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"Alternating Coding and its Decoder Architectures for Unary-Prefixed Codes"

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ABSTRACT

The entropy coding of high peak, heavy-tailed probability distributions such as the Laplacian, Cauchy, and generalized Gaussian have been a topic of interest because they are able to provide good models for data in many coding systems, especially in image and video coding systems. This thesis studies the entropy coding of such high peak, heavy-tailed probability distributions. By summarizing the encoding of such distributions under the concept "Unary Prefixed Codes" (UPC), the thesis depicts the encoding via a different approach. By extending the concept of UPC, the thesis proposes a universally applicable coding algorithm "Unary Prefixed Huffman" (UPH) that could be applied to both finite and infinite sources. The code set resulting from the UPH algorithm has a coding efficiency which is upper-bounded by entropy + 2 given that the entropy is finite, and is able to provide sub-optimal encoding of the sources studied in the thesis. The thesis also proposes several different variations of UPCs that are simple in structure yet efficient for use for several variations of the high peak, heavy-tailed distributions that are commonly found in image and video coding systems.

By applying the concept of the UPC, the thesis further proposes a coding method named the "Alternating Coding" (ALT) method. The ALT coding provides a coding pattern that is different from the conventional method which enables the extraction of special properties of the UPCs. Using the extraction of the special property of the UPCs, decoding could be greatly simplified and parallel decoding could be a possibility. Moreover, for the highly structured UPCs that are widely used in image and video coding systems, the ALT coding enables an error resiliency mechanism to be applied, which helps to improve the error tolerance of these UPC packets to a significant extent. Simulations and actual application results of the ALT coding are discussed in the thesis.

By applying the ALT coding, the hardware architecture of the decoder changes accordingly. The ALT decoder is different to the conventional variable length decoders that have been applied in the decoding of UPCs, as it is able to utilize the special properties of the UPCs and thus simplify the decoder architecture. As shown in the thesis, the ALT decoders are smaller in size, faster in speed and consume much less power compared to the conventional decoders. This is particularly true for those highly structured UPCs that are commonly used in image and video coding systems. Actual realizations of several ALT decoders are discussed in the thesis, and comparisons are made to the conventional decoders. The improvements are shown to be very evident.