Алгоритмы сопровождения динамических целей в трехмерных облаках точек

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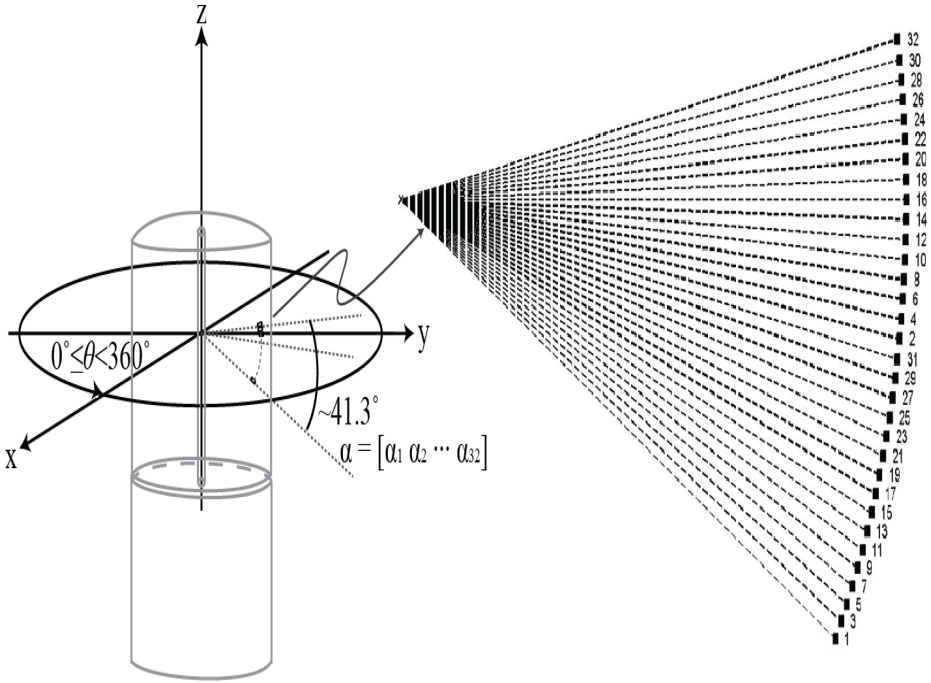
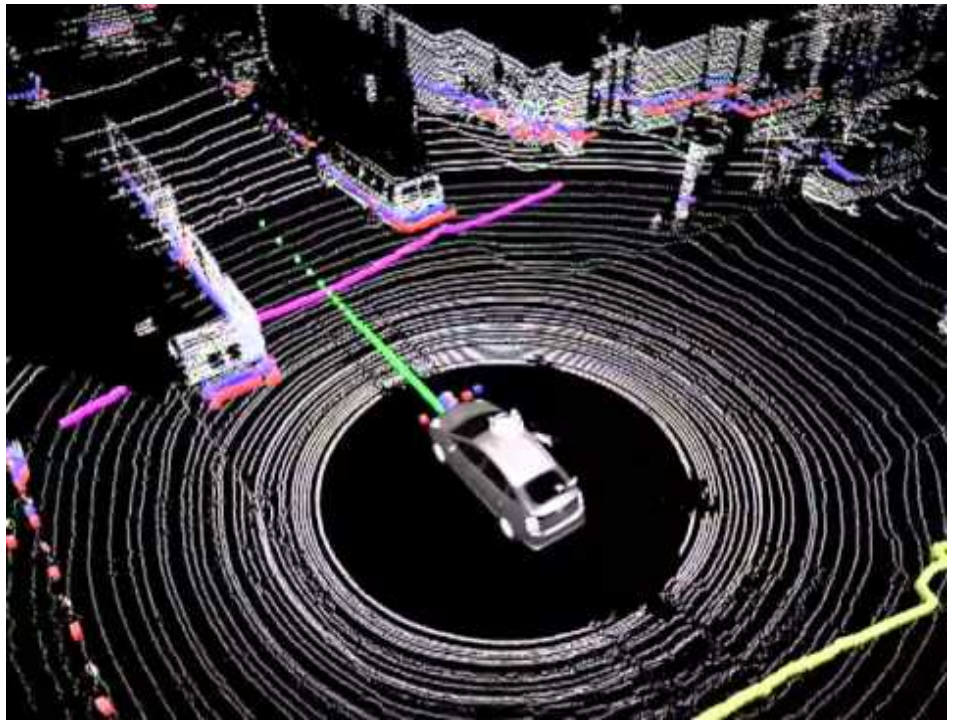
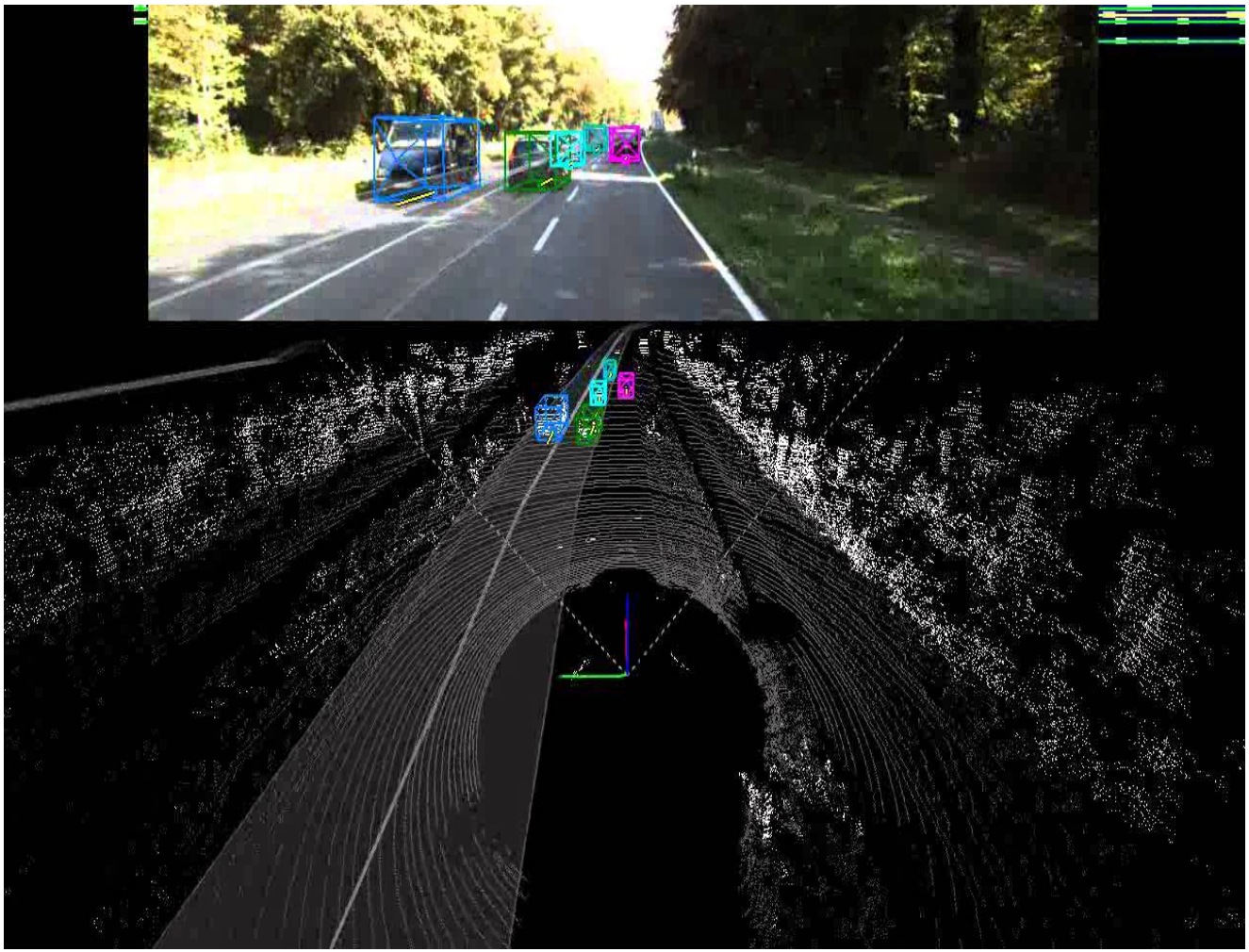
LIDAR





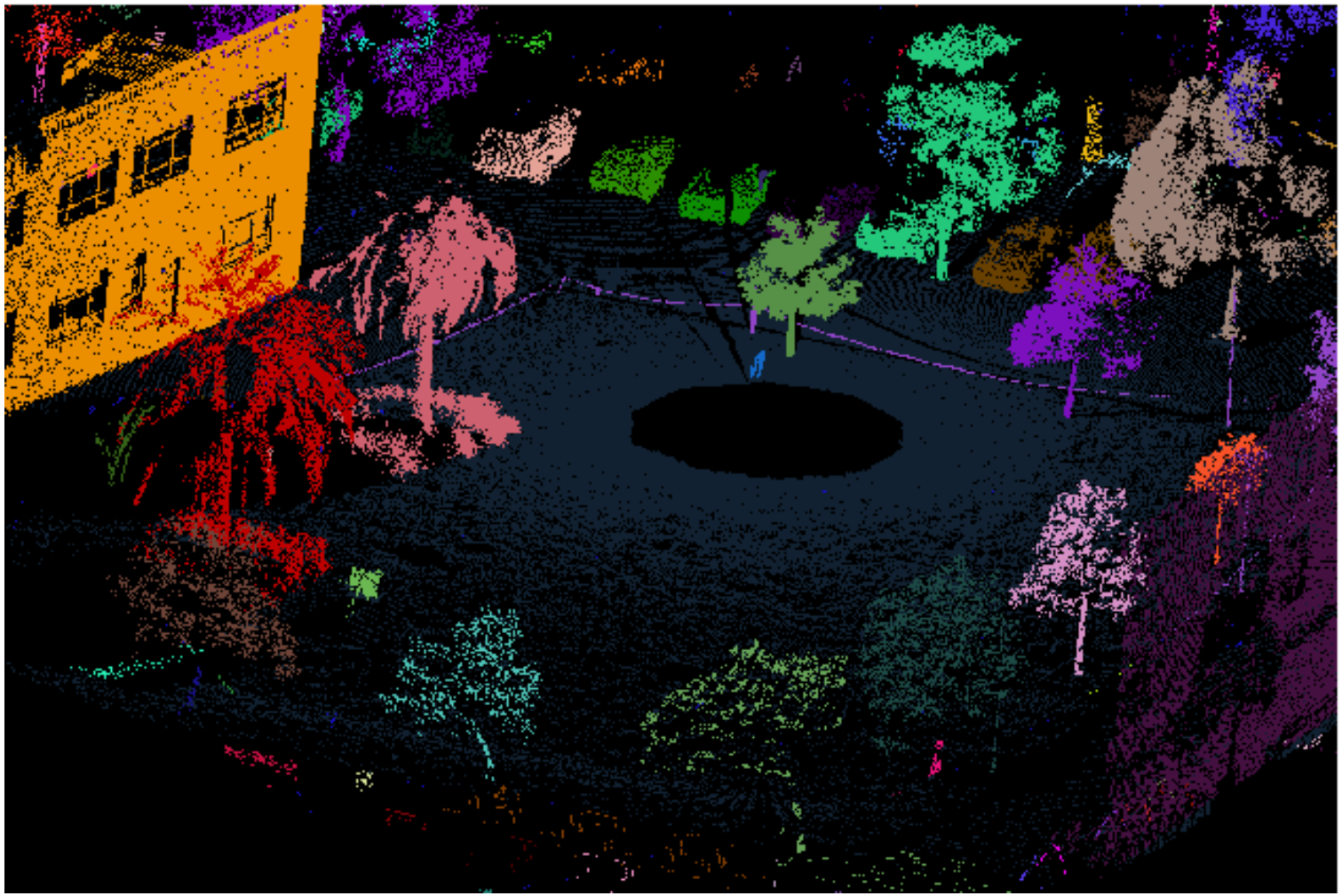
- 64 beams
- 10 Hz

KITTI

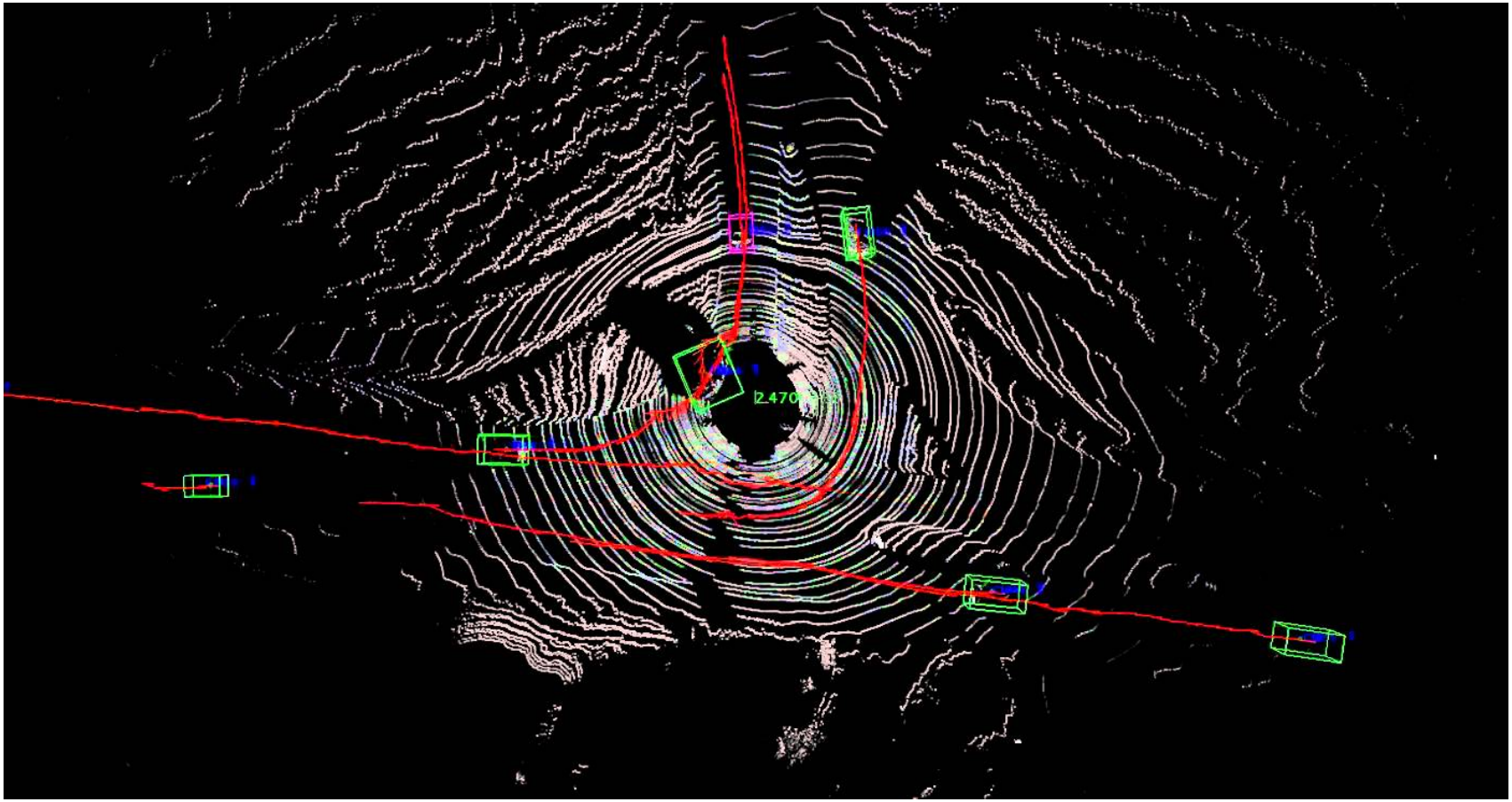


- 50 tracklets from 10 to 45 seconds each
- Bbox for each object

Segmentation task

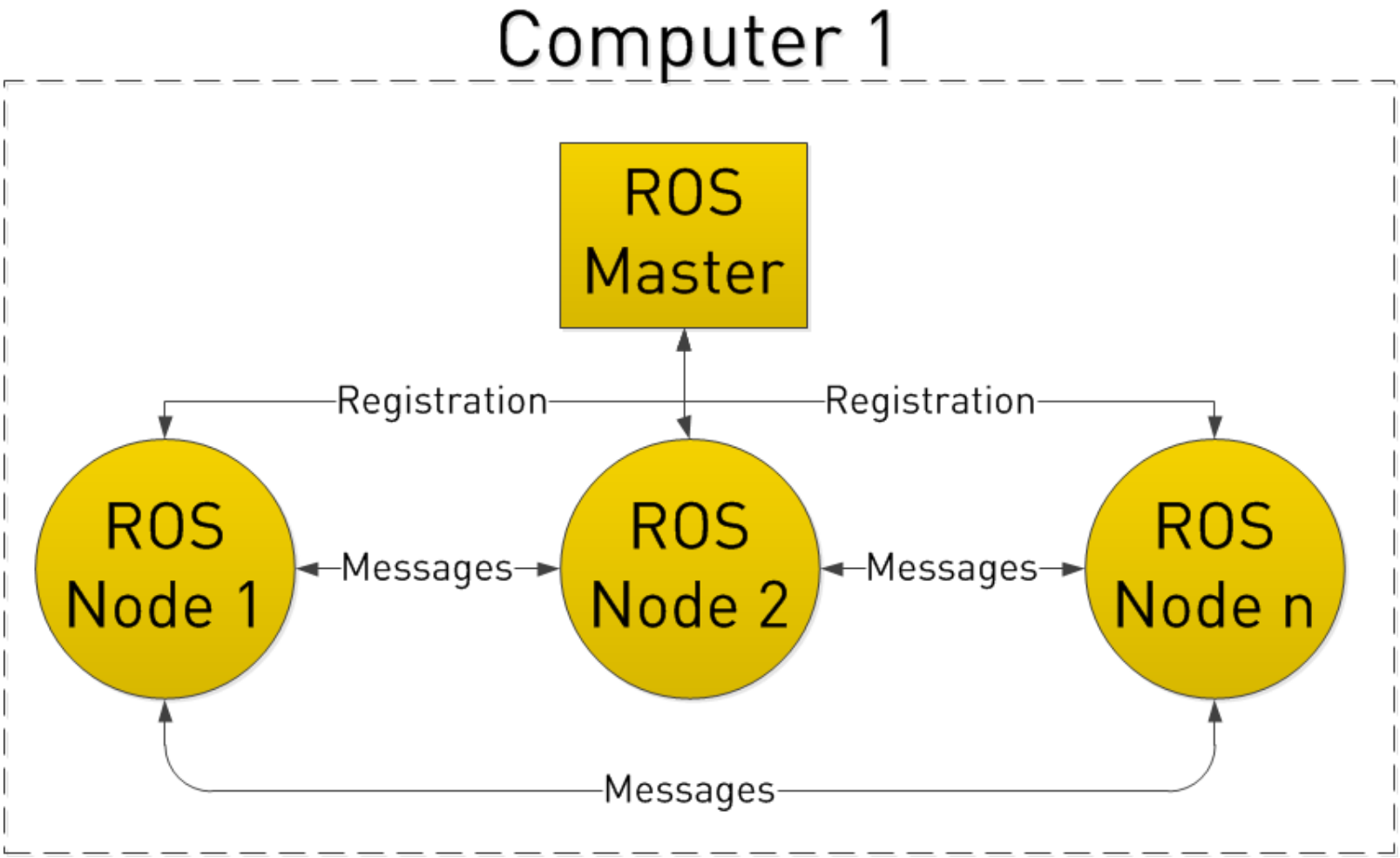


Detection and Tracking tasks

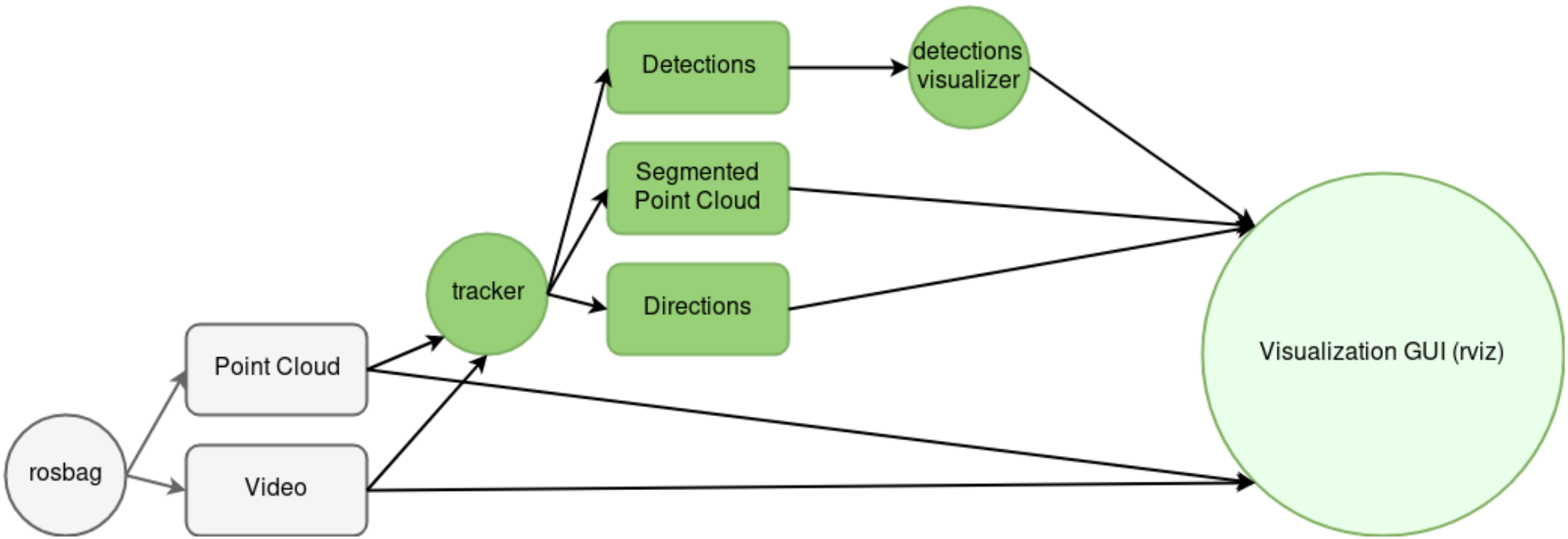


- Problems: occlusion, mismatch between frames
- One may be or may not be interested in direction, acceleration and speed

Robot Operating System (ROS)



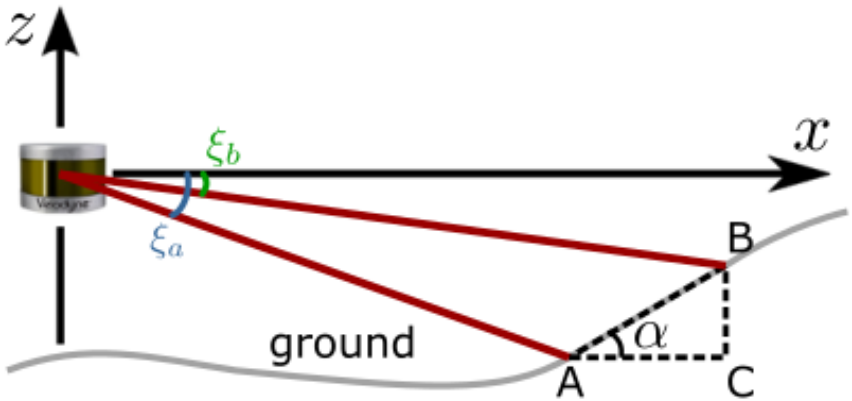
Robot Operating System (ROS): tracker graph



Pipeline

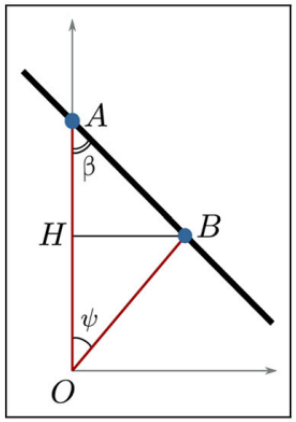
1. Segmentation
2. Tracking

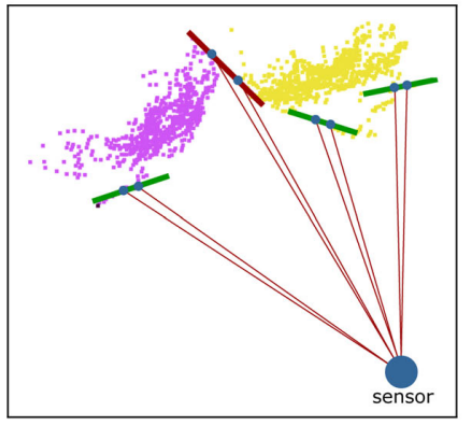
Segmentation



Algorithm 1 Ground Labelling

```
1: procedure LabelGround(R)
2:     M ← [α^r_{r−1,c}], matrix of angles α computed with Eq. (1).
3:     for c = 1 ... R_cols do
4:         if M(0, c) not labelled then
5:             LabelGroundBFS(0, c);
6: procedure LabelGroundBFS(r, c)
7:     queue.push({r, c})
8:     while queue is not empty do
9:         {r, c} ← queue.top()
10:        {r, c} ←labelled as ground
11:        for {r_n, c_n} ∈ neighbourhood{r, c} do
12:            if |M(r, c) − M(r_n, c_n)| < 5° then
13:                queue.push({r_n, c_n})
14:        queue.pop()
```

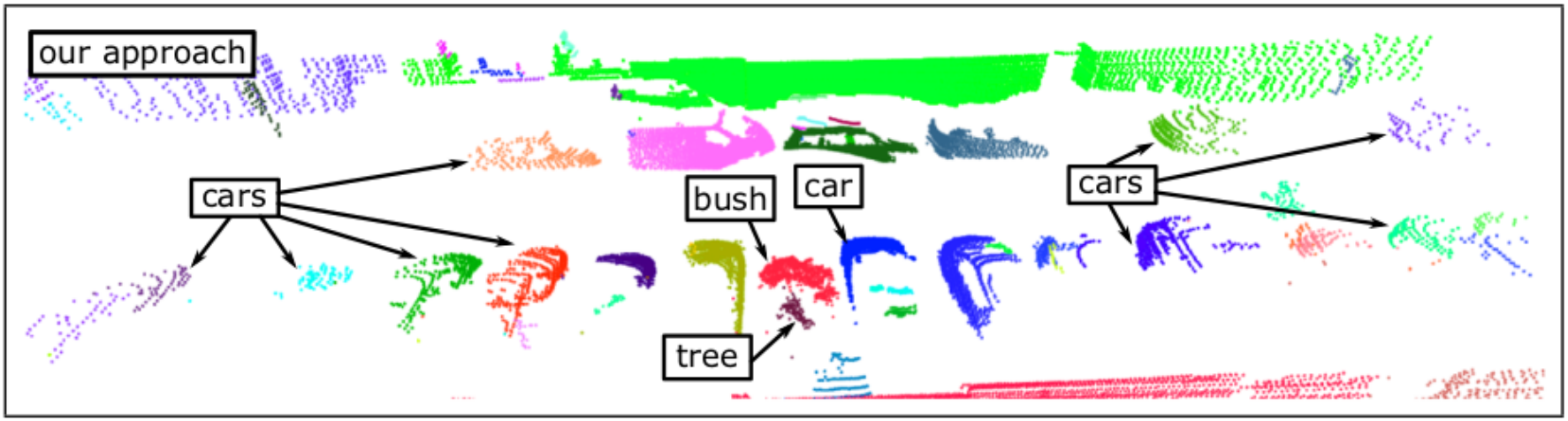




Algorithm 2 Range Image Labelling

```
1: procedure LabelRangeImage(R)
2:     Label ← 1, L ← zeros(R_rows × R_cols)
3:     for r = 1 ... R_rows do
4:         for c = 1 ... R_cols do
5:             if L(r, c) = 0 then
6:                 LabelComponentBFS(r, c, Label);
7:                 Label ← Label + 1;
8: procedure LabelComponentBFS(r, c, Label)
9:     queue.push({r, c})
10:    while queue is not empty do
11:        {r, c} ← queue.top()
12:        L(r, c) ← Label
13:        for {r_n, c_n} ∈ Neighbourhood{r, c} do
14:            d_1 ← max(R(r, c), R(r_n, c_n))
15:            d_2 ← min(R(r, c), R(r_n, c_n))
16:            if atan2 (d_2 sin ψ)/(d_1 − d_2 cos ψ) > θ then
17:                queue.push({r_n, c_n})
18:        queue.pop()
```

Segmentation: troubleshooting



We need only good segmentation of moving objects
There's a number of problems:

1. Undersegmentation of the ground
2. Incapability to work in the presence of plants

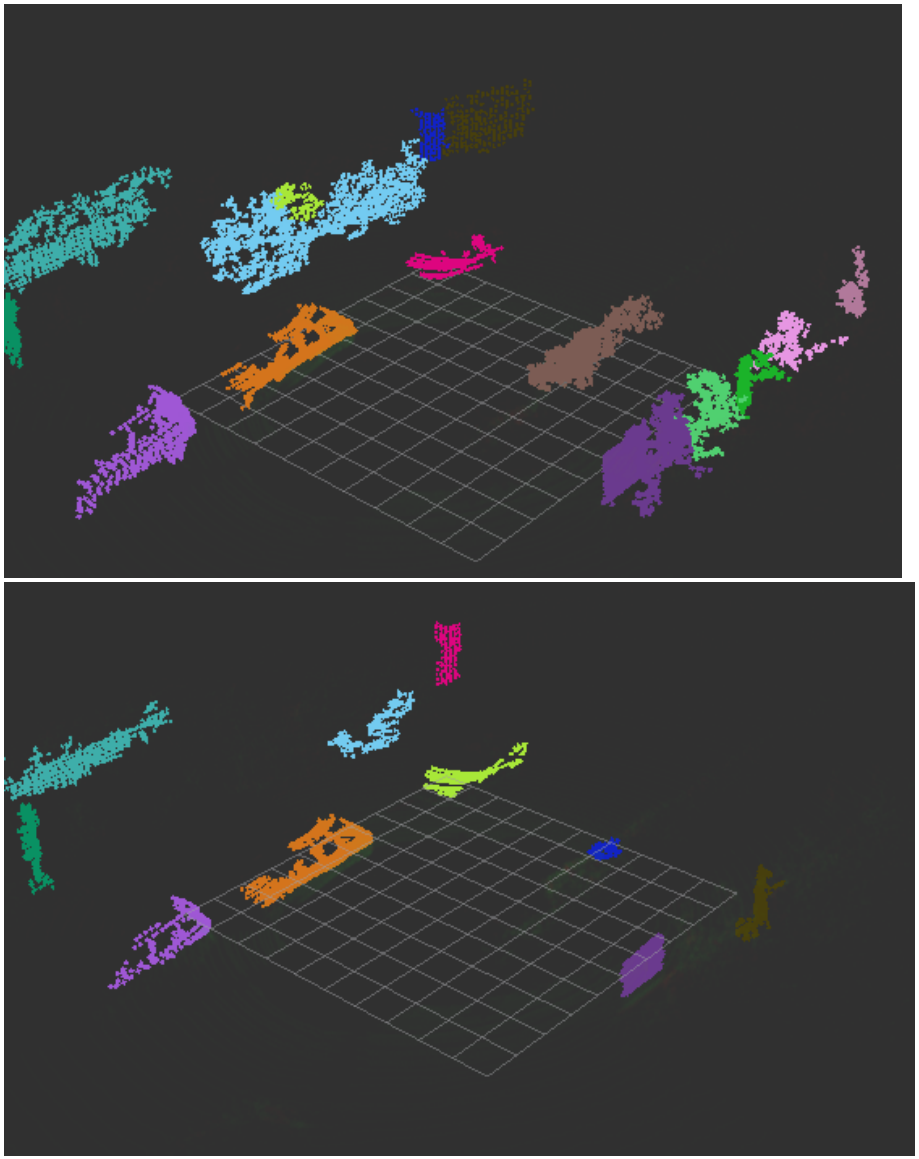
1. Normal based approach
2. Trees and grass removal algorithm

Segmentation: trees

Segmentation: trees removal

For each point:

- Create local approximation of an object shape
- Check deviation of a point
- Remove points with many outliers in neighbourhood



Runtime < 50ms

Segmentation: notes

- Not moving obstacles doesn't matter
- Only cars and pedestrians segmentation necessary
- Car shapes should be accurate

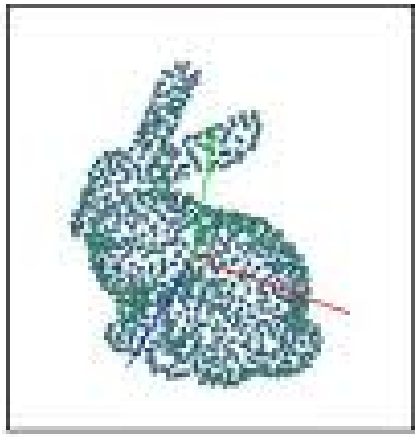
Tracking: pipeline

1. ICP
2. Kalman filter

ICP

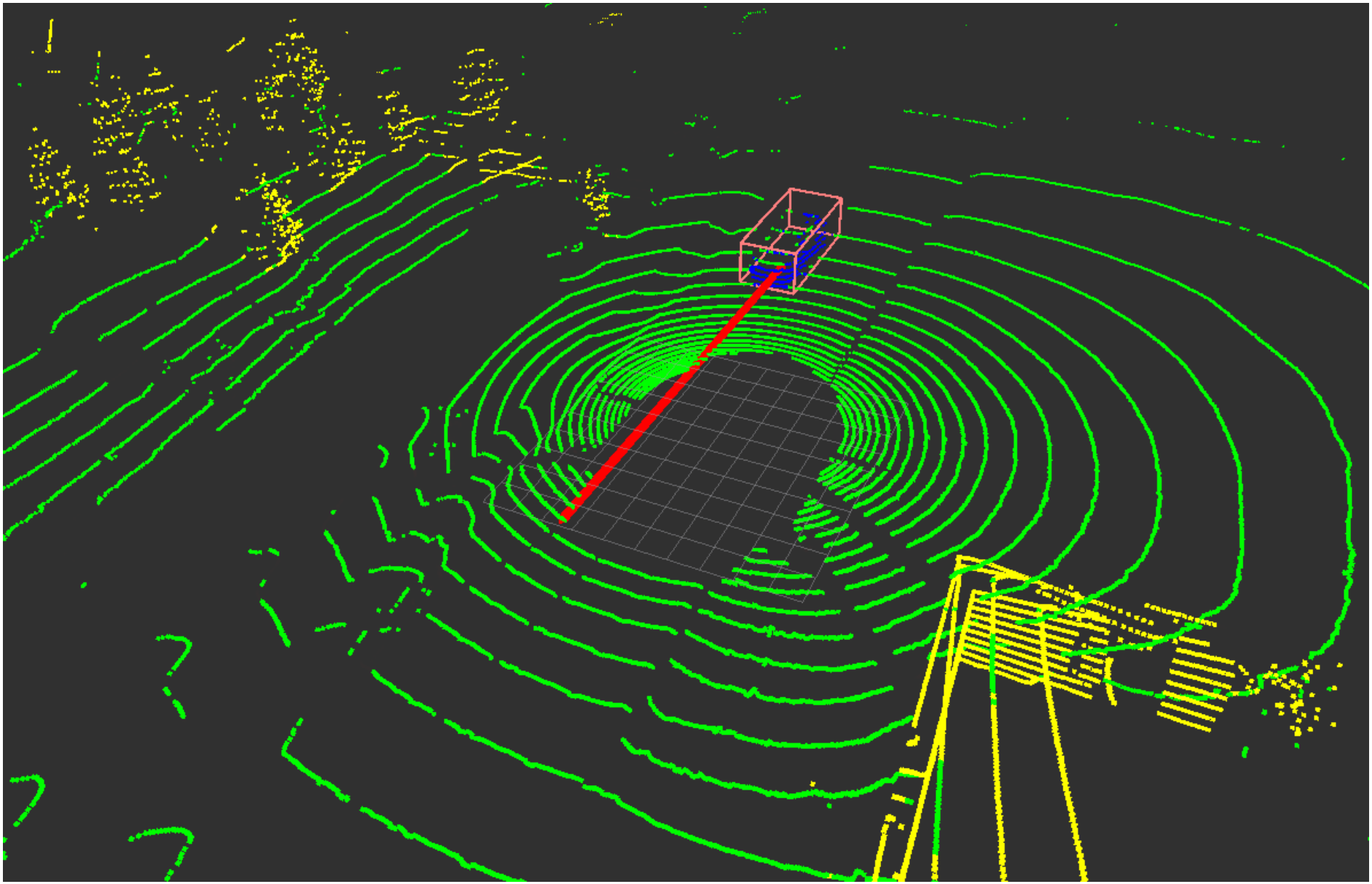
Iteration 0

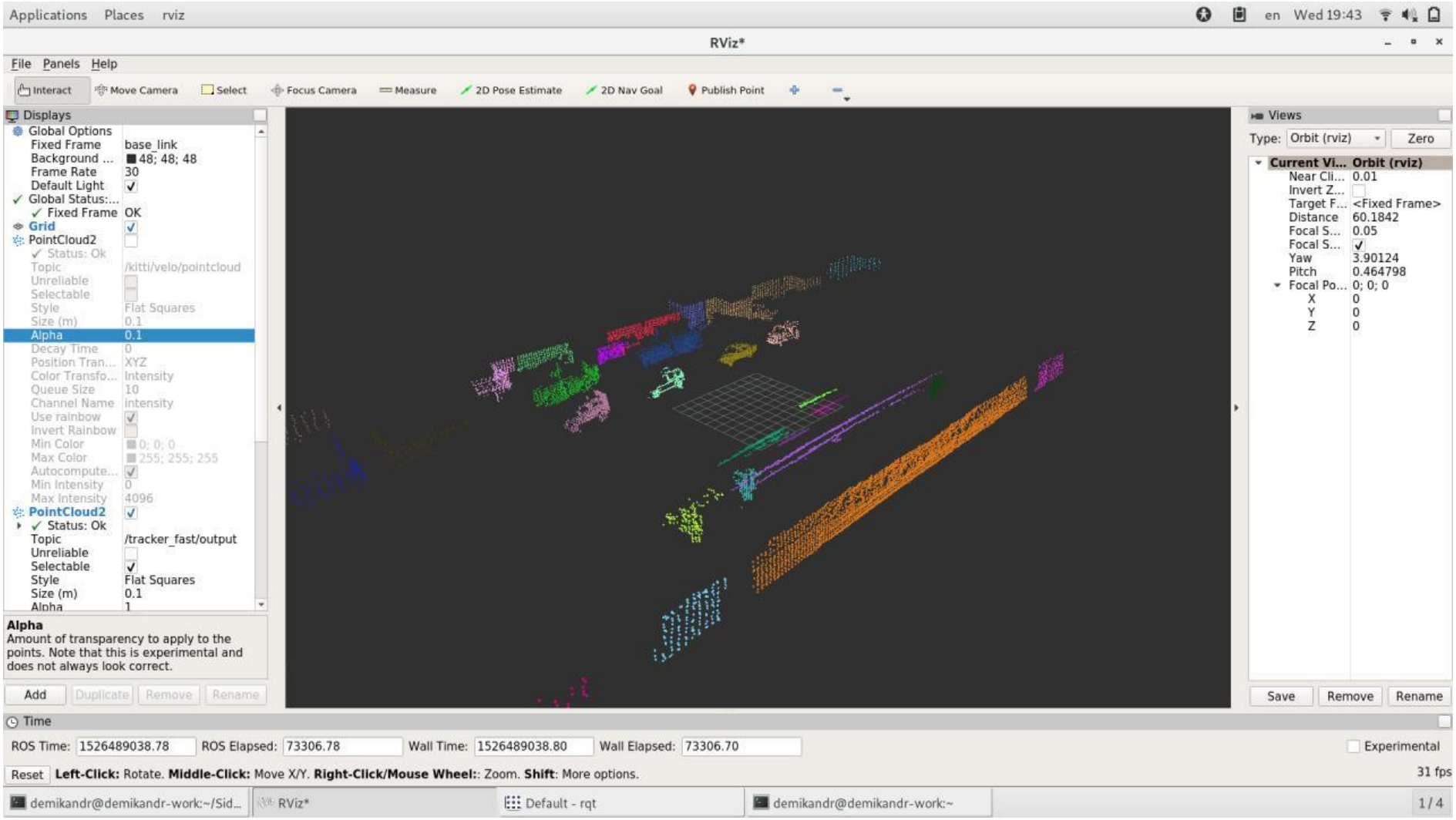
Iteration 1



Iteration 10

1. For each point of firs clout find closest from the second
2. Fit corresponding transformation and apply it
3. Repeat

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Experimental
Reset Left-Click: Rotate. Middle-Click: Move X/Y. Right-Click/Mouse Wheel:: Zoom. Shift: More options.
31 fps
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demikandr@demikandr-work:~
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Questions?