CLAIMS

What is claimed is:

1. An auto focus image system, comprising:

an image sensor that captures an image that has at least one edge with a width; and,

a controller coupled to said image sensor, said controller generates a focus signal that is a function of said edge width.

2. The system of claim 1, wherein said controller includes an edge detection unit, a width measurement unit and a focus signal generation unit.

3. The system of claim 1, further comprising a lens that adjusts a focus in response to said focus signal.

4. The system of claim 1, wherein said edge width is determined by calculating a plurality of gradients of a plurality of image pixels.

5. The system of claim 1, wherein said edge width is refined by removing gradients that are below a threshold that is a fraction of a peak gradient.

6. The system of claim 4, wherein said gradients include a plurality of horizontal gradient values and a plurality of vertical gradient values.

7. The system of claim 6, wherein a vertical edge is selected to include at least one pixel that has a horizontal gradient greater than a vertical gradient, and a horizontal edge is

selected to include at least one pixel that has a vertical gradient greater than a horizontal gradient.

8. The system of claim 7, wherein a width of said edge is determined by comparing said gradients with a threshold.

9. The system of claim 1, wherein said focus signal is based on a histogram of a plurality of edge widths.

10. The system of claim 8, wherein at least one of said edge widths has a weighted value.

11. An auto focus image system, comprising:

an image sensor that captures an image that has at least one edge with a width; and,

means for generating a focus signal as a function of said edge width.

12. The system of claim 11, wherein said means calculates a plurality of gradients of a plurality of image pixels.

13. The system of claim 11, wherein said edge width is refined by removing gradients that are below a threshold that is a fraction of a peak gradient.

14. The system of claim 11, further comprising a lens that adjusts a focus in response to said focus signal.

15. The system of claim 11, wherein said gradients include a plurality of horizontal gradient values and a plurality of vertical gradient values.

16. The system of claim 15, wherein a vertical edge is selected to include at least one pixel that has a horizontal gradient greater than a vertical gradient, and a horizontal edge is selected to include at least one pixel that has a vertical gradient greater than a horizontal gradient.

17. The system of claim 16, wherein a width of said edge is determined by comparing said gradients with a threshold.

18. The system of claim 11, wherein said focus signal is based on a histogram of a plurality of edge widths.

19. The system of claim 18, wherein at least one of said edge widths has a weighted value.

20. A method for generating a focus signal, comprising:

capturing an image that has at least one edge with a width;

generating a focus signal that is a function of the edge width.

21. The method of claim 20, further comprising varying a lens focus in response to the focus signal.

22. The method of claim 20, wherein the generation of the focus signal includes calculating a plurality of gradients of a plurality of image pixels.

23. The method of claim 22, further comprising refining the edge width by removing gradients that are below a threshold that is a fraction of a peak gradient.

24. The method of claim 22, wherein the gradients include a plurality of horizontal gradient values and a plurality of vertical gradient values.

25. The method of claim 24, wherein a vertical edge is selected to include at least one pixel that has a horizontal gradient greater than a vertical gradient, and a horizontal edge is selected from at least one pixel that has a vertical gradient greater than a horizontal gradient.

26. The method of claim 21, wherein a width of the edge is determined by comparing the gradients with a threshold.

27. The method of claim 22, wherein the focus signal is based on a histogram of a plurality of edge widths.

28. The method of claim 27, wherein at least one of the edge widths has a weighted value.

Claims

What is claimed is:

1. A method for generating a focus signal from a plurality of edges of an image to indicate a degree of image sharpness, each edge among the plurality of edges making a contribution to the focus signal on basis of a width of said each edge, comprising: excluding an image pixel from an edge among the plurality of edges by means of a device, wherein a gradient having a magnitude smaller than a threshold is at the image pixel or between the image pixel and a peak gradient of the edge, the threshold being smaller than and proportional to the peak gradient.

2. The method of claim 1, wherein the threshold is a predetermined fraction of the peak gradient.

3. The method of claim 1, wherein the width is a count of pixels across said each edge.

4. The method of claim 1, wherein the gradient is generated from a first-order edge detection operator.

5. The method of claim 4, wherein the first-order edge detection operator is a Sobel edge detection operator.

6. A method for generating a focus signal from a plurality of edges of an image to indicate a degree of image sharpness, comprising: making a contribution from each edge among the plurality of edges to the focus signal on basis of a width of said each edge by means of a device, wherein a first image pixel among a plurality of image pixels of a first edge among the plurality of edges, the plurality of image pixels being arrayed in a first direction, has a first gradient in the first direction and a second gradient in a second direction, the second gradient being larger than the first gradient but smaller than the first gradient plus a positive hysteresis value, the first direction being same as a preferred direction for the first image pixel.

7. The method of claim 6, wherein the preferred direction is an edge direction of a reference pixel for the first image pixel, the reference pixel having a largest gradient among image pixels adjacent to the first image pixel.

8. The method of claim 6, wherein either the first direction is a horizontal direction and the second direction is a vertical direction or the first direction is the vertical direction and the second direction is the horizontal direction.

9. The method of claim 6, wherein the width is a count of pixels across said each edge.

10. The method of claim 6, wherein the gradient is generated from a first-order edge detection operator.

11. The method of claim 10, wherein the first-order edge detection operator is a Sobel edge detection operator.

12. A method for generating a focus signal from a plurality of edges of an image to indicate a degree of image sharpness, each edge among the plurality of edges making a contribution to the focus signal on basis of a width of said each edge, comprising: assigning different weights to contributions of the plurality of edges by means of a device, wherein said contribution from a first edge that has a larger width receives a first weight larger than a second weight received by said contribution from a second edge that has a smaller width, both the first and second edges being oriented in a same direction.

13. The method of claim 12, further comprising: taking a weighted average of the contributions.

14. The method of claim 12, wherein the width is a count of pixels across said each edge.

15. The method of claim 12, wherein the gradient is generated from a first-order edge detection operator.

16. The method of claim 15, wherein the first-order edge detection operator is a Sobel edge detection operator.

17. A method for generating a focus signal from a plurality of edges of an image to indicate a degree of image sharpness, each edge making a contribution to the focus signal on basis of a width of said each edge, the focus signal being generated from a histogram having a plurality of bins that corresponds to different values of the width, said each edge being counted in a population of a bin that is selected from the plurality of bins of the histogram on basis of the width, comprising: multiplying a first population of a first bin and a second population of a second bin with a larger weight and a smaller weight, respectively, wherein the first and second bins are among the plurality of bins and are respectively associated with a larger value and a smaller value of the width.

18. A method for generating a focus signal from a plurality of edges in an image to indicate a degree of image sharpness, each edge among the plurality of edges making a contribution to the focus signal on basis of a width of said each edge, comprising: excluding a gradient from a sequence of gradients of an edge among the plurality of edges by means of a device, wherein the gradient has a magnitude smaller than a threshold, the threshold being smaller than and proportional to a peak gradient of the sequence.

19. The method of claim 18, wherein the threshold is a predetermined fraction of the peak gradient.

20. The method of claim 18, wherein the width is a count of the gradients that remain in the sequence after said excluding.

21. The method of claim 18, wherein the gradient is generated from a first-order edge detection operator.

22. The method of claim 21, wherein the first-order edge detection operator is a Sobel edge detection operator.