Amended Set of Claims 1 to 48

1. A method of video coding, the method comprising:

determining a first metric for a group of pixels within a block of pixels, wherein the first metric is determined based on comparing pixel values of the group of pixels to pixel values of the block of pixels;

determining a second metric for the group of pixels, wherein the second metric comprises a direction metric determined based on comparing a measure of horizontal activity for the group of pixels to a measure of vertical activity for the group of pixels;

based on the first metric and the second metric, determining a filter;

generating a filtered image by applying the filter to the group of pixels.

2. The method of claim 1, wherein the first metric comprises an activity metric.

3. The method of claim 2, wherein the activity metric comprises a sum-modified Laplacian value.

4. The method of claim 1, wherein determining the second metric for the group of pixels comprises determining a direction for the group of pixels, wherein determining the direction for the group of pixels comprises:

in response to the measure of horizontal activity being greater than the measure of vertical activity, determining the direction is equal to a first direction indicating that the pixel values are changing more in the horizontal direction than in the vertical direction;

in response to the measure of vertical activity being greater than the measure of horizontal activity, determining the direction is equal to a second direction indicating that pixel values are changing more in the vertical direction than in the horizontal direction.

5. The method of claim 1, wherein the measure of horizontal activity is determined based on comparing a pixel value of a current pixel to a pixel value of a left neighboring pixel and a pixel value of a right neighboring pixel.

6. The method of claim 1, wherein the measure of vertical activity is determined based on comparing a pixel value of a current pixel to a pixel value of an upper neighboring pixel and a pixel value of lower neighboring pixel.

7. The method of claim 2, wherein the activity metric is determined based on a sum of the measure of horizontal activity and the measure of vertical activity.

8. The method of claim 1, wherein the group of pixels comprises a 4x4 block of pixels.

9. The method of claim 1, wherein the group of pixels comprises one pixel.

10. The method of claim 1, wherein the video encoder implements a Quadtree-based Adaptive Loop Filter (QALF) scheme with multiple filters.

11. The method of claim 1, wherein the method is performed by a video coding device comprising a video encoder.

12. The method of claim 1, wherein the method is performed by a video coding device comprising a video decoder.

13. A video coding device comprising:
a filter unit configured to:
determine a first metric for a group of pixels within a block of pixels, wherein the first metric is determined based on comparing pixel values of the group of pixels to pixel values of the block of pixels;
determine a second metric for the group of pixels, wherein the second metric comprises a direction metric determined based on comparing a measure of horizontal activity for the group of pixels to a measure of vertical activity for the group of pixels;
determine a filter based on the first metric and the second metric;
generate a filtered image by applying the filter to the group of pixels;

a memory configured to store a filtered result of the filter unit.

14. The video coding device of claim 13, wherein the first metric comprises an activity metric.

15. The video coding device of claim 14, wherein the activity metric comprises a sum-modified Laplacian value.

16. The video coding device of claim 13, wherein the filter unit is further configured to determine the second metric for the group of pixels by determining a direction for the group of pixels, wherein the filter unit determines the direction for the group of pixels by:

in response to the measure of horizontal activity being greater than the measure of vertical activity, determining the direction is equal to a first direction indicating that the pixel values are changing more in the horizontal direction than in the vertical direction;

in response to the measure of vertical activity being greater than the measure of horizontal activity, determining the direction is equal to a second direction indicating that pixel values are changing more in the vertical direction than in the horizontal direction.

17. The video coding device of claim 13, wherein the filter unit determines the measure of horizontal activity based on comparing a pixel value of a current pixel to a pixel value of a left neighboring pixel and a pixel value of a right neighboring pixel.

18. The video coding device of claim 13, wherein the filter unit determines the measure of vertical activity based on comparing a pixel value of a current pixel to a pixel value of an upper neighboring pixel and a pixel value of lower neighboring pixel.

19. The video coding device of claim 14, wherein the activity metric is determined based on a sum of the measure of horizontal activity and the measure of vertical activity.

20. The video coding device of claim 13, wherein the group of pixels comprises a 4x4 block of pixels.

21. The video coding device of claim 13, wherein the group of pixels comprises one pixel.

22. The video coding device of claim 13, wherein the video coding device implements a Quadtree-based Adaptive Loop Filter (QALF) scheme with multiple filters.

23. The video coding device of claim 13, wherein the filter unit is a part of a video encoding device.

24. The video coding device of claim 13, wherein the filter unit is a part of a video decoding device.

25. An apparatus comprising:

means for determining a first metric for a group of pixels within a block of pixels, wherein the means for determining the first metric comprises means for determining the first metric based on comparing pixel values of the group of pixels to pixel values of the block of pixels;

means for determining a second metric for the group of pixels, wherein the second metric comprises a direction metric, and wherein the means for determining the second metric comprises means for determining the second metric based on comparing a measure of horizontal activity for the group of pixels to a measure of vertical activity for the group of pixels;

means for determining a filter based on the first metric and the second metric;

means for generating a filtered image by applying the filter to the group of pixels.

26. The apparatus of claim 25, wherein the first metric comprises an activity metric.

27. The apparatus of claim 26, wherein the activity metric comprises a sum-modified Laplacian value.

28. The apparatus of claim 25, wherein the means for determining the second metric for the group of pixels comprises means for determining a direction for the group of pixels, wherein the means for determining the direction for the group of pixels comprises:

means for determining the direction is equal to a first direction indicating that the pixel values are changing more in the horizontal direction than in the vertical direction in response to the measure of horizontal activity being greater than the measure of vertical activity;

means for determining the direction is equal to a second direction indicating that pixel values are changing more in the vertical direction than in the horizontal direction in response to the measure of vertical activity being greater than the measure of horizontal activity.

29. The apparatus of claim 25, wherein the measure of horizontal activity is determined based on comparing a pixel value of a current pixel to a pixel value of a left neighboring pixel and a pixel value of a right neighboring pixel.

30. The apparatus of claim 25, wherein the measure of vertical activity is determined based on comparing a pixel value of a current pixel to a pixel value of an upper neighboring pixel and a pixel value of lower neighboring pixel.

31. The apparatus of claim 26, wherein the activity metric is determined based on a sum of the measure of horizontal activity and the measure of vertical activity.

32. The apparatus of claim 25, wherein the group of pixels comprises a 4x4 block of pixels.

33. The apparatus of claim 25, wherein the group of pixels comprises one pixel.

34. The apparatus of claim 25, wherein the apparatus implements a Quadtree-based Adaptive Loop Filter (QALF) scheme with multiple filters.

35. The apparatus of claim 25, wherein the apparatus comprises a video coding device comprising a video encoder.

36. The apparatus of claim 25, wherein the apparatus comprises a video coding device comprising a video decoder.

37. A computer-readable storage medium having stored thereon instructions that when executed cause one or more processors to:

determine a first metric for a group of pixels within a block of pixels, wherein the first metric is determined based on comparing pixel values of the group of pixels to pixel values of the block of pixels;

determine a second metric for the group of pixels, wherein the second metric comprises a direction metric determined based on comparing a measure of horizontal activity for the group of pixels to a measure of vertical activity for the group of pixels;

determine a filter based on the first metric and the second metric;

generate a filtered image by applying the filter to the group of pixels.

38. The computer-readable storage medium of claim 37, wherein the first metric comprises an activity metric.

39. The computer-readable storage medium of claim 38, wherein the activity metric comprises a sum-modified Laplacian value.

40. The computer-readable storage medium of claim 37, storing further instructions that when executed cause the one or more processors to determining the second metric for the group of pixels by determining a direction for the group of pixels, wherein determining the direction for the group of pixels comprises:

in response to the measure of horizontal activity being greater than the measure of vertical activity, determining the direction is equal to a first direction indicating that the pixel values are changing more in the horizontal direction than in the vertical direction;

in response to the measure of vertical activity being greater than the measure of horizontal activity, determining the direction is equal to a second direction indicating that pixel values are changing more in the vertical direction than in the horizontal direction.

41. The computer-readable storage medium of claim 37, wherein the measure of horizontal activity is determined based on comparing a pixel value of a current pixel to a pixel value of a left neighboring pixel and a pixel value of a right neighboring pixel.

42. The computer-readable storage medium of claim 37, wherein the measure of vertical activity is determined based on comparing a pixel value of a current pixel to a pixel value of an upper neighboring pixel and a pixel value of lower neighboring pixel.

43. The computer-readable storage medium of claim 38, wherein the activity metric is determined based on a sum of the measure of horizontal activity and the measure of vertical activity.

44. The computer-readable storage medium of claim 37, wherein the group of pixels comprises a 4x4 block of pixels.

45. The computer-readable storage medium of claim 37, wherein the group of pixels comprises one pixel.

46. The computer-readable storage medium of claim 37, wherein the one or more processors implement a Quadtree-based Adaptive Loop Filter (QALF) scheme with multiple filters.

47. The computer-readable storage medium of claim 37, wherein the one or more processors perform video encoding.

48. The computer-readable storage medium of claim 37, wherein the one or more processors perform video decoding.

CLAIMS

1. A method of video coding, the method comprising:

determining a first metric for a group of pixels within a block of pixels, wherein the first metric is determined based on comparing pixel values of the group of pixels to pixel values of the block of pixels;

determining a second metric for the group of pixels, wherein determining the second metric comprises determining a direction of the group of pixels from a set of directions, wherein the set of directions includes a horizontal direction, a vertical direction, a 45-degree direction, and a 135-degree direction;

based on the first metric and the second metric, determining a filter; and

generating a filtered image by applying the filter to the group of pixels.

2. The method of claim **1**, wherein the first metric comprises an activity metric.

3. The method of claim **2**, wherein the activity metric comprises a sum-modified Laplacian value, wherein the sum-modified Laplacian value comprises var(i,j) defined according to the following equation:

$$\mathrm{var}(i,\ j) =$$

$$\sum_{k=-K}^{K}\sum_{l=-L}^{L} |2R(i+k,\ j+l) - R(i+k-1,\ j+l) - R(i+k+1,\ j+l| +$$

$$|2R(i+k,\ j+l) - R(i+k,\ j+l-1) - R(i+k,\ j+l+1)|$$

wherein k represents a value of a summation from –K to K and l represents a value of a summation from –L to L for a two-dimensional window that spans from –K to K and –L to L, wherein i and j represent pixel coordinates of the pixel data, R(i,j) represents a given pixel value at coordinates i and j, and var(i,j) is the activity metric.

4. The method of claim **1**, wherein determining the second first metric for the group of pixels comprises:

comparing at least one pixel of the group of pixels to a first neighboring pixel within the block of pixels;

in response to a pixel value of the at least one pixel being greater than a pixel value of the first neighboring pixel, incrementing an edge metric variable; and

in response to the pixel value of the at least one pixel being less than the pixel value of the first neighboring pixel, decrementing the edge metric variable.

5. The method of claim **1**, wherein the first metric is determined based on comparing a pixel value of at least one pixel of the group of pixels to a pixel value of a left neighboring pixel within the block of pixels and a pixel value of a right neighboring pixel within the block of pixels.

6. The method of claim **1**, wherein the first metric is determined based on comparing a pixel value of at least one pixel of the group of pixels to a pixel value of an upper neighboring pixel within the block of pixels and a pixel value of lower neighboring pixel within the block of pixels.

7. The method of claim **2**, wherein the activity metric is determined based on a sum of the measure of horizontal activity and the measure of vertical activity.

8. The method of claim **1**, wherein the group of pixels comprises a 4×4 block of pixels.

9. The method of claim **1**, wherein the group of pixels comprises one pixel.

10. The method of claim **1**, wherein the method of video coding implements a Quadtree-based Adaptive Loop Filter (QALF) scheme with multiple filters.

11. The method of claim **1**, wherein the method is performed by a video coding device comprising a video encoder.

12. The method of claim **1**, wherein the method is performed by a video coding device comprising a video decoder.

13. A video coding device comprising:

a filter unit configured to:

determine a first metric for a group of pixels within a block of pixels, wherein the first metric is determined based on comparing pixel values of the group of pixels to pixel values of the block of pixels;

determine a second metric for the group of pixels, wherein the second metric comprises a direction selected from a set of directions, wherein the set of directions includes a horizontal direction, a vertical direction, a 45-degree direction, and a 135-degree direction;

determine a filter based on the first metric and the second metric; and

generate a filtered image by applying the filter to the group of pixels; and

a memory configured to store a filtered result of the filter unit.

14. The video coding device of claim **13**, wherein the first metric comprises an activity metric.

15. The video coding device of claim **14**, wherein the activity metric comprises a sum-modified Laplacian value, and wherein the sum-modified Laplacian value comprises var(i,j) defined according to the following equation:

$$\text{var}(i, j) =$$

$$\sum_{k=-K}^{K} \sum_{l=-L}^{L} |2R(i+k, j+l) - R(i+k-1, j+l) - R(i+k+1, j+l| +$$

$$|2R(i+k, j+l) - R(i+k, j+l-1) - R(i+k, j+l+1)|$$

wherein k represents a value of a summation from –K to K and l represents a value of a summation from –L to L for a two-dimensional window that spans from –K to K and –L to L, wherein i and j represent pixel coordinates of the pixel data, R(i,j) represents a given pixel value at coordinates i and j, and var(i,j) is the activity metric.

16. The video coding device of claim **13**, wherein the filter unit is further configured to determine the first metric for the group of pixels by:

comparing at least one pixel of the group of pixels to a first neighboring pixel within the block of pixels;

in response to a pixel value of the at least one pixel being greater than a pixel value of the first neighboring pixel, incrementing an edge metric variable; and

in response to the pixel value of the at least one pixel being less than the pixel value of the first neighboring pixel, decrementing the edge metric variable.

17. The video coding device of claim **13**, wherein the filter unit determines the first metric based on comparing a pixel value of at least one pixel of the group of pixels to a pixel value of a left neighboring pixel within the block of pixels and a pixel value of a right neighboring pixel within the block of pixels.

18. The video coding device of claim **13**, wherein the filter unit determines the first metric based on comparing a pixel value of at least one pixel of the group of pixels to a pixel value of an upper neighboring pixel within the block of pixels and a pixel value of lower neighboring pixel within the block of pixels.

19. The video coding device of claim **14**, wherein the activity metric is determined based on a sum of the measure of horizontal activity and the measure of vertical activity.

20. The video coding device of claim **13**, wherein the group of pixels comprises a 4×4 block of pixels.

21. The video coding device of claim **13**, wherein the group of pixels comprises one pixel.

22. The video coding device of claim **13**, wherein the video coding device implements a Quadtree-based Adaptive Loop Filter (QALF) scheme with multiple filters.

23. The video coding device of claim **13**, wherein the filter unit is a part of a video encoding device.

24. The video coding device of claim **13**, wherein the filter unit is a part of a video decoding device.

25. An apparatus comprising:

means for determining a first metric for a group of pixels within a block of pixels, wherein the means for determining the first metric comprises means for determining the first metric based on comparing pixel values of the group of pixels to pixel values of the block of pixels;

means for determining a second metric for the group of pixels, wherein the second metric comprises a direction selected from a set of directions, wherein the set of directions includes a horizontal direction, a vertical direction, a 45-degree direction, and a 135-degree direction;

means for determining a filter based on the first metric and the second metric; and

means for generating a filtered image by applying the filter to the group of pixels.

26. The apparatus of claim **25**, wherein the first metric comprises an activity metric.

27. The apparatus of claim **26**, wherein the activity metric comprises a sum-modified Laplacian value, and wherein the sum-modified Laplacian value comprises var(i,j) defined according to the following equation:

$$\mathrm{var}(i,\ j) =$$

$$\sum_{k=-K}^{K}\sum_{l=-L}^{L} |2R(i+k,\ j+l) - R(i+k-1,\ j+l) - R(i+k+1,\ j+l| +$$

$$|2R(i+k,\ j+l) - R(i+k,\ j+l-1) - R(i+k,\ j+l+1)|$$

wherein k represents a value of a summation from –K to K and l represents a value of a summation from –L to L for a two-dimensional window that spans from –K to K and –L to L, wherein i and j represent pixel coordinates of the pixel data, R(i,j) represents a given pixel value at coordinates i and j, and var(i,j) is the activity metric.

28. The apparatus of claim **25**, wherein the means for determining the first metric for the group of pixels comprises:

means for comparing at least one pixel of the group of pixels to a first neighboring pixel within the block of pixels;

means for incrementing an edge metric variable in response to a pixel value of the at least one pixel being greater than a pixel value of the first neighboring pixel; and

means for decrementing the edge metric variable in response to the pixel value of the at least one pixel being less than the pixel value of the first neighboring pixel.

29. The apparatus of claim **25**, wherein the first metric is determined based on comparing a pixel value of at least one pixel of the group of pixels to a pixel value of a left neighboring pixel within the block of pixels and a pixel value of a right neighboring pixel within the block of pixels.

30. The apparatus of claim **25**, wherein the first metric is determined based on comparing a pixel value of at least one pixel of the group of pixels to a pixel value of an upper neighboring pixel within the block of pixels and a pixel value of lower neighboring pixel within the block of pixels.

31. The apparatus of claim **26**, wherein the activity metric is determined based on a sum of the measure of horizontal activity and the measure of vertical activity.

32. The apparatus of claim **25**, wherein the group of pixels comprises a 4×4 block of pixels.

33. The apparatus of claim **25**, wherein the group of pixels comprises one pixel.

34. The apparatus of claim **25**, wherein the apparatus implements a Quadtree-based Adaptive Loop Filter (QALF) scheme with multiple filters.

35. The apparatus of claim **25**, wherein the apparatus comprises a video coding device comprising a video encoder.

36. The apparatus of claim **25**, wherein the apparatus comprises a video coding device comprising a video decoder.

37. A non-transitory, computer-readable storage medium having stored thereon instructions that when executed cause one or more processors to:

determine a first metric for a group of pixels within a block of pixels, wherein the first metric is determined based on comparing pixel values of the group of pixels to pixel values of the block of pixels;

determine a second metric for the group of pixels, wherein the second metric comprises a direction selected from a set of directions, wherein the set of directions includes a horizontal direction, a vertical direction, a 45-degree direction, and a 135-degree direction;

determine a filter based on the first metric and the second metric; and

generate a filtered image by applying the filter to the group of pixels.

38. The non-transitory, computer-readable storage medium of claim **37**, wherein the first metric comprises an activity metric.

39. The non-transitory, computer-readable storage medium of claim **38**, wherein the activity metric comprises a sum-modified Laplacian value, and where in the sum-modified Laplacian value comprises var(i,j) defined according to the following equation:

$$\mathrm{var}(i,\ j) =$$

$$\sum_{k=-K}^{K}\sum_{l=-L}^{L} |2R(i+k,\ j+l) - R(i+k-1,\ j+l) - R(i+k+1,\ j+l| +$$

$$|2R(i+k,\ j+l) - R(i+k,\ j+l-1) - R(i+k,\ j+l+1)|$$

wherein k represents a value of a summation from –K to K and l represents a value of a summation from –L to L for a two-dimensional window that spans from –K to K and –L to L, wherein i and j represent pixel coordinates of the pixel data, R(i,j) represents a given pixel value at coordinates i and j, and var(i,j) is the activity metric.

40. The non-transitory, computer-readable storage medium of claim **37**, storing further instructions that when executed cause the one or more processors to determining the first metric for the group of pixels by:

comparing at least one pixel of the group of pixels to a first neighboring pixel within the block of pixels;

incrementing an edge metric variable in response to a pixel value of the at least one pixel being greater than a pixel value of the first neighboring pixel; and

decrementing the edge metric variable in response to the pixel value of the at least one pixel being less than the pixel value of the first neighboring pixel.

41. The non-transitory, computer-readable storage medium of claim **37**, wherein the first metric is determined based on comparing a pixel value of at least one pixel of the group of pixels to a pixel value of a left neighboring pixel within the block of pixels and a pixel value of a right neighboring pixel within the block of pixels.

42. The non-transitory, computer-readable storage medium of claim **37**, wherein the first metric is determined based on comparing a pixel value of at least one pixel of the group of pixels to a pixel value of an upper neighboring pixel within the block of pixels and a pixel value of lower neighboring pixel within the block of pixels.

43. The non-transitory, computer-readable storage medium of claim **38**, wherein the activity metric is determined based on a sum of the measure of horizontal activity and the measure of vertical activity.

44. The non-transitory, computer-readable storage medium of claim **37**, wherein the group of pixels comprises a 4×4 block of pixels.

45. The non-transitory, computer-readable storage medium of claim **37**, wherein the group of pixels comprises one pixel.

46. The non-transitory, computer-readable storage medium of claim **37**, wherein the one or more processors implement a Quadtree-based Adaptive Loop Filter (QALF) scheme with multiple filters.

47. The non-transitory, computer-readable storage medium of claim **37**, wherein the one or more processors perform video encoding.

48. The non-transitory, computer-readable storage medium of claim **37**, wherein the one or more processors perform video decoding.