Novel Histogram-Based Scene Change Detection Scheme for x265 – Open-Source Video Encoder

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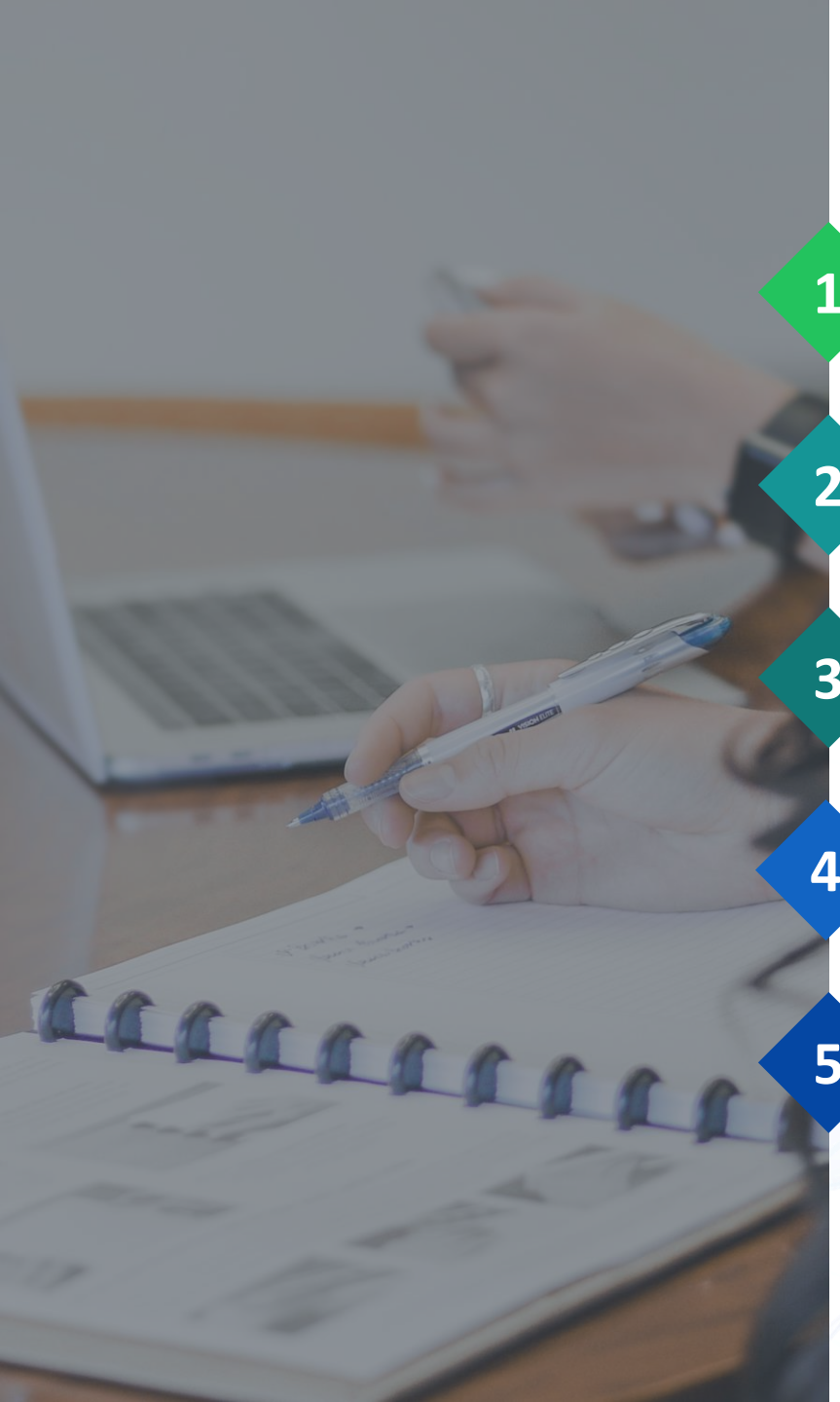
multicoreware



AGENDA

1. **Introduction**
2. **Background**
   x265 : Traditional Scene Change Detection Algorithm
3. **Proposed Novel Histogram Based Scene Change Detection**
4. **Experiments & Results**
5. **Summary & Conclusions**

Introduction

A video codec is a software or hardware that compresses and decompresses digital video.

A device that only compresses is typically called an encoder and the one that only decompresses is a decoder.

The compressed data format usually conforms to a standard video coding format. The compression is typically lossy.

There are complex relationships between the video quality, the bitrate, the complexity of the encoding and decoding algorithms, sensitivity to data losses and errors and end-to-end delay (latency).

The most popular video coding standards used for codecs have been the MPEG standards.

AVC in 2003, HEVC in 2013 and VVC in 2020.

Background

Scene change detection refers to the task of localizing changes and identifying change-categories given two scenes.

A scene change detection may be made prior to slice type decision.

Reliable detection of scene change and gradual transitions (fades, wipes, dissolves) can improve coding efficiency.

Video indexing techniques, which are necessary for video databases, rely on it.

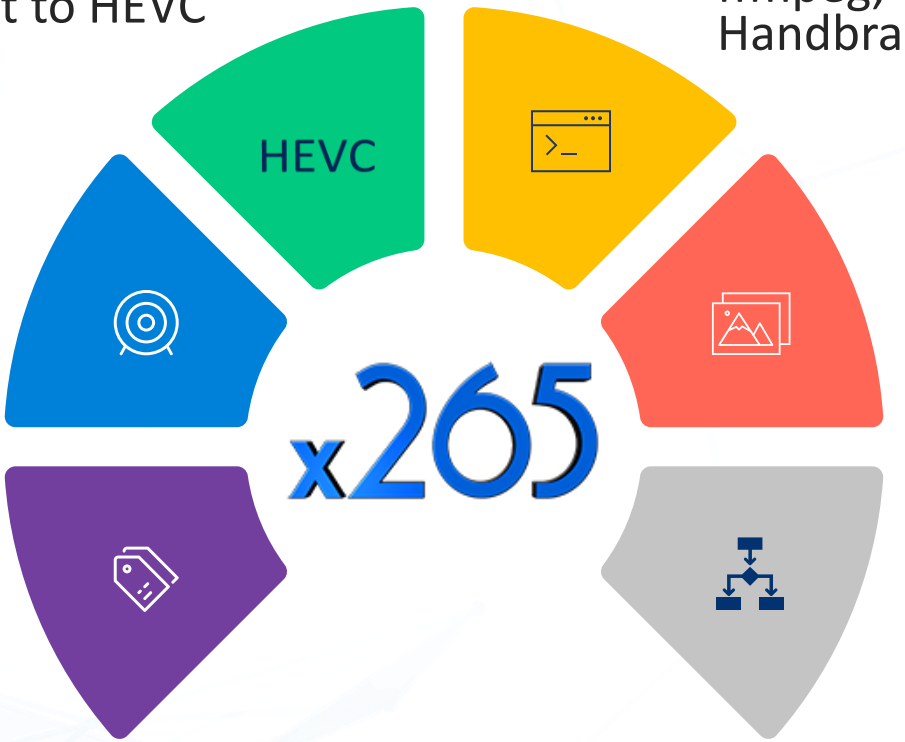
Scene change detection is also necessary for the extraction of high-level semantic features. Moreover, it provides information for video preprocessing and error concealment techniques.

Histogram based scene change detection algorithms uses histogram of current frame to detect scene change.

x265 – Traditional Scene Change Detection Algorithm

x265 – One of the most popular open-source encoders compliant to HEVC standard [3] – [6].

Integrated to many popular open-source frameworks like ffmpeg, GStreamer and Handbrake [9] – [10].



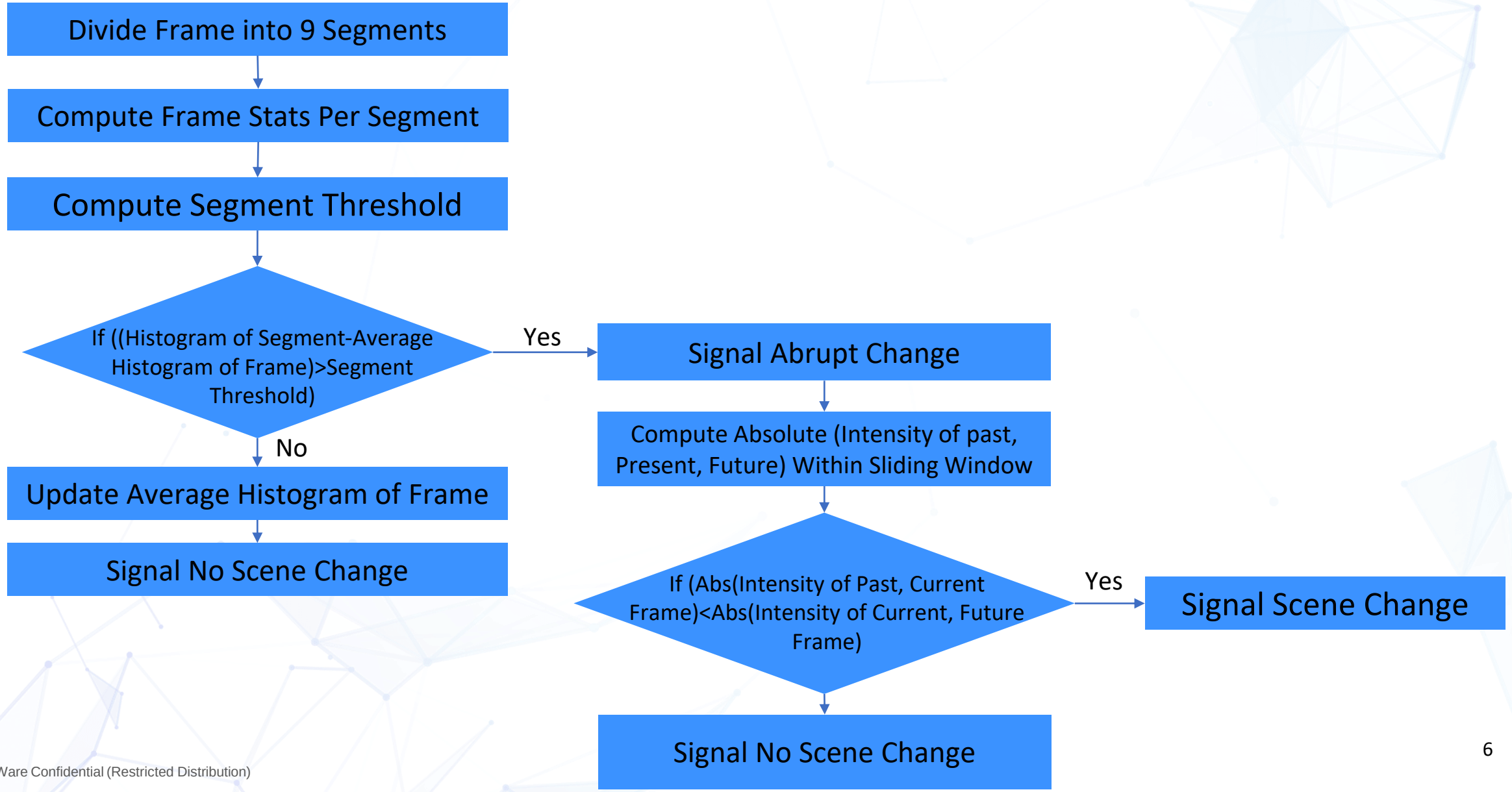
x265 has scene change detection algorithm as a preprocessing to encoding.

In the traditional algorithm SATD cost between frames combined with a threshold value is used to detect scene changes.

Average of the SATD cost for consecutive frames is computed to identify a great fluctuation and avoid false positives.

A decision is made to insert I or P/B picture depending on whether the frame is a complete scene change or a gradual scene transition, respectively.

Proposed Novel Histogram-based Scene Change Detection



Proposed Novel Histogram-based Scene Change Detection

- The proposed histogram-based scene change detection uses histograms, variance and pixel intensity.
- A sliding window of three adjacent frames is employed to determine abrupt scene change & a gradual transition.
- Each frame is divided into several regions, and histograms and pixel intensities are considered for these regions separately.
- Higher the number of regions, higher is the reliability of the algorithm.

Experimental Setup

- Experiments were conducted to compare histogram-based scene change detection algorithm against the traditional algorithm in x265
- 1080p-8bit and 4K-8bit videos tested with CRF values => 24, 25, 26, 27 for medium preset, random access and intra-period = 250 frames to compute BD% values [11]

SAMPLE COMMAND:

Traditional scene-cut detection

```
../x265 –input Samsung_Power_of_Curve.yuv --input-res 1920x1080 --fps 60 --input-depth 8 --input-csp i420
--psnr --ssim --crf 24 –csv Samsung_Power_of_Curve_traditional.csv --csv-log-level 2
--output Samsung_Power_of_Curve_traditional.hevc
```

Histogram based scene-cut detection

```
../x265 --input Samsung_Power_of_Curve.yuv --input-res 1920x1080 --fps 60 --input-depth 8 --input-csp i420
--psnr --ssim --crf 24 --csv Samsung_Power_of_Curve_hist.csv --csv-log-level 2
--output Samsung_Power_of_Curve_hist.hevc --hist-scenecut
```

Experimental Setup

Video Title	Video Resolution	Video FPS	Video Length (sec)
Samsung Power of Curve	1920x1080	60	60
Football	1920x1080	30	33
Combo	1920x1080	25	600
Elephants dream	3840x2160	24	300

Results

x265 encodes comparing histogram-based scene change detection algorithm and traditional scene change detection algorithm against the actual number of scene changes.

Test Sequence	No: of Scene Changes - Actual	No: of Scene Changes - Existing	No: of Scene Changes - Histogram (Proposed)	BD RATE (%) (PSNR)
Samsung Power of Curve	27	6	27	-0.1
Football	18	16	17	-0.1
Combo	164	153	162	-0.4
Elephants dream	49	59	49	-0.5

Results

The proposed algorithm can detect scene change with high reliability and reduced computational complexity.

Video Name	F1 Score [13]				
	Video Resolution	Video FPS	Video Length	Traditional Scene Change	Histogram Scene Change
BBC 01	360x288	25	49min 15 sec	0.83	0.93
RAI 01	960x540	25	9min 41 sec	0.76	0.85

Summary & Conclusions

- Histogram based scene change detection algorithm eliminates false positive and false negatives
- Its compression efficiency is better than traditional scene change detection algorithm
- The precision of novel histogram-based scene change detection algorithm is better than the traditional scene change detection algorithm

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