# Pose Optimized Multiple Camera Systems For Vehicle Surround-View Vision


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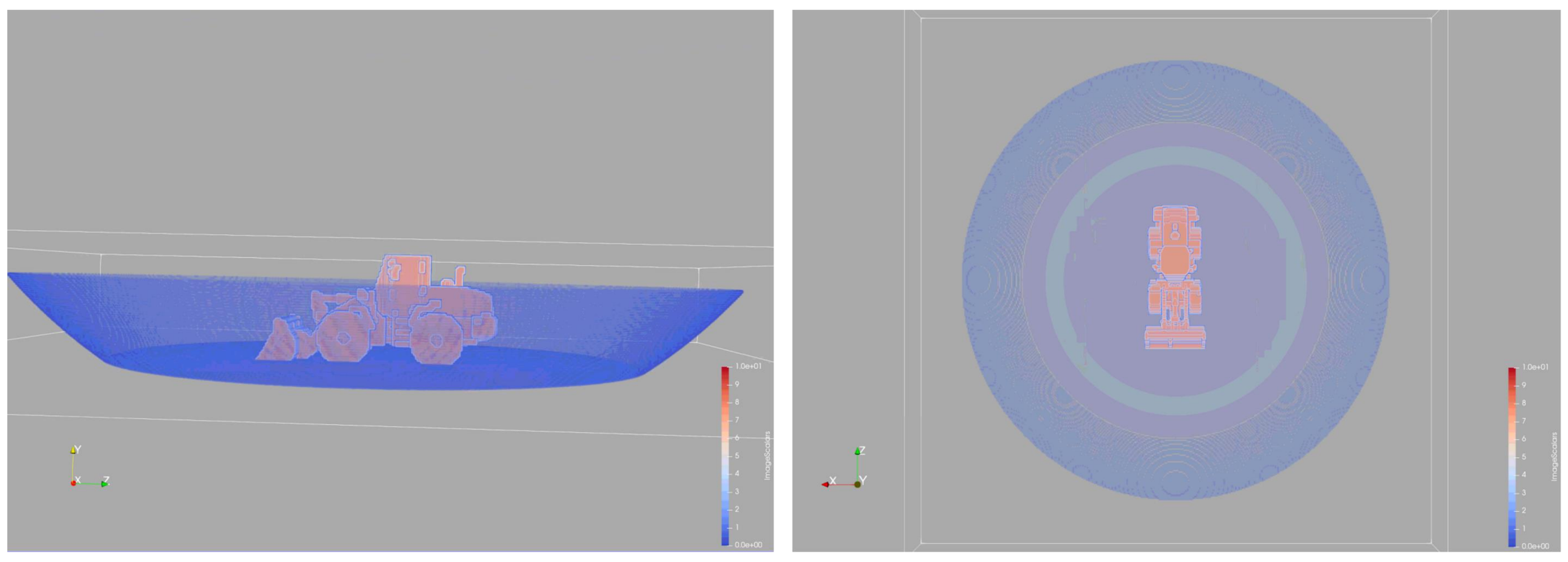
## 1. Introduction

Goal – find cameras' pose on the vehicle's surface (red) for maximum coverage (shown in blue).

Optimal Camera Placement – Challenges

- SOTA methods use discrete space models
- Discrete model => large number Of variables (~2million) => high computational time (> 40hrs for HD models)



(a) Side View (b) Top View

## 2. Problem Description

Discrete binary decision variables, I.e., value is either '1' or '0'

$X_{i\alpha}$ -> camera pose (voxel in red)

$C_j$ -> control (voxel in blue) point

Objective -> max $\Sigma C_j$ s.t. $\Sigma X_{i\alpha} = 5$

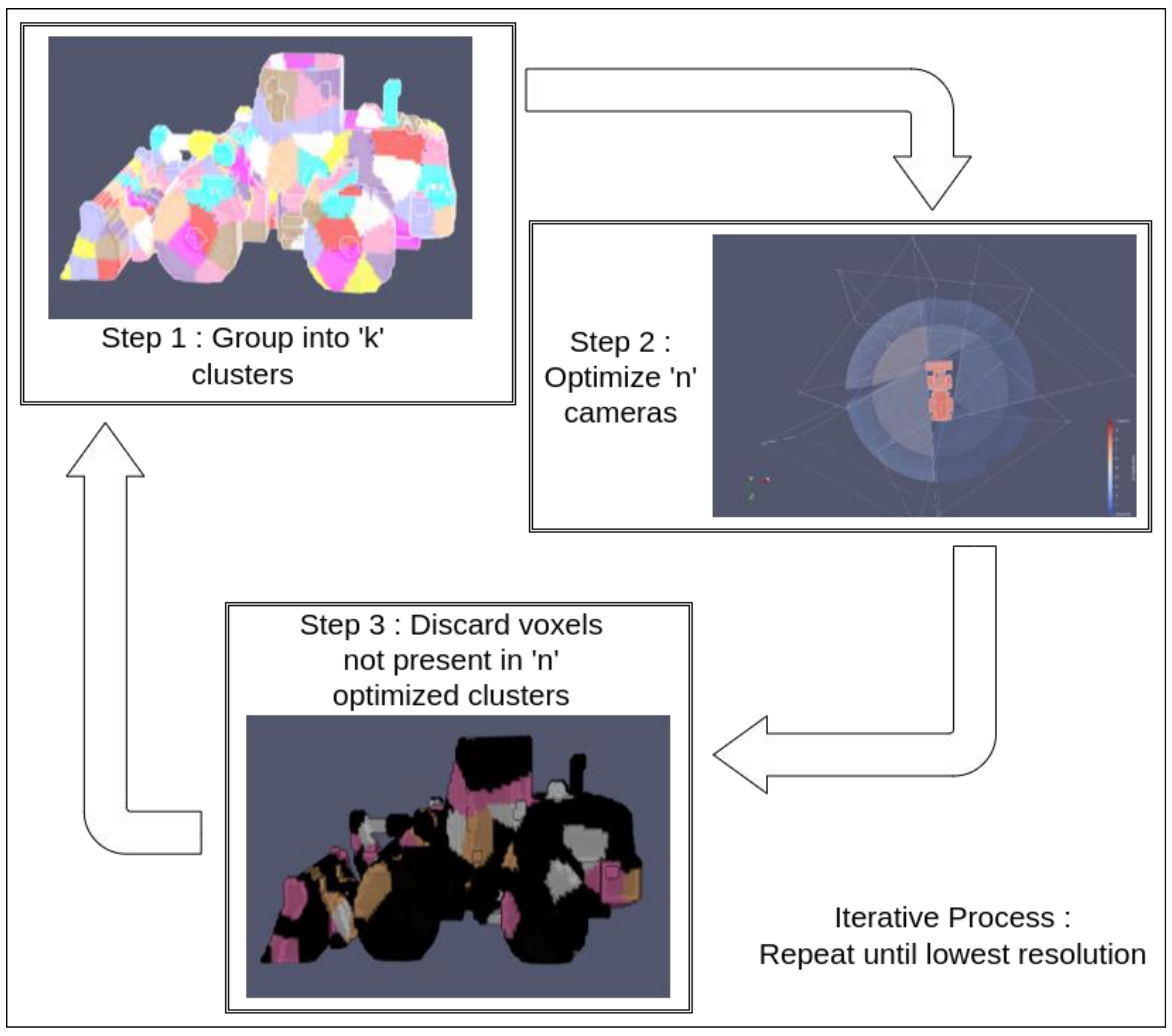
Optimization -> discrete combinatorial optimization methods

Integer Linear Programming

## 3. Methodology

Goal -> Reduce computational time by reducing number of input variables. (multi-resolution optimization method)

How? -> clustering 'red' voxels based on points orientation (or surface normal of the voxel in discrete model).




- Iteratively cluster the surface voxels and optimize for camera poses. Pass only selected clusters for next iteration
- Advantages : 1) no memory run-out problem 2) computational time reduced by over 50 times
- Another approach : continuous space model (camera pose optimization on parametric ellipsoid around the vehicle)
- Advantages : requires only 5 variables (2 polar angles for position on ellipsoid and 3 variables for camera view-direction vector), therefore much faster than discrete model + no expensive pre-processing steps

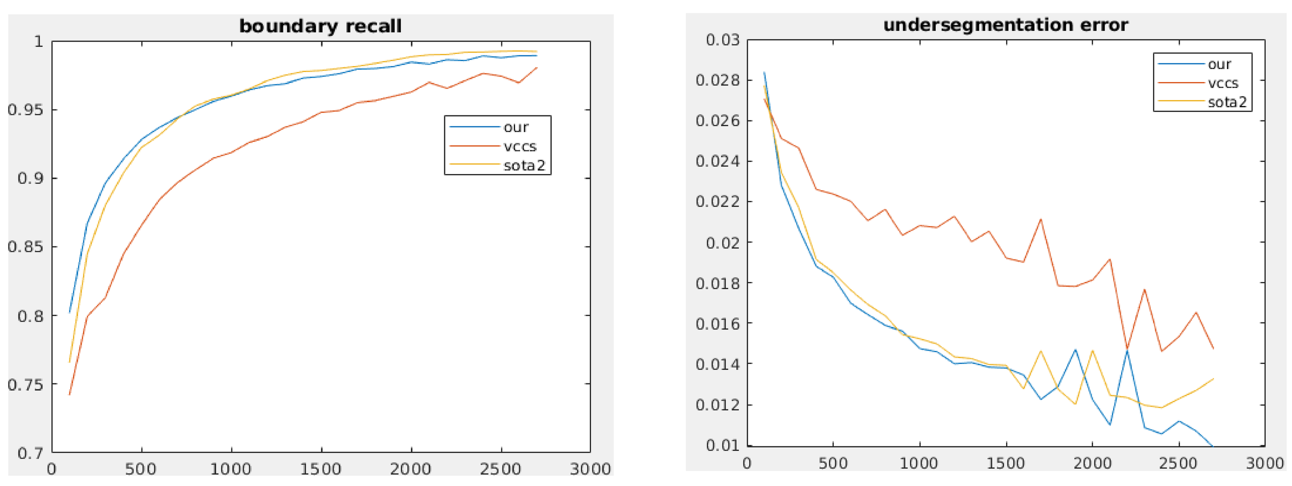
## 4. Results

- Marginally better camera coverage than SOTA due to sub-voxel accuracy achieved using clustering method
- Our method more than 150 times faster than SOTA


- Comparison of computational times (in seconds):

| Instance | Pre-processing | Greedy | RWLS | PSO-variant |
|---|---|---|---|---|
| small | 22.33 | 8.48 | 609.22 | 7.27 |
| small (our) | 0.75 | 4.81 | 67.04 | 21.05 |
| large | 12422.20 | 65.07 | 14467.06 | 13.39 |
| Large (our) | 140.05 | 23.41 | 329.04 | 99.75 |

- Our proposed clustering method better than SOTA on benchmark point cloud dataset (NYU-v2)




## 5. Conclusion

We proposed a novel optimization strategy that produces the same or better results than SOTA methods in only a fraction of the computational time. The clustering method designed for multi-resolution optimization method is better than SOTA methods on benchmark 3D point cloud datasets. Work on the continuous model for the optimal camera placement problem for vehicle surround-view vision in progress with promising priliminary results.

## 6. Project Acknowledgement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