AN EFFICIENT INTRA CODING ALGORITHM BASED ON STATISTICAL LEARNING FOR SCREEN CONTENT CODING

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INTRODUCTION

➢Screen content video (SCV), different from natural video, contains amount of stationary or moving computer graphics, animation and text. HEVC coding tools is inefficient to compress videos with screen content due to these characteristics.

➢HEVC based Screen Content Coding (SCC) is developed to enable significantly improved compression performance for SCV. New coding tools (Intra Block Copy (IBC), Palette mode, Adaptive Color Transform (ACT), etc.) achieve high coding efficiency but impose enormous computation burden on encoders.

➢The screen based applications became more and more popular in recent years, including cloud applications, screen sharing, remote education, etc. Real-time applications need low-latency coding technical. Consequently, fast coding algorithms are desirable for SCC.

HISTORICAL REVIEW

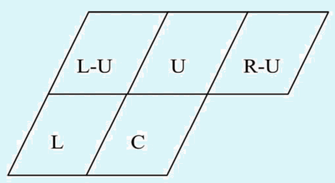
➢The existing fast intra coding algorithms can be categorized into three classical methods: texture based fast intra mode prediction(TBMP), adjacent information based CU size prediction (AI-SP) and machine learning based CU size prediction (ML-SP).

0	0	0
1	0	-1
0	0	0

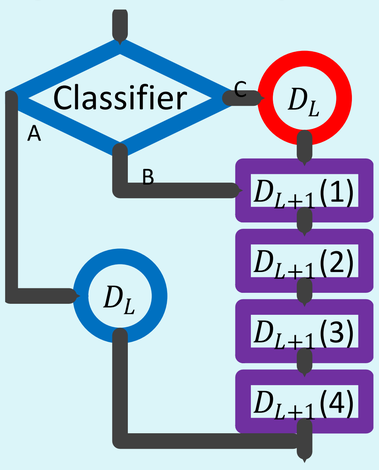
0	1	0
0	0	0
0	-1	0

TBMP uses the main texture direction to reduce the mode candidates used in intra prediction.

AI-SP obtains the depth information or coding information from neighboring blocks [9]. Such information is used to predict current CU depth range or make an early termination decision.



C: current CU *L*: left CU *U*: upper CU
L-U: left upper CU *R-U*: right upper CU



ML-SP uses data mining technical and designs several learning based models to predict the optimal coding parameters. Three-output classifiers are usually used to solve the hard samples as left figure [11] shows.

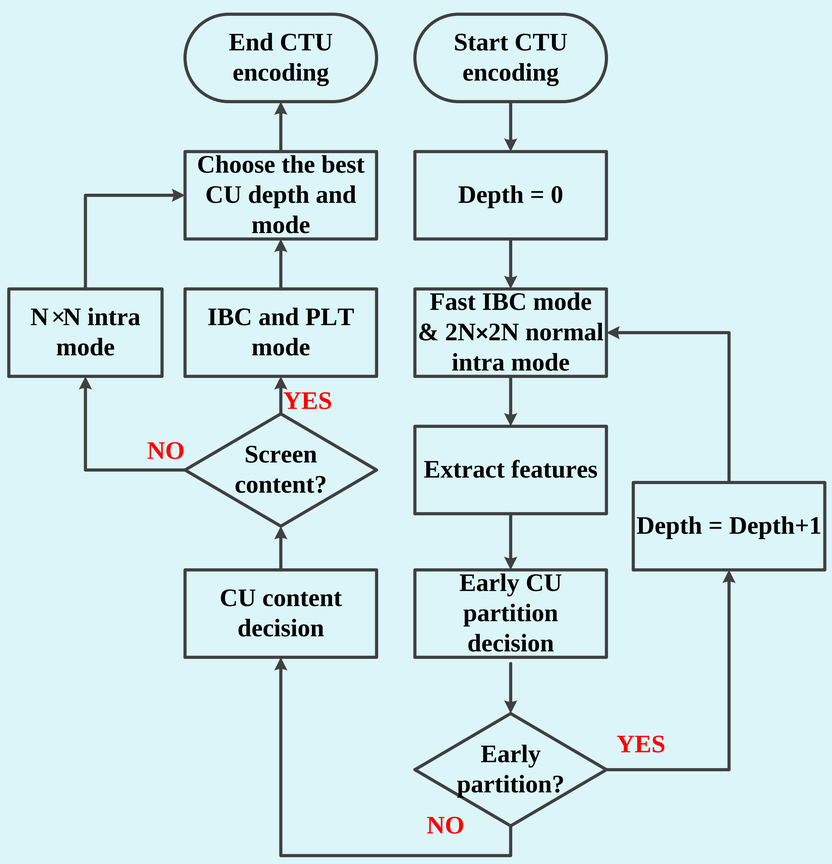
➢These method are proposed for HEVC, which don't consider the characteristics of SCV and can't achieve high complexity reduction in SCC.

OBJECTIVES

➢Take characteristics of SCV to predict the content-type and size of each block.

➢Put forward a more apropos framework to reduce the coding complexity.

THE PROPOSED CODING FRAMEWORK



THE PROPOSED APPROACH

■ FEATURES SELECTION

➢ Statistical information of current CU

- Maximum gradient magnitude (MGM) and variance (VAR) indicate the flatness of current CU;
- Color number (CN) and the number of pixels whose gradient magnitude equals to zero (ZGN) within current CU;
- Minimum difference between the DC values of four sub-CUs (MDSCU) shows local smoothness of current CU.

➢ Coding and context information of current CU

- RD cost (RDC) and coding bits (BIT) have strong correlation with CU partition and mode selection;
- The number of adjust CUs whose depth larger than current CU (SLAPF) and left CU depth (LCUD);
- Whether current best mode is IntraBC after testing 2N×2N intra mode (FIBCF).

■ TRAINING AND TESTING

➢ Database

- Data sources: 4 sequences, including "Map", "Programming", "BasketballScreen" and "Robot", with QP 22, 27, 32, 37 under common test conditions.
- Training strategy: classifiers are trained for each CU size.
- Totally, 28160, 112640, 450560, 1802240 samples are obtained for CU size 64×64, 32×32, 16×16 and 8×8, respectively.
- Database is equally divided into tree parts (training set, testing set and validation set).

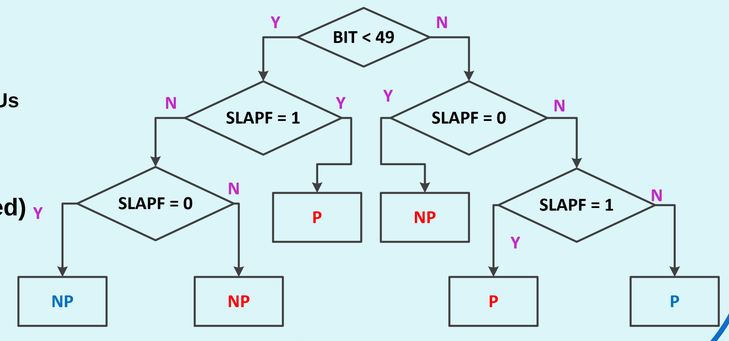
➢ Classifier : Decision Tree (DT)

➢ An example of the trained DT

P : Partition into four equal size sub-CUs

NP: Not Partition and termination

Cross-validation experiments show that several leave nodes (shown in red) don't have sufficient classification accuracy. For the CUs classified into these nodes, full RDO tests are applied to keep the RD performance.



Early CU partition tree of CU 16×16

RESULTS

➢Test conditions

SCC Test Model (HM) reference software version 5.0 is modified for the proposed scheme. The configuration parameters used in the paper is the "Intra, main". Four tested Quantization Parameters (22, 27, 32, and 37) are adopted. One hundred frames of 11 test sequences are used in the test under common test condition.

➢Experiment results

Table I complexity and performance compared to SCM 5.0

Sequence	Resolution	BDBR (%)	TS(%)
Robot	1280×720	1.11	50.00
Programming	1280×720	3.80	44.43
WebBrowing	1280×720	2.49	47.62
SlideShow	1280×720	3.28	70.65
Map	1280×720	2.93	43.83
Desktop	1920×1080	4.53	50.05
MissionControlClip3	1920×1080	1.79	45.04
FlyingGraphics	1920×1080	4.85	41.27
Kimono	1920×1080	0.40	52.40
BasketballScreen	2560×1440	2.92	43.85
MissionControlClip2	2560×1440	1.80	48.66
Average	---	**2.72**	**48.89**

Table II complexity and performance compared to previous works

	BDBR (%)	TS (%)
[12]	3.05	36.7
[19]	2.56	37.2
[20]	0.93	7.04
Proposed	2.72	48.89

CONCLUSIONS

➢This paper introduced an efficient fast intra-coding scheme for screen content coding using machine learning.

➢ The proposed algorithm brings 48.89% encoding time saving with 2.72% BDBR increase compared to author SCM-5.0, which outperms state-of-the-art methods.

REFERENCE

[12] F. Duanmu .etc, Fast CU partition decision using machine learning for screen content compression, in ICIP, Sep. 2015.

[19] Y. Kawakami .etc, Content based mode and depth skipping with Sharp and Directional Edges for intra prediction in Screen Content Coding, in ICASSP, Mar. 2016.

[20] S.-H. Tsang .etc, Fast and efficient intra coding techniques for smooth regions in screen content coding based on boundary prediction samples, in ICASSP, Apr. 2015.