m57369
Reference point cloud upsampling for geometry inter prediction

Kyohei Unno, Kohei Matsuzaki, Kei Kawamura

KDDI Corp. (KDDI Research, Inc.)

Copyright(C) 2021 KDDI Research, Inc. All Rights Reserved.

Overview

KDDI Research

■ Problem statement

- In geometry inter prediction, node occupancy is predicted by reference frame.
- Occupancy prediction is sometimes difficult especially when both reference point cloud and current point cloud are sparse.

■ Proposed Methods

- Upsampling is applied to reference point cloud.
- Each point is upsampled according to the direction corresponding to origin.

■ Experimental results

- For lossless, 2.3% geometry bits are reduced.
- For lossy, BD-rates for D1/D2 are -0.8%/-0.8%.

Copyright(C) 2021 KDDI Research, Inc. All Rights Reserved.

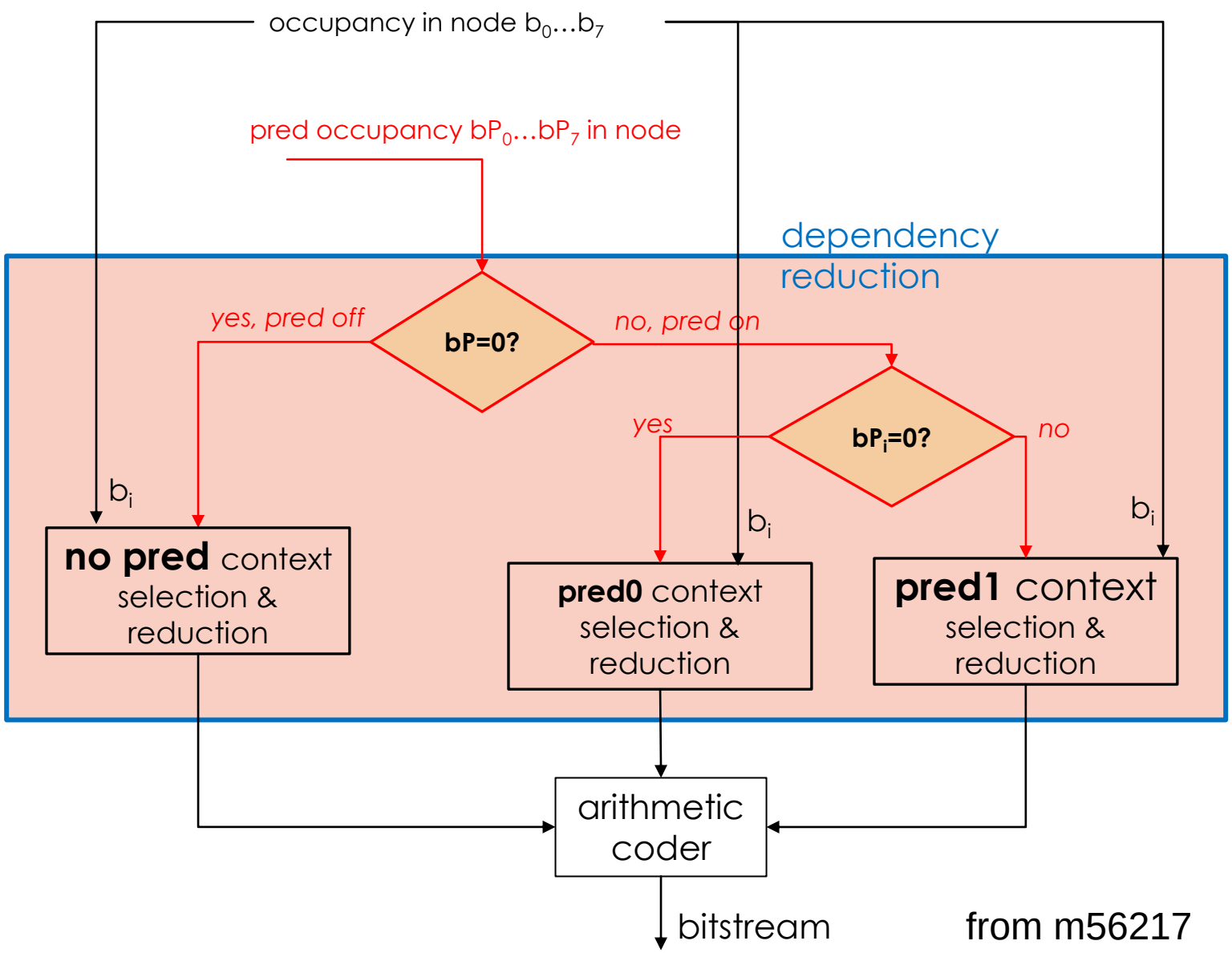
Background

■ Problem statement

- **Three context settings for occupancy coding are switched depending on whether reference points exist.**
- **“no pred” tends to be selected even if actually points exist.**
  - Due to sparsity of (LiDAR) point clouds, geometry noise by acquisition, motion estimation error, etc.

■ Proposal

- **To improve efficiency of the context modeling, reference point cloud is upsampled.**



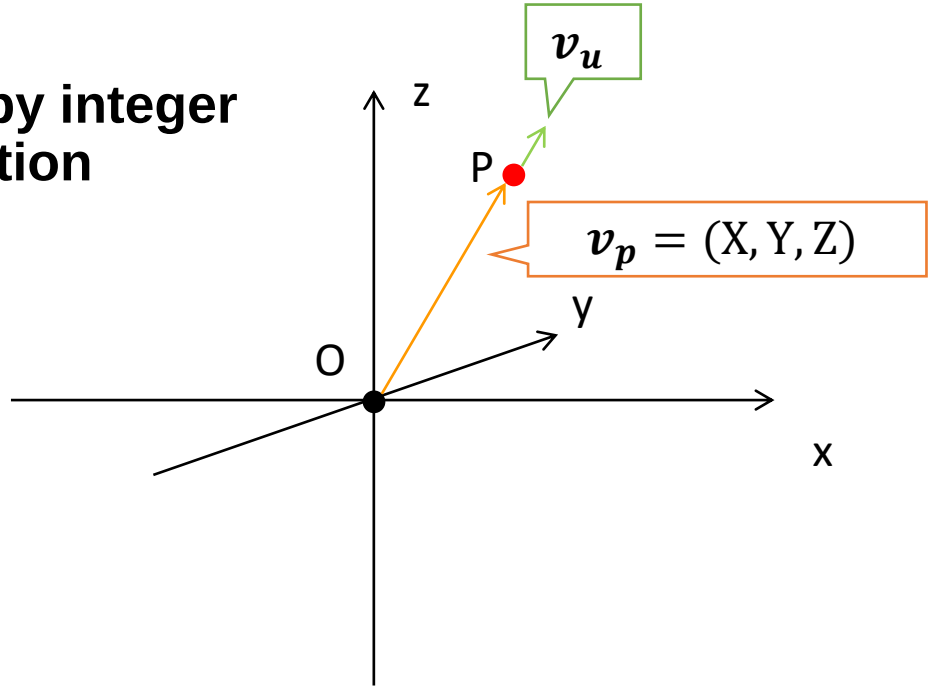
from m56217

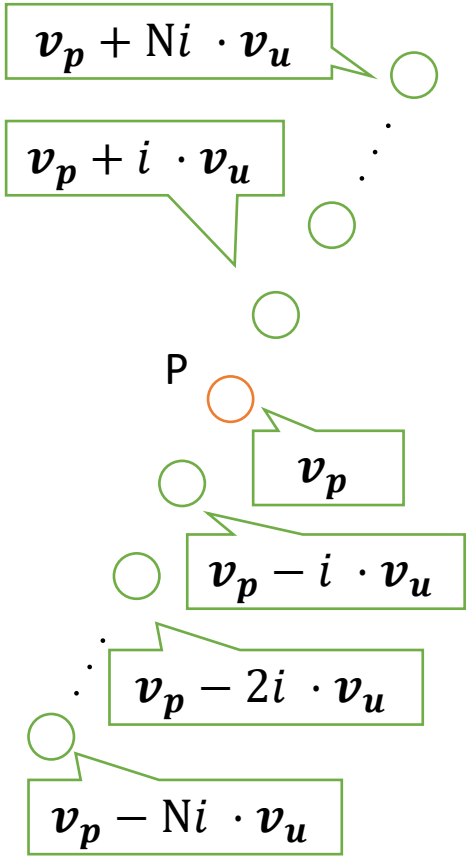
Copyright(C) 2021 KDDI Research, Inc. All Rights Reserved.

Proposed method

- **Each point is upsampled according to the direction corresponding to origin.**
  1. **The unit vector v_u of a reference point v_p is calculated as** $v_u = v_p / \|v_p\|_2$
  2. v_p **is upsampled as** $v_p \pm n \cdot I \cdot v_u$ $(n = 1,2,\ldots,N)$**.**
     - I : the parameter to control the interval of generated points
     - N : the parameter to control the number of generated points ($2N$ points generated)

These process are done by integer operation and approximation (division is not used).





Copyright(C) 2021 KDDI Research, Inc. All Rights Reserved.

Experiments

■ Conditions

- **Anchor : EE13.2 anchor software**
  - Octree base, Only use global motion to objects, global motion is estimated by internal method.
  - Angular OFF, Planar OFF.
- **Test : Anchor + Proposed method**
- **Octree – Predlift (CW/C2 condition, Cat3-frame Sequences)**

■ Parameter settings

- **Settings for lossy rate points are derived based on the parameters for lossless and positionQuantizationScale for each point.**

Parameter	r01	r02	r03	r04	r05	r06	Lossless
positionQuantizationScale (defined by CTC)	1/512	1/256	1/64	1/32	1/8	1/4	1
upsampling interval I	0	0	1	1	1	2	8
number of generated points (div2) N	0	0	1	2	8	8	8

Copyright(C) 2021 KDDI Research, Inc. All Rights Reserved.

Experiments

■ Results

- **For lossless, 2.3% geometry bits are reduced.**
- **For lossy, BD-rates for D1/D2 are -0.8%/-0.8%.**
- **Proposed method has gain for all test sequences and for both lossless and lossy.**
- **Gains for qnxadas sequences are larger than that of ford sequences.**
  - In this results, the proposed parameters (interval/number) are the same for all sequences.
  - Those parameters can be changed for each sequence.
- **Especially decoding runtime is increased.**
  - Upsample process can be simplified to reduce runtime.

Lossless

Sequences	Geometry bpip ratio [%]	Enc Time	Dec Time
ford_01_q1mm	99.1%	122%	183%
ford_02_q1mm	99.2%	123%	182%
ford_03_q1mm	99.2%	122%	186%
qnxadas-junction-approach	95.5%	125%	184%
qnxadas-junction-exit	95.3%	125%	187%
qnxadas-motorway-join	96.9%	123%	195%
qnxadas-navigating-bends	97.2%	123%	192%
Overall Average	97.7%	123%	187%

Lossy

Sequences	D1 BDR	D2 BDR	Enc Time	Dec Time
ford_01_q1mm	−0.3%	−0.3%	108%	135%
ford_02_q1mm	−0.3%	−0.3%	108%	133%
ford_03_q1mm	−0.2%	−0.2%	107%	134%
qnxadas-junction-approach	−1.6%	−1.6%	109%	133%
qnxadas-junction-exit	−1.5%	−1.6%	109%	130%
qnxadas-motorway-join	−0.7%	−0.7%	107%	128%
qnxadas-navigating-bends	−0.7%	−0.7%	107%	130%
Overall Average	−0.8%	−0.8%	108%	132%

Copyright(C) 2021 KDDI Research, Inc. All Rights Reserved.

Conclusion

- **Problem statement**
  - In geometry inter prediction, node occupancy is predicted by reference frame.
  - Occupancy prediction is sometimes difficult especially when both reference point cloud and current point cloud are sparse.
- **Proposed Methods**
  - Upsampling is applied to reference point cloud.
  - Each point is upsampled according to the direction corresponding to origin.
- **Experimental results**
  - For lossless, 2.3% geometry bits are reduced.
  - For lossy, BD-rates for D1/D2 are -0.8%/-0.8%.
- **Recommendation**
  - The proposed method is study in EE 13.2.

Thank Qualcomm for cross-checking.

Copyright(C) 2021 KDDI Research, Inc. All Rights Reserved.