

CLAIMS

1. A method of decoding video data, the method comprising:
 - determining a luma block that corresponds to a chroma block;
 - fetching neighboring luma samples for downsampling the neighboring luma samples, wherein the fetched neighboring luma samples comprise a plurality of luma samples from a plurality of rows that are above the luma block and exclude luma samples that are above and left of a top-left luma sample of the luma block;
 - determining a plurality of downsampled luma samples based on the fetched neighboring luma samples, wherein one of the downsampled luma samples corresponds to a downsampled luma sample immediately above the top-left luma sample, and wherein the downsampled luma sample is determined from luma samples from the plurality of rows that are above the luma block;
 - determining one or more scaling parameters based on the downsampled luma samples;
 - determining a predictive block based on the one or more scaling parameters; and
 - linear model (LM) prediction decoding the chroma block based on the predictive block.

2. The method of claim 1, wherein a coordinate of the top-left luma sample of the luma block is (x0, y0), and wherein the fetched neighboring luma samples exclude luma samples having an x-coordinate less than x0 and a y-coordinate less than y0.

3. The method of claim 1, wherein determining the plurality of downsampled luma samples comprises:
 - applying a first filter to a first set of the fetched neighboring luma samples to determine a first downsampled luma sample of the plurality of downsampled luma samples, based on a determination that no luma samples that are above and left of the top-left luma sample are needed for downsampling in accordance with the first filter; and
 - applying a second, different filter to a second set of the fetched neighboring luma samples to determine a second downsampled luma sample of the plurality of downsampled luma samples, based on a determination that at least one luma sample that is above and left of the top-left luma sample of the luma block is needed for downsampling in accordance with the first filter.

4. The method of claim 3, wherein the first filter utilizes three luma samples from a first row that is above the luma block and three luma samples from a second row that is above the first row.
5. The method of claim 3, wherein the second filter utilizes less than three luma samples from a first row that is above the luma block and less than three luma samples from a second row that is above the first row.
6. The method of claim 1, wherein determining the plurality of downsampled luma samples comprises:
 - generating, without fetching, luma values that correspond to luma samples located above and left of the top-left luma sample of the luma block; and
 - applying a filter to the generated luma values to determine at least one downsampled luma sample of the plurality of downsampled luma samples.
7. The method of claim 1, wherein LM prediction decoding the chroma block based on the predictive block comprises adding the predictive block to a residual block to reconstruct the chroma block.
8. The method of claim 1, further comprising:
 - decoding a flag for a current block that includes the luma block and the chroma block, wherein the flag indicates that LM prediction coding is enabled for the chroma block, and wherein decoding the flag comprises decoding the flag based on a context comprising one or more flags that indicate whether the LM prediction coding is enabled for neighboring blocks.
9. A device for decoding video data, the device comprising:
 - a video data memory; and
 - a video decoder comprising at least one of fixed-function circuitry or programmable circuitry, wherein the video decoder is configured to:
 - determine a luma block that corresponds to a chroma block;

fetch, from the video data memory, neighboring luma samples for downsampling the neighboring luma samples, wherein the fetched neighboring luma samples comprise a plurality of luma samples from a plurality of rows that are above the luma block and exclude luma samples that are above and left of a top-left luma sample of the luma block;

determine a plurality of downsampled luma samples based on the fetched neighboring luma samples, wherein one of the downsampled luma samples corresponds to a downsampled luma sample immediately above the top-left luma sample, and wherein the downsampled luma sample is determined from luma samples from the plurality of rows that are above the luma block;

determine one or more scaling parameters based on the downsampled luma samples;

determine a predictive block based on the one or more scaling parameters; and

linear model (LM) prediction decode the chroma block based on the predictive block.

10. The device of claim 9, wherein a coordinate of the top-left luma sample of the luma block is (x_0, y_0) , and wherein the fetched neighboring luma samples exclude luma samples having an x-coordinate less than x_0 and a y-coordinate less than y_0 .

11. The device of claim 9, wherein to determine the plurality of downsampled luma samples, the video decoder is configured to:

apply a first filter to a first set of the fetched neighboring luma samples, to determine a first downsampled luma sample of the plurality of downsampled luma samples, based on a determination that no luma samples that are above and left of the top-left luma sample are needed for downsampling in accordance with the first filter; and

apply a second, different filter to a second set of the fetched neighboring luma samples, to determine a second downsampled luma sample of the plurality of downsampled luma samples, based on a determination that at least one luma sample that is above and left of the top-left luma sample of the luma block is needed for downsampling in accordance with the first filter.

12. The device of claim 11, wherein the first filter utilizes three luma samples from a first

row that is above the luma block and three luma samples from a second row that is above the first row.

13. The device of claim 11, wherein the second filter utilizes less than three luma samples from a first row that is above the luma block and less than three luma samples from a second row that is above the first row.

14. The device of claim 9, wherein to determine the plurality of downsampled luma samples, the video decoder is configured to:

generate, without fetching, luma values that correspond to luma samples located above and left of the top-left luma sample of the luma block; and

apply a filter to the generated luma values to determine at least one downsampled luma sample of the plurality of downsampled luma samples.

15. The device of claim 9, wherein to LM prediction decode the chroma block based on the predictive block, the video decoder is configured to add the predictive block to a residual block to reconstruct the chroma block.

16. The device of claim 9, wherein the video decoder is configured to:

decode a flag for a current block that includes the luma block and the chroma block, wherein the flag indicates that LM prediction coding is enabled for the chroma block, and wherein decoding the flag comprises decoding the flag based on a context comprising one or more flags that indicate whether the LM prediction coding is enabled for neighboring blocks.

17. A method of encoding video data, the method comprising:

determining a luma block that corresponds to a chroma block;

fetching neighboring luma samples for downsampling the neighboring luma samples, wherein the fetched neighboring luma samples comprise a plurality of luma samples from a plurality of rows that are above the luma block and exclude luma samples that are above and left of a top-left luma sample of the luma block;

determining a plurality of downsampled luma samples based on the fetched neighboring

luma samples, wherein one of the downsampled luma samples corresponds to a downsampled luma sample immediately above the top-left luma sample, and wherein the downsampled luma sample is determined from luma samples from the plurality of rows that are above the luma block;

determining one or more scaling parameters based on the downsampled luma samples;

determining a predictive block based on the one or more scaling parameters; and

linear model (LM) prediction encoding the chroma block based on the predictive block.

18. The method of claim 17, wherein a coordinate of the top-left luma sample of the luma block is (x_0, y_0) , and wherein the fetched neighboring luma samples exclude luma samples having an x-coordinate less than x_0 and a y-coordinate less than y_0 .

19. The method of claim 17, wherein determining the plurality of downsampled luma samples comprises:

applying a first filter to a first set of the fetched neighboring luma samples, to determine a first downsampled luma sample of the plurality of downsampled luma samples, based on a determination that no luma samples that are above and left of the top-left luma sample are needed for downsampling in accordance with the first filter; and

applying a second, different filter to a second set of the fetched neighboring luma samples, to determine a second downsampled luma sample of the plurality of downsampled luma samples, based on a determination that at least one luma sample that is above and left of the top-left luma sample of the luma block would be needed for downsampling in accordance with the first filter.

20. The method of claim 19, wherein the first filter utilizes three luma samples from a first row that is above the luma block and three luma samples from a second row that is above the first row.

21. The method of claim 19, wherein the second filter utilizes less than three luma samples from a first row that is above the luma block and less than three luma samples from a second row that is above the first row.

22. The method of claim 17, wherein determining the plurality of downsampled luma samples comprises:

generating, without fetching, luma values that correspond to luma samples located above and left of the top-left luma sample of the luma block; and

applying a filter to the generated luma values to determine at least one downsampled luma sample of the plurality of downsampled luma samples.

23. The method of claim 17, wherein LM prediction encoding the chroma block based on the predictive block comprises subtracting the predictive block from the chroma block to generate a residual block to be used, by a video decoder, to reconstruct the chroma block.

24. The method of claim 17, further comprising:

encoding a flag for a current block that includes the luma block and the chroma block, wherein the flag indicates that LM prediction coding is enabled for the chroma block, and wherein encoding the flag comprises encoding the flag based on a context comprising one or more flags that indicate whether the LM prediction coding is enabled for neighboring blocks.

25. A device for encoding video data, the device comprising:

a video data memory; and

a video encoder comprising at least one of fixed-function circuitry or programmable circuitry, wherein the video encoder is configured to:

determine a luma block that corresponds to a chroma block;

fetch, from the video data memory, neighboring luma samples for downsampling the neighboring luma samples, wherein the fetched neighboring luma samples comprise a plurality of luma samples from a plurality of rows that are above the luma block and exclude luma samples that are above and left of a top-left luma sample of the luma block;

determine a plurality of downsampled luma samples based on the determined neighboring luma samples, wherein one of the downsampled luma samples corresponds to a downsampled luma sample immediately above the top-left luma sample, and wherein the downsampled luma sample is determined from luma samples from the plurality of

rows that are above the luma block;

determine one or more scaling parameters based on the downsampled luma samples;

determine a predictive block based on the one or more scaling parameters; and

linear model (LM) prediction encode the chroma block based on the predictive block.

26. The device of claim 25, wherein a coordinate of the top-left luma sample of the luma block is (x_0, y_0) , and wherein the fetched neighboring luma samples exclude luma samples having an x-coordinate less than x_0 and a y-coordinate less than y_0 .

27. The device of claim 25, wherein to determine the plurality of downsampled luma samples, the video encoder is configured to:

apply a first filter to a first set of the fetched neighboring luma samples, to determine a first downsampled luma sample of the plurality of downsampled luma samples, based on a determination that no luma samples that are above and left of the top-left luma sample are needed for downsampling in accordance with the first filter; and

apply a second, different filter to a second set of the fetched neighboring luma samples, to determine a second downsampled luma sample of the plurality of downsampled luma samples, based on a determination that at least one luma sample that is above and left of the top-left luma sample of the luma block is needed for downsampling in accordance with the first filter.

28. The device of claim 27, wherein the first filter utilizes three luma samples from a first row that is above the luma block and three luma samples from a second row that is above the first row.

29. The device of claim 27, wherein the second filter utilizes less than three luma samples from a first row that is above the luma block and less than three luma samples from a second row that is above the first row.

30. The device of claim 25, wherein to determine the plurality of downsampled luma

samples, the video encoder is configured to:

- generate, without fetching, luma values that correspond to luma samples located above and left of the top-left luma sample of the luma block; and

- apply a filter to the generated luma values to determine at least one downsampled luma sample of the plurality of downsampled luma samples.

31. The device of claim 25, wherein to LM prediction encode the chroma block based on the predictive block, the video encoder is configured to subtract the predictive block from the chroma block to generate a residual block, to be used by a video decoder, to reconstruct the chroma block.

32. The device of claim 25, wherein the video encoder is configured to:

- encode a flag for a current block that includes the luma block and the chroma block, wherein the flag indicates that LM prediction coding is enabled for the chroma block, and wherein encoding the flag comprises encoding the flag based on a context comprising one or more flags that indicate whether the LM prediction coding is enabled for neighboring blocks.

33. A method of decoding video data, the method comprising:

- determining a luma block that corresponds to a chroma block;

- fetching neighboring luma samples for downsampling the neighboring luma samples, wherein the fetched neighboring luma samples comprise a plurality of luma samples that are left of the luma block from a plurality of rows and exclude luma samples that are more than a threshold number of samples left of the luma block and below a top-left luma sample of the luma block;

- determining a plurality of downsampled luma samples based on the fetched neighboring luma samples, wherein one of the downsampled luma samples corresponds to a downsampled luma sample that is the threshold number of samples left of the luma block, and wherein the downsampled luma sample is determined from luma samples from the plurality of rows that are left of the luma block;

- determining one or more scaling parameters based on the downsampled luma samples;

- determining a predictive block based on the one or more scaling parameters; and

linear model (LM) prediction decoding the chroma block based on the predictive block.

34. The method of claim 33, wherein a coordinate of the top-left luma sample of the luma block is (x_0, y_0) , and wherein the fetched neighboring luma samples exclude luma samples having an x-coordinate less than $(x_0 - k)$ and a y-coordinate greater than y_0 , and wherein k is the threshold number and k is an integer larger than 0.

35. The method of claim 34, wherein k equals 4.

36. The method of claim 33, wherein one of the downsampled luma samples corresponds to a downsampled luma sample more than two columns to the left of the top-left luma sample.

37. The method of claim 33, wherein determining the plurality of downsampled luma samples comprises:

applying a first filter to a first set of the fetched neighboring luma samples, to determine a first downsampled luma sample of the plurality of downsampled luma samples, based on a determination that no luma samples that are more than the threshold number of samples to the left of the luma block and below the top-left luma sample are needed for downsampling in accordance with the first filter, and wherein the first downsampled luma sample is in a column that is a first number of columns to the left of the luma block; and

applying a second, different filter to a second set of the fetched neighboring luma samples, to determine a second downsampled luma sample of the plurality of downsampled luma samples, based on a determination that at least one luma sample that is more than the threshold number of samples to the left of the luma block and below the top-left luma sample of the luma block is needed for downsampling in accordance with the first filter, wherein the second downsampled luma sample is in a column that is a second number of columns to the left of the luma block, and wherein the second number is greater than the first number.

38. The method of claim 37, wherein the first filter utilizes three luma samples from a first row that is left of the luma block and three luma samples from a second row that is below the first row.

39. The method of claim 37, wherein the second filter utilizes less than three luma samples from a first row that is left of the luma block and less than three luma samples from a second row that is below the first row.
40. The method of claim 33, wherein determining the plurality of downsampled luma samples comprises:
- generating, without fetching, luma values that correspond to luma samples located more than the threshold number of samples left of the luma block and below the top-left luma sample of the luma block; and
 - applying a filter to the generated luma values to determine at least one downsampled luma sample of the plurality of downsampled luma samples.
41. The method of claim 33, wherein LM prediction decoding the chroma block based on the predictive block comprises adding the predictive block to a residual block to reconstruct the chroma block.
42. The method of claim 33, further comprising:
- decoding a flag for a current block that includes the luma block and the chroma block, wherein the flag indicates that LM prediction coding is enabled for the chroma block, and wherein decoding the flag comprises decoding the flag based on a context comprising one or more flags that indicate whether the LM prediction coding is enabled for neighboring blocks.
43. A device for decoding video data, the device comprising:
- a video data memory; and
 - a video decoder comprising at least one of fixed-function circuitry or programmable circuitry, wherein the video decoder is configured to:
 - determine a luma block that corresponds to a chroma block;
 - fetch neighboring luma samples for downsampling the neighboring luma samples, wherein the fetched neighboring luma samples comprise a plurality of luma samples from a plurality of rows that are left of the luma block and exclude luma samples that are more

than a threshold number of samples left of the luma block and below a top-left luma sample of the luma block;

determine a plurality of downsampled luma samples based on the fetched neighboring luma samples, wherein one of the downsampled luma samples corresponds to a downsampled luma sample that is the threshold number of samples left of the luma block, and wherein the downsampled luma sample is determined from luma samples from the plurality of rows that are left of the luma block;

determine one or more scaling parameters based on the downsampled luma samples;

determine a predictive block based on the one or more scaling parameters; and

linear model (LM) prediction decode the chroma block based on the predictive block.

44. The device of claim 43, wherein a coordinate of the top-left luma sample of the luma block is (x_0, y_0) , and wherein the fetched neighboring luma samples exclude luma samples having an x-coordinate less than $(x_0 - k)$ and a y-coordinate greater than y_0 , and wherein k is the threshold number and k is an integer larger than 0.

45. The device of claim 44, wherein k equals 4.

46. The device of claim 43, wherein one of the downsampled luma samples corresponds to a downsampled luma sample more than two columns to the left of the top-left luma sample.

47. The device of claim 43, wherein to determine the plurality of downsampled luma samples, the video decoder is configured to:

apply a first filter to a first set of the neighboring luma samples, to determine a first downsampled luma sample of the plurality of downsampled luma samples, based on a determination that no luma samples that are more than the threshold number of samples to the left of the luma block and below the top-left luma sample are needed for downsampling in accordance with the first filter, and wherein the first downsampled luma sample is in a column that is a first number of columns to the left of the luma block; and

apply a second, different filter to a second set of the neighboring luma samples, to determine a second downsampled luma sample of the plurality of downsampled luma samples, based on a determination that at least one luma sample that is more than the threshold number of samples to the left of the luma block and below the top-left luma sample of the luma block is needed for downsampling in accordance with the first filter, wherein the second downsampled luma sample is in a column that is a second number of columns to the left of the luma block, and wherein the second number is greater than the first number.

48. The device of claim 47, wherein the first filter utilizes three luma samples from a first row that is left of the luma block and three luma samples from a second row that is below the first row.

49. The device of claim 47, wherein the second filter utilizes less than three luma samples from a first row that is left of the luma block and less than three luma samples from a second row that is below the first row.

50. The device of claim 43, wherein to determine the plurality of downsampled luma samples, the video decoder is configured to:

generate, without fetching, luma values that correspond to luma samples located more than the threshold number of samples left of the luma block and below the top-left luma sample of the luma block; and

apply a filter to the generated luma values to determine at least one downsampled luma sample of the plurality of downsampled luma samples.

51. The device of claim 43, wherein to LM prediction decode the chroma block, the video decoder is configured to add the predictive block to a residual block to reconstruct the chroma block.

52. The device of claim 43, wherein the video decoder is configured to:

decode a flag for a current block that includes the luma block and the chroma block, wherein the flag indicates that LM prediction coding is enabled for the chroma block, and

wherein to decode the flag, the video decoder is configured to decode the flag based on a context comprising one or more flags that indicate whether the LM prediction coding is enabled for neighboring blocks.

53. A method of encoding video data, the method comprising:
determining a luma block that corresponds to a chroma block;
fetching neighboring luma samples for downsampling the neighboring luma samples, wherein the fetched neighboring luma samples comprise a plurality of luma samples from a plurality of rows that are left of the luma block and exclude luma samples that are more than a threshold number of samples left of the luma block and below a top-left luma sample of the luma block;
determining a plurality of downsampled luma samples based on the fetched neighboring luma samples, wherein one of the downsampled luma samples corresponds to a downsampled luma sample that is the threshold number of samples left of the luma block, and wherein the downsampled luma sample is determined from luma samples from the plurality of rows that are left of the luma block;
determining one or more scaling parameters based on the downsampled luma samples;
determining a predictive block based on the one or more scaling parameters; and
linear model (LM) prediction encoding the chroma block based on the predictive block.
54. The method of claim 53, wherein a coordinate of the top-left luma sample of the luma block is (x_0, y_0) , and wherein the fetched neighboring luma samples exclude luma samples having an x-coordinate less than $(x_0 - k)$ and a y-coordinate greater than y_0 , and wherein k is the threshold number and k is an integer larger than 0.
55. The method of claim 54, wherein k equals 4.
56. The method of claim 53, wherein one of the downsampled luma samples corresponds to a downsampled luma sample more than two columns to the left of the top-left luma sample.
57. The method of claim 53, wherein determining the plurality of downsampled luma

samples comprises:

applying a first filter to a first set of the fetched neighboring luma samples, to determine a first downsampled luma sample of the plurality of downsampled luma samples, based on a determination that no luma samples that are more than the threshold number of samples to the left of the luma block and below the top-left luma sample are needed for downsampling in accordance with the first filter, and wherein the first downsampled luma sample is in a column that is a first number of columns to the left of the luma block; and

applying a second, different filter to a second set of the fetched neighboring luma samples, to determine a second downsampled luma sample of the plurality of downsampled luma samples, based on a determination that at least one luma sample that is more than the threshold number of samples to the left of the luma block and below the top-left luma sample of the luma block is needed for downsampling in accordance with the first filter, wherein the second downsampled luma sample is in a column that is a second number of columns to the left of the luma block, and wherein the second number is greater than the first number.

58. The method of claim 57, wherein the first filter utilizes three luma samples from a first row that is left of the luma block and three luma samples from a second row that is below the first row.

59. The method of claim 57, wherein the second filter utilizes less than three luma samples from a first row that is left of the luma block and less than three luma samples from a second row that is below the first row.

60. The method of claim 53, wherein determining the plurality of downsampled luma samples comprises:

generating, without fetching, luma values that correspond to luma samples located more than the threshold number of samples left of the luma block and below the top-left luma sample of the luma block; and

applying a filter to the generated luma values to determine at least one downsampled luma sample of the plurality of downsampled luma samples.

61. The method of claim 53, wherein LM prediction encoding the chroma block based on the predictive block comprises subtracting the predictive block from the chroma block to generate a residual block to be used, by a video decoder, to reconstruct the chroma block.
62. The method of claim 53, further comprising:
 encoding a flag for a current block that includes the luma block and the chroma block, wherein the flag indicates that LM prediction coding is enabled for the chroma block, and wherein encoding the flag comprises encoding the flag based on a context comprising one or more flags that indicate whether the LM prediction coding is enabled for neighboring blocks.
63. A device for encoding video data, the device comprising:
 a video data memory; and
 a video encoder comprising at least one of fixed-function circuitry or programmable circuitry, wherein the video encoder is configured to:
 determine a luma block that corresponds to a chroma block;
 fetch neighboring luma samples for downsampling the neighboring luma samples, wherein the fetched neighboring luma samples comprise a plurality of luma samples from a plurality of rows that are left of the luma block and exclude luma samples that are more than a threshold number of samples left of the luma block and below a top-left luma sample of the luma block;
 determine a plurality of downsampled luma samples based on the fetched neighboring luma samples, wherein one of the downsampled luma samples corresponds to a downsampled luma sample that is the threshold number of samples left of the luma block, and wherein the downsampled luma sample is determined from luma samples from the plurality of rows that are left of the luma block;
 determine one or more scaling parameters based on the downsampled luma samples;
 determine a predictive block based on the one or more scaling parameters; and
 linear model (LM) prediction encode the chroma block based on the predictive block.

64. The device of claim 63, wherein a coordinate of the top-left luma sample of the luma block is (x_0, y_0) , and wherein the fetched neighboring luma samples exclude luma samples having an x-coordinate less than $(x_0 - k)$ and a y-coordinate greater than y_0 , wherein k is the threshold number and k is an integer larger than 0.

65. The device of claim 64, wherein k equals 4.

66. The device of claim 63, wherein one of the downsampled luma samples corresponds to a downsampled luma sample more than two columns to the left of the top-left luma sample.

67. The device of claim 63, wherein to determine the plurality of downsampled luma samples, the video encoder is configured to:

 apply a first filter to a first set of the neighboring luma samples, to determine a first downsampled luma sample of the plurality of downsampled luma samples, based on a determination that no luma samples that are more than the threshold number of samples to the left of the luma block and below the top-left luma sample are needed for downsampling in accordance with the first filter, and wherein the first downsampled luma sample is in a column that is a first number of columns to the left of the luma block; and

 apply a second, different filter to a second set of the neighboring luma samples, to determine a second downsampled luma sample of the plurality of downsampled luma samples, based on a determination that at least one luma sample that is more than the threshold number of samples to the left of the luma block and below the top-left luma sample of the luma block is needed for downsampling in accordance with the first filter, wherein the second downsampled luma sample is in a column that is a second number of columns to the left of the luma block, and wherein the second number is greater than the first number.

68. The device of claim 67, wherein the first filter utilizes three luma samples from a first row that is left of the luma block and three luma samples from a second row that is below the first row.

69. The device of claim 67, wherein the second filter utilizes less than three luma samples

from a first row that is left of the luma block and less than three luma samples from a second row that is below the first row.

70. The device of claim 63, wherein to determine the plurality of downsampled luma samples, the video encoder is configured to:

generate, without fetching, luma values that correspond to luma samples located more than the threshold number of samples left of the luma block and below the top-left luma sample of the luma block; and

apply a filter to the generated luma values to determine at least one downsampled luma sample of the plurality of downsampled luma samples.

71. The device of claim 63, wherein to LM prediction encode the chroma block based on the predictive block, the video encoder is configured to subtract the predictive block from the chroma block to generate a residual block, to be used by a video decoder, to reconstruct the chroma block.

72. The device of claim 63, wherein the video encoder is configured to:

encode a flag for a current block that includes the luma block and the chroma block, wherein the flag indicates that LM prediction coding is enabled for the chroma block, and wherein encoding the flag comprises encoding the flag based on a context comprising one or more flags that indicate whether the LM prediction coding is enabled for neighboring blocks.