# A fast geometric prediction merge mode decision algorithm based on CU gradient for VVC

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To address the problem of large computational redundancy in the geometric prediction merge mode with motion vector refinement (GPM with MMVD), a new decision algorithm based on CU gradient is proposed. By comparing the mean value of the gradient in four directions to determine whether GPM can be terminated early. The advance decision of GPM partition mode can be determined by the calculated gradient direction of CU. Meanwhile, the proposed algorithm saves coding time by reducing the number of candidate modes during the mode selection process.

The proposed algorithm computes the mean value of the gradients of the CU in four directions, horizontal, vertical, 45° and 135°, using the Sobel operator template and arranging them by magnitude, as shown in Equations 1 and 2. If the current image is uniformly smooth, it means that there is almost no difference between pixels. The calculated the mean value of the gradients have small differences in the four directions, satisfying Condition (A) and skipping the GPM prediction process. Otherwise, the GPM prediction process will continue.

$$G_k = \sum_{i=1}^{w} \sum_{j=1}^{h} A \times S_k, \ (k = x, y, 45, 135) \tag{1}$$

$$\overline{G_k} = \sum_{x=0}^{W-1} \sum_{y=0}^{H-1} G_k / (W \times H), \ (k = x, y, 45, 135) \tag{2}$$

$$(\overline{G_{max}} - \overline{G_{min}}) \leq 0.85 * \overline{G_{min}} \qquad \text{Condition (A)}$$

The frequency of GPM usage is mostly chosen in the object texture boundary region and is closely related to the direction of the edge texture. The quantization angle can be considered as the direction of the texture boundary. The gradient direction is perpendicular to the texture boundary direction, so the GPM quantization angle φ can be quantified using the gradient direction to make advance decisions. The 64 GPM partition modes are divided into six sets of candidate pattern according to the quantization angles. By calculating the gradient direction of CU, as shown in Equation 3, the appropriate of GPM candidate pattern sets is selected and the GPM partition modes in the unnecessary candidate pattern sets are skipped. Then RDO is calculated for the partition modes in the selected GPM candidate pattern sets, and the GPM best partition mode with the lowest cost is selected.

$$\theta = \arctan \frac{G_y}{G_x} \tag{3}$$

The proposed algorithm is implemented in the VVC reference software VTM8.0 and tested for each sequence at different QPs (22, 27, 32, 37) under random access (RA) configuration. BD-rate is used to measure the rate distortion performance of the proposed algorithm. Experimental results show that the proposed algorithm can reduce the coding time by 13.5% on average while the BD-rate of Y, U, and V components have only increased by 0.14%, 0.13%, and 0.31% respectively.

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