Perceptual Relevance Measure for Generic Shape Coding [*]

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Approximation metric is a significant factor for subjective quality improvement of polygonal vertex-based shape codec. Usually this metric is defined by absolute distance measure (ADM). ADM only considers the shortest absolute distance from candidate vertices on the original object contour segment to corresponding approximating line segment and ignores other visual characteristics of the contour segment. Thus it cannot describe the original contour appropriately in visual aspects. As a result, it may severely degrade the subjective reconstruction quality, especially for contours with sharp salience.

We propose perceptual relevance measure (PRM) to address this problem. We first describe the original relative position relationship between candidate vertex *C* and approximating line segment *AB* by three parameters having definite visual meanings, namely turn angle α and lengths of two adjacent line segments *a* and *b*. And then we provide the following three visual properties to find the exactly expression of PRM.

Commutative Property: *a* and *b* in the expression of PRM can be exchanged;

Linear Scale Property: the value of PRM is proportional to the scale of salience constructed by *a*, *b* and α;

Nonlinear Rotation Property: the value of PRM is increasing but the increment is decelerating as α increases.

Finally, we select the function that can satisfy these properties as simply as possible. The exactly expression of PRM is shown as follows:

$$\text{PRM}(C, AB) = r(a, b, \alpha) = \frac{2ab}{a+b} \sin\left(\frac{\alpha}{2}\right), \quad a, b \in (0, +\infty) \ \text{ and } \ \alpha \in (0, \pi)$$

We then present the relationship between ADM and PRM and show that our proposed measure superiors to the traditional one in visual aspects in theory. Next we embed PRM into both top-down and bottom-up vertex-based shape coding frameworks. For each framework, we embed it into both stages of vertex selection and adjustments. And for vertex adjustments, we introduce it into both class one (maximum) and class two (average) distortion definitions. Thus we show the broad applicability of PRM in practice.

We choose both MPEG-4 sequences and MPEG-7 images for our test. Objective rate-distortion assessment shows that PRM outperforms ADM in almost all cases. And subjective assessment shows that PRM can significantly improve reconstruction quality in visual aspects, especially for contour parts that have sharp corners.

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