

Introducing Tools for Storing, Rendering and Annotating Triangle Meshes in ROS and RViz

׃ Mesh Tools

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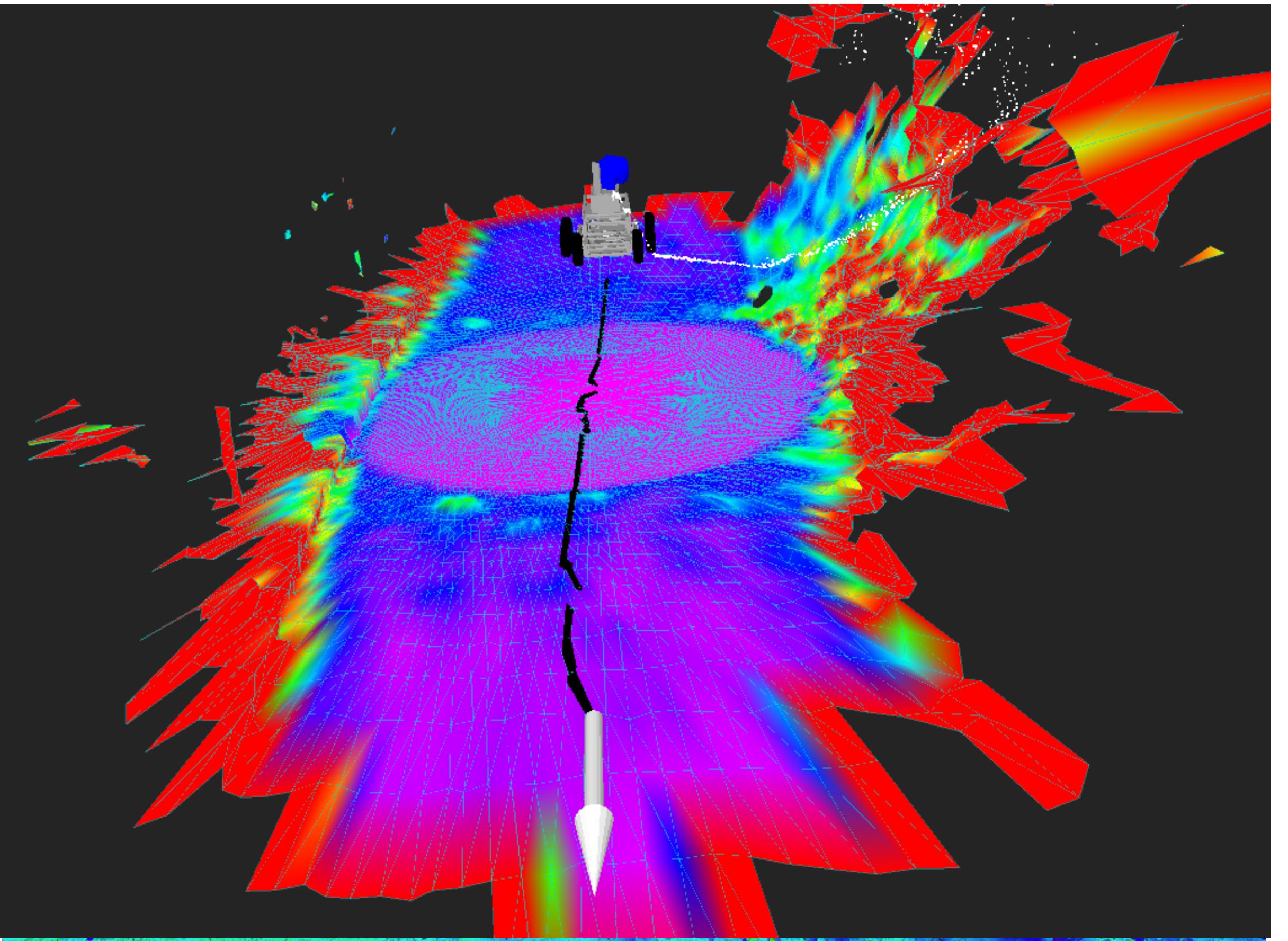
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- T. Wiemann, I. Mitschke, A. Mock, and J. Hertzberg. Surface reconstruction from arbitrarily large point clouds. In 2018 Second IEEE International Conference on Robotic Computing (IRC), pages 278–281, Jan 2018.

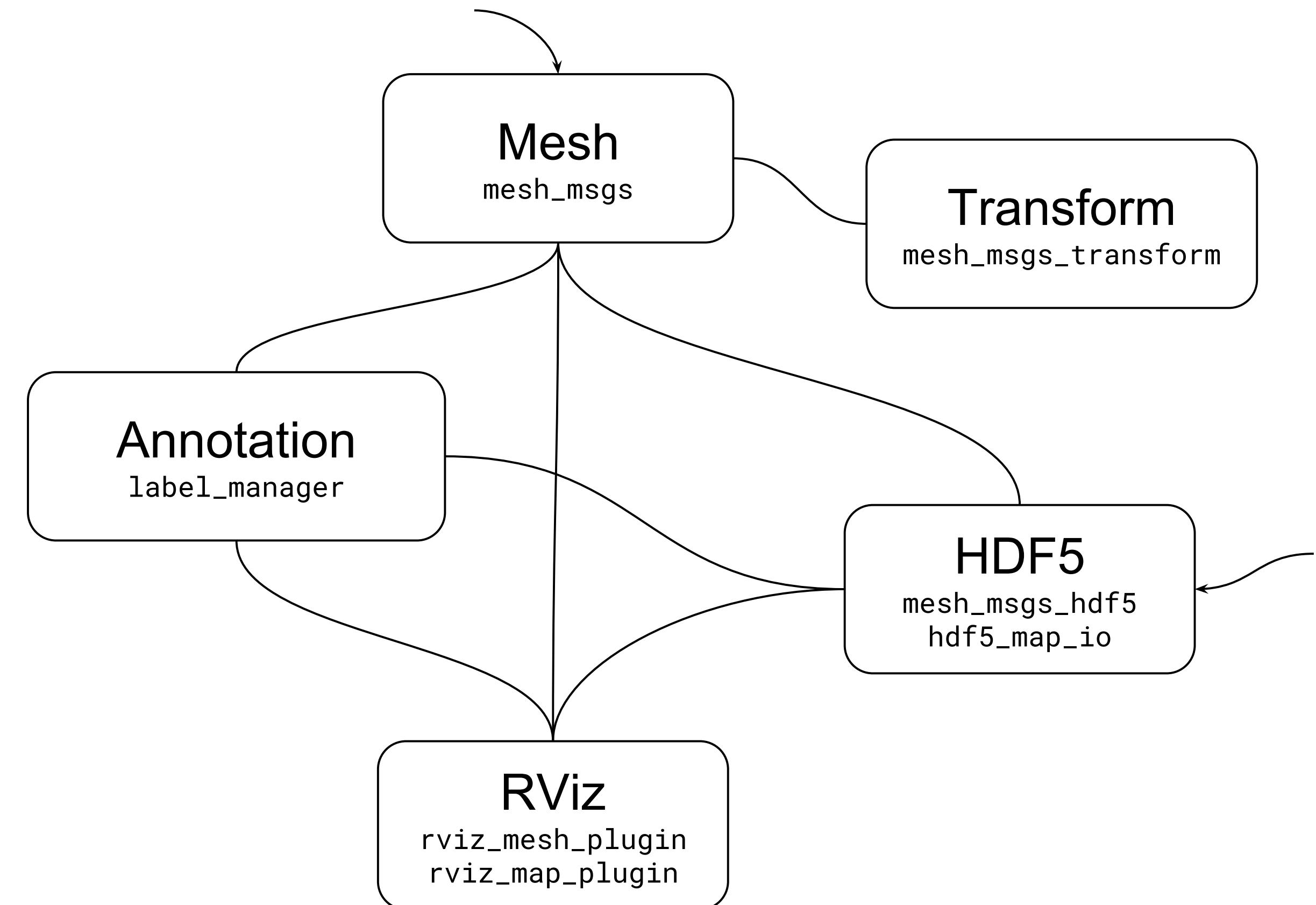
Mesh Applications and Advantages

- 3D Mapping of outdoor terrain
- Obtaining surface information
- Multilayer surface information
- Multilevel environments
- Visualization of terrain analysis
- Robot Mesh navigation planning
- Visualization of textures
- Data reduction
- Intuitive annotation of objects



Mesh Tools – Packages

- mesh_msgs
- mesh_msgs_transform
- mesh_msgs_hdf5
- hdf5_map_io
- label_manager
- rviz_mesh_plugin
- rviz_map_plugin

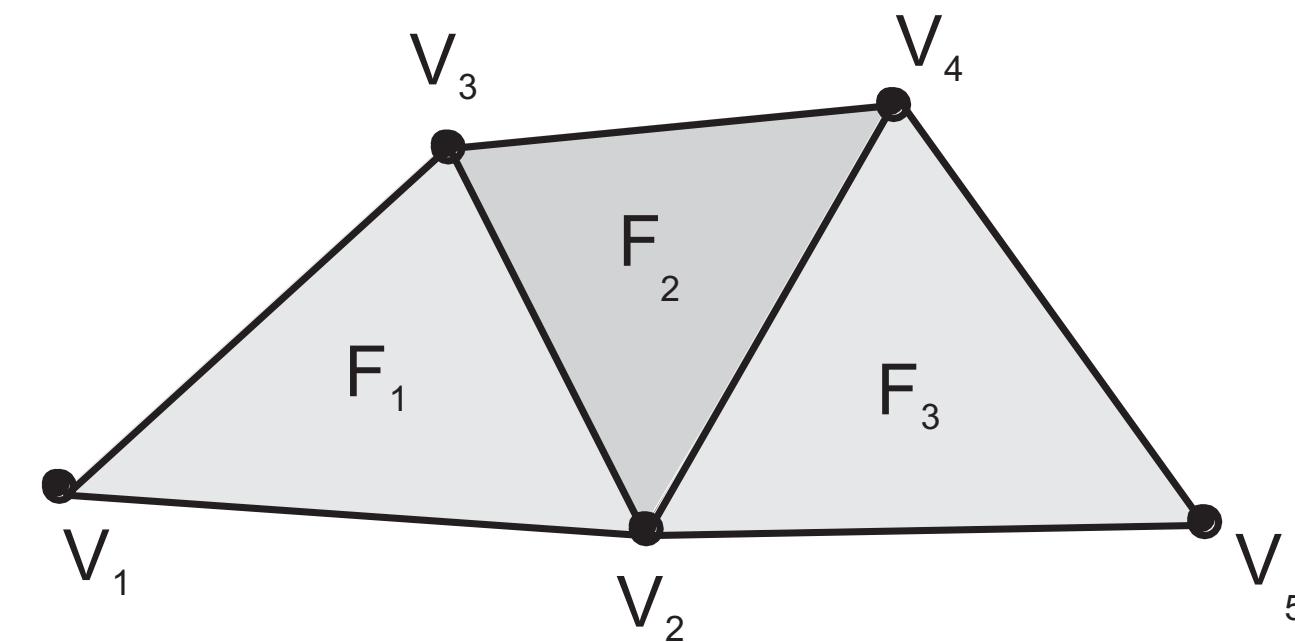


Mesh Geometry

```
# MeshGeometry Message
geometry_msgs/Point[] vertices
geometry_msgs/Point[] vertex_normals
mesh_msgs/TriangleIndices[] faces
```

```
# TriangleIndices Message
uint32[3] vertex_indices
```

```
# MeshGeometryStamped Message
std_msgs/Header header
string uuid
mesh_msgs/MeshGeometry mesh_geometry
```

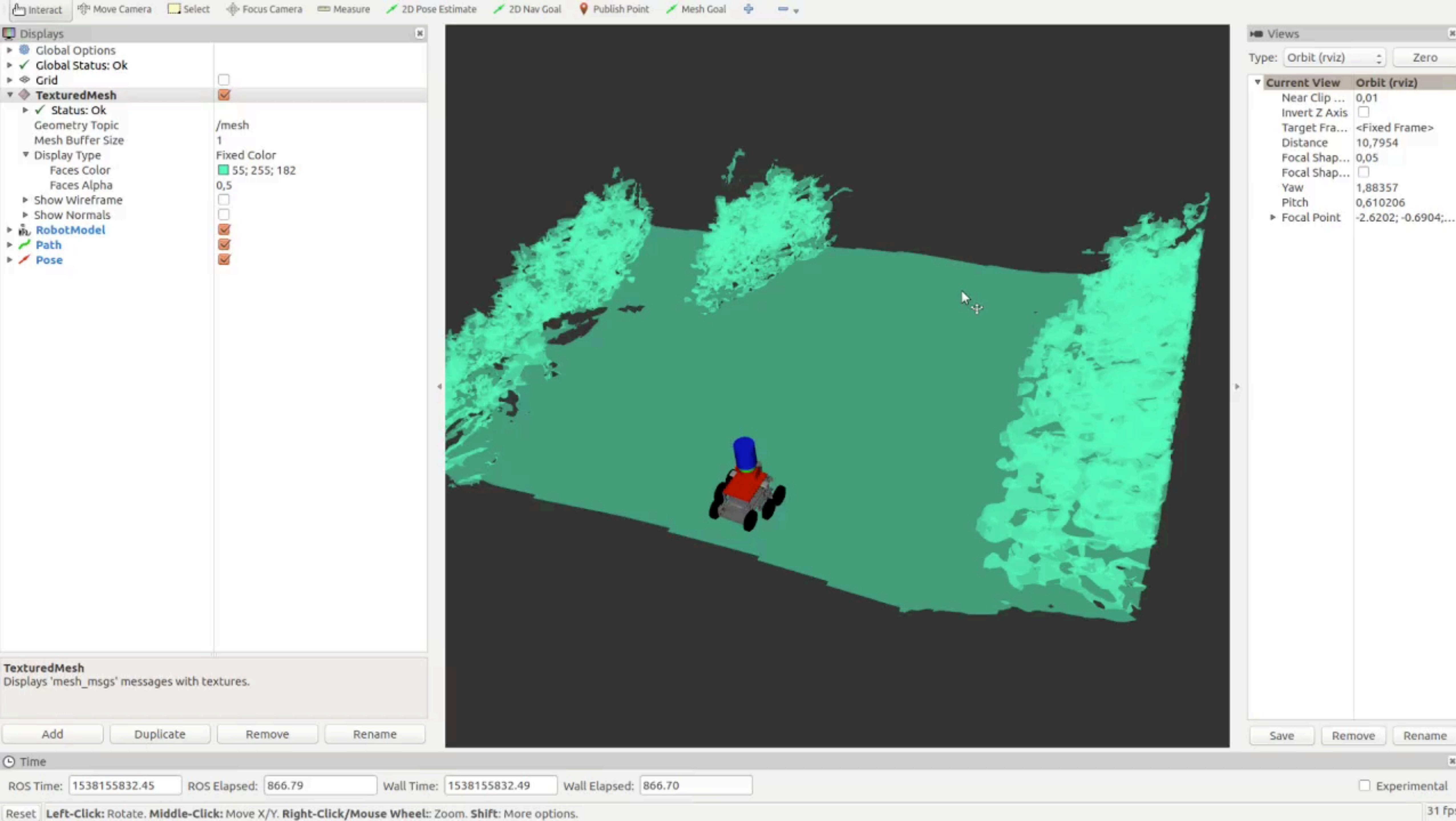


Vertex Buffer

V_1	V_2	V_3	V_4	V_5
1	2	3	4	5

Index Buffer

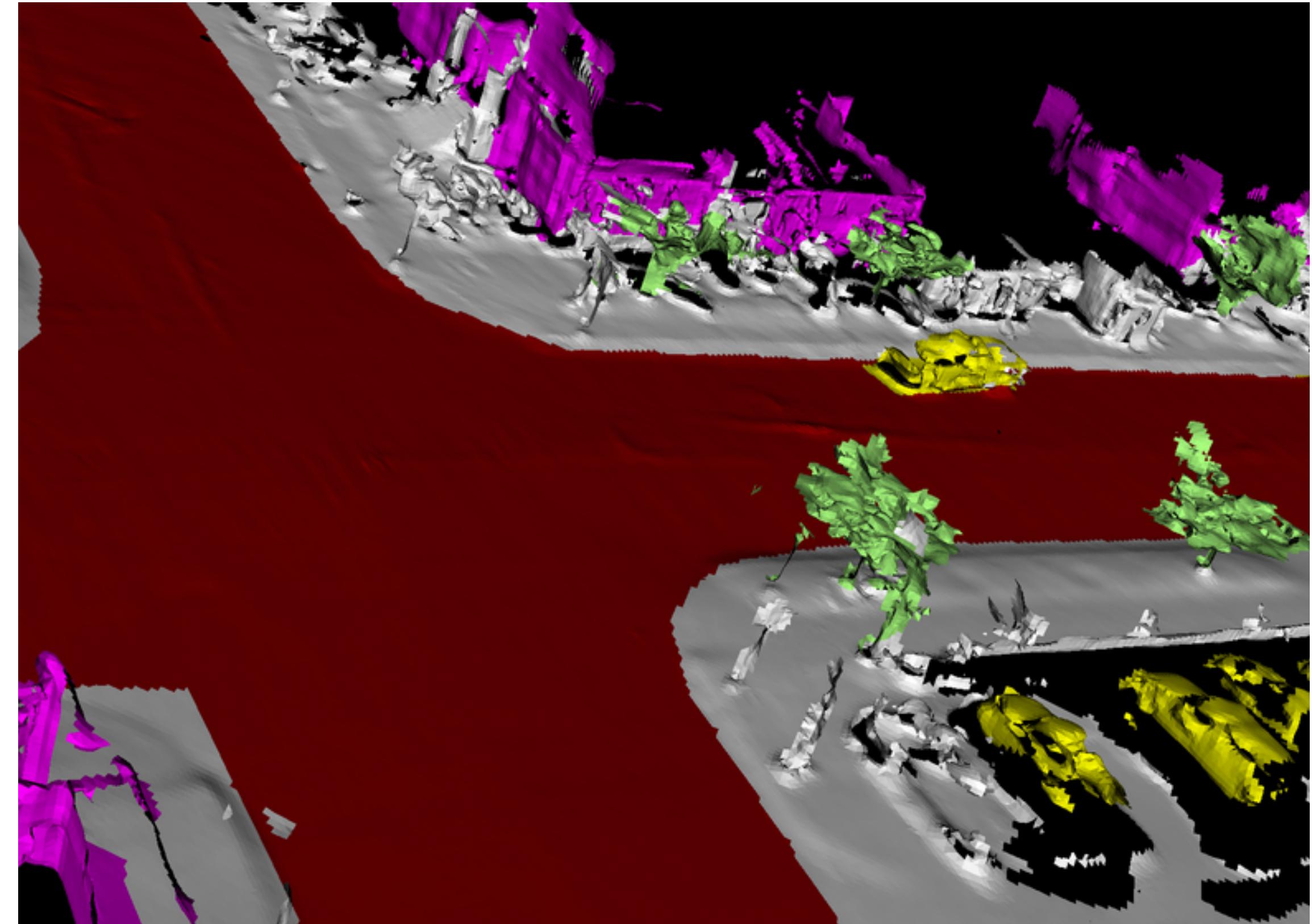
1	2	3		2	4	3		2	5	4
F_1		F_2			F_3					



Mesh Vertex Costs and Colors

```
# MeshVertexCosts
float32[] costs
```

```
# MeshVertexCosts Stamped
std_msgs/Header header
string uuid # reference to the mesh
string type # costs type
mesh_msgs/MeshVertexCosts
    mesh_vertex_costs
```

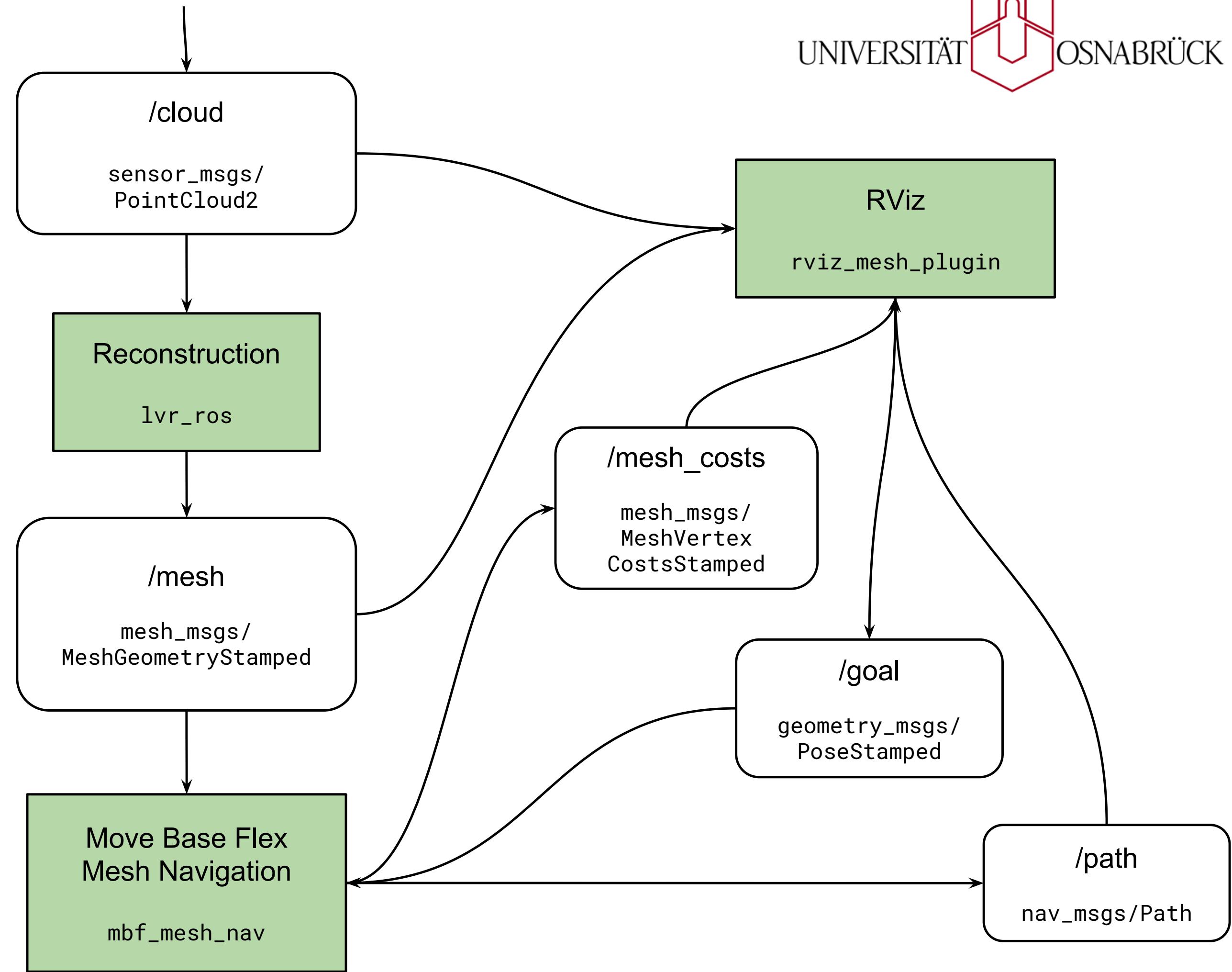


MeshVertexColors and labeled objects on the Ford Campus Dataset

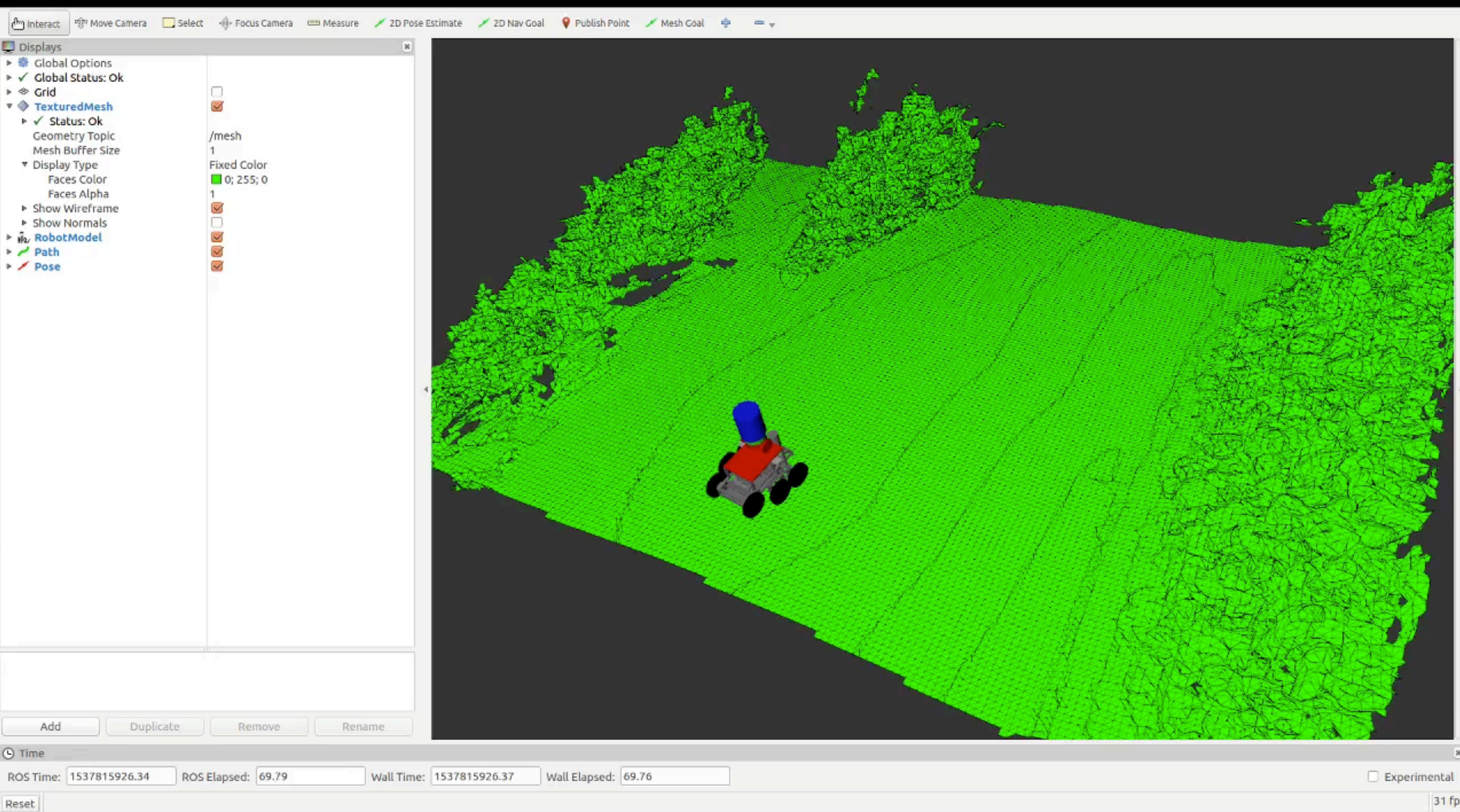
- G. Pandey, J. R. McBride, and R. M. Eustice. Ford campus vision and lidar data set. *The International Journal of Robotics Research*, 30(13):1543– 1552, 2011.

Mesh Navigation

- Reconstruct sensor data to a mesh
- Terrain analysis on the mesh to cost layers
- Combine cost layers to a navigation layer
- Perform path planning and motion control on the mesh using Move Base Flex



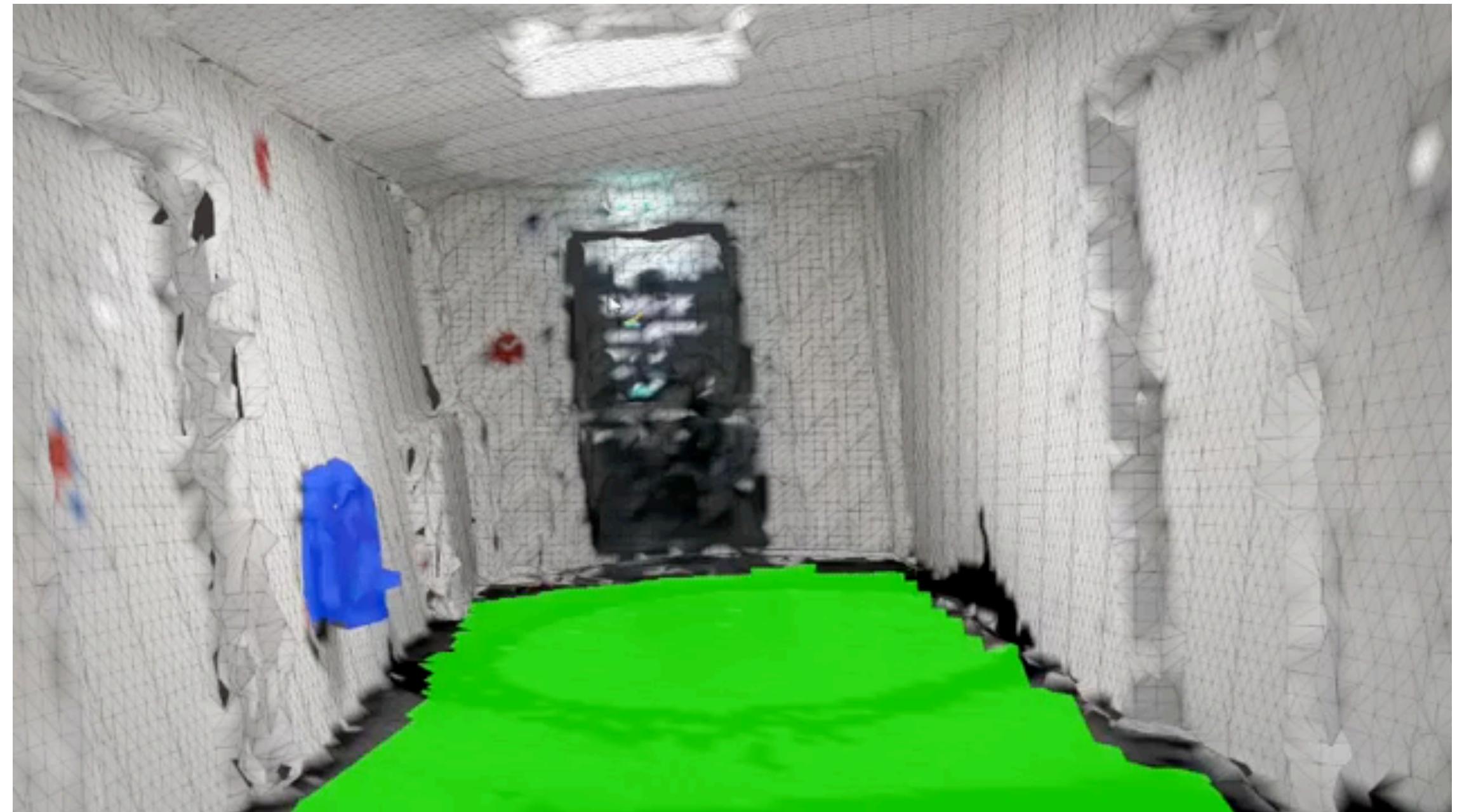
- 3D Navigation Mesh Generation for Path Planning in Uneven Terrain. S. Pütz, T. Wiemann, J. Sprickerhof, and J. Hertzberg. 9th IFAC Symposium on Intelligent Autonomous Vehicles (IAV 2016).
- Move Base Flex: A Highly Flexible Navigation Framework for Mobile Robots. Sebastian Pütz, Jorge Santos Simón, Joachim Hertzberg, International Conference on Intelligent Robots and Systems 2018 (IROS 2018)



Mesh Face Cluster

```
# MeshFaceCluster
uint32[] face_indices
# label (optional)
string label

# MeshFaceClusterStamped Message
std_msgs/Header header
string uuid
MeshFaceCluster cluster
# overwrite existing labeled faces
bool override
```



Mesh Materials & Textures

```
# MeshTexture
string uuid
uint32 texture_index
sensor_msgs/Image image

# MeshMaterial
uint32 texture_index
std_msgs/ColorRGBA color
bool has_texture

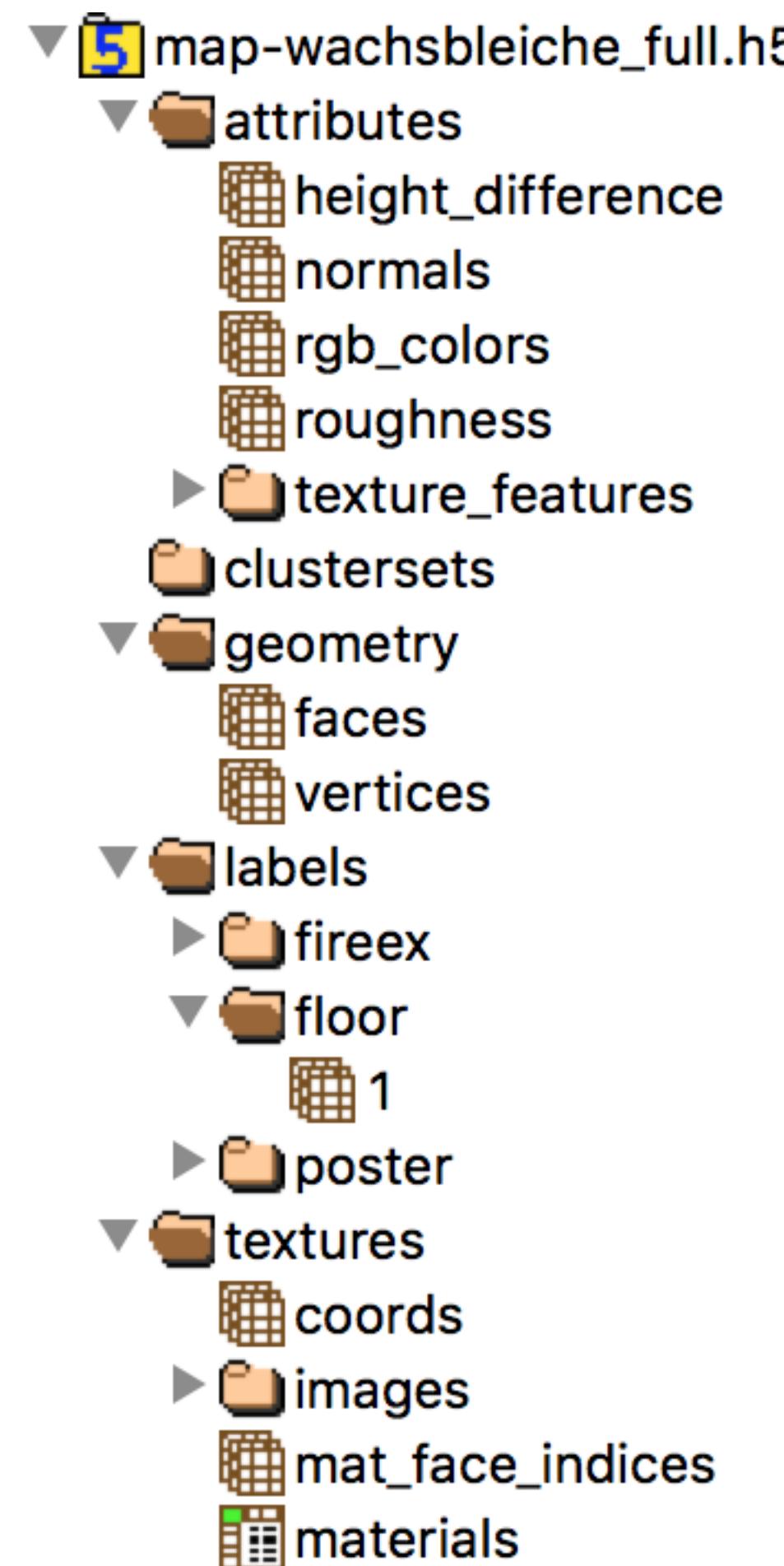
# MeshVertexTexCoords
float32 u
float32 v
```

```
# MeshMaterials
mesh_msgs/MeshFaceCluster[] clusters
mesh_msgs/MeshMaterial[] materials
uint32[] cluster_materials
mesh_msgs/MeshVertexTexCoords[]
    vertex_tex_coords
```

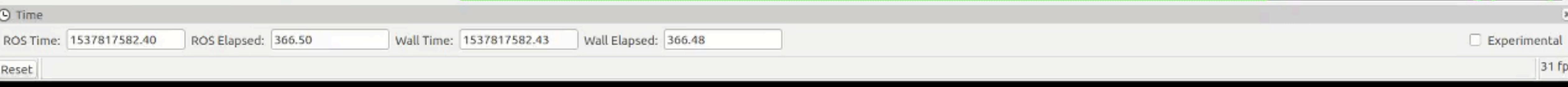
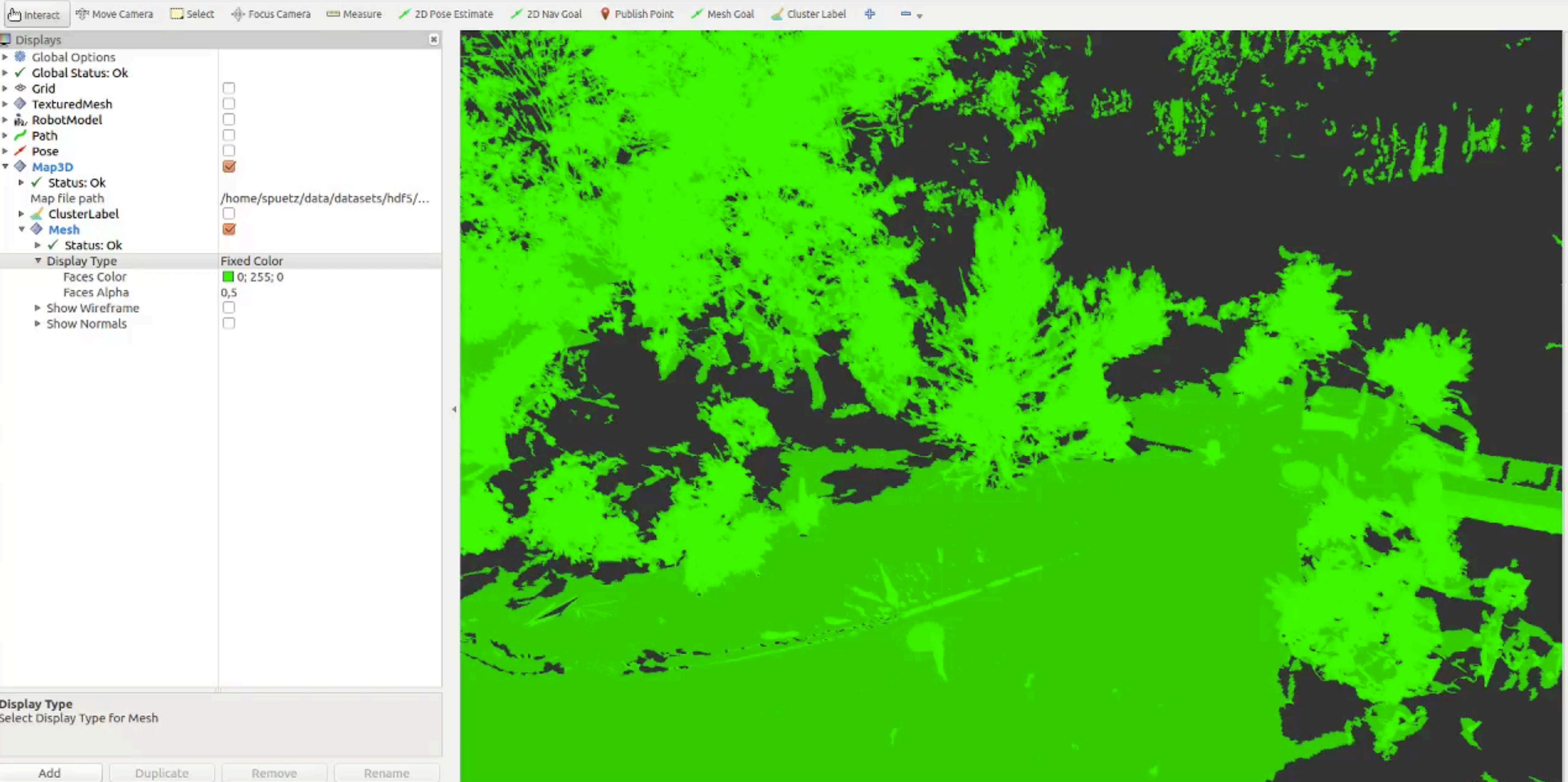
```
# MeshMaterialsStamped
std_msgs/Header header
string uuid
mesh_msgs/MeshMaterials mesh_materials
```

Hierarchical Data Format IO

- Representation of complex data structures metadata.
- Portable file format
- No limits (number or size of data)
- C, C++, Python, Fortran 90, and Java interfaces.
- Storing pre computed mesh layers, e.g. roughness, height differences, and semantic information
- Storing textures like, RGB images or even textures generated by a hyper spectral camera.



Markerless Ad-hoc Calibration of a Hyperspectral Camera and a 3D Laser Scanner. Felix Igelbrink, Thomas Wiemann, Sebastian Pütz, Joachim Hertzberg, 15th International Conference on Intelligent Autonomous Systems (IAS 2018)



github.com/uos/mesh_tools

wiki.ros.org/mesh_tools