II. LIFTING WAVELET TRANSFORM PROCESS

During enhancement image, cause the information transformation, thus also strengthened the noise. All have simultaneously carried on the high frequency information as well as include the suitable than the primitive image in human’s visual sensitivity. The main purpose is to process image suitable for highlights certain special information of an image. The Wavelet analysis is the new algorithm which is best deal with multi-resolution analysis which is time and memory consuming which impedes its real-time application. The process of lifting method was introduced in this paper. The lifting and discrete image enhancement algorithms are compared. The Wavelet analysis is the new algorithm which is more suitable than the primitive image in human’s visual characteristic or the machine recognition system. The discrete image enhancement algorithm is usually based on the whole image statics, so when transforms the entire image, the low frequency information, the high frequency information as well as include the noise, all have simultaneously carried on the transformation, thus also strengthened the noise during enhancement image, cause the information entropy to drop. Consider the problems existed in image processing system; this paper put a new algorithm.

II. LIFTING WAVELET TRANSFORM PROCESS

The lifting algorithm to constitute three steps, Split, Predict and Update. They are described as follow:

**Split**
The original signals $c_j$ are split into two nonintersecting subsets $c_{j+1}$ and $d_{j+1}$. The greater the correlation between them, the better the split effect is. The signal sequence is split into odd and even sequences as $c_{j+1} = c_j(2n), d_{j+1} = c_j(2n + 1)$.

In terms of the lifting algorithm, the split method looks simple but smart, because it is using the local correlation of signal.

**Predict**
Using the similarity of data, $d_{j+1}$ predict from $c_{j+1}$ by using a predict operator $P$, which is independent of the dataset. The resulting difference is called the wavelet coefficients $d_{j+2}[n]$ and represents the closeness of the two data sequences. If the prediction is good, the difference dataset contains much less information than in the original subset. The predict process is described as $d_{j+2} = c_j(2n + 1) - P(c_{j+1}) = d_{j+1} - P(c_{j+1})$.

**Update**
The characteristics of the coefficient subset $c_{j+2}$ derived form the above steps are inconsistent with that of the original dataset. Therefore, the update step is necessary; we use an update operator $U$ to generate a better subset $c_{j+2}[n]$ to keep the characteristics of original dataset. That is $c_{j+2} = c_j(2n) + U(d_{j+2}) = c_{j+1} + U(d_{j+2})$.

The above three steps constitute a lifting scheme with iteratively lifting, we can obtain the approximate signals $c_{j+2}$ and the high-frequency detail signals $d_{j+2}$. After $n$ times of decomposition, the
wavelet transform of the original data can described by
\[ c_{j+1} = d_{j+1} - U(d_{j+1}) \]
\[ d_{j+1} = d_{j+1} + P(c_{j+1}) \]
\[ c_j = \text{Merge}(c_{j+1}, d_{j+1}) \]

Where the Merge in equation means that the \( c_{j+1} \) are designed even sequence of \( c_j \) and the \( d_{j+1} \) are designed odd sequence of \( c_j \).

### III. IMAGE ENHANCEMENT USING LIFTING WAVELET TRANSFORM

The basic idea of image enhancement based on lifting wavelet transform is as follow:
- Decompose the original image into four sub-images with lifting wavelet transform.
- Base on the gain coefficient of each sub-image to operate amplification calculating, obtain the new wavelet coefficient.
- According to the new amplified gain coefficient to reconstruct the new image.

The algorithmic framework is as follow (figure 1):

**Figure 1** Image enhancement based on lifting wavelet transform

#### IV. SIMULATION AND RESULT

This paper presents the result of using the lifting wavelet decomposition and reconstruction. The lifting wavelet image enhancement algorithm and discrete wavelet image enhancement algorithms are compared. Take 'lenna.jpg' and 'woman.bmp' as input image for enhancement. The Matlab7.6 is used for simulation.

**Decomposition and Reconstruction**

The top left corner of the lifting wavelet decompose image is the low sub-band, the others are high frequency sub-band, according to the figure 2, the high frequency sub-band are basically black, so it including less information, the low frequency sub-band including most information.

**Figure 2** Decomposition and reconstruction

**Image Enhancement**

The Paper use discrete wavelet and lifting wavelet to enhance the image, the analysis and simulation result are shown as:

**Figure 3** use discrete wavelet to enhance image and histogram
From the above figures, we can have this conclusion: the original images are dark and the image gray scale scope is very narrow; but the enhanced images using the lifting wavelet, the images gray scale scope is very wide and each gradation level has pixel, contrast is big, detail is clear. Therefore, using the lifting wavelet to enhance the images has a better effect.

<table>
<thead>
<tr>
<th>Techniques</th>
<th>DWT</th>
<th>LWT</th>
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<tr>
<td>PSNR</td>
<td>Women</td>
<td>Leena</td>
</tr>
<tr>
<td></td>
<td>Image</td>
<td>Image</td>
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<tr>
<td></td>
<td>12.1118 db</td>
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<tr>
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<td>1.637532 seconds</td>
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<tr>
<td>MSE</td>
<td>4.0299e+003</td>
<td>4.2640e+003</td>
</tr>
</tbody>
</table>

From above table we have peak signal to noise ratio is high in lifting wavelet method as compare to discrete wavelet transform which is required and Elapsed time to run the program is low and mean square error is low in lifting scheme.

V. CONCLUSION
This work is done for the image enhancement based on lifting wavelet transform through an experiment, carried on the comparison based on the lifting wavelet image enhancement effect and the tradition wavelet image enhancement effect. Through the experiment, we can see using the lifting wavelet to enhance the image has a wide gray scale scope and detail is clear. Therefore, the lifting wavelet algorithm is superior to tradition wavelet algorithm. It can make good enhancement effect.
REFERENCES


