efficient in terms of data compression) or adaptive schemes like CABAC (more efficient, but very complex).

Methods and embodiments herein represent an innovative approach to achieve efficient entropy coding results with low computational complexity.

BRIEF DESCRIPTION

Embodiments herein deviate with respect to conventional systems and methods to produce compressed, encoded data in a tiered signal quality hierarchy. For example, certain embodiments herein are directed to unique ways of generating encoded reconstruction data in a hierarchy based on standard entropy encoding techniques. For simplicity of implementation and efficiency of compression, the present patent application describes embodiments leveraging range encoding techniques, although the approaches covered herein can be applied also with several other types of entropy encoders.

More specifically, one embodiment herein includes a signal processor configured to encode a signal in a hierarchy including multiple levels of quality. To this end, the signal processor produces a rendition of the signal for at least a first level of quality. The signal processor generates sets of reconstruction data specifying how to convert the rendition of the signal at the first level of quality into a rendition of the signal at a second (higher) level of quality in the hierarchy. For instance, in accordance with some methods, the sets of reconstruction data specify all the information that is necessary to correct, integrate and complement the data and the rendition of the signal that can be automatically derived ("inherited") from the previous (lower) level of quality.

The signal processor then utilizes an entropy encoder such as a range encoder to encode each set of reconstruction data. Encoding of each set of reconstruction data can include producing a range value (bit string) representative of the reconstruction data being encoded.

In accordance with further embodiments, note that prior to encoding, the signal processor can be configured to analyze each set of reconstruction data to produce probability distribution information indicating a probability distribution of some or all symbols in the

efficient in terms of data compression) or adaptive schemes like CABAC (more efficient, but very complex).

Methods and embodiments herein represent an innovative approach to achieve efficient entropy coding results with low computational complexity.

BRIEF DESCRIPTION

In accordance with an aspect there is provided a method of encoding a signal in a hierarchy including multiple levels of quality, the multiple levels of quality including a first level of quality and a second level of quality, the method comprising:

processing a rendition of the signal at the second level of quality, the second level of quality higher than the first level of quality;

producing a rendition of the signal at the first level of quality;

generating reconstruction data, the reconstruction data specifying how to reconstruct, based on the rendition of the signal at the first level of quality, the rendition of the signal at the second level of quality in the hierarchy; and

utilizing an entropy encoder to encode the reconstruction data, the entropy encoder producing an encoded value representative of symbols in the reconstruction data; wherein utilizing the entropy encoder further includes:

analyzing the reconstruction data to produce decoding information, the decoding information including probability distribution information indicating a probability of the symbols in the reconstruction data; and

storing the encoded value and the probability distribution information for subsequent decoding of the encoded value back into the reconstruction data.

In accordance with an aspect there is provided a method of decoding at multiple levels of quality in a hierarchy, the multiple method of decoding at multiple levels of quality in a hierarchy, the multiple levels of quality including a first level of quality and a second level of quality, the method comprising:

producing a rendition of a signal at the first level of quality;

receiving encoded reconstruction data indicating how to reconstruct the rendition of the signal at the first level of quality into a rendition of the signal at the second level of quality, the second level of quality higher than the first level of quality in the hierarchy;

utilizing an entropy decoder to retrieve probability distribution information and a value stored in the encoded reconstruction data;

via the decoder, utilizing the probability distribution information to decode the value into decoded reconstruction data; and

utilizing the decoded reconstruction data produced by the decoder to reconstruct, based on the rendition of the signal at the first level of quality, the rendition of the signal at the second level of quality.

In accordance with an aspect there is provided a computer-readable storage hardware having instructions stored thereon, the instructions, when carried out by a processing device, causing the processing device to perform operations of:

encoding a signal in a hierarchy including multiple levels of quality, the multiple levels of quality including a first level of quality and a second level of quality, the encoding comprising:

processing a rendition of the signal at the second level of quality, the second level of quality higher than the first level of quality in the hierarchy;

producing a rendition of the signal at the first level of quality;

generating reconstruction data, the reconstruction data specifying how to reconstruct, based on the rendition of the signal at the first level of quality, the rendition of the signal at the second level of quality in the hierarchy; and

utilizing an entropy encoder to encode the reconstruction data, the entropy encoder producing an encoded value representative of symbols contained in the reconstruction data;

wherein utilizing the entropy encoder includes:

analyzing the reconstruction data to produce decoding information, the decoding information including probability distribution information indicating a probability of the symbols in the reconstruction data; and

storing the encoded value and the probability distribution information for subsequent decoding of the encoded value back into the reconstruction data.

In accordance with an aspect there is provided a computer system comprising:

a processor;

a memory unit that stores instructions associated with an application executed by the processor; and

an interconnect coupling the processor and the memory unit, enabling the computer system to execute the application and perform operations of:

encoding a signal in a hierarchy including multiple levels of quality, the multiple levels of quality including a first level of quality and a second level of quality, the encoding comprising:

producing a rendition of the signal at the second level of quality, the second level of quality higher than the first level of quality in the hierarchy;

producing a rendition of the signal at the first level of quality;

generating reconstruction data, the reconstruction data specifying how to reconstruct, based on the rendition of the signal at the first level of quality, the rendition of the signal at the second level of quality in the hierarchy; and

utilizing an entropy encoder to encode the reconstruction data, the entropy encoder producing an encoded value representative of symbols contained in the reconstruction data;

wherein utilizing the entropy encoder includes:

analyzing the reconstruction data to produce decoding information, the decoding information including probability distribution information indicating a probability of the symbols in the reconstruction data; and

storing the encoded value and the probability distribution information for subsequent decoding of the encoded value back into the reconstruction data.

Embodiments herein deviate with respect to conventional systems and methods to produce compressed, encoded data in a tiered signal quality hierarchy. For example, certain embodiments herein are directed to unique ways of generating encoded

reconstruction data in a hierarchy based on standard entropy encoding techniques. For simplicity of implementation and efficiency of compression, the present patent application describes embodiments leveraging range encoding techniques, although the approaches covered herein can be applied also with several other types of entropy encoders.

More specifically, one embodiment herein includes a signal processor configured to encode a signal in a hierarchy including multiple levels of quality. To this end, the signal processor produces a rendition of the signal for at least a first level of quality. The signal processor generates sets of reconstruction data specifying how to convert the rendition of the signal at the first level of quality into a rendition of the signal at a second (higher) level of quality in the hierarchy. For instance, in accordance with some methods, the sets of reconstruction data specify all the information that is necessary to correct, integrate and complement the data and the rendition of the signal that can be automatically derived ("inherited") from the previous (lower) level of quality.

The signal processor then utilizes an entropy encoder such as a range encoder to encode each set of reconstruction data. Encoding of each set of reconstruction data can include producing a range value (bit string) representative of the reconstruction data being encoded.

In accordance with further embodiments, note that prior to encoding, the signal processor can be configured to analyze each set of reconstruction data to produce probability distribution information indicating a probability distribution of some or all symbols in the

CLAIMS

1. A method of encoding a signal in a hierarchy including multiple levels of quality, the method comprising:

producing a rendition of the signal at a first level of quality;

generating at least one set of reconstruction data, the at least one set of reconstruction data specifying how to reconstruct, based on the rendition of the signal at the first level of quality and/or on available reference signals, a rendition of the signal at a second level of quality in the hierarchy, the second level of quality higher than the first level of quality; and

utilizing an entropy encoder to encode different sets of reconstruction data, the entropy encoder producing for each set an encoded value or bit string representative of symbols contained in the reconstruction data, by:

analyzing each set of reconstruction data to produce one or more decoding parameters with probability distribution information, the probability distribution information indicating a probability of at least one symbol in an alphabet of symbols used by that set of reconstruction data; and

storing the encoded value or bit string and the probability distribution information for subsequent decoding of the encoded value or bit string back into the reconstruction data.

2. The method as in claim 1 further comprising:

implementing an entropy decoder to decode, for each set of reconstruction data, the encoded value or bit string and the probability distribution information into the reconstruction data; and

utilizing the sets of reconstruction data produced by the decoder to reconstruct, based on the rendition of the signal at the first level of quality and/or on available reference signals, the rendition of the signal at the second level of quality.

3. The method as in claim 1, wherein one of the sets of reconstruction data includes residual data indicating adjustments to be made after upsampling the rendition of signal at the first level of quality into the rendition of signal at the second level of quality; and

wherein utilizing the entropy encoder includes producing at least one decoding parameter

to be used by a respective entropy decoder to extrapolate a probability distribution for multiple symbols in the residual data.

4. The method as in claim 1, wherein the at least one decoding parameter includes a first parameter and additional parameters, the first parameter specifying a percentage of elements in the reconstruction data that are assigned a first symbol, the additional parameters indicating probabilities of multiple additional symbols in the reconstruction data.

5. The method as in claim 1, wherein the at least one decoding parameter includes a first parameter and a second parameter, the first parameter specifying a percentage of elements in the reconstruction data that are assigned a first symbol, the second parameter indicating to the decoder how to extrapolate probability distribution values for multiple other symbols in the reconstruction data.

6. The method as in claim 1, wherein the at least one decoding parameter includes only a single parameter indicating a probability for a first symbol in the reconstruction data, the entropy decoder extrapolating a probability distribution for multiple other symbols based on a predetermined set of standard parameters known to an entropy decoder that converts the encoded value or bit string back into the reconstruction data.

7. The method as in claims 1, wherein for one or more sets of reconstruction data utilizing the entropy encoder includes:

parsing each set of reconstruction data into multiple groupings of reconstruction data;

utilizing the entropy encoder to produce respective probability distribution information for the symbols present in each of the multiple groupings; and

utilizing the entropy encoder to encode the multiple groupings of each set of reconstruction data into encoded values or bit strings based on the respective probability distribution information for the groupings.

8. The method as in claim 7, wherein each of the multiple groupings of reconstruction data is a tile of residual data elements relative to a specific portion of the signal, each of the residual data elements indicating an adjustment to be made to a corresponding element of the signal after upsampling of the signal from the first level of quality to the second level of quality, the method further comprising:

initiating parallel execution of multiple entropy decoders to reproduce the multiple groupings of reconstruction data using, for each grouping, the specific encoded values or bit strings and probability distribution values.

9. The method as in claim 1, wherein the reconstruction data is a first array of sets of reconstruction data, the method further comprising:

generating a second array of sets of reconstruction data, the second array of sets of reconstruction data specifying how to reconstruct, based on the rendition of the signal at the second level of quality, a rendition of the signal at a third level of quality in the hierarchy, the third level of quality higher than the second level of quality; and

analyzing each set of reconstruction data of the second array to produce one or more decoding parameters based on probability distribution information, the probability distribution information indicating a probability of at least one symbol in an alphabet of symbols used by that set of reconstruction data; and

utilizing the entropy encoder to encode the second array of sets of reconstruction data, the entropy encoder producing for each set of reconstruction data an encoded value or bit string representative of the data based on the probability distribution information produced for that set.

10. The method as in claim 1, wherein the reconstruction data is a first array of sets of reconstruction data, the method further comprising:

generating a second array of sets of reconstruction data, the second array of sets of reconstruction data specifying how to reconstruct, based on the rendition of the signal at the second level of quality and/or on available reference signals, a rendition of the signal at a third level of quality in the hierarchy, the third level of quality being higher than the second level of quality; and

utilizing the entropy encoder to encode the second array of sets of reconstruction data, the entropy encoder producing for each set of reconstruction data an encoded value or bit string representative of the data based on the probability distribution information of the corresponding set of data in the first array of sets of reconstruction data.

11. The method as in claim 1, wherein the reconstruction data is a first array of sets of reconstruction data, the method further comprising:

receiving encoded values or bit strings for a second array of sets of reconstruction data, the array of sets of reconstruction data indicating how to reconstruct, based on the rendition of the signal at the second level of quality and/or on available reference signals, a rendition of the signal at a third level of quality, the third level of quality being higher than the second level of quality;

receiving decoding parameters and identifying probability distributions for symbols in each set of reconstruction data of the second array; and

utilizing the identified probability distributions to decode the encoded values or bit strings for the second array of sets of reconstruction data into the second array of sets of reconstruction data.

12. The method as in claim 11 further comprising:

receiving the encoded values or bit strings representative of the second array of sets of reconstruction data; and

for each set of reconstruction data, in response to detecting that the entropy encoder did not send probability distribution information for one or more sets of data or that the entropy encoder previously specified that it would not send probability distribution parameters for one or more sets of data, utilizing the probability distribution information decoded for the corresponding set(s) in the first array of reconstruction data to entropy decode the encoded value or bit string representative of the set of data.

13. The method as in claim 2 further comprising:

receiving the encoded value or bit string for each set of reconstruction data; and

in response to detecting that the entropy encoder did not send specific information on the probability distribution of symbols in that set of reconstruction data, utilizing a default probability distribution value for symbols to decode the encoded value or bit string into the reconstruction data.

14. The method as in claim 1 further comprising:

parsing one or more sets of reconstruction data into multiple groupings including at least a first grouping of reconstruction data and a second grouping of reconstruction data;

populating the first grouping of reconstruction data so that all elements of the generated set of reconstruction data having a value/symbol that falls within a first range of

values/symbols maintain their value/symbol, while all other elements are set to a default value/symbol;

populating the second grouping of reconstruction data so that all elements of the generated set of reconstruction data having a value/symbol that falls within a second range of values/symbols maintain their value/symbol, while all other elements are set to a default value/symbol; and

populating the additional groupings according to the same method, according to additional ranges of values/symbols; and

wherein utilizing the entropy encoder for such sets further comprises individually entropy encoding the first grouping of reconstruction data, the second grouping of reconstruction data and any other additional grouping of reconstruction data.

15. The method as in claim 14, wherein individually entropy encoding further comprises:

for the first grouping:

analyzing the first grouping of reconstruction data to produce one or more decoding parameters with probability distribution information, the probability distribution information indicating a probability distribution of the symbols in the alphabet used by the first grouping; and

utilizing the entropy encoder to produce a first encoded value or bit string based on the first probability distribution information, the first encoded value or bit string representative of the first grouping of reconstruction data;

for the second grouping:

analyzing the second grouping of reconstruction data to produce one or more decoding parameters with probability distribution information, the probability distribution information indicating a probability distribution of the symbols in the alphabet used by the second grouping; and

utilizing the entropy encoder to produce a second encoded value or bit string based on the second probability distribution information, the second encoded value or bit string representative of the second grouping of reconstruction data; for any other additional grouping:

analyzing the specific grouping of reconstruction data to produce one or more decoding parameters with probability distribution information, the probability distribution information indicating a probability distribution of the symbols in the alphabet used by the specific grouping; and

utilizing the entropy encoder to produce an encoded value or bit string for the grouping based on the respective probability distribution information, the encoded value or bit string representative of the specific grouping of reconstruction data.

16. The method as in claim 15 further comprising:

for specific sets of reconstruction data, in response to occurrence of an impediment preventing timely entropy decoding of all of the groupings of reconstruction data, initiating entropy decoding of only some of the encoded values or bit strings into the respective groupings of reconstruction data, said entropy decoding of each grouping of reconstruction data based on the respective decoding parameters indicating probability distribution information; and

utilizing, along with the other sets of reconstruction data already decoded, the entropy decoded groupings of reconstruction data to reconstruct, based on the rendition of the signal at the first level of quality and/or on available reference signals, the second level of quality.

17. The method as in claim 15 further comprising:

for specific sets of reconstruction data, in response to specific needs or to occurrence of an impediment preventing timely entropy encoding or to unavailability of the necessary information bandwidth for the transmission of all of the groupings of reconstruction data, transmission to the decoder of only some of the encoded values or bit strings corresponding to the respective groupings of reconstruction data, along with any decoding parameters indicating probability distribution information.

18. The method as in claim 1 further comprising:

generating residual data to reconstruct the signal at a given level of quality in the hierarchy; and

estimating, based on an entropy metric, the number of bits required to entropy encode the residual data; and

applying a quantizer to the residual data to reduce an entropy of the residual data at the given level of quality prior to the entropy encoding, application of the quantizer to the residual data facilitating transmission of the encoded residual data in accordance with a desired bit rate.

19. The method as in claim 1 further comprising:

calculating a probability distribution of symbols in residual data used to make adjustments to the signal at multiple levels of quality in the hierarchy;

utilizing the probability distribution to estimate a bit rate of entropy encoding the residual data based on a first quantizer setting;

in response to detecting that the estimated bit rate is above a desired threshold value, applying additional quantization to the residual data to reduce an entropy associated with the residual data; and

utilizing the entropy encoder to encode the quantized residual data.

20. The method as in claim 1, wherein the entropy encoder is a range encoder.

21. Computer-readable storage hardware having instructions stored thereon, the instructions, when carried out by a processing device, causing the processing device to perform operations of:

producing a rendition of the signal at a first level of quality;

generating at least one set of reconstruction data, the at least one set of reconstruction data specifying how to reconstruct, based on the rendition of the signal at the first level of quality and/or on available reference signals, a rendition of the signal at a second level of quality in the hierarchy, the second level of quality higher than the first level of quality; and

utilizing an entropy encoder to encode different sets of reconstruction data, the entropy encoder producing for each set an encoded value or bit string representative of symbols contained in the reconstruction data, by:

analyzing each set of reconstruction data to produce one or more decoding parameters with probability distribution information, the probability distribution information indicating a probability of at least one symbol in an alphabet of symbols used by that set of reconstruction data; and

storing the encoded value or bit string and the probability distribution information for subsequent decoding of the encoded value or bit string back into the reconstruction data.

22. A computer system comprising:

a processor;

a memory unit that stores instructions associated with an application executed by the processor; and

an interconnect coupling the processor and the memory unit, enabling the computer system to execute the application and perform operations of:

producing a rendition of the signal at a first level of quality;

generating at least one set of reconstruction data, the at least one set of reconstruction data specifying how to reconstruct, based on the rendition of the signal at the first level of quality, a rendition of the signal at a second level of quality in the hierarchy, the second level of quality higher than the first level of quality; and

utilizing an entropy encoder to encode different sets of reconstruction data, the entropy encoder producing for each set an encoded value or bit string representative of symbols contained in the reconstruction data, by:

analyzing each set of reconstruction data to produce one or more decoding parameters with probability distribution information, the probability distribution information indicating a probability of at least one symbol in an alphabet of symbols used by that set of reconstruction data; and

storing the encoded value or bit string and the probability distribution information for subsequent decoding of the encoded value or bit string back into the reconstruction data.

CLAIMS

1. A method of encoding a signal in a hierarchy including multiple levels of quality, the multiple levels of quality including a first level of quality and a second level of quality, the method comprising:

processing a rendition of the signal at the second level of quality, the second level of quality higher than the first level of quality;

producing a rendition of the signal at the first level of quality;

generating reconstruction data, the reconstruction data specifying how to reconstruct, based on the rendition of the signal at the first level of quality, the rendition of the signal at the second level of quality in the hierarchy; and

utilizing an entropy encoder to encode the reconstruction data, the entropy encoder producing an encoded value representative of symbols in the reconstruction data; wherein utilizing the entropy encoder further includes:

analyzing the reconstruction data to produce decoding information, the decoding information including probability distribution information indicating a probability of the symbols in the reconstruction data; and

storing the encoded value and the probability distribution information for subsequent decoding of the encoded value back into the reconstruction data.

2. The method as in claim 1,

wherein the reconstruction data includes multiple different sets of reconstruction data, each of the multiple different sets of reconstruction data individually encoded with respect to each other and specifying how to reconstruct a rendition of the signal at the second level of quality based on a rendition of the signal at the first level of quality, each of the multiple different sets of reconstruction data supporting different corresponding sub-levels of quality.

3. The method as in claim 1, wherein the reconstruction data includes multiple sets of reconstruction data:

wherein one of the sets of reconstruction data includes residual data indicating adjustments to be made after upsampling the rendition of signal at the first level of quality to the second level of quality; and

wherein utilizing the entropy encoder includes producing a decoding parameter to be used by a respective entropy decoder to extrapolate a probability distribution for multiple symbols in the residual data.

4. The method as in claim 1, wherein the decoding information includes a first parameter and additional parameters, the first parameter specifying a percentage of elements in the reconstruction data that are assigned a first symbol, the additional parameters indicating probabilities of multiple additional symbols in the reconstruction data.

5. The method as in claim 1, wherein the decoding information includes a first parameter and a second parameter, the first parameter specifying a percentage of elements in the reconstruction data that are assigned a first symbol, the second parameter indicating to the decoder how to extrapolate probability distribution values for multiple symbols other than the first symbol in the reconstruction data.

6. The method as in claim 1, wherein the decoding information includes only a single parameter indicating a probability for a first symbol in the reconstruction data, the entropy decoder extrapolating a probability distribution for multiple symbols other than the first symbol based on a predetermined set of standard parameters known to an entropy decoder that converts the encoded value back into the reconstruction data.

7. The method as in claim 1 further comprising:

parsing the reconstruction data into multiple groupings of reconstruction data;

utilizing the entropy encoder to produce respective probability distribution information for symbols present in each of the multiple groupings; and

utilizing the entropy encoder to encode the multiple groupings of reconstruction data into encoded values based on respective probability distribution information for the groupings.

8. The method as in claim 7, wherein each of the multiple groupings of reconstruction data correspond to a tile of residual data elements relative to a specific portion of the signal, each of the residual data elements indicating an adjustment to be made to a corresponding element of the signal after upsampling of the signal from the first level of quality to the second level of quality, the method further comprising:

initiating parallel execution of multiple entropy decoders to decode the multiple groupings of reconstruction data using, for each grouping, specific encoded values and probability distribution values.

9. The method as in claim 1, wherein the reconstruction data includes a first array of sets of reconstruction data, the method further comprising:

generating a second array of sets of reconstruction data, the second array of sets of reconstruction data specifying how to reconstruct, based on the rendition of the signal at the second level of quality, a rendition of the signal at a third level of quality in the hierarchy, the third level of quality higher in the hierarchy than the second level of quality; and

analyzing each set of reconstruction data of the second array to produce decoding parameters based on probability distribution information, the probability distribution information indicating a probability of a symbol used by that set of reconstruction data; and

utilizing the entropy encoder to encode the second array of sets of reconstruction data, the entropy encoder producing for each respective set of reconstruction data in the second array an encoded value representative of data based on probability distribution information produced for the respective set.

10. The method as in claim 1, wherein the reconstruction data includes a first array of sets of reconstruction data, the method further comprising:

generating a second array of sets of reconstruction data, the second array of sets of reconstruction data specifying how to reconstruct, based on the rendition of the signal at the second level of quality, a rendition of the signal at a third level of quality in the hierarchy, the third level of quality being higher than the second level of quality; and

utilizing the entropy encoder to encode the second array of sets of reconstruction data, the entropy encoder producing for each set of reconstruction data in the second array an encoded value representative of data based on probability distribution information of a corresponding set of data in the second array.

11. The method as in claim 1 further comprising:

parsing the reconstruction data into multiple groupings including at least a first grouping of reconstruction data and a second grouping of reconstruction data;

populating the first grouping of reconstruction data so that elements associated with the first grouping of reconstruction data having a value that falls within a first range are set to a default value;

populating the second grouping of reconstruction data so that elements associated with the second grouping having a value that falls within a second range are set to a default value; and

wherein utilizing the entropy encoder further comprises individually entropy encoding the first grouping of reconstruction data and the second grouping of reconstruction data.

12. The method as in claim 11, wherein individually entropy encoding further comprises:

for the first grouping:

analyzing the first grouping of reconstruction data to produce decoding parameters with first probability distribution information, the first probability distribution information indicating a probability distribution of symbols used by the first grouping; and

utilizing the entropy encoder to produce a first encoded value based on first probability distribution information, the first encoded value representative of the first grouping of reconstruction data;

for the second grouping:

analyzing the second grouping of reconstruction data to produce decoding parameters with second probability distribution information, the second probability distribution information indicating a probability distribution of symbols in the the second grouping; and

utilizing the entropy encoder to produce a second encoded value based on the second probability distribution information, the second encoded value representative of the second grouping of reconstruction data.

13. The method as in claim 12 further comprising:

for specific sets of reconstruction data, in response to occurrence of an impediment preventing timely entropy decoding of all of the groupings of reconstruction data, initiating entropy decoding of only some encoded values into respective groupings of reconstruction data, said entropy decoding of each grouping of reconstruction data based on respective decoding parameters indicating probability distribution information; and

utilizing, along with other sets of reconstruction data already decoded, entropy decoded groupings of reconstruction data to reconstruct, based on the rendition of the signal at the first level of quality, the rendition of the signal at the second level of quality.

14. The method as in claim 12 further comprising:

for specific sets of reconstruction data, in response to occurrence of an impediment preventing timely entropy encoding, initiating transmission to the decoder of only some of the encoded values corresponding to the respective groupings of reconstruction data, along with any decoding parameters indicating probability distribution information.

15. The method as in claim 1 further comprising:

generating residual data to reconstruct the signal at a given level of quality in the hierarchy; and

estimating, based on an entropy metric, a number of bits required to entropy encode the residual data; and

applying a quantizer to the residual data to reduce an entropy of the residual data at the given level of quality prior to entropy encoding, application of the quantizer to the residual data facilitating transmission of the encoded residual data in accordance with a desired bit rate.

16. The method as in claim 1 further comprising:

calculating a probability distribution of symbols in residual data used to make adjustments to the signal at multiple levels of quality in the hierarchy;

utilizing the probability distribution to estimate a bit rate of entropy encoding the residual data based on a first quantizer setting;

in response to detecting that the estimated bit rate is above a desired threshold value, applying additional quantization to the residual data to reduce an entropy associated with the residual data; and

utilizing the entropy encoder to encode the quantized residual data.

17. The method as in claim 1, wherein the entropy encoder is a range encoder.

18. The method as in claim 1, wherein producing the rendition of the signal at the first level of quality includes:

downsampling the rendition of the signal at the second level of quality to produce the rendition of the signal at the first level of quality, the rendition of the signal at the first level of quality being a downsampled rendition of the signal at the second level of quality.

19. The method as in claim 1, wherein the signal specifies settings of display elements in an image, the rendition of the signal at the second level of quality including a larger field of display elements than the rendition of the signal at the first level of quality.

20. The method as in claim 1, wherein the signal specifies settings of display elements in a volumetric image, the rendition of the signal at the second level of quality including a larger field of display elements than the rendition of the signal at the first level of quality.

21. The method as in claim 1, wherein generating the reconstruction data includes:

producing the reconstruction data to indicate how to upsample the rendition of the signal at the first level of quality to the rendition of the signal at the second level of quality.

22. A method of decoding at multiple levels of quality in a hierarchy, the multiple method of decoding at multiple levels of quality in a hierarchy, the multiple levels of quality including a first level of quality and a second level of quality, the method comprising:

producing a rendition of a signal at the first level of quality;

receiving encoded reconstruction data indicating how to reconstruct the rendition of the signal at the first level of quality into a rendition of the signal at the second level of quality, the second level of quality higher than the first level of quality in the hierarchy;

utilizing an entropy decoder to retrieve probability distribution information and a value stored in the encoded reconstruction data;

via the decoder, utilizing the probability distribution information to decode the value into decoded reconstruction data; and

utilizing the decoded reconstruction data produced by the decoder to reconstruct, based on the rendition of the signal at the first level of quality, the rendition of the signal at the second level of quality.

23. The method as in claim 22, wherein the encoded reconstruction data includes a first array of sets of reconstruction data, the method further comprising:

receiving encoded values for a second array of sets of reconstruction data, the second array of sets of reconstruction data indicating how to reconstruct, based on the rendition of the signal at the second level of quality, a rendition of the signal at a third level of quality in the hierarchy, the third level of quality being higher than the second level of quality;

receiving decoding parameters and identifying probability distributions for symbols in each set of reconstruction data of the second array; and

utilizing the identified probability distributions to decode the encoded values for the second array of sets of reconstruction data.

24. The method as in claim 23 further comprising:

for each set of reconstruction data in the second array, in response to detecting that the entropy encoder did not provide probability distribution information, utilizing the probability distribution information decoded for a corresponding set in the first array of reconstruction data to entropy decode encoded values in the second array of sets of reconstruction data.

25. The method as in claim 22, wherein the encoded reconstruction data includes multiple sets of encoded reconstruction data, the method further comprising:

receiving a respective encoded value for each set of encoded reconstruction data; and

in response to detecting that the entropy encoder did not provide specific information on probability distribution of symbols to decode a respective encoded value in a set of encoded reconstruction data, utilizing a default probability distribution value to decode the respective encoded value.

26. The method as in claim 22, wherein the received encoded reconstruction data includes multiple groupings of reconstruction data, each of the groupings corresponding to a respective tile of residual data elements relative to a specific portion of the signal, each of the residual data elements in the respective tile indicating an adjustment to be made to a

corresponding element of the signal after upsampling the specific portion of the signal from the first level of quality to the second level of quality, the method further comprising:

initiating parallel execution of multiple entropy decoders to independently decode the multiple groupings of reconstruction data.

27. The method as in claim 26, wherein the specific portion of the signal to which the respective tile of residual data pertains is less than all of the signal, the decoder producing the rendition of the signal at the second level of quality for the specific portion of the signal.

28. The method as in claim 22, wherein the reconstruction data includes multiple groupings, each of the multiple groupings of reconstruction data including a set of residual data elements, each set of residual data elements indicating adjustments to be made to corresponding elements of the signal after upsampling of the corresponding elements of the signal from the first level of quality to the second level of quality, each of the multiple groupings supporting a different sub-level of reconstruction quality to reconstruct the rendition of the signal from the first level of quality to the rendition of the signal at the second level of quality.

29. The method as in claim 28, wherein the multiple groupings of reconstruction data includes a first grouping of reconstruction data and a second grouping of reconstruction data, the first grouping of reconstruction data supporting a first sub-level of quality of reconstructing the second rendition of the signal from the first rendition of the signal, the second grouping of reconstruction data supporting a second sub-level of quality of reconstructing the second rendition of the signal from the first rendition of the signal, the first sub-level of quality being higher than the second sub-level of quality.

30. The method as in claim 22, wherein the decoded reconstruction data includes multiple sets of decoded reconstruction data, each of the multiple sets supporting reconstruction of

the rendition of the signal at the second level of quality based on the rendition of the signal at the first level of quality;

wherein parameters used to entropy decode each of the multiple sets of reconstruction data are independent with respect to each other; and

wherein the entropy decoder utilizes a decoding method selected from the group consisting of:

i) range decoding,

ii) run-length decoding,

iii) Huffmann decoding,

iv) table-based Variable Length decoding.

31. The method as in claim 22, wherein producing the rendition of the signal at the first level of quality includes:

receiving a first set of data;

decoding the first set of data; and

utilizing the decoded first set of data to produce the rendition of the signal at the first level of quality; and

wherein producing the rendition of the signal at the second level of quality includes:

receiving a second set of data;

decoding the second set of data, the decoded second set of data including residual data element settings, the residual data element settings indicating adjustments to be made with respect to produce the rendition of the signal at the second level of quality;

upsampling the rendition of the signal at the first level of quality to produce a first rendition of the signal at the second level of quality; and

applying the adjustments as specified by the residual data element settings to the first rendition of the signal at the second level of quality to generate a second rendition of the signal at the second level of quality.

32. The method as in claim 31 further comprising:

utilizing the second rendition of the signal at the second level of quality to upsample and produce a rendition of the signal at a third level of quality, the third level of quality being higher than the second level of quality in the hierarchy.

33. The method as in claim 22, wherein producing the rendition of the signal at the first level of quality includes:

receiving a first set of data;

decoding the first set of data;

utilizing the decoded first set of data to produce a first rendition of the signal at the first level of quality;

receiving a second set of data;

decoding the second set of data into residual data element settings, the residual data element settings in the second set indicating adjustments to produce the rendition of the signal at the first level of quality; and

applying the residual data element settings in the second set to produce the rendition of the signal at the first level of quality; and

wherein producing the rendition of the signal at the second level of quality includes:

receiving a third set of data;

decoding the third set of data, the decoded third set of data including residual data element settings, the residual data element settings in the third set indicating adjustments to produce the rendition of the signal at the second level of quality;

upsampling the rendition of the signal at the first level of quality to produce the rendition of the signal at the second level of quality; and

applying the adjustments as specified by the residual data element settings in the third set to produce the rendition of the signal at the second level of quality.

34. The method as in claim 33, wherein parameters of upsample operations as specified by the third set of data to produce a first portion of the rendition of the signal at the second level of quality are different from parameters of upsampling operations as

specified by the third set of data to produce a second portion of the rendition of the signal at the second level of quality.

35. The method as in claim 22, wherein the encoded reconstruction data specifies operations indicating how to upsample the rendition of the signal at the first level of quality into the rendition of the signal at the second level of quality.

36. The method as in claim 22, wherein the decoded reconstruction data indicates how to upsample the rendition of the signal at the first level of quality to the rendition of the signal at the second level of quality, the method further comprising:

in accordance with the decoded reconstruction data, upsampling the rendition of the signal at the first level of quality to the rendition of the signal at the second level of quality.

37. Computer-readable storage hardware having instructions stored thereon, the instructions, when carried out by a processing device, causing the processing device to perform operations of:

encoding a signal in a hierarchy including multiple levels of quality, the multiple levels of quality including a first level of quality and a second level of quality, the encoding comprising:

processing a rendition of the signal at the second level of quality, the second level of quality higher than the first level of quality in the hierarchy;

producing a rendition of the signal at the first level of quality;

generating reconstruction data, the reconstruction data specifying how to reconstruct, based on the rendition of the signal at the first level of quality, the rendition of the signal at the second level of quality in the hierarchy; and

utilizing an entropy encoder to encode the reconstruction data, the entropy encoder producing an encoded value representative of symbols contained in the reconstruction data;

wherein utilizing the entropy encoder includes:

analyzing the reconstruction data to produce decoding information, the decoding information including probability distribution information indicating a probability of the symbols in the reconstruction data; and

storing the encoded value and the probability distribution information for subsequent decoding of the encoded value back into the reconstruction data.

38. A computer system comprising:

a processor;

a memory unit that stores instructions associated with an application executed by the processor; and

an interconnect coupling the processor and the memory unit, enabling the computer system to execute the application and perform operations of:

encoding a signal in a hierarchy including multiple levels of quality, the multiple levels of quality including a first level of quality and a second level of quality, the encoding comprising:

producing a rendition of the signal at the second level of quality, the second level of quality higher than the first level of quality in the hierarchy;

producing a rendition of the signal at the first level of quality;

generating reconstruction data, the reconstruction data specifying how to reconstruct, based on the rendition of the signal at the first level of quality, the rendition of the signal at the second level of quality in the hierarchy; and

utilizing an entropy encoder to encode the reconstruction data, the entropy encoder producing an encoded value representative of symbols contained in the reconstruction data;

wherein utilizing the entropy encoder includes:

analyzing the reconstruction data to produce decoding information, the decoding information including probability distribution information indicating a probability of the symbols in the reconstruction data; and

storing the encoded value and the probability distribution information for subsequent decoding of the encoded value back into the reconstruction data.