使用的eigen版本需和pcl的一致，

科学实验方法的三个原则: 可比较(可评估)、可复现(稳定重复)、可证明(可解释) 算法内在：什么参数、不同参数下表现的差异 算法外在：准确度、精度

The first one is to remove some points that do not bring any valuable infor- mation for the registration. As the complexity of the algorithm is linear in the number of points, reducing this number can have a significant impact on the time of registration. The second use of filters can be to add information to the point. The typical example is the inference of local structural properties of the shape, such as normal information or curvature. This information, which is usually not present in the raw sensor data, can allow for better registration through a more precise association of the points, or the computation of the error to minimize

$$ \hat{T^B_A}=arg\min_{T}(error(T(P^A),Q^B)) $$

different platform

parameters	Arto(rough Terrain outdoor robot)
DataFilter	

1. Reading and Reference Sources shapes P are point clouds and can be written in a matrix form with each column a point vector: $$\mathcal P = \bold{P}=[p_1\quad p_2\quad ...\quad p_N]$$ where $p_i$is a point and N the number of points in the point cloud

2. Transformation Functions In case of a rigid transformation, if points are represented using homogeneous coordinates, a transformation T can be represented as a matrix T such that:

   $$\mathcal T(\mathcal P) = \boldsymbol{TP} = [\boldsymbol{T}\boldsymbol{p_1}\quad \boldsymbol{T}\boldsymbol{p_2}\quad ...\quad \boldsymbol{T}\boldsymbol{p_N}]$$

   $\boldsymbol{T}$ is then of the form:

   $$\boldsymbol{T} = \begin{bmatrix}\boldsymbol{R} & \boldsymbol{t} \\ \boldsymbol{0^T} & 1 \end{bmatrix} $$

   where$\boldsymbol{R}$ is a rotation matrix and $\boldsymbol{t}$ is a translation vector

   The generic formula computiing the final transform Equation becomes a simple matrix product:

   $$ \begin{aligned} \hat{\mathcal{T}}_{\mathbb{A}}^{\mathbb{B}} = ({\mathop{\bigcirc}\limits_{i}}\mathcal{T}_{i-1}^i)\circ\mathcal{T}_{init} \\ \Leftrightarrow \hat{\boldsymbol{T}}_{\mathbb{A}}^{\mathbb{B}}=\left(\mathop{\prod}\limits_{i}\boldsymbol{T}_{i-1}^i\right)\boldsymbol{T}_{init} \end{aligned} $$

3. Data Filters

   - Feature Enhancement

   - Descriptor Enhancement

- Feature Reduction features are sparse but not uniformly distributed. Nevertheless, the fact that sensors can provide a huge number of readings on a short period of time reates a bottleneck in term of computation power for the association as explained later

- Sensor Noise example1: random subsampling in order to decimate the point cloud:

  $$\mathcal{P}^{\acute{}} = datafilter(\mathcal{P}) = \left{\boldsymbol{p}\in\mathcal{P}:\eta(\boldsymbol{p}) < \theta\right}$$

  where $\eta\in[0,1)$ is a uniform-distributed random value and $\theta \in [0, 1]$ a fixed threshold, corresponding to the fraction of points to keep

  example2: the computation of normal vectors in a point cloud:

  $$\mathcal{P}^{\acute{}} = datafilter(\mathcal{P}) = \left{\boldsymbol{p}\in\mathcal{P}:\eta(\boldsymbol{p}) < \theta\right}$$