

LidarView

LidarView, the advanced 3D data visualization tool, now connected to ROS2!

Gatien Ferret, Kitware Europe

kitware

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Summary

- Kitware Presentation
- LidarView Introduction
- ROS2IO Plugin
- LidarView Algorithms
- Demo
- Conclusion

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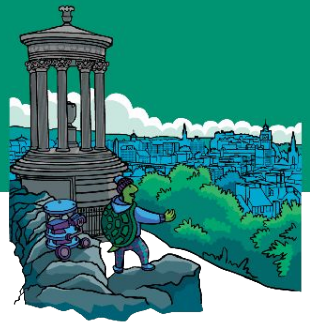
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Kitware Presentation

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Kitware / Leader in AI & scientific open source solutions

Software development
Based on open source tools
300+ active projects worldwide

Sustained Growth
Over $50M revenue

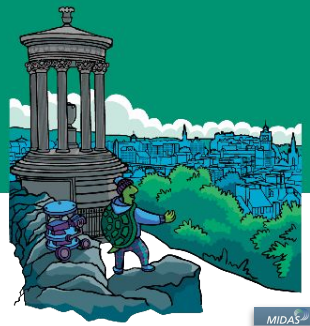
230 employees Worldwide
6 offices across USA/Europe (Lyon, FR)

Most staff with PhD or Master
High Level customer expertise

25+ years of expertise
Kitware USA, 1998
Kitware Europe, 2010

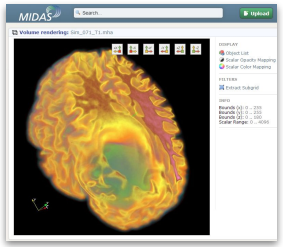
Founded on Open Source
Vibrant, enduring platform/communities
Strong commitment to Open Science

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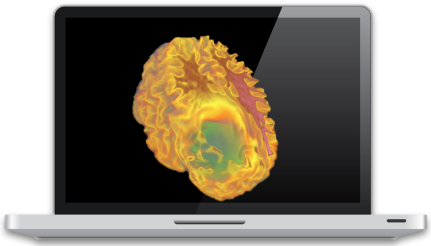


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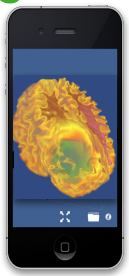
Applications / Universal Platforms



Web



Desktop



Mobile

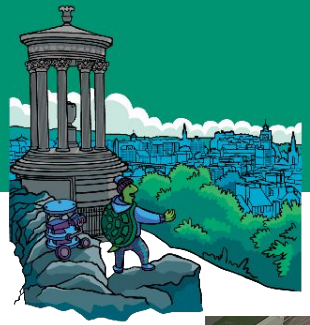


Cloud /HPC

kitware **Platforms**

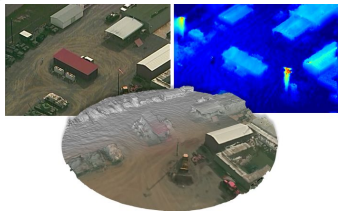
VTK ParaView CMake KWIVER

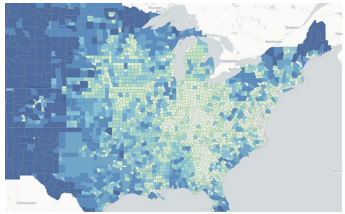
trame 3D Slicer LidarView VIAME ITK

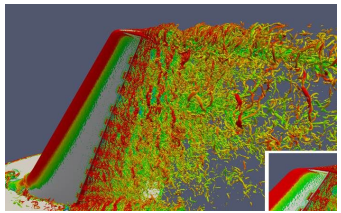


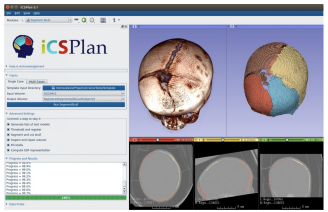
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Areas of expertise / Built on open source











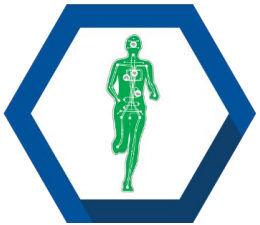
Computer Vision



Data and Analytics



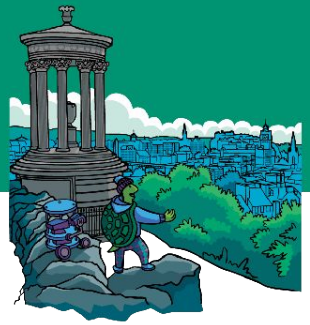
Scientific Computing



Medical Computing



Software Solutions



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Kitware / Services

- TRAINING
- SUPPORT
- DEVELOPMENT
- GRANT COLLABORATION

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LidarView Introduction

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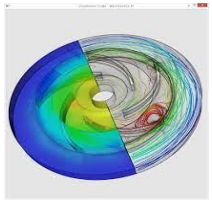
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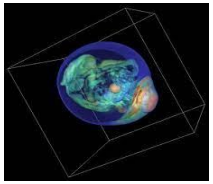
VTK / Cross-Platform Visualization Toolkit (1993)

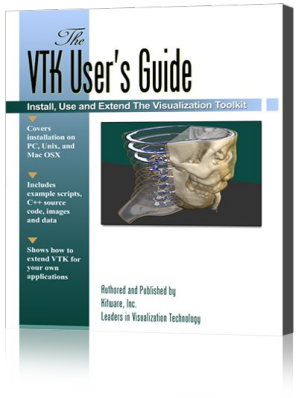
Open-source (BSD-3 licence), freely available, cross-platform toolkit for post-processing and visualization of scientific data

VTK





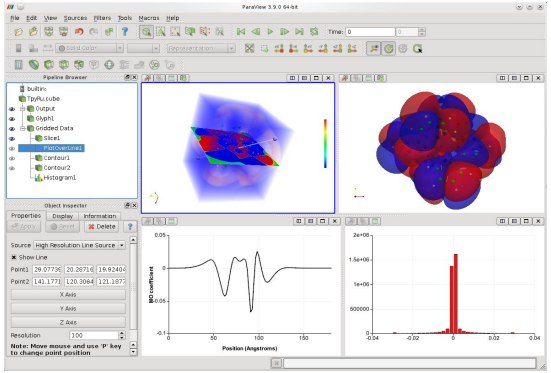


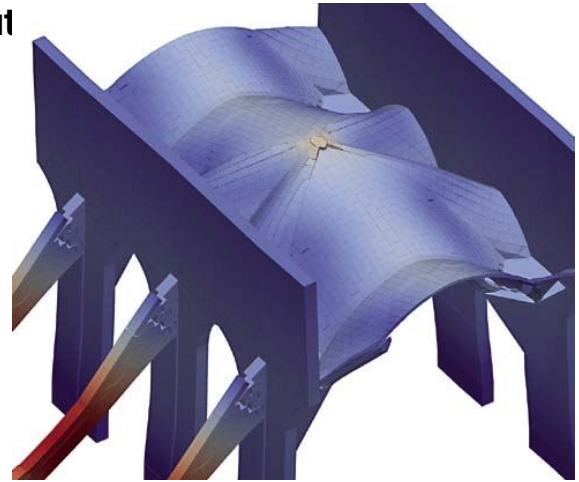




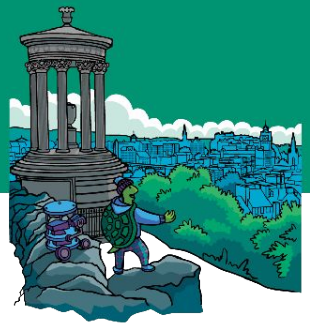
ParaView / High-Performance Post-Processing (2002)

- Open-source, multi-platform, data analysis and visualization application
- Analysis of extremely large datasets using distribut memory computing resources

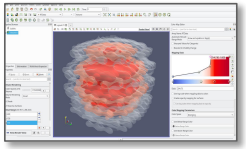




Notre-Dame Damaged Structure Study with Cast3M - https://theses.fr/api/v1/document/2023PESC2018



ParaView Ecosystem



ParaView Client

jupyter

PyTorch

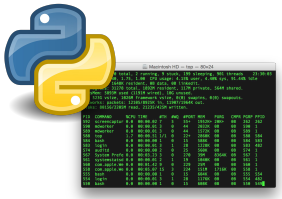
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OpenXR

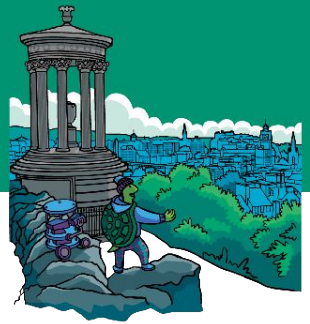


ParaView Server

ParaView Catalyst



Batch mode
(ParaView Python)



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ParaView / High-Performance Post-Processing (2002)

Velodyne Lidar

HESAI

LIVOX

robosense

OUSTER

LSLIDAR

Many others in
private plugins

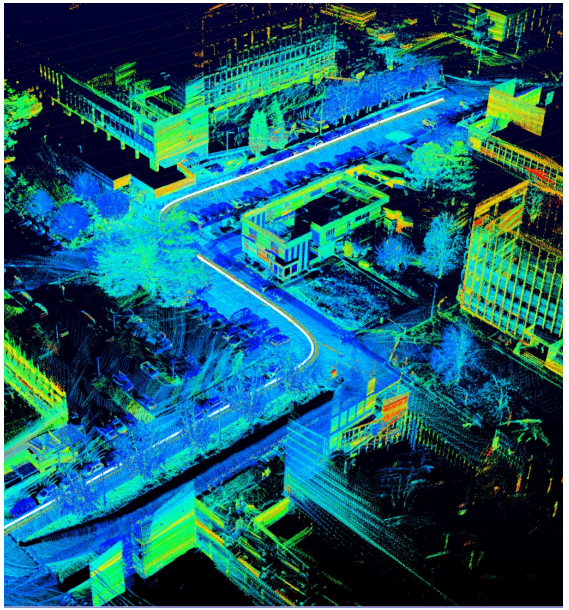


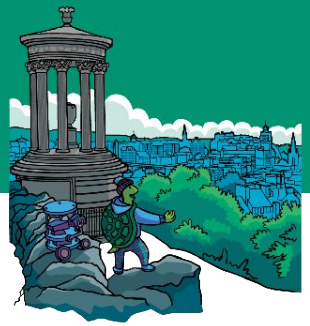


LidarView / A ParaView Based App (2019)

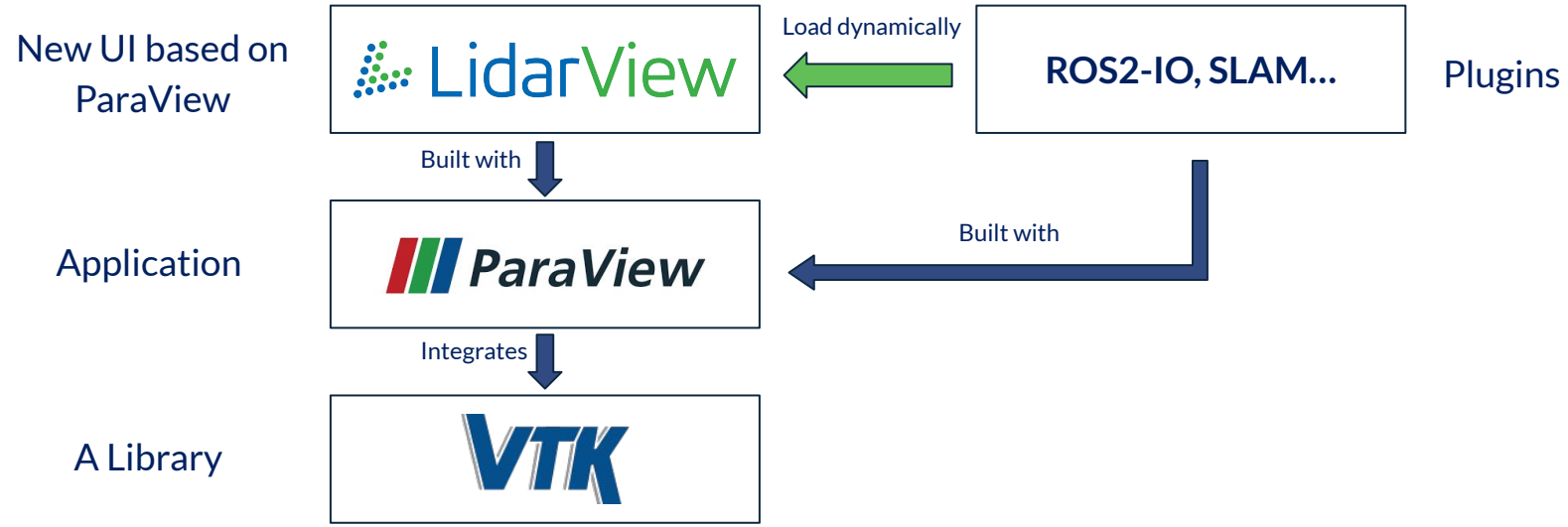
LidarView

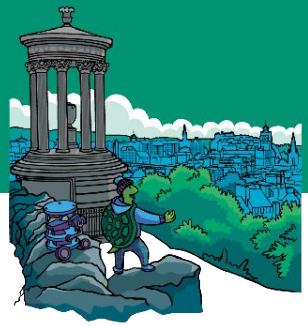
- Generic version of VeloView (2013) from Velodyne
- Adapted to real time and data replay
- Specialized in point cloud processing
- Interpret data directly from LiDAR UDP packets (.pcap) and can connect to sensors
- Connection to ROS2 Stream and MCAP handling
- Domain-specific filters ready to use (SLAM, object detection, segmentation)





LidarView Architecture





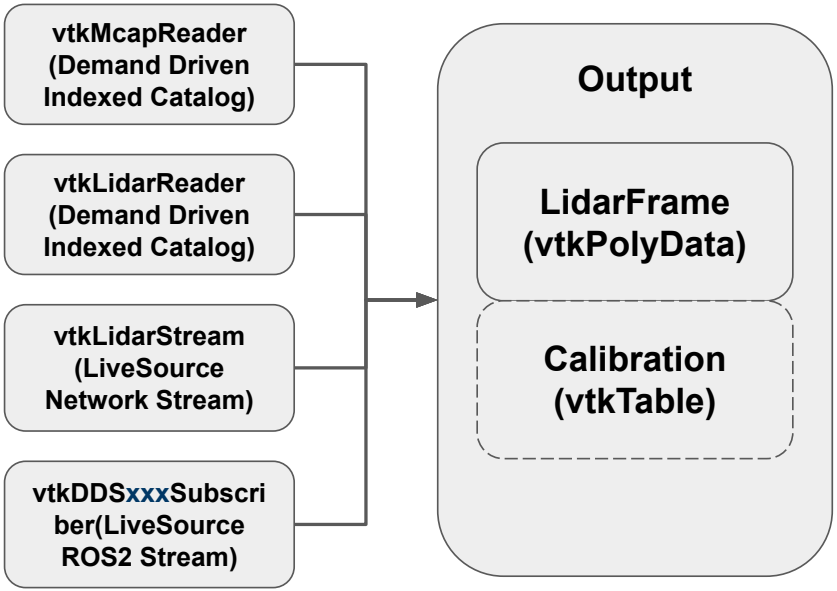
LidarView / Readers and streams

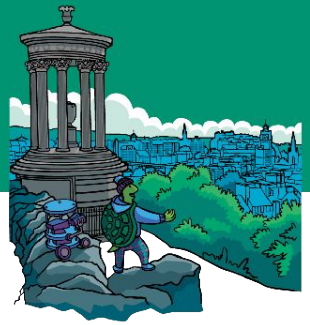
OpenMcap()
- Capture.mcap
  (Assuming ROS2 format)

OpenPcap()
- capture.pcap
- Calibration file (or within pcap)

OpenStream()
- UDP stream
- Calibration file (or within stream)

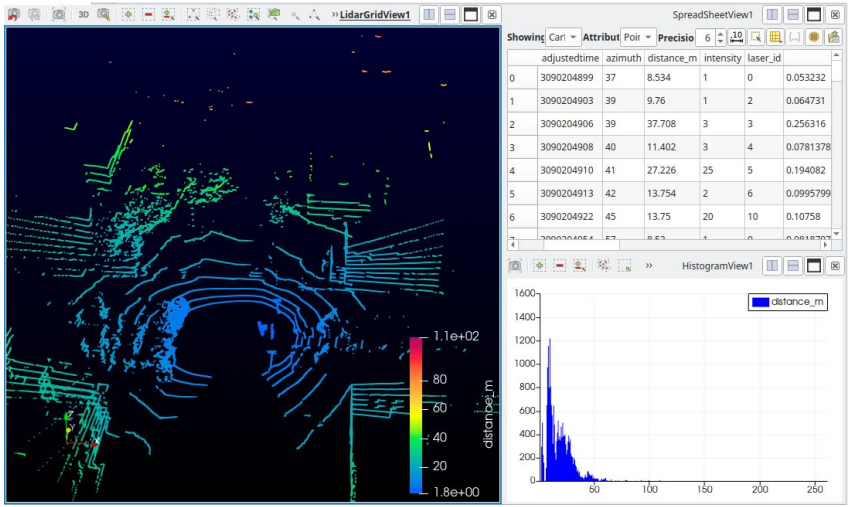
OpenROS2DDsStream()
- ROS2 DDS stream



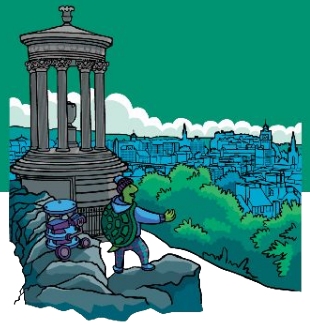


LidarView / View options

- Different types of view (3D view, spreadsheet, histogram…)
- Multiple views can be shown at the same times
- Render views can have the same linked camera
- Camera manipulation tools
- Save / load custom view points

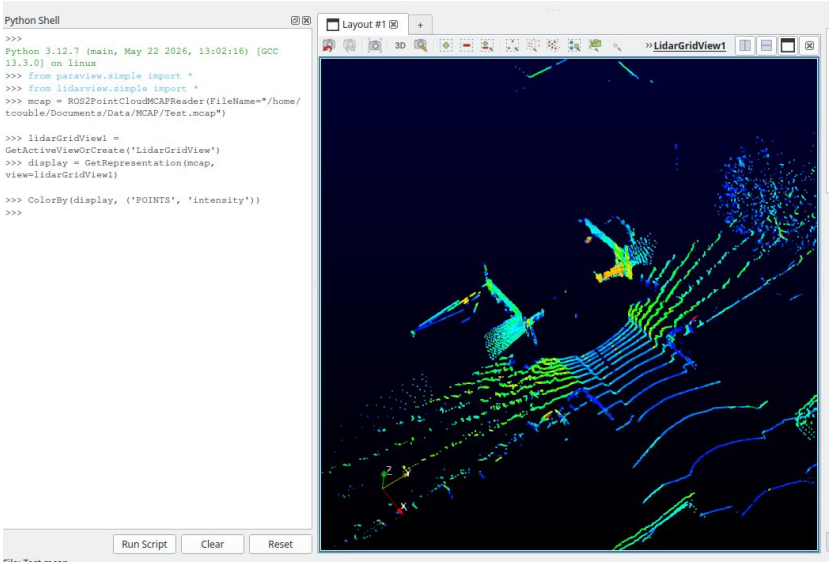






Lidarview / Integrated Python Shell

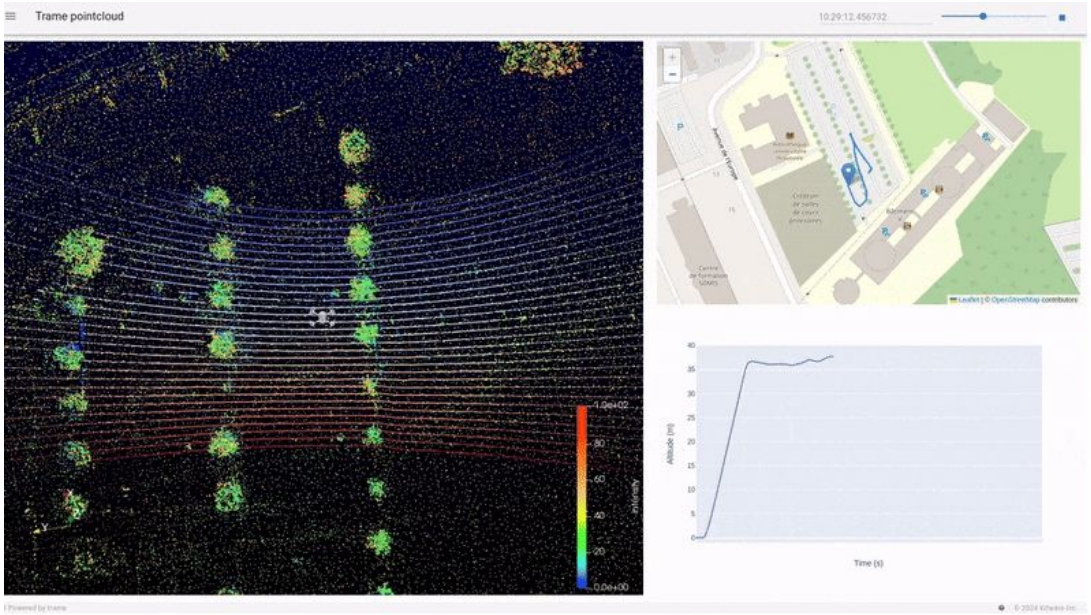
- A Python shell is accessible within ParaView / LidarView
- Python binary is also available
- Save everything happening in the UI in a Python script with a trace.
- Macro can be saved and accessible in UI
- Filters can also be implemented in Python





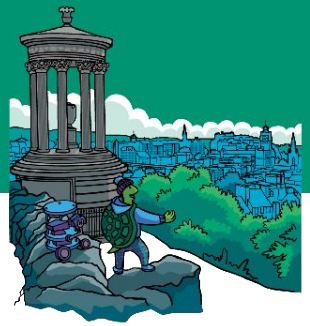
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LidarView on the Web with trame





ROS2IO Plugin



LidarView/ ROS2-IO Plugin Overview

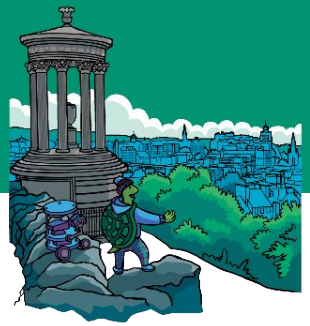
Started in 2023 - could initially only read point clouds in rosbag MCAP

Recent effort made it possible to:

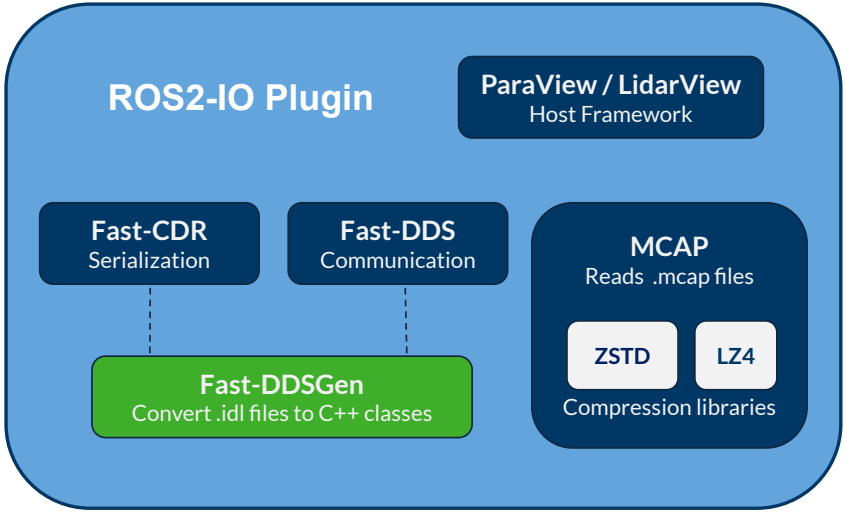
- **Read / Write MCAP**
- **Receive / Send topics using DDS protocol to communicate with ROS2**
- **Record received data in a mcap file**
- **Support multiple topics type:**
  - Point Cloud topics
  - Image data topics
  - Data oriented topics (in tabular format)

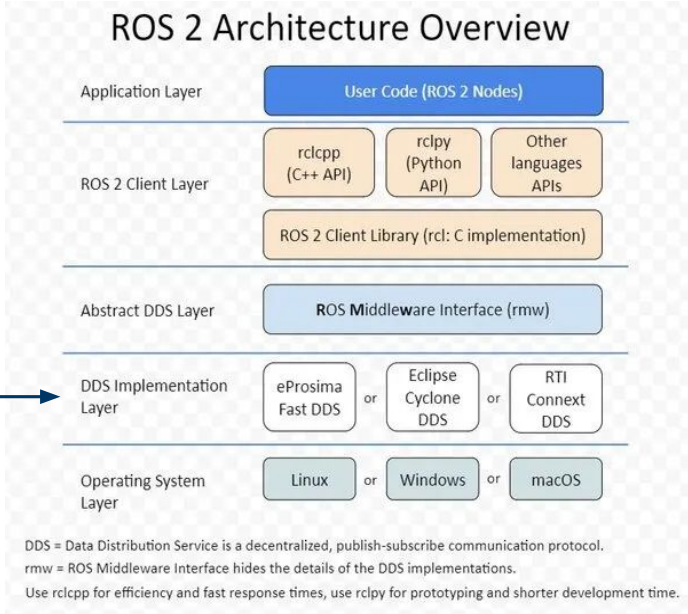
Supported received messages types are:

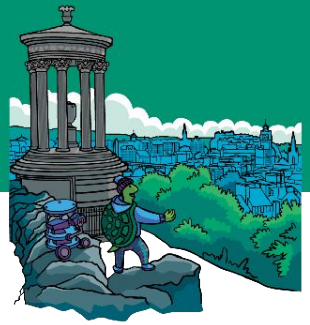
- Point clouds with `sensor_msgs/msg/PointCloud2` topic
- Table data with the followings topics:
  - `sensor_msgs/msg/Imu`
  - `sensor_msgs/msg/NavSatFix`
  - `nav_msgs/msg/Odometry`
  - `oxts_msgs/msg/NavSatRef`
- Image data with the followings topics:
  - `sensor_msg/msg/CompressedImage`
  - `sensor_msg/msg/Image`



LidarView/ ROS2-IO Plugin Implementation







LidarView/ Why using Fast-DDS directly ?

Advantages

- Skip ROS2 build toolchain
- No ROS2 runtime dependencies, Fast-DDS is self contained in plugin
- Easier cross-platform distribution
- Version-independent, as long as message definitions stay stable

Limitations

- Must replicate ROS2's implicit conventions (topic naming, QoS)
- Message types must be added and maintained
- No services/actions support

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LidarView available algorithms

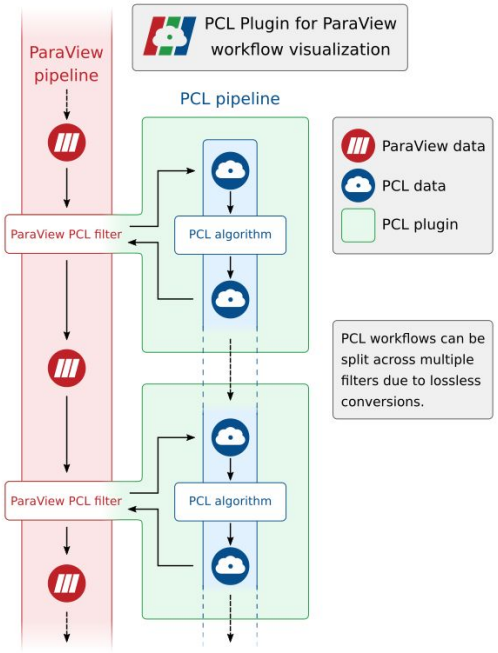
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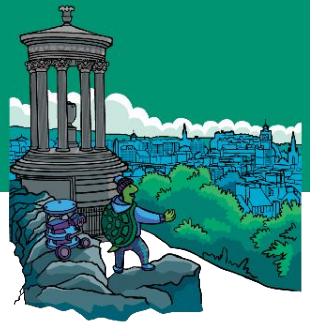
Algorithms/ PCL Plugin

- PCL functionalities wrapped in a ParaView plugin
- Prebuilt binaries are available with PCL 1.15
- Multiple modules are available:
  - Point cloud cleaning
  - Sample consensus
  - Segmentation
  - Surface (Meshing)
- Blog post



pointcloudlibrary

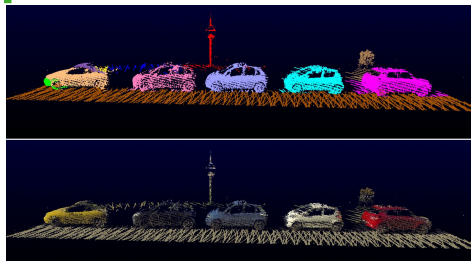
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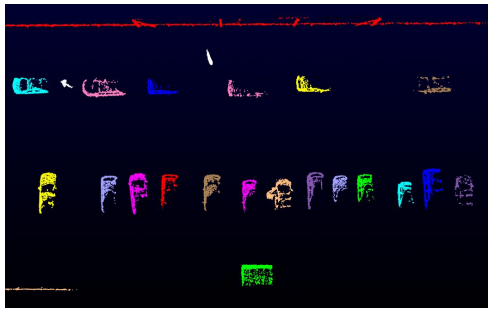
Algorithms/ PCL Plugin Examples



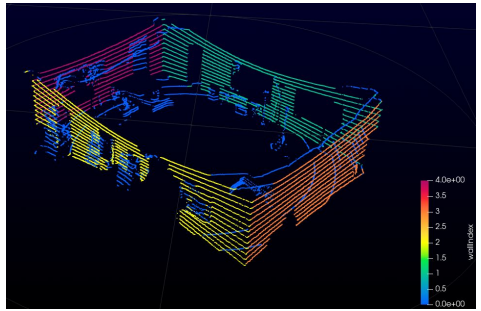
Meshing Algorithms



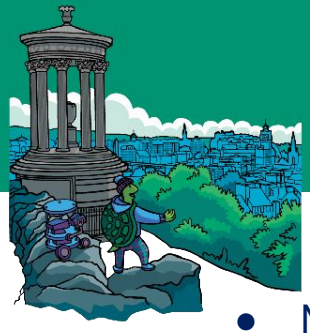
Region Growing by Color



Euclidean Cluster Extraction

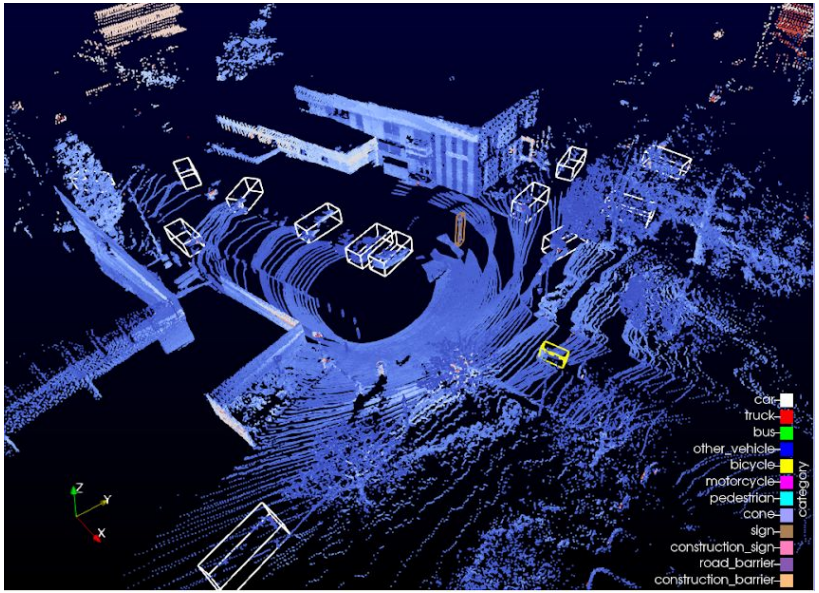


Wall Fitting filter based on multiple PCL algorithms

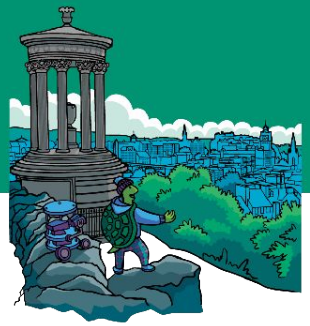


Algorithms / Object detection

- Motion Detector
  - Euclidean clustering
  - Gaussian Mixture Model
  - Region growing
- Image based clustering
- Kalman tracker
- Deep learning methods
  - Leveraging Pytorch, and ONNX based inference

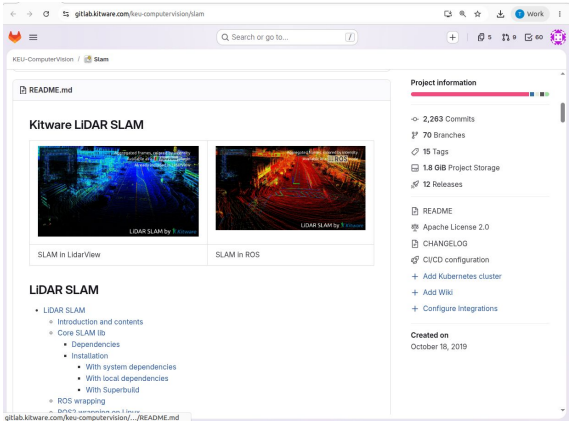


Detection with MMDetection3D in LidarView



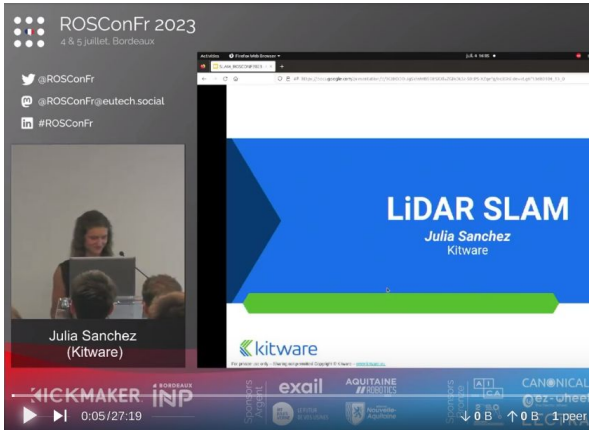
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SLAM / Simultaneous Localization And Mapping



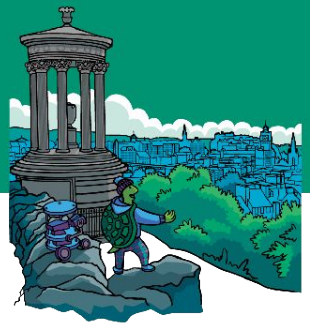
LiDAR SLAM library:

- Apache License 2.0
- ROS/ROS2 wrapper
- ParaView wrapper



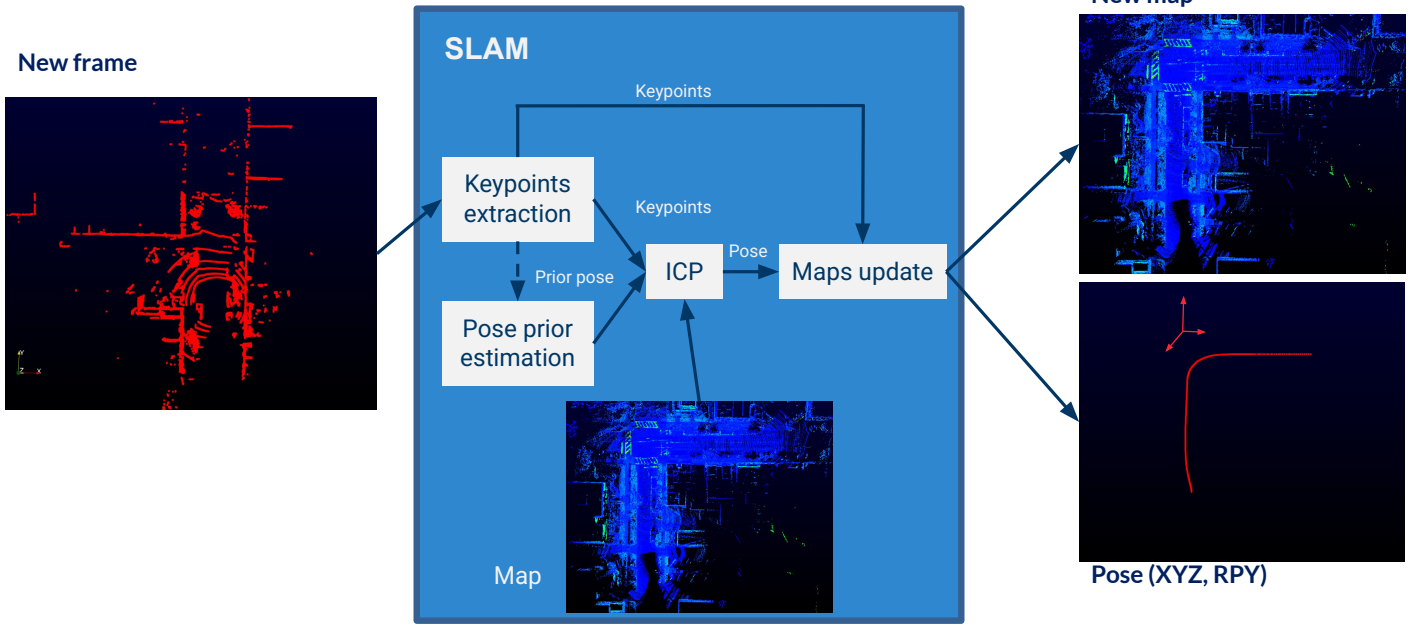
Presented in ROSConFr 2023

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SLAM / Simultaneous Localization And Mapping

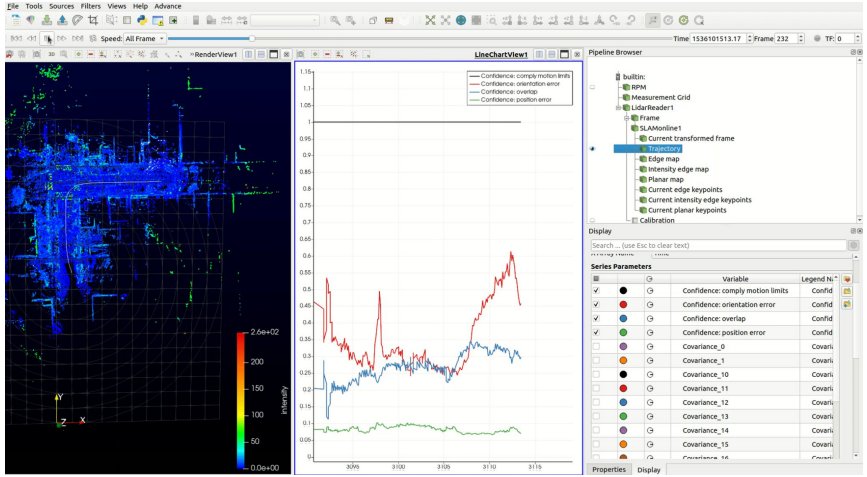


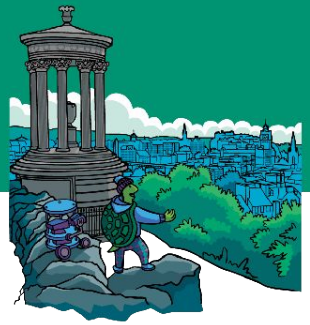


SLAM / Simultaneous Localization And Mapping

Features:

- External sensor support : INS / IMU / GNSS / Wheel encoder / Camera / Landmark
- Loop closure detection
- Confidence estimator
- Moving objects rejection
- Dense map generation
- Georeferenced map generation
- etc

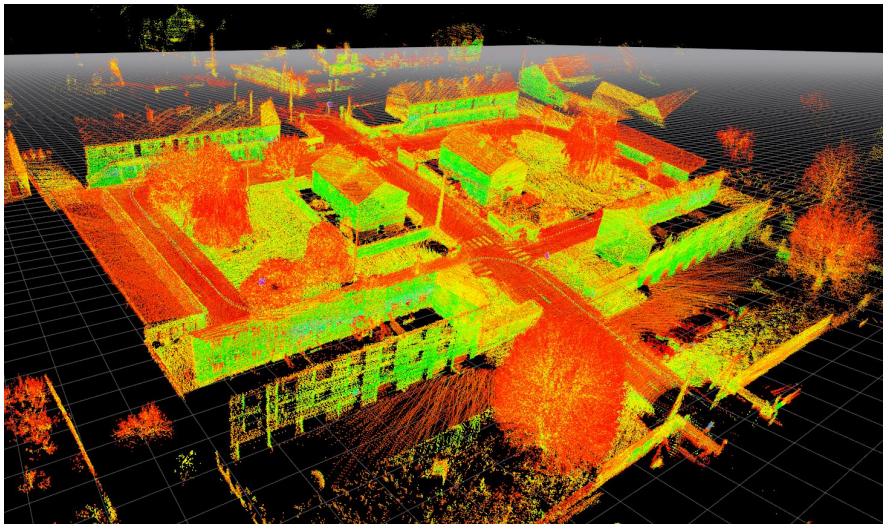


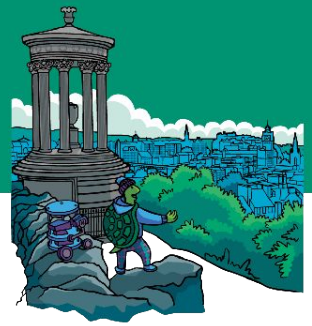


SLAM / Simultaneous Localization And Mapping

Applications:

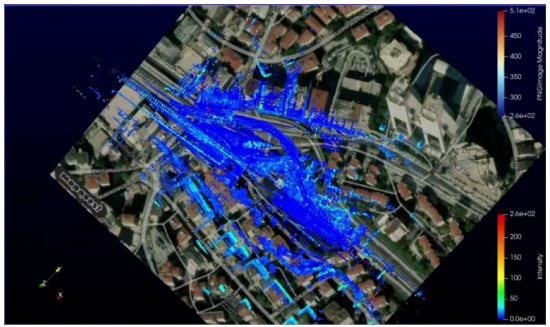
- Localization
- Map generation
  - SLAM output = keypoint maps
  - **Aggregation filter** : Filter to aggregate all the points with parameterizable resolution

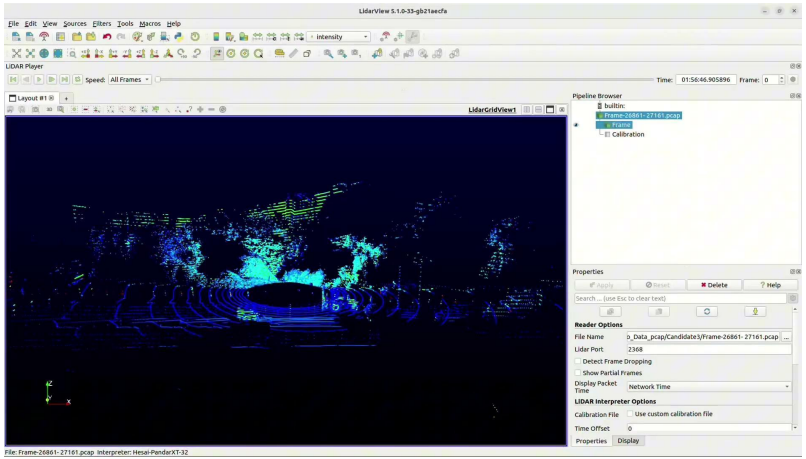


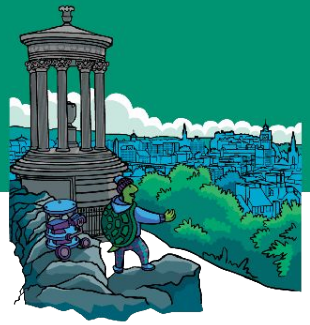


LidarView / Georeferencing Tools

- Downloaded maps from providers such as Google Maps, MapQuest and OpenStreetmap
- Colorize point cloud with satellite data
- Tools to align slam trajectory to map
- Blog post

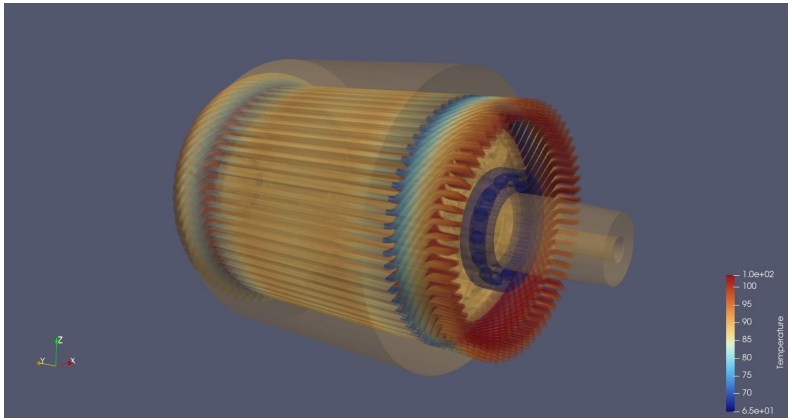






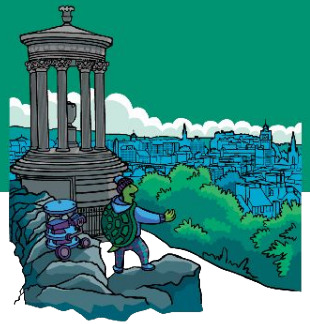
LidarView / Extension to other types of data

- Whenever data can be represented in 3D from a stream, you can use LidarView to visualize it and apply all the available filters to it
- Other exemple : T° Sensors equipped on an electric drive used to interpolate the Temperature within the drive
  - Could be applied on other use case where live data is acquired : Airflow visualization in buildings, Air Pollution in a city…
  - More complex interpolation / modelling schemes can be used: Physics informed simulation, Surrogate models
- BlogPost for more details





Demo Time



Conclusion

ROS2 — ROS2-IO — LidarView

- **For ROS2 users**
  - Access advanced ParaView / LidarView tools
  - SLAM, calibration and georeferencing
  - Convert easily from / to .mcap format
- **For non-ROS users**
  - Access ROS2 data without ROS expertise / environment
  - Reuse existing LidarView workflows
  - Explore ROS2 datasets interactively

Other works with ROS2 at Kitware

- **Real time AI pipeline for object detection of video**
  - Plugin ros with GStreamer / ONNX
- **Infrastructure Analysis**
- **ROS2 integration for medical robot integration in 3DSlicer**



ROSCon UK '26 EDINBURGH

Thank you!

Questions to the audience:

- What features can be useful in your work?
- What is missing in your opinion?
- Other needs in point cloud visualisation?

Contribute !

LidarView

ROS2-IO

SLAM

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