

# A VIDEO ENCODER, A VIDEO DECODER AND CORRESPONDING METHODS

## Flexible Tiling in Video Coding

### CROSS-REFERENCE TO RELATED APPLICATIONS

~~{0001}—This patent application claims the benefit of U.S. Provisional Patent Application No. 62/785,511, filed December 27, 2018 by FNU Hendry, et. al., and titled “Flexible Tiling in Video Coding,” which is hereby incorporated by reference.~~

### **TECHNICAL FIELD**

**[0002]** The present disclosure is generally related to video coding, and is specifically related to a flexible video tiling scheme that supports multiple tiles with different resolutions in the same picture.

### **BACKGROUND**

**[0003]** The amount of video data needed to depict even a relatively short video can be substantial, which may result in difficulties when the data is to be streamed or otherwise communicated across a communications network with limited bandwidth capacity. Thus, video data is generally compressed before being communicated across modern day telecommunications networks.

**[0003]** The size of a video could also be an issue when the video is stored on a storage device because memory resources may be limited. Video compression devices often use software and/or hardware at the source to code the video data prior to transmission or storage, thereby decreasing the quantity of data needed to represent digital video images. The compressed data is then received at the destination by a video decompression device that decodes the video data. With limited network resources and ever increasing demands of higher video quality, improved compression and decompression techniques that improve compression ratio with little to no sacrifice in image quality are desirable.

### **SUMMARY**

**[0004]** In an embodiment, the disclosure includes a method implemented in an encoder, the method comprising: partitioning, by a processor of the encoder, a picture into a plurality of first level tiles; partitioning, by the processor, a subset of the first level tiles into a plurality of second level tiles, wherein each second level tile contains a single rectangular slice of picture data; encoding, by the processor, the first level tiles and the second level tiles into a bitstream;

## CLAIMS

What is claimed is:

1. A method implemented in an encoder, the method comprising:  
partitioning, ~~by a processor of the encoder,~~ a picture into a plurality of first level tiles;  
partitioning, ~~by the processor,~~ a subset of the first level tiles into a plurality of second level tiles that each contains a single rectangular slice of picture data;  
encoding, ~~by the processor,~~ the first level tiles and the second level tiles into a bitstream;  
and  
storing, in a memory of the encoder, the bitstream for communication toward a decoder.
2. The method of claim 1, wherein the first level tiles outside the subset contain picture data at a first resolution, and wherein the second level tiles contain picture data at a second resolution different from the first resolution.
3. The method of ~~any of claims 1-2,~~ wherein each of the first level tiles in the subset of the first level tiles includes two or more complete second level tiles.
4. The method of ~~any of claims 1-3,~~ further comprising encoding, ~~by the processor,~~ data indicating a configuration of second level tiles in a picture parameter set associated with the picture.
5. The method of ~~any of claims 1-4,~~ wherein the configuration of second level tiles is signaled as a number of second level tile columns and a number of second level tile rows.
6. The method of ~~any of claims 1-3,~~ wherein data explicitly indicating a number of second level tile columns and a number of second level tile rows is omitted from the bitstream when a first level tile width is less than twice a minimum width threshold and a first level tile height is less than twice a minimum height threshold
7. The method of ~~any of claims 1-6,~~ further comprising assigning, ~~by the processor,~~ the first level tiles and the second level tiles into one or more tile groups such that all tiles in a corresponding tile group are constrained to cover a rectangular portion of the picture.

8. The method of ~~any of~~ claims 1-7, further comprising encoding, ~~by the processor,~~ split indications indicating the first level tiles that are partitioned into second level tiles, wherein the split indications are omitted from the bitstream when a first level tile width is less than a minimum width threshold and a first level tile height is less than a minimum height threshold.

9. A method implemented in a decoder, the method comprising:

receiving, ~~by a processor of the decoder via a receiver,~~ a bitstream including a picture partitioned into a plurality of first level tiles including a subset of the first level tiles further partitioned into a plurality of second level tiles that each contains a single rectangular slice of picture data;

determining, ~~by the processor,~~ a configuration of the first level tiles and a configuration of the second level tiles based on parameters included in the bitstream;

decoding, ~~by the processor,~~ the first level tiles and the second level tiles based on the configuration of the first level tiles and the configuration of the second level tiles; and

generating, ~~by the processor,~~ a reconstructed video sequence for display based on the ~~decoded~~ first level tiles and the second level tiles as decoded.

10. The method of claim 9, wherein the first level tiles outside the subset contain picture data at a first resolution and the second level tiles contain picture data at a second resolution different from the first resolution.

11. The method of ~~any of~~ claims 9-10, wherein each of the first level tiles in the subset of the first level tiles includes two or more complete second level tiles.

12. The method of ~~any of~~ claims 9-11, further comprising obtaining, ~~by the processor,~~ data indicating the configuration of the second level tiles from a picture parameter set associated with the picture.

13. The method of ~~any of~~ claims 9-12, wherein the configuration of the second level tiles is signaled as a number of second level tile columns and a number of second level tile rows.

14. The method of ~~any of~~ claims 9-11, wherein data explicitly indicating a number of second level tile columns and a number of second level tile rows is omitted from the bitstream when a first level tile width is less than twice a minimum width threshold and a first level tile height is less than twice a minimum height threshold.

15. The method of ~~any of claims 9-14~~, wherein the first level tiles and the second level tiles are assigned into one or more tile groups such that all tiles in a corresponding tile group are constrained to cover a rectangular portion of the picture.

16. The method of ~~any of claims 9-15~~, further comprising obtaining, ~~by the processor~~, split indications indicating the first level tiles that are partitioned into second level tiles, wherein the split indications are omitted from the bitstream when a first level tile width is less than a minimum width threshold and a first level tile height is less than a minimum height threshold.

17. An encoding device, comprising:

a memory storing instructions; and

a processor coupled to the memory, the processor configured to execute the instructions to cause the encoding device to:

partition a picture into a plurality of first level tiles;

partition a subset of the first level tiles into a plurality of second level tiles that each contains a single rectangular slice of picture data;

encode the first level tiles and the second level tiles into a bitstream; and  
store, in the memory, the bitstream for communication toward a decoder.

18. The encoding device of claim 17, further comprising a transmitter coupled to the processor, the transmitter configured to transmit the bitstream toward the decoder.

19. A decoding device, comprising:

a memory storing instructions; and

a processor coupled to the memory, the processor configured to execute the instructions to cause the decoding device to:

receive a bitstream including a picture partitioned into a plurality of first level tiles including a subset of the first level tiles further partitioned into a plurality of second level tiles that each contains a single rectangular slice of picture data;

determine a configuration of the first level tiles and a configuration of the second level tiles based on parameters included in the bitstream;

decode the first level tiles and the second level tiles based on the configuration of the first level tiles and the configuration of the second level tiles; and

generate a reconstructed video sequence for display based on the first level tiles and the second level tiles as decoded.

20. The decoding device of claim 19, further comprising a display configured to display the reconstructed video sequence.

~~17. A video coding device comprising:~~

~~— a processor, a receiver coupled to the processor, and a transmitter coupled to the processor, the processor, receiver, and transmitter configured to perform the method of any of claims 1-16.~~

~~18. A non-transitory computer readable medium comprising a computer program product for use by a video coding device, the computer program product comprising computer executable instructions stored on the non-transitory computer readable medium such that when executed by a processor cause the video coding device to perform the method of any of claims 1-16.~~

~~19. An encoder comprising:~~

~~a partitioning means for:~~

~~partitioning a picture into a plurality of first level tiles; and~~

~~partitioning a subset of the first level tiles into a plurality of second level tiles that each contains a single rectangular slice of picture data;~~

~~an encoding means for encoding the first level tiles and the second level tiles into a bitstream; and~~

~~a storing means for storing the bitstream for communication toward a decoder.~~

~~20. The encoder of claim 19, wherein the encoder is further configured to perform the method of any of claims 1-8.~~

~~21. A decoder comprising:~~

~~a receiving means for receiving a bitstream including a picture partitioned into a plurality of first level tiles including a subset of the first level tiles further partitioned into a plurality of second level tiles that each contains a single rectangular slice of picture data;~~

~~— a determining means for determining a configuration of the first level tiles and a configuration of the second level tiles based on parameters included in the bitstream;~~

~~a decoding means for decoding the first level tiles and the second level tiles based on the configuration of the first level tiles and the configuration of the second level tiles; and~~

~~a generating means for generating a reconstructed video sequence for display based on the decoded first level tiles and the second level tiles.~~

~~22. The decoder of claim 20, wherein the decoder is further configured to perform the method of any of claims 9-16.~~