[0006]

Therefore, embodiments of the present invention disclose a deblocking filtering process to apply filtering appropriately.

SOLUTIONS TO PROBLEMS

[0007]

According to a first aspect, there is provided an image processing device including circuitry configured to: decode an encoded stream to generate a decoded image; apply a deblocking filter including a first deblocking filter and a second deblocking filter, which is different from the first deblocking filter and has a stronger filter strength than the first deblocking filter, to neighboring pixels neighboring a block boundary within the decoded image generated by the circuitry; and control, as a condition that the second deblocking filter is applied, the second deblocking filter so as to apply a second clipping process to a difference value changed by the second deblocking filter using a second clipping value, wherein a first clipping process is applied using a first clipping value as a condition that the first deblocking filter is applied and the second clipping process is applied according to the following expressions:

$$
\begin{aligned}
p0' &= p0+Clip_{(-pv)-(pv)}((p2+2*p1-6*p0+2*q0+q1+4)>>3);\\
&= Clip_{(p0-pv)-(p0+pv)}((p2+2*p1+2*p0+2*q0+q1+4)>>3);\\
&= Clip3(p0-pv, p0+pv, (p2+2*p1+2*p0+2*q0+q1+4)>>3);\\
p1' &= p1+Clip_{(-pv)-(pv)}((p2-3*p1+p0+q0+2)>>2);\\
&= Clip_{(p1-pv)-(p1+pv)}((p2+p1+p0+q0+2)>>2);\\
&= Clip3(p1-pv, p1+pv, (p2+p1+p0+q0+2)>>2);\\
p2' &= p2+Clip_{(-pv)-(pv)}((2*p2-5*p2+p1+p0+q0+4)>>3);\\
&= Clip_{(p2-pv)-(p2+pv)}((2*p3+3*p2+p1+p0+q0+4)>>3);\\
&= Clip3(p2-pv, p2+pv, (2*p3+3*p2+p1+p0+q0+4)>>3);\\
q0' &= q0+Clip_{(-pv)-(pv)}((p1+2*p0-6*q0+2*q1+q2+4)>>3);\\
&= Clip_{(q0-pv)-(q0+pv)}((p1+2*p0+2*q0+2*q1+q2+4)>>3);
\end{aligned}
$$

= Clip3(q0-pv, q0+pv, (p1+2*p0+2*q0+2*q1+q2+4)>>3);

q1' = $q1+Clip_{(-pv)-(pv)}((p0+q0-3*q1+q2+2)>>2)$;

= $Clip_{(q1-pv)-(q1+pv)}((p0+q0+q1+q2+2)>>2)$;

= Clip3(q1-pv, q1+pv, (p0+q0+q1+q2+2)>>2);

q2' = $q2+Clip_{(-pv)-(pv)}((p0+q0+q1-5*q2+2*q3+4)>>3)$;

= $Clip_{(q2-pv)-(q2+pv)}((p0+q0+q1+3*q2+2*q3+4)>>3)$;

= Clip3(q2-pv, q2+pv, p0+q0+q1+3*q2+2*q3+4)>>3);

where

p0', p1', p2', q0', q1' and q2' are pixels filtered by the second deblocking filter,

p0, p1, p2, q0, q1 and q2 are pixels of the decoded image, and

pv is the second clipping value.

[0008]

The controller may apply the clipping process to values of parts that change when the deblocking filter is applied.

[0009]

The controller applies the clipping process according to the following expressions:

[Mathematical formula 37]

$$p0_i = p0_i + Clip_{(-pv)-(pv)}((p2_i+2*p1_i-6*p0_i+2*q0_i+q1_i+4)>>3);$$

$$q0_i = q0_i + Clip_{(-pv)-(pv)}((p1_i+2*p0_i-6*q0_i+2*q1_i+q2_i+4)>>3);$$

$$p1_i = p1_i + Clip_{(-pv)-(pv)}((p2_i-3*p1_i+p0_i+q0_i+2)>>2);$$

$$q1_i = q1_i + Clip_{(-pv)-(pv)}((p0_i+q0_i-3*q1_i+q2_i+2)>>2);$$

$$p2_i = p2_i + Clip_{(-pv)-(pv)}((2*p2_i-5*p2_i+p1_i+p0_i+q0_i+4)>>3);$$

$$q2_i = q2_i + Clip_{(-pv)-(pv)}((p0_i+q0_i+p1_i-5*q2_i+2*q3_i+4)>>3);$$

where i = 0, 7 and pv is a clipping value.

[0010]

The controller may set a value that is integer multiples of parameters of the deblocking filter as the clipping value used when the clipping process is performed.

[0011]

The controller may set a value that is twice the

parameters of the deblocking filter as the clipping value used when the clipping process is performed.

[0012]

The image processing device further includes: a filter strength determining unit that determines the strength of the deblocking filter applied to the block boundary, and the filtering unit may apply the deblocking filter to the block boundary according to the strength determined by the filter strength determining unit, and the controller may control the filtering unit so that, when the filter strength determining unit determines that strong filtering is to be applied, a clipping process is applied to the deblocking filter with respect to the luminance components of the image generated by the decoding unit.

[0013]

The filter strength determining unit may determine the strength of the deblocking filter using a plurality of lines as processing units.

[0014]

The filter strength determining unit may determine the strength of the deblocking filter using four lines as the processing units.

[0015]

The image processing device further includes: a filtering necessity determining unit that determines whether the deblocking filter is to be applied to the block boundary using a plurality of lines as processing units, and the filter strength determining unit may determine the strength of the deblocking filter when the filtering necessity determining unit determines that the deblocking filter is to be applied.

[0016]

According to a second aspect, there is provided an image processing method including the steps of: decoding an encoded stream to generate a decoded image; applying a deblocking filter including a first deblocking filter and a second deblocking filter, which is different from the first

deblocking filter and has a stronger filter strength than the first deblocking filter, to neighboring pixels neighboring a block boundary within the generated decoded image; and controlling, as a condition that the second deblocking filter is applied, the second deblocking filter to apply a second clipping process to a difference value changed by the second deblocking filter using a second clipping value, wherein a first clipping process is applied using a first clipping value as a condition that the first deblocking filter is applied and the second clipping process is applied according to the following expressions:

$$p0' = p0+Clip_{(-pv)-(pv)}((p2+2*p1-6*p0+2*q0+q1+4)>>3);$$
$$= Clip_{(p0-pv)-(p0+pv)}((p2+2*p1+2*p0+2*q0+q1+4)>>3);$$
$$= Clip3(p0-pv, p0+pv, (p2+2*p1+2*p0+2*q0+q1+4)>>3);$$
$$p1' = p1+Clip_{(-pv)-(pv)}((p2-3*p1+p0+q0+2)>>2);$$
$$= Clip_{(p1-pv)-(p1+pv)}((p2+p1+p0+q0+2)>>2);$$
$$= Clip3(p1-pv, p1+pv, (p2+p1+p0+q0+2)>>2);$$
$$p2' = p2+Clip_{(-pv)-(pv)}((2*p3-5*p2+p1+p0+q0+4)>>3);$$
$$= Clip_{(p2-pv)-(p2+pv)}((2*p3+3*p2+p1+p0+q0+4)>>3);$$
$$= Clip3(p2-pv, p2+pv, (2*p3+3*p2+p1+p0+q0+4)>>3);$$
$$q0' = q0+Clip_{(-pv)-(pv)}((p1+2*p0-6*q0+2*q1+q2+4)>>3);$$
$$= Clip_{(q0-pv)-(q0+pv)}((p1+2*p0+2*q0+2*q1+q2+4)>>3);$$
$$= Clip3(q0-pv, q0+pv, (p1+2*p0+2*q0+2*q1+q2+4)>>3);$$
$$q1' = q1+Clip_{(-pv)-(pv)}((p0+q0-3*q1+q2+2)>>2);$$
$$= Clip_{(q1-pv)-(q1+pv)}((p0+q0+q1+q2+2)>>2);$$
$$= Clip3(q1-pv, q1+pv, (p0+q0+q1+q2+2)>>2);$$
$$q2' = q2+Clip_{(-pv)-(pv)}((p0+q0+q1-5*q2+2*q3+4)>>3);$$
$$= Clip_{(q2-pv)-(q2+pv)}((p0+q0+q1+3*q2+2*q3+4)>>3);$$
$$= Clip3(q2-pv, q2+pv, p0+q0+q1+3*q2+2*q3+4)>>3);$$

where

p0', p1', p2', q0', q1' and q2' are pixels filtered by the second deblocking filter,

p0, p1, p2, q0, q1 and q2 are pixels of the decoded image, and

pv is the second clipping value.

[0017]

Disclosed herein is an image processing device including: a filtering unit that applies a deblocking filter

to a block boundary according to a strength of the deblocking filter applied to the block boundary which is a boundary between a block of an image locally decoded when an image is encoded and an adjacent block adjacent to the block; a controller that controls the filtering unit so that, when strong filtering is applied as the strength of the deblocking filter, a clipping process is applied to the deblocking filter with respect to luminance components of the locally decoded image; and an encoding unit that encodes the image in units each having a layer structure using an image to which the deblocking filter is applied.

[0018]

The controller may apply the clipping process to values of parts that change when the deblocking filter is applied.

[0019]

The controller applies the clipping process according to the following expressions:

[Mathematical formula 38]

$$p0_i = p0_i + Clip_{(-pv)-(pv)}((p2_i + 2*p1_i - 6*p0_i + 2*q0_i + q1_i + 4) >> 3);$$

$$q0_i = q0_i + Clip_{(-pv)-(pv)}((p1_i + 2*p0_i - 6*q0_i + 2*q1_i + q2_i + 4) >> 3);$$

$$p1_i = p1_i + Clip_{(-pv)-(pv)}((p2_i - 3*p1_i + p0_i + q0_i + 2) >> 2);$$

$$q1_i = q1_i + Clip_{(-pv)-(pv)}((p0_i + q0_i - 3*q1_i + q2_i + 2) >> 2);$$

$$p2_i = p2_i + Clip_{(-pv)-(pv)}((2*p2_i - 5*p2_i + p1_i + p0_i + q0_i + 4) >> 3);$$

$$q2_i = q2_i + Clip_{(-pv)-(pv)}((p0_i + q0_i + p1_i - 5*q2_i + 2*q3_i + 4) >> 3);$$

where i = 0, 7 and pv is a clipping value.

[0020]

The controller may set a value that is integer multiples of parameters of the deblocking filter as the clipping value used when the clipping process is performed.

[0021]

The controller may set a value that is twice the parameters of the deblocking filter as the clipping value used when the clipping process is performed.

[0022]

The above image processing device further includes: a filter strength determining unit that determines the strength of the deblocking filter applied to the block boundary, and the filtering unit may apply the deblocking filter to the block boundary according to the strength determined by the filter strength determining unit, and the controller may control the filtering unit so that, when the filter strength determining unit determines that strong filtering is to be applied, a clipping process is applied to the deblocking filter with respect to the luminance components of the image generated by the decoding unit.

[0023]

The filter strength determining unit may determine the strength of the deblocking filter using a plurality of lines as processing units.

[0024]

The filter strength determining unit may determine the strength of the deblocking filter using four lines as the processing units.

[0025]

The image processing device further includes: a filtering necessity determining unit that determines whether the deblocking filter is to be applied to the block boundary using a plurality of lines as processing units, and the filter strength determining unit may determine the strength of the deblocking filter when the filtering necessity determining unit determines that the deblocking filter is to be applied.

[0026]

Disclosed herein is an image processing method that allows an image processing device to execute the steps of: applying a deblocking filter to a block boundary according to

a strength of the deblocking filter applied to the block boundary which is a boundary between a block of an image locally decoded when an image is encoded and an adjacent block adjacent to the block; controlling so that, when strong filtering is applied as the strength of the deblocking filter, a clipping process is applied to the deblocking filter with respect to luminance components of the locally decoded image; and encoding the image in units each having a layer structure using an image to which the deblocking filter is applied.

[0027]

In an embodiment, an encoded stream encoded in units each having a layer structure is decoded to generate an image; and a deblocking filter is applied to a block boundary according to a strength of the deblocking filter applied to the block boundary which is a boundary between a block of the generated image and an adjacent block adjacent to the block. Moreover, control is performed so that, when strong filtering is applied as the strength of the deblocking filter, a clipping process is applied to the deblocking filter with respect to luminance components of the generated image.

[0028]

In an embodiment, a deblocking filter is applied to a block boundary according to a strength of the deblocking filter applied to the block boundary which is a boundary between a block of an image locally decoded when an image is encoded and an adjacent block adjacent to the block. Moreover, control is performed so that, when strong filtering is applied as the strength of the deblocking filter, a clipping process is applied to the deblocking filter with respect to luminance components of the locally decoded image; and the image is encoded in units each having a layer structure using an image to which the deblocking filter is applied.

EFFECTS OF THE INVENTION

[0029]

According to embodiments of the present invention, it is possible to allow a deblocking filtering process to apply filtering appropriately.

BRIEF DESCRIPTION OF THE DRAWINGS

[0030]

Figs. 1(A) and 1(B) are diagrams for describing a conventional deblocking filtering process.

Fig. 2 is a diagram illustrating a configuration when applied to an image encoding device.

Fig. 3 is a flowchart illustrating an image encoding operation.

Fig. 4 is a flowchart illustrating an intra-prediction process.

Fig. 5 is a flowchart illustrating an inter-prediction process.

Fig. 6 is a diagram illustrating a configuration when applied to an image decoding device.

Fig. 7 is a flowchart illustrating an image decoding operation.

Fig. 8 is a diagram for describing a basic operation of a deblocking filtering unit.

Fig. 9 is a diagram illustrating the configuration of a first embodiment of the deblocking filtering unit.

Fig. 10 is a flowchart illustrating the operation of the first embodiment of the deblocking filtering unit.

Fig. 11 is a diagram illustrating the configuration of a filter operation unit.

CLAIMS:

1. An image processing device comprising:

circuitry configured to:

decode an encoded stream to generate a decoded image;

apply a deblocking filter including a first deblocking filter and a second deblocking filter, which is different from the first deblocking filter and has a stronger filter strength than the first deblocking filter, to neighboring pixels neighboring a block boundary within the decoded image generated by the circuitry; and

control, as a condition that the second deblocking filter is applied, the second deblocking filter so as to apply a second clipping process to a difference value changed by the second deblocking filter using a second clipping value, wherein a first clipping process is applied using a first clipping value as a condition that the first deblocking filter is applied and the second clipping process is applied according to the following expressions:

$$p0' = p0+Clip_{(-pv)-(pv)}((p2+2*p1-6*p0+2*q0+q1+4)>>3);$$
$$= Clip_{(p0-pv)-(p0+pv)}((p2+2*p1+2*p0+2*q0+q1+4)>>3);$$
$$= Clip3(p0-pv, p0+pv, (p2+2*p1+2*p0+2*q0+q1+4)>>3);$$
$$p1' = p1+Clip_{(-pv)-(pv)}((p2-3*p1+p0+q0+2)>>2);$$
$$= Clip_{(p1-pv)-(p1+pv)}((p2+p1+p0+q0+2)>>2);$$
$$= Clip3(p1-pv, p1+pv, (p2+p1+p0+q0+2)>>2);$$
$$p2' = p2+Clip_{(-pv)-(pv)}((2*p2-5*p2+p1+p0+q0+4)>>3);$$
$$= Clip_{(p2-pv)-(p2+pv)}((2*p3+3*p2+p1+p0+q0+4)>>3);$$
$$= Clip3(p2-pv, p2+pv, (2*p3+3*p2+p1+p0+q0+4)>>3);$$
$$q0' = q0+Clip_{(-pv)-(pv)}((p1+2*p0-6*q0+2*q1+q2+4)>>3);$$
$$= Clip_{(q0-pv)-(q0+pv)}((p1+2*p0+2*q0+2*q1+q2+4)>>3);$$
$$= Clip3(q0-pv, q0+pv, (p1+2*p0+2*q0+2*q1+q2+4)>>3);$$
$$q1' = q1+Clip_{(-pv)-(pv)}((p0+q0-3*q1+q2+2)>>2);$$
$$= Clip_{(q1-pv)-(q1+pv)}((p0+q0+q1+q2+2)>>2);$$

= Clip3(q1-pv, q1+pv, (p0+q0+q1+q2+2)>>2);

q2' = $q2+Clip_{(-pv)-(pv)}((p0+q0+q1-5*q2+2*q3+4)>>3)$;

= $Clip_{(q2-pv)-(q2+pv)}((p0+q0+q1+3*q2+2*q3+4)>>3)$;

= Clip3(q2-pv, q2+pv, p0+q0+q1+3*q2+2*q3+4)>>3);

where

p0', p1', p2', q0', q1' and q2' are pixels filtered by the second deblocking filter,

p0, p1, p2, q0, q1 and q2 are pixels of the decoded image, and

pv is the second clipping value.

2. The image processing device according to claim 1,

wherein

the second clipping value is 2*tc and the first clipping value is tc,

wherein tc is a value set based on a predetermined quantization parameter.

3. The image processing device according to claim 2,

wherein

the circuitry is configured to apply, as the condition that the second deblocking filter is applied, the second clipping process according to the following expressions:

p0' = $p0+Clip_{(-2*tc)-(2*tc)}((p2+2*p1-6*p0+2*q0+q1+4)>>3)$;

= $Clip_{(p0-2*tc)-(p0+2*tc)}((p2+2*p1+2*p0+2*q0+q1+4)>>3)$;

= Clip3(p0-2*tc, p0+2*tc, (p2+2*p1+2*p0+2*q0+q1+4)>>3);

p1' = $p1+Clip_{(-2*tc)-(2*tc)}((p2-3*p1+p0+q0+2)>>2)$;

= $Clip_{(p1-2*tc)-(p1+2*tc)}((p2+p1+p0+q0+2)>>2)$;

= Clip3(p1-2*tc, p1+2*tc, (p2+p1+p0+q0+2)>>2);

q1' = $q1+Clip_{(-2*tc)-(2*tc)}((p0+q0-3*q1+q2+2)>>2)$;

= $Clip_{(q1-2*tc)-(q1+2*tc)}((p0+q0+q1+q2+2)>>2)$;

= Clip3(q1-2*tc, q1+2*tc, (p0+q0+q1+q2+2)>>2);

p2' = $p2+Clip_{(-2*tc)-(2*tc)}((2*p3-5*p2+p1+p0+q0+4)>>3)$;

= $Clip_{(p2-2*tc)-(p2+2*tc)}((2*p3+3*p2+p1+p0+q0+4)>>3)$;

= Clip3(p2-2*tc, p2+2*tc, (2*p3+3*p2+p1+p0+q0+4)>>3);

$$q0' = q0+Clip_{(-2*tc)-(2*tc)}((p1+2*p0-6*q0+2*q1+q2+4)>>3);$$

$$= Clip_{(q0-2*tc)-(q0+2*tc)}((p1+2*p0+2*q0+2*q1+q2+4)>>3);$$

$$= Clip3(q0-2*tc, q0+2*tc, (p1+2*p0+2*q0+2*q1+q2+4)>>3);$$

$$q2' = q2+Clip_{(-2*tc)-(2*tc)}((p0+q0+q1-5*q2+2*q3+4)>>3);$$

$$= Clip_{(q2-2*tc)-(q2+2*tc)}((p0+q0+q1+3*q2+2*q3+4)>>3);$$

$$= Clip3(q2-2*tc, q2+2*tc, (p0+q0+q1+3*q2+2*q3+4)>>3);$$

where tc is a value set based on a predetermined quantization parameter.

4. The image processing device according to claim 3, wherein

the circuitry is configured to apply the second deblocking filter to luminance components of pixels neighboring a block boundary.

5. The image processing device according to claim 4, wherein

the second deblocking filter is configured to filter six neighboring pixels, and

the first deblocking filter is configured to filter four neighboring pixels.

6. The image processing device according to claim 5, wherein the circuitry is configured to:

perform an arithmetic decoding process on the encoded stream to generate quantized data;

inversely quantize the quantized data to generate transform coefficient data; and

inversely transform the transform coefficient data to generate the decoded image.

7. An image processing method comprising the steps of:

decoding an encoded stream to generate a decoded image;

applying a deblocking filter including a first deblocking filter and a second deblocking filter, which is different from the first deblocking filter and has a stronger filter strength than the first deblocking filter, to neighboring pixels neighboring a block boundary within the generated decoded image; and

controlling, as a condition that the second deblocking filter is applied, the second deblocking filter to apply a second clipping process to a difference value changed by the second deblocking filter using a second clipping value, wherein a first clipping process is applied using a first clipping value as a condition that the first deblocking filter is applied and the second clipping process is applied according to the following expressions:

$$
\begin{aligned}
p0' &= p0+Clip_{(-pv)-(pv)}((p2+2*p1-6*p0+2*q0+q1+4)>>3);\\
&= Clip_{(p0-pv)-(p0+pv)}((p2+2*p1+2*p0+2*q0+q1+4)>>3);\\
&= Clip3(p0-pv, p0+pv, (p2+2*p1+2*p0+2*q0+q1+4)>>3);\\
p1' &= p1+Clip_{(-pv)-(pv)}((p2-3*p1+p0+q0+2)>>2);\\
&= Clip_{(p1-pv)-(p1+pv)}((p2+p1+p0+q0+2)>>2);\\
&= Clip3(p1-pv, p1+pv, (p2+p1+p0+q0+2)>>2);\\
p2' &= p2+Clip_{(-pv)-(pv)}((2*p3-5*p2+p1+p0+q0+4)>>3);\\
&= Clip_{(p2-pv)-(p2+pv)}((2*p3+3*p2+p1+p0+q0+4)>>3);\\
&= Clip3(p2-pv, p2+pv, (2*p3+3*p2+p1+p0+q0+4)>>3);\\
q0' &= q0+Clip_{(-pv)-(pv)}((p1+2*p0-6*q0+2*q1+q2+4)>>3);\\
&= Clip_{(q0-pv)-(q0+pv)}((p1+2*p0+2*q0+2*q1+q2+4)>>3);\\
&= Clip3(q0-pv, q0+pv, (p1+2*p0+2*q0+2*q1+q2+4)>>3);\\
q1' &= q1+Clip_{(-pv)-(pv)}((p0+q0-3*q1+q2+2)>>2);\\
&= Clip_{(q1-pv)-(q1+pv)}((p0+q0+q1+q2+2)>>2);\\
&= Clip3(q1-pv, q1+pv, (p0+q0+q1+q2+2)>>2);\\
q2' &= q2+Clip_{(-pv)-(pv)}((p0+q0+q1-5*q2+2*q3+4)>>3);\\
&= Clip_{(q2-pv)-(q2+pv)}((p0+q0+q1+3*q2+2*q3+4)>>3);\\
&= Clip3(q2-pv, q2+pv, p0+q0+q1+3*q2+2*q3+4)>>3);
\end{aligned}
$$

where

p0', p1', p2', q0', q1' and q2' are pixels filtered by the second deblocking filter,

p0, p1, p2, q0, q1 and q2 are pixels of the decoded image, and

pv is the second clipping value.

8. The image processing method according to claim 7, wherein

the second clipping value is 2*tc and the first clipping value is tc,

wherein tc is a value set based on a predetermined quantization parameter.

9. The image processing method according to claim 8, wherein the second clipping process is applied, as the condition that the second deblocking filter is applied, according to the following expressions:

$$
\begin{aligned}
p0' &= p0+Clip_{(-2*tc)-(2*tc)}((p2+2*p1-6*p0+2*q0+q1+4)>>3);\\
&= Clip_{(p0-2*tc)-(p0+2*tc)}((p2+2*p1+2*p0+2*q0+q1+4)>>3);\\
&= Clip3(p0-2*tc, p0+2*tc, (p2+2*p1+2*p0+2*q0+q1+4)>>3);\\
p1' &= p1+Clip_{(-2*tc)-(2*tc)}((p2-3*p1+p0+q0+2)>>2);\\
&= Clip_{(p1-2*tc)-(p1+2*tc)}((p2+p1+p0+q0+2)>>2);\\
&= Clip3(p1-2*tc, p1+2*tc, (p2+p1+p0+q0+2)>>2);\\
q1' &= q1+Clip_{(-2*tc)-(2*tc)}((p0+q0-3*q1+q2+2)>>2);\\
&= Clip_{(q1-2*tc)-(q1+2*tc)}((p0+q0+q1+q2+2)>>2);\\
&= Clip3(q1-2*tc, q1+2*tc, (p0+q0+q1+q2+2)>>2);\\
p2' &= p2+Clip_{(-2*tc)-(2*tc)}((2*p3-5*p2+p1+p0+q0+4)>>3);\\
&= Clip_{(p2-2*tc)-(p2+2*tc)}((2*p3+3*p2+p1+p0+q0+4)>>3);\\
&= Clip3(p2-2*tc, p2+2*tc, (2*p3+3*p2+p1+p0+q0+4)>>3);\\
q0' &= q0+Clip_{(-2*tc)-(2*tc)}((p1+2*p0-6*q0+2*q1+q2+4)>>3);\\
&= Clip_{(q0-2*tc)-(q0+2*tc)}((p1+2*p0+2*q0+2*q1+q2+4)>>3);\\
&= Clip3(q0-2*tc, q0+2*tc, (p1+2*p0+2*q0+2*q1+q2+4)>>3);\\
q2' &= q2+Clip_{(-2*tc)-(2*tc)}((p0+q0+q1-5*q2+2*q3+4)>>3);\\
&= Clip_{(q2-2*tc)-(q2+2*tc)}((p0+q0+q1+3*q2+2*q3+4)>>3);\\
&= Clip3(q2-2*tc, q2+2*tc, (p0+q0+q1+3*q2+2*q3+4)>>3);
\end{aligned}
$$

where tc is a value set based on a predetermined quantization parameter.

10. The method according to claim 9, wherein the second deblocking filter is applied to luminance components of pixels neighboring a block boundary.

11. The method according to claim 10, wherein
the second deblocking filter is configured to filter six neighboring pixels, and
the first deblocking filter is configured to filter four neighboring pixels.

12. The image processing device according to claim 1,
wherein
the second clipping value is an integer multiple of the first clipping value.

13. The image processing method according to claim 7, wherein
the second clipping value is an integer multiple of the first clipping value.