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| **Title** | **[V-PCC][New Proposal] Single-pass Boundary Points Identification** |
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# Introduction

In the current implementation of boundary points detection in the V-PCC reference software, boundary points are identified in two passes that requires looping over all points twice. This contribution proposes a single-pass boundary points identification technique. Additionally, the boundary points near the occupancy map edges are missed in current V-PCC reference software. This contribution presents a technique to correctly identify boundary points at the edges of the occupancy map image.

# Proposal

## Single-pass boundary points identification

In the current V-PCC reference software, two layers of points near patch boundaries are identified. That requires looping over all points to identify the points at patch boundaries and then looping over all points again to find neighboring points of the points at patch boundaries.

In the single-pass method, it is needed to loop over all points once to identify the boundary layers. In doing so, for each query point, two groups of neighboring points are defined: the first group includes the immediate neighboring points and the second group includes the points 2-pixel apart from the query point, Figure 2 shows the two group of neighbors for a query point.

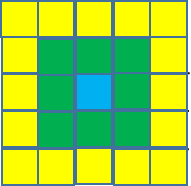


Figure 2. Neighboring points of a query point (colored in blue): first group of neighbors (colored in green), second group of neighbors (colored in yellow).

In this method, for a query point, if any neighboring pixel (colored in green and yellow in Figure 2) is empty, the query point is identified as a boundary point. Also, if the query point is located at an edge of the image or 1-pixel apart from any edge of the image, the query point will be identified as a boundary point as well.

## Boundary points detection for points near occupancy map edges

In the current V-PCC reference software, two layers of boundary points are identified. A point is identified as a boundary point if one of its neighbors is empty (i.e. occupancy value equal 0). Then in the second pass, all the neighboring point of boundary points (identified in the first pass) are also identified as boundary points. In the current implementation of boundary points identification in V-PCC reference software, the points near the occupancy map edges are missed. This contribution proposes to modify the V-PCC reference software by identifying all the occupied pixels in two rows and two columns near occupancy map edges as boundary points. Figure 1 shows some boundary points near the occupancy map edge after the fix.

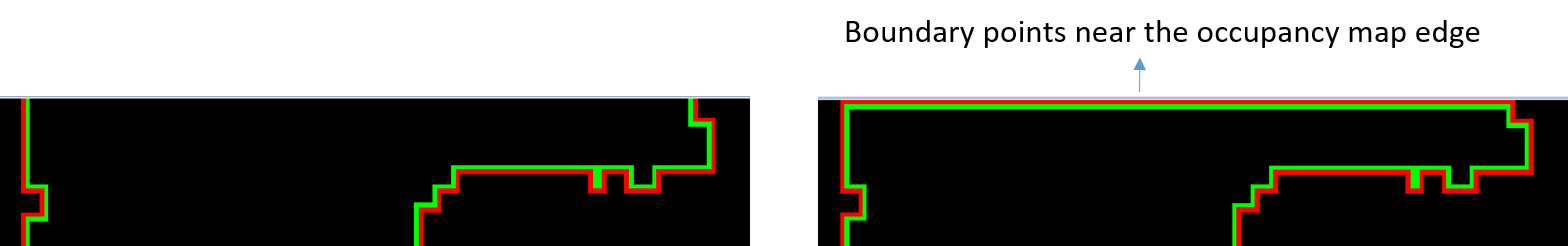


Figure 1. Boundary points not detected (left), boundary points detected near the occupancy map edge (right).

# Results

The 32-frame simulation results with the bugfix for two-pass boundary identification are shown in Table 1.

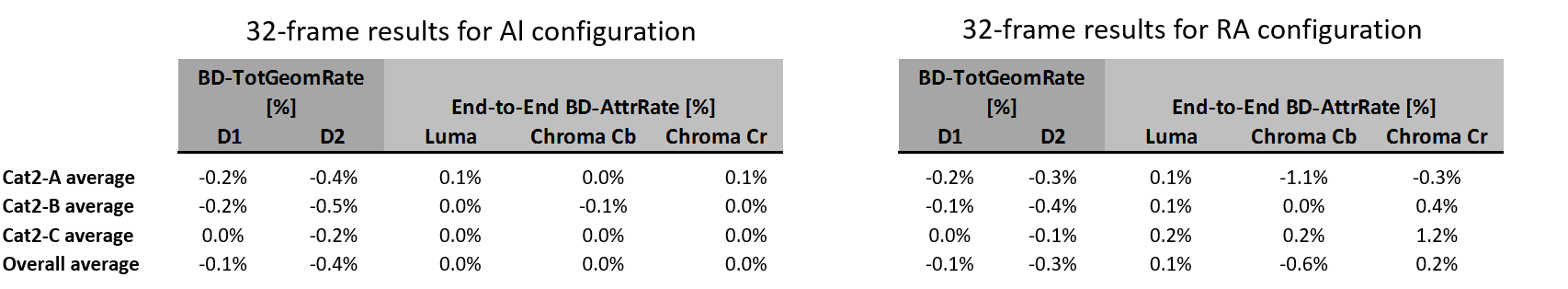


Table 1. Objective results for two-pass boundary identification with the bugfix integrated into TMC2v6.0.

Table 2 shows the 32-frame simulation results comparing two-pass and single-pass boundary identification.

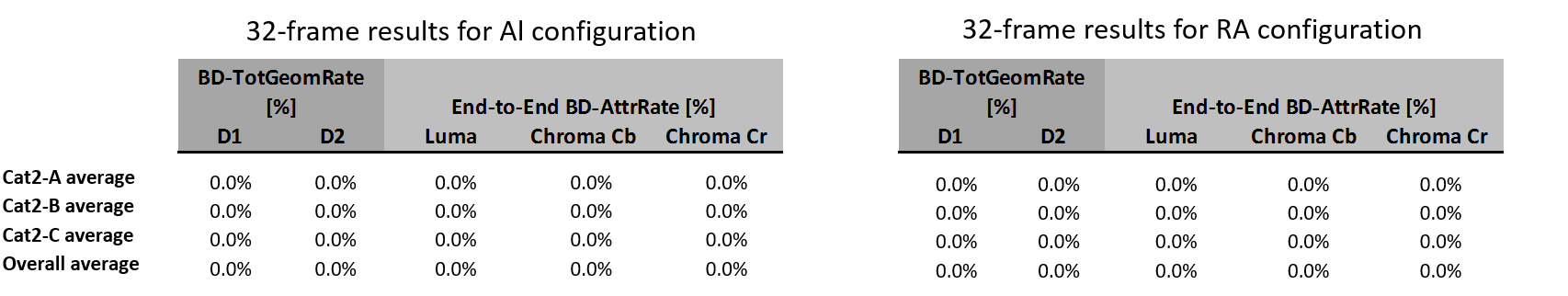


Table 2. Objective comparison of two-pass and single-pass boundary identification.

# Conclusion

This contribution proposes techniques to correctly identify boundary points at the edges of occupancy map and a single-pass boundary identification in V-PCC reference software. We request both these techniques to be integrated into the V-PCC reference software.