Efficient Coding of 360-Degree Pseudo-Cylindrical Panoramic Video for Virtual Reality Applications

Ramin et al.,

Nokia Technologies, Tampere, Finland

2016 IEEE International Symposium on Multimedia

Motivation

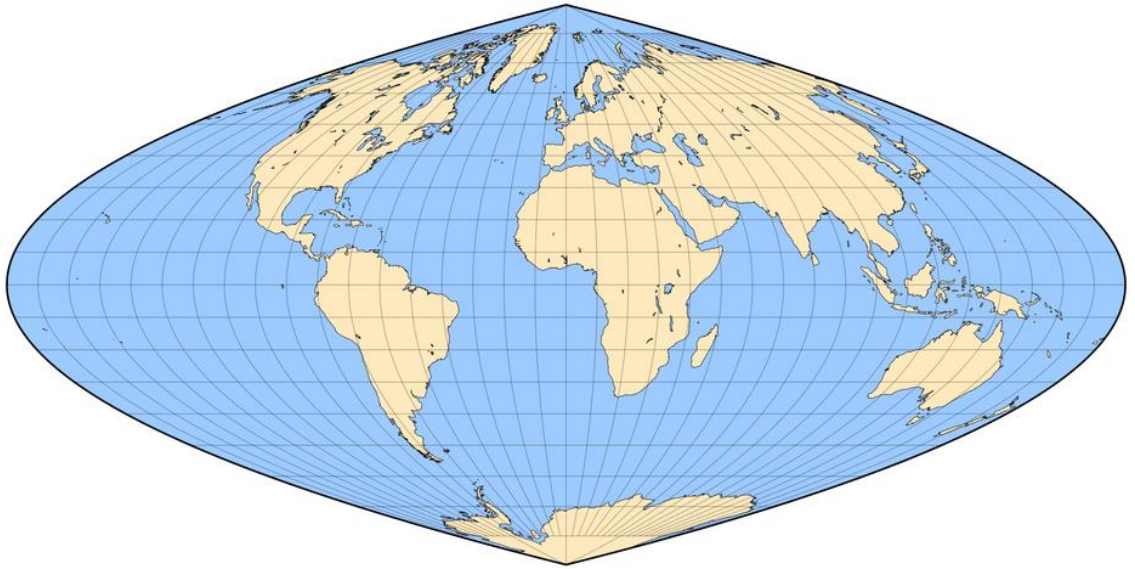
- Polar area stretching in cylindrical projection makes it sub-optimal
- Pseudo-cylindrical projection doesn't fit the video codec well for its non-rectangular boundary

Introduction

- Two methods are proposed to improve the pseudo-cylindrical projection compression performance
- Aim to solve the intra-frame and inter-frame coding problem to make them work along with the video codec

Pseudo-Cylindrical Projection

- Many ways of projection implementation based upon the shape of the meridians, e.g., sinusoidal, elliptical, parabolic… etc.
- Minimize the distortion of polar area and use fewer pixel to present



Problems

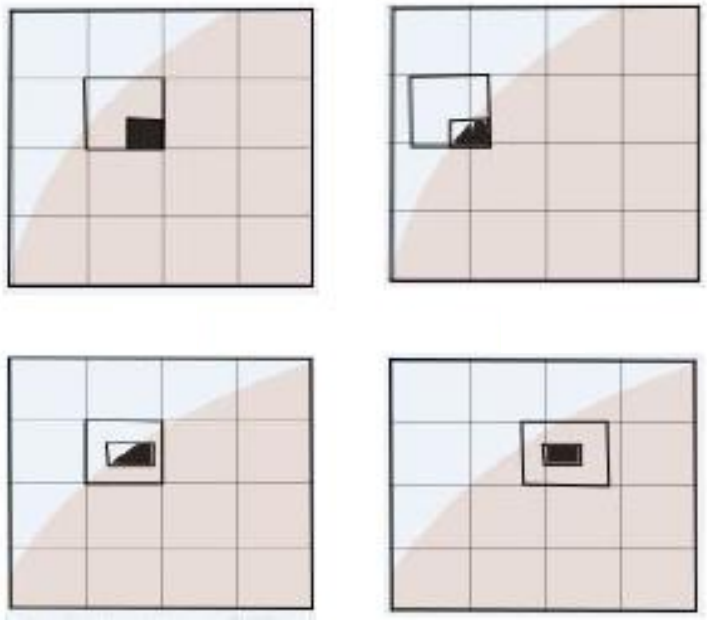
Intra-frame Coding

- Sharp edges in the boundary areas of panoramas create blocks including pixels inside and outside the effective picture area
- They produce high-frequency components after DCT and quantization process
- Cause an increase in bitrate and create visible artifacts after quantization

Problems

Inter-frame Coding

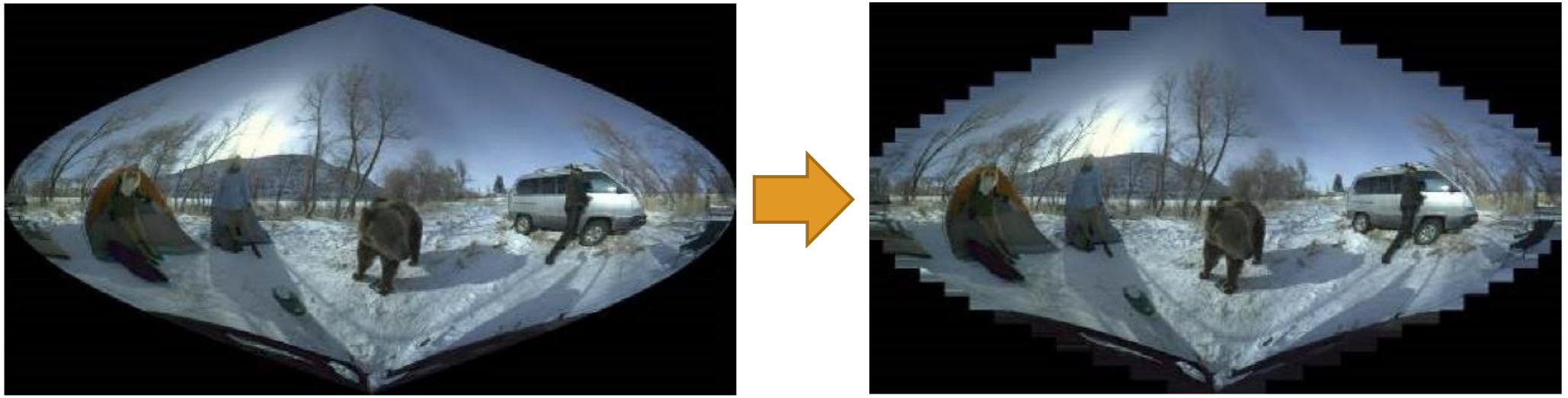
- The mismatch between the reference block and the target block creates error samples and hence incur some extra bitrate.



Solutions

Intra-frame Coding

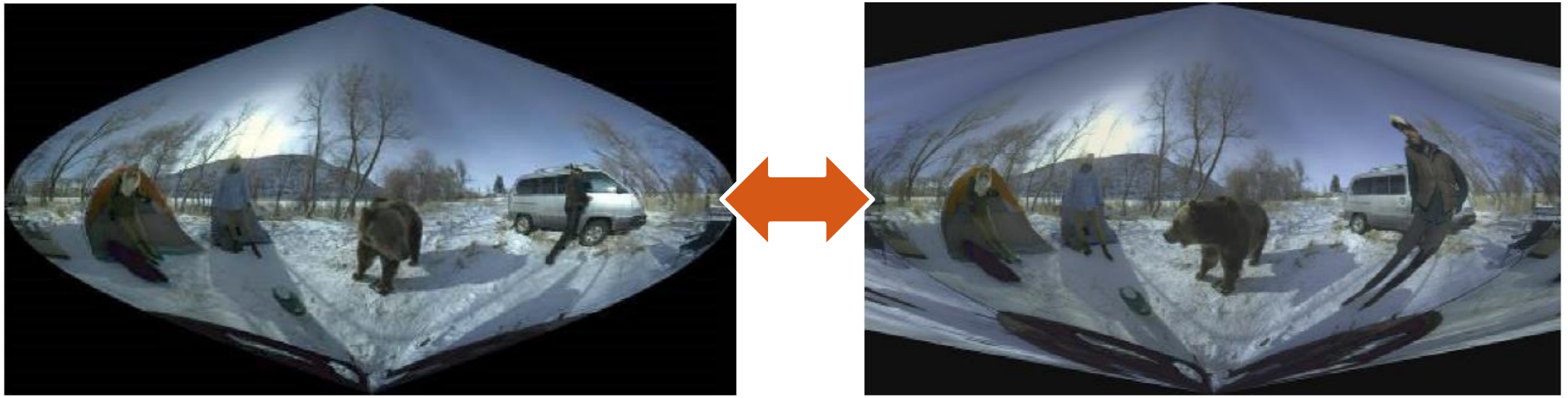
- For each row, the pixel on the border of the effective picture boundary is replicated to the non-effective pixels of the boundary block
- the samples become correlated and the encoder is able to compress these blocks efficiently



Solutions

Inter-frame Coding

- In the reference frames, samples are copied from the opposite-side of the effective picture area to fill the non-effective picture area in each side of the cropped image.



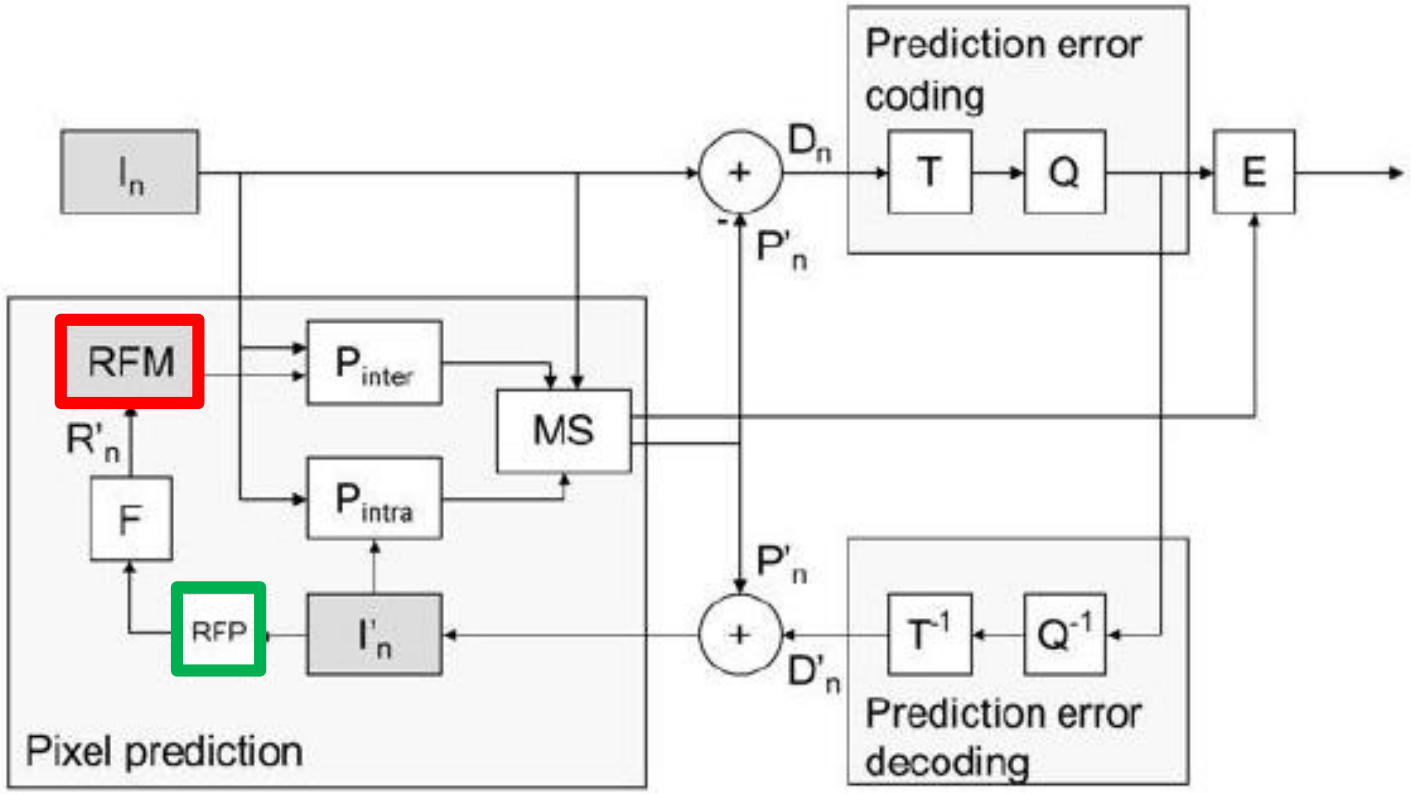
Solutions

Inter-frame Coding

- ***Residual Manipulation***: By replacing the residuals with zero values, the encoder can code these areas with fewer bits
- ***Distortion Calculation***: During the R-D optimization process; the reconstruction error outside the effective picture area should be excluded from the distortion cost in processes such as motion estimation and mode decision
- ***SAO Modification***: SAO process adds huge offset values to the samples outside the effective area in order to compensate the difference with original picture. To avoid the cost, the SAO must be handled or disabled in the encoding side

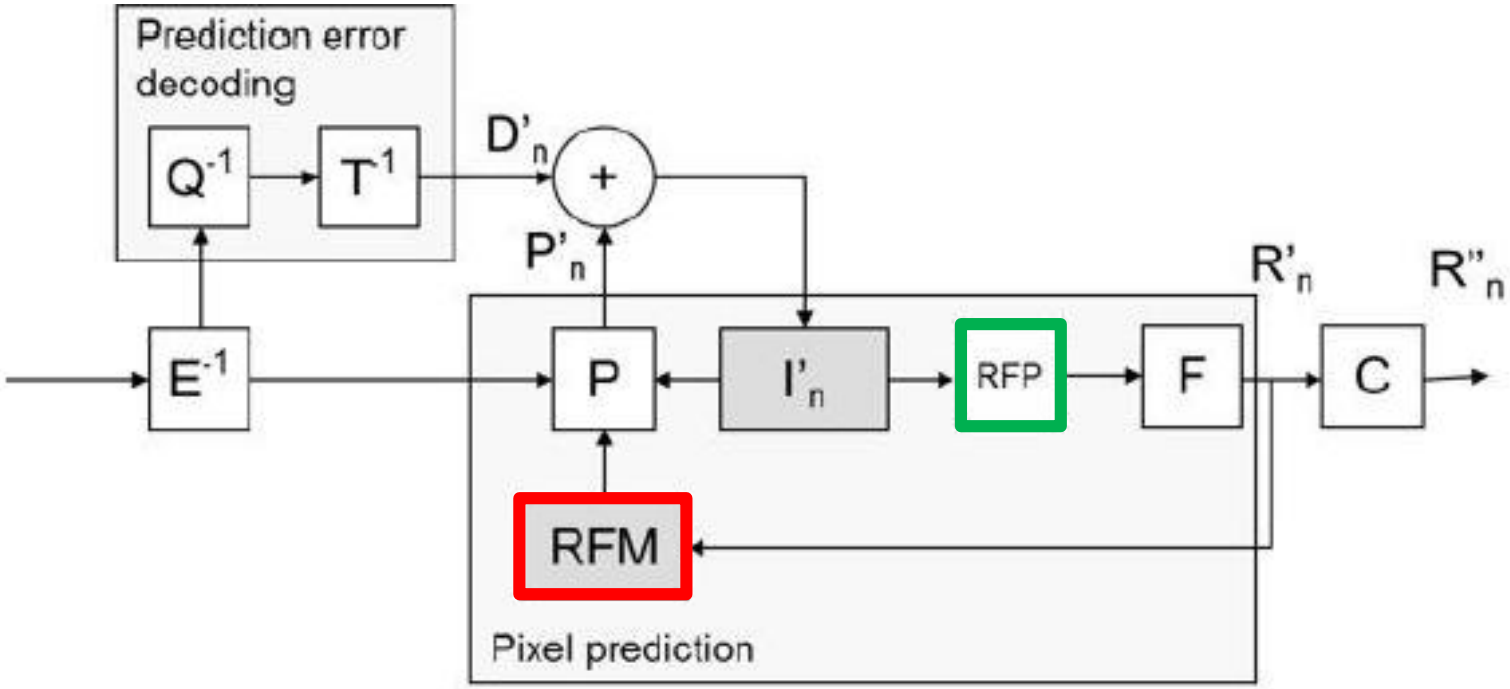
Proposed Structures

Encoder



Proposed Structures

Decoder



Experiment
Results

- Compare BD-BR among 8 panorama sequences with different experiments

TABLE 1. BD-RATE COMPARISON OF USING PROPOSED METHODS RELATIVE TO REFERENCE HEVC

SEQUENCE	INTRA	INTER	TOTAL
LISBOA	-12.76	-6.36	-7.22
SHERIFF	-5.43	-1.69	-3.23
MOSCOW	-4.18	-0.1	-1.33
BEAR ATTACK	-5.26	-1.25	-4.20
VRC CONCERT	-5.80	-1.21	-2.71
DAISY	-16.52	-0.95	-8.80
SHELTER MOV	-5.18	-3.01	-6.23
SHELTER STA	-7.11	-4.72	-7.70
AVERAGE	-7.78	-2.41	-5.18

Experiment

Evaluation

- High bitrate reduction can be reached for the sequences with the following characteristics:
  - uniform texture in the boundaries (improves intra prediction)
  - higher global motion (improves inter prediction)
- The performances are improved compared to the original HEVC

Conclusion

- Simple yet efficient methods are proposed to improve the compression performance of pseudo-cylindrically projected panoramas
- The methods can be easily integrated with the current coding tools

Thanks For Listening

Q&A