

m61055 [EE13.50-related][New] Modifications of Trisoup to Enabling All Test Points in CTC

**Kyohei Unno, Satoshi Komorita, Kei Kawamura
KDDI Corp. (KDDI Research, Inc.)**

■ Problem statement

- Current Trisoup (TMC13-v19.0) can not be executed for all test points in CTC.
- Cause of the problem is the decoded number of points is exceeded to the limit.

■ Proposal

- Proposal 1 (normative): Minor modification of reconstruction process,
- Proposal 2 (non-normative): Disabling an encoder optimization.

■ Experimental results

- All rate points can be executed by proposed fixes.
- BD-rates are 61.7%/58.0% (D1/D2) in comparison with TMC13-v14.

- Some rate points can not be tested by TMC13-v19.0

from CTC

Test material filename	R4	R3	R2	R1
Facade_00009_vox12		✓	✓	✓
Facade_00009_vox20		✓	✓	✓
Frog_00067_vox12		✓	✓	✓
Frog_00067_vox20		✓	✓	✓
Head_00039_vox12		✓	✓	✓
Head_00039_vox20		✓	✓	✓
House_without_roof_00057_vox12		✓	✓	✓
House_without_roof_00057_vox20		✓	✓	✓
Shiva_00035_vox12		✓	✓	✓
Shiva_00035_vox20		✓	✓	✓
ULB_Unicorn_vox13			✓	✓
ULB_Unicorn_vox20			✓	✓

- Because number of output point cloud exceeds limits even if the largest sampling distance is selected.

■ what happens

- loop, in the encoder, on the sampling parameter to obtain less points than the original point cloud
- sampling \leq TriSoup node size
- even with sampling $=$ TriSoup node size , there are too many points -> encoding fails

from m59294

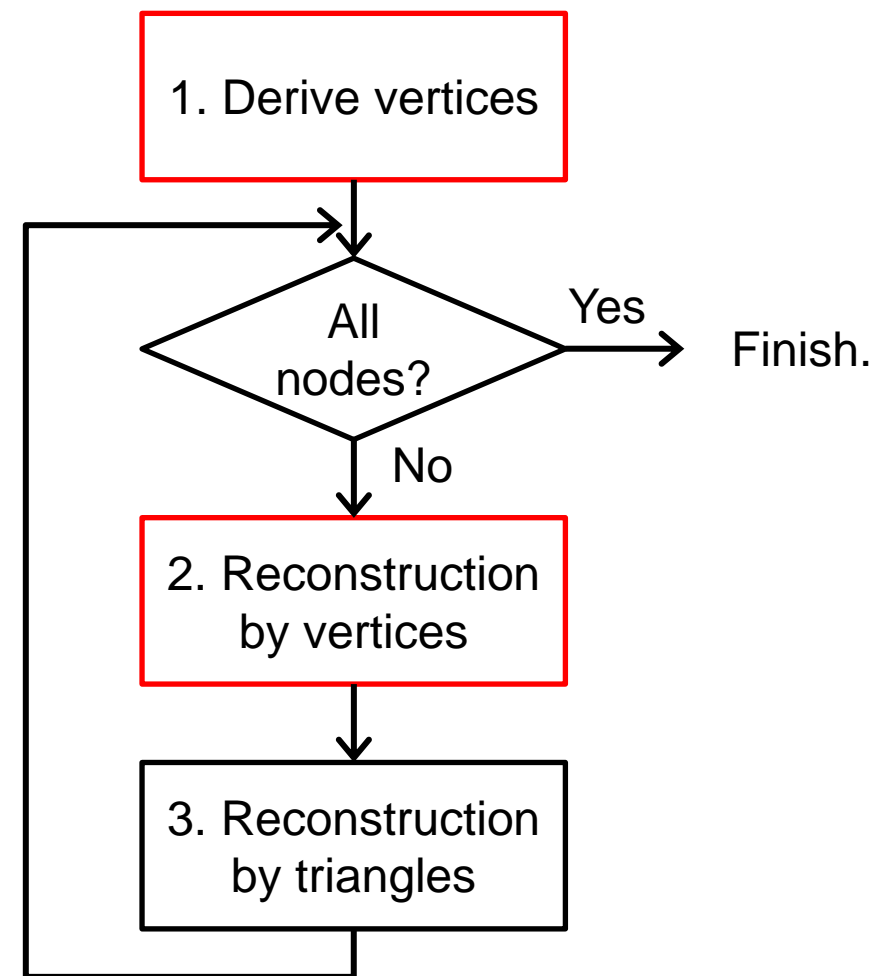
- All rate points should be tested.

- Previous version of TMC13 (v14) can test all rate points. -> The causes are recent changes.
- Trisoup reconstruction process at encoder side
 1. **Derive vertices (decode vertices at decoder side)**
 2. **Reconstruction by vertices**
 3. Reconstruction by triangles (ray tracing)
- Above 1. and 2. are causes of the problem.
 - Up to 12 vertices from 1 input point by above 1.
 - Up to 4 output points from 1 vertex by above 2.

ex) ULB_Unicorn_vox20, r04, 1st slice

	TMC13-v19.0
Input points	881,299
Vertices	1,355,734
Output points by vertices	3,189,777
Output points by triangles	610,732
Output points	3,800,509

Threshold for number of output points is set to **1,100,000**.



Overview of rec. process in encoder.

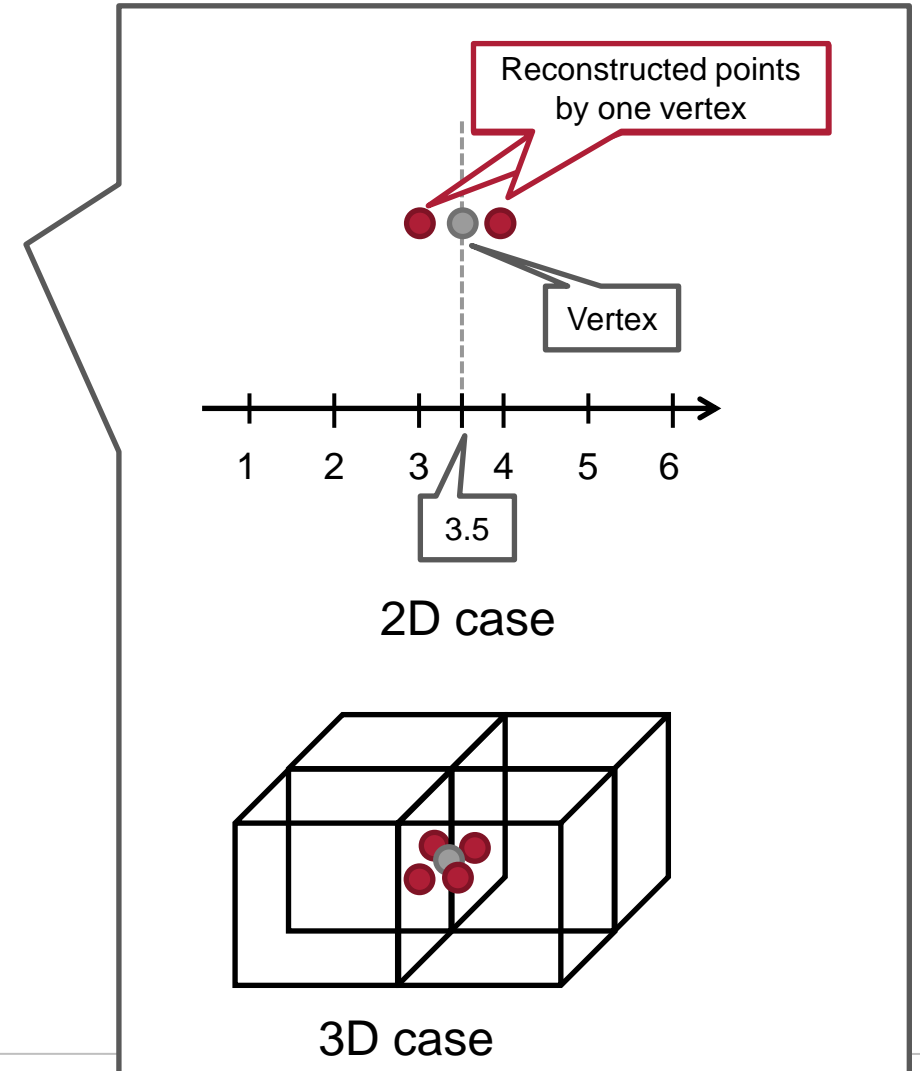
Proposal 1: Minor Modification of Reconstruction Process

- Current process: Up to **4 points** are reconstructed by one vertex.

```
// vertex to list of points
Vec3<int32_t> foundvoxel = segment.startpos;
for (int k = 0; k <= 2; k++) {
    if (direction[k])
        foundvoxel[k] += segment.vertex == (blockWidth >> bitDropped) - 1 ?
                        blockWidth - 1 : segment.vertex << bitDropped;
    if (segment.startpos[k] - leaves[i].pos[k] > 0) // back to B-1 if B
        foundvoxel[k]--;
}
if (boundaryinsidecheck(foundvoxel, poistionClipValue))
    refinedVerticesBlock.push_back(foundvoxel);
```

- Proposed fix: Only one point is reconstructed by one vertex

```
// vertex to list of points
Vec3<int32_t> foundvoxel = segment.startpos;
bool skip_flag=false;
for (int k = 0; k <= 2; k++) {
    if (direction[k])
        foundvoxel[k] += segment.vertex == (blockWidth >> bitDropped) - 1 ?
                        blockWidth - 1 : segment.vertex << bitDropped;
    if (segment.startpos[k] - leaves[i].pos[k] > 0) // back to B-1 if B
        skip_flag=true;
}
if (!skip_flag && boundaryinsidecheck(foundvoxel, poistionClipValue))
    refinedVerticesBlock.push_back(foundvoxel);
```



Proposal 2: Disabling an encoder optimization

- Disabling “trisoupImprovedEncoderEnabled” to prevent too many vertices are generated.
 - Range from boundary to derive trisoup vertex is expanded depending on the density of original point cloud.
 - **Up to 12 vertices** are generated by **1 input point** when the range > nodeSize/2.

Distance of sampling



■ Calculate sampling distance d_{samp}

- estimated point number in leaf node

$$N_{\text{node}} \approx N^2 / d_{\text{samp}}^2$$

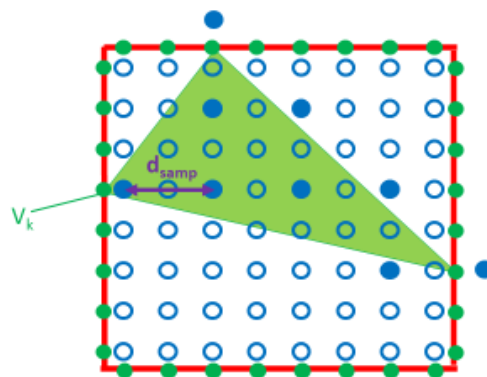
- estimated total number of points

$$N_{\text{tot}} \approx N_{\text{leaf}} * N_{\text{node}}$$

— N_{leaf} is the number of leaf node

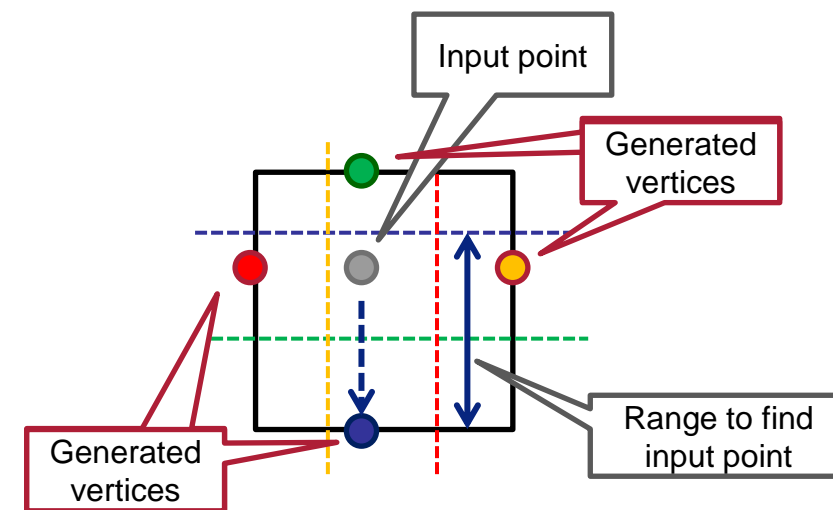
- SO

— d_{samp} depends on leaf node size N



$$d_{\text{samp}} = \sqrt{N_{\text{leaf}} / N_{\text{tot}}} * N$$

octree original point cloud TriSoup parameter



Up to 4 vertices generated in 2D case.
-> Up to 12 vertices in 3D case.

Summary of the Proposed Fixes and Example

■ Current Implementation and Settings:

- Up to 12 vertices from 1 input point
- Up to 4 output points from 1 vertex

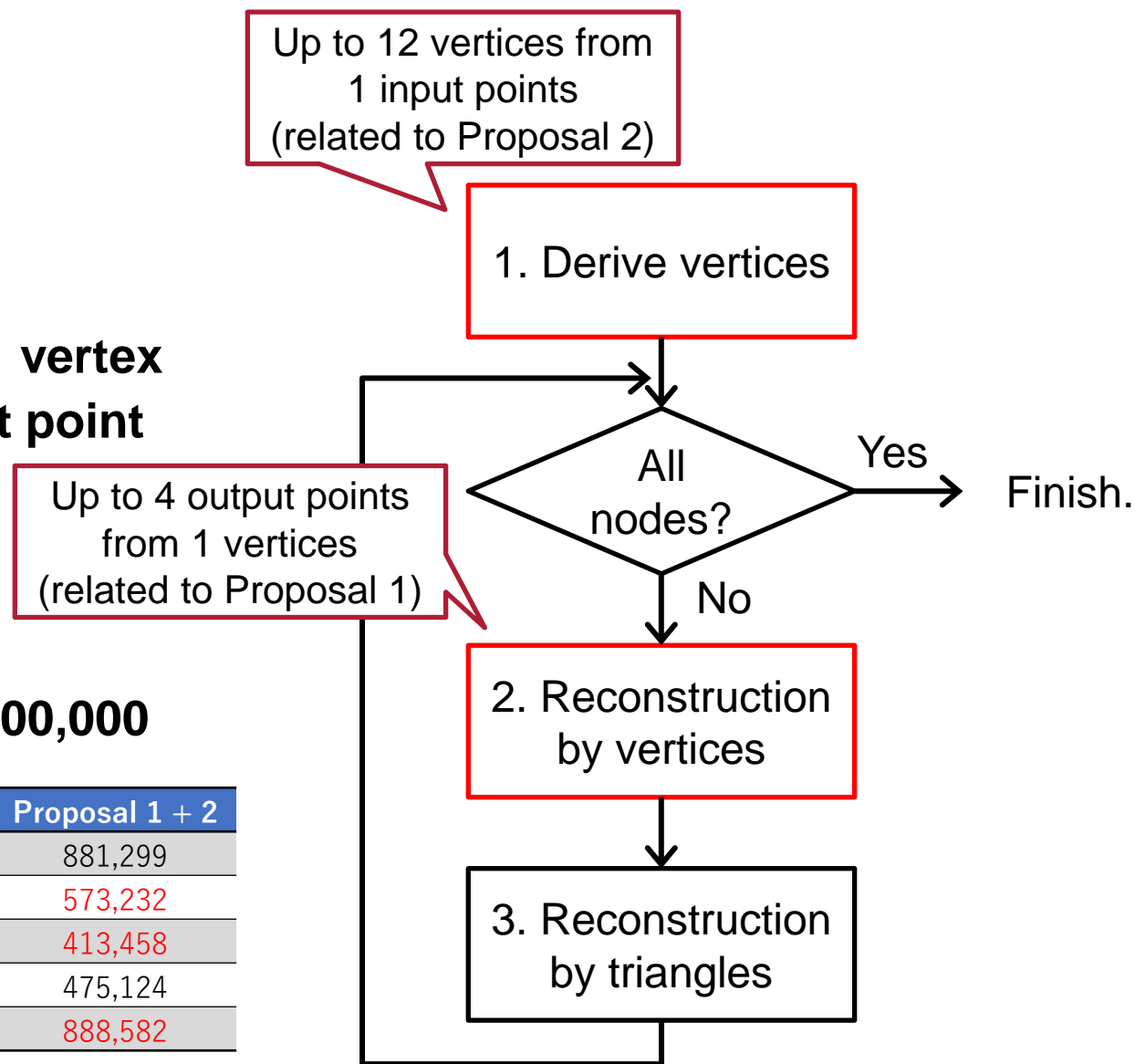
■ Proposal

- Proposal 1: To reduce output points from 1 vertex
- Proposal 2: To reduce vertices from 1 input point

■ Example

- ULB_Unicorn_vox20, r04, 1st slice
- Threshold for number of output points: 1,100,000

	TMC13-v19.0	Proposal 1	Proposal 2	Proposal 1 + 2
Input points	881,299	881,299	881,299	881,299
Vertices	1,355,734	1,355,734	573,232	573,232
Output points by vertices	3,189,777	925,098	1,204,194	413,458
Output points by triangles	610,732	1,137,584	214,299	475,124
Output points	3,800,509	2,062,682	1,418,493	888,582



■ 4 tests are conducted under the CTCs.

- TMC13-v19.0
- TMC13-v19.0 + Proposal 1 (normative)
- TMC13-v19.0 + Proposal 2 (non-normative)
- TMC13-v19.0 + Proposal 1 + Proposal 2

Encode can be done or not for each point.

sequence	variant	TMC13-v19.0	Proposal 1	Proposal 2	Proposal 1 + 2
facade_00009_vox12	r04	NG	OK	NG	OK
frog_00067_vox12	r04	NG	OK	OK	OK
head_00039_vox12	r04	NG	NG	NG	OK
house_without_roof_00057_vox12	r04	NG	OK	OK	OK
shiva_00035_vox12	r04	NG	OK	OK	OK
ulb_unicorn_vox13	r03	NG	OK	OK	OK
ulb_unicorn_vox13	r04	NG	NG	NG	OK
facade_00009_vox20	r04	NG	OK	NG	OK
frog_00067_vox20	r04	NG	OK	OK	OK
head_00039_vox20	r04	NG	NG	NG	OK
house_without_roof_00057_vox20	r04	NG	OK	OK	OK
shiva_00035_vox20	r04	NG	OK	OK	OK
ulb_unicorn_vox20	r03	NG	OK	OK	OK
ulb_unicorn_vox20	r04	NG	NG	NG	OK

Most of coding gains
in comparison with TMC13-v14.0
are preserved.
(-67.7%/-56.7 for D1/D2)

Proposal 1+2 vs. TMC13-v14.0

C2	Geom. BD-TotGeomRate [%]	
	D1	D2
Solid average	-67.2%	-63.2%
Dense average	-57.7%	-51.6%
Sparse average	-61.1%	-57.2%
Scant average	-62.1%	-60.3%
Overall average	-61.7%	-58.0%
Avg. Enc Time [%]	112%	
Avg. Dec Time [%]	118%	

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■ Recommendation

- Adopt this simple fixes to the next version of TMC13 (v20) and the CTC.