geq 0$, η symbol given directly in the algorithm), rewrite the parameters in the transformation as follows:

Positive Transform

$$Z_2 = (t \pm \sum_{i=1}^q Z_3) \gg 1$$

Inverse transformation

$$t = \pm (\sum_{i=1}^q Z_3) \gg 1$$

Encoding Process

In this paper, the wavelet algorithm is adopted at the front end, then the SPIHT algorithm is applied to the wavelet coefficients, and then the new color image compression algorithm is obtained by SHIRCT transform. Decoding is the inverse of the encoding, including the three steps corresponding to the forward SPIHT: restore the quantization step refresh, restore the prediction and sort.

Experimental Results and Conclusions

In order to illustrate the effectiveness of the algorithm, this paper compares the lossless image compression algorithms of JP2, RAR, ZIP, PNG, TGA, PCX and TIF in 12 color international standard test images, and the average compression ratio is not. Than the above algorithm were increased by -1%, 12%, 60%, 60%, 32%, 50%, 28%, see Table 1.

Table 1 12 color international standard test image compression experiment comparison results

Compress ion scheme Internati onal Standard Test Images	JP2	RAR	PCX	TGA	ZIP	TIF	PNG
Kodak1	511631	598789	1161410	1157891	796111	1065614	783060
Kodak2	451678	508771	1142233	1150300	665774	865916	621478
Kodak3	399015	458212	1096862	1085783	569796	890712	549676
Kodak4	461292	512279	1172752	1153733	747996	108740	640877
Kodak5	533178	684773	1185005	1162343	915984	1238244	810363
Kodak6	472736	532397	1188493	1148689	718077	1001630	673733
Kodak7	419224	488048	1113169	1109121	650774	976216	573980
Kodak8	548967	804423	1309333	1163564	951692	1255784	791697
Kodak9	446250	488367	1190110	1152950	619045	838012	587850
Kodak10	454440	495213	1171219	1154093	686399	958320	598508
Kodak11	458044	553611	1139853	1129959	699897	930316	643047
Kodak12	426781	482724	1247133	1130272	598262	881932	575313
SPIHT+ MRCT	2%	15%	51%	51%	34%	52%	31%

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