

# Inverse Transform Using Linearity

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<Reviewer 2>

The authors should accurately address the below comments.

- Introduction Section: This comment still requires a response. The authors should add the main contributions briefly at the end of the introduction.
- Discussion Section: The authors did not respond accurately to this comment. The authors should add a section where they discuss comparing their results with those of existing research. Also, they should clarify the limitations of the proposed method.
- Figures and Tables: All figures and tables are shown before they are used in the text.

We would like to thank the reviewer for the thorough review and very helpful comments. The revised manuscript was reviewed and substantially modified by a native speaker. Ref [31] was removed because the paper was nothing to do with the proposed manuscript.

In answer to the specific comments:

**Comment 1)** Introduction Section: This comment still requires a response. The authors should add the main contributions briefly at the end of the introduction.

**Answer 1)** According to reviewer's comment, we the following sentences at the end of the Introduction.

"In this paper, we analyze the number of multiplications of the existing fast transform methods in the VVC standard, and we propose a new fast inverse transform using the number of non-zero coefficients based on linearity to reduce the number of multiplications."

**Comment 2)** Discussion Section: The authors did not respond accurately to this comment. The authors should add a section where they discuss comparing their results with those of existing research. Also, they should clarify the limitations of the proposed method.

**Answer 2)** According to reviewer's comment, we added Discussion Section.

## 4. Discussion

The previously proposed fast methods were mainly addressed to reduce complexity in the video encoder with the BD-rate loss. In [29], a fast intra mode decision algorithm was

proposed and the result showed the encoding time savings of 51%~53% with BD-rate loss of 0.93%~1.08%. A low-complexity CTU (Coding Tree Unit) partition structure decision and fast intra mode decision were proposed in [30] and showed the average encoding time saving of 63% with the BD-rate loss of 1.93%. The fast encoders for video coding reduce only the encoder complexity but the BD-rates were always increased without decreasing the decoder complexity. However, the proposed fast inverse transform is different from the fast encoders in that it reduces the complexity in both the encoder and decoder while maintaining the BD-rate of the VVC standard. In the RA configuration, the proposed method reduces the average encoding and decoding times by approximately (4, 10) %, respectively, while maintaining average BD-rates.

If the proposed inverse transform using the number of non-zero coefficients is applied to the VVC standard, the inverse transform of the VVC standard should be changed to include the proposed method. This fact can be demerit. However, the proposed method can be considered in the next-generation video coding standards because it achieves decoding run-time saving, while maintaining average BD-rate. In addition to that, the proposed method is more effective in high QP value than in low QP value, because the higher the QP value is, the fewer no-zero coefficients there are.

**Comment 3) Figures and Tables:** All figures and tables are shown before they are used in the text.

**Answer 3)** We cannot find them.