Improvements in Registration phase of 3D Scanning

The previous work that was done in registration phase of 3D Scanning was based on traditional approach and existing registration method. Here in this report we have tried to propose a new approach which if used with registration phase gives more efficiency and effectiveness to the results.

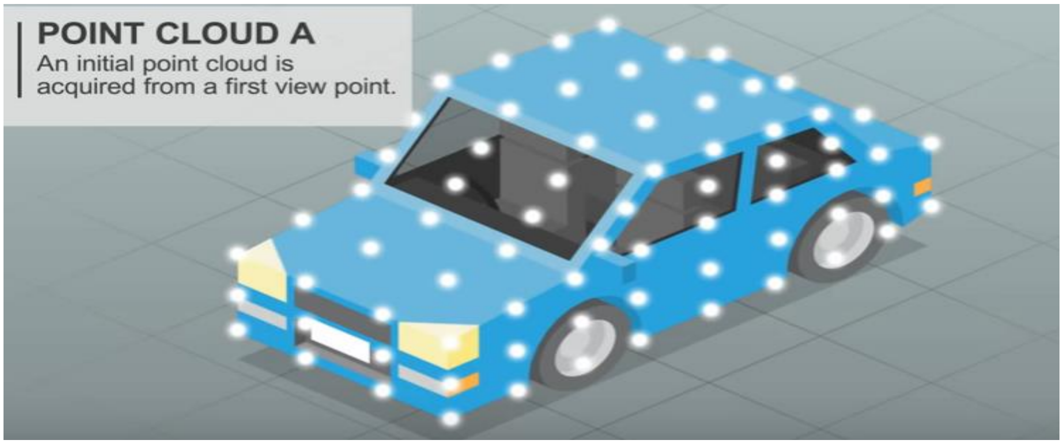
3D point cloud registration is a fundamental and critical issue in 3D reconstruction and object recognition. Most of the existing methods are based on local shape descriptor. Here, we propose a Regional Curvature Map (RCM) method. Based on the RCM, an efficient and accurate 3D point cloud registration method is presented. We firstly find 3D point correspondences by a RCM searching and matching strategy based on the sub-regions of the RCM. Then, a coarse registration can be achieved with geometrically consistent point correspondences, followed by a fine registration based on a modified iterative closest point (ICP) algorithm.

The experimental results demonstrate that the RCM is distinctive and robust against normal errors and varying point cloud density. The corresponding registration method can achieve a higher registration precision and efficiency compared with two existing registration methods.

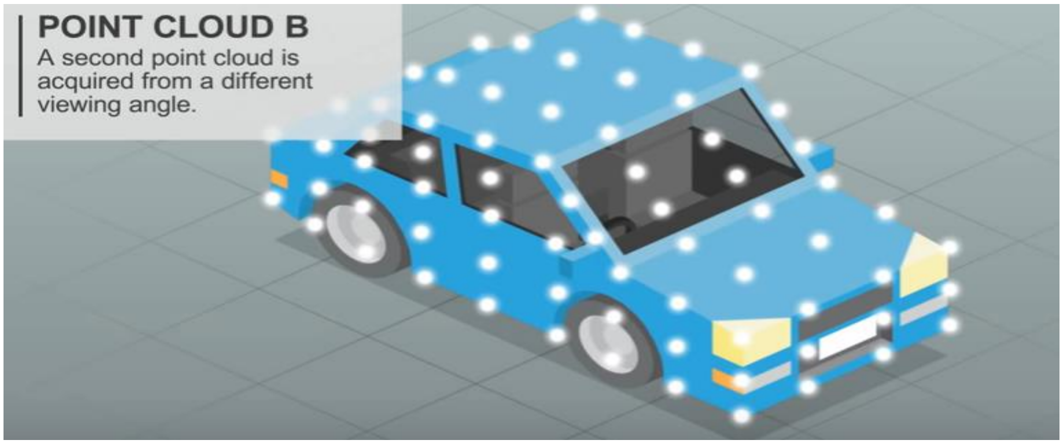
Traditional point cloud Alignment: -

Suppose an object requires a 360-degree 3D digitization.

An initial point cloud is acquired from a first view point. A second point cloud is acquired from a different viewing angle. If the relative camera position is unknown the two-point clouds cannot be easily aligned with current technology.



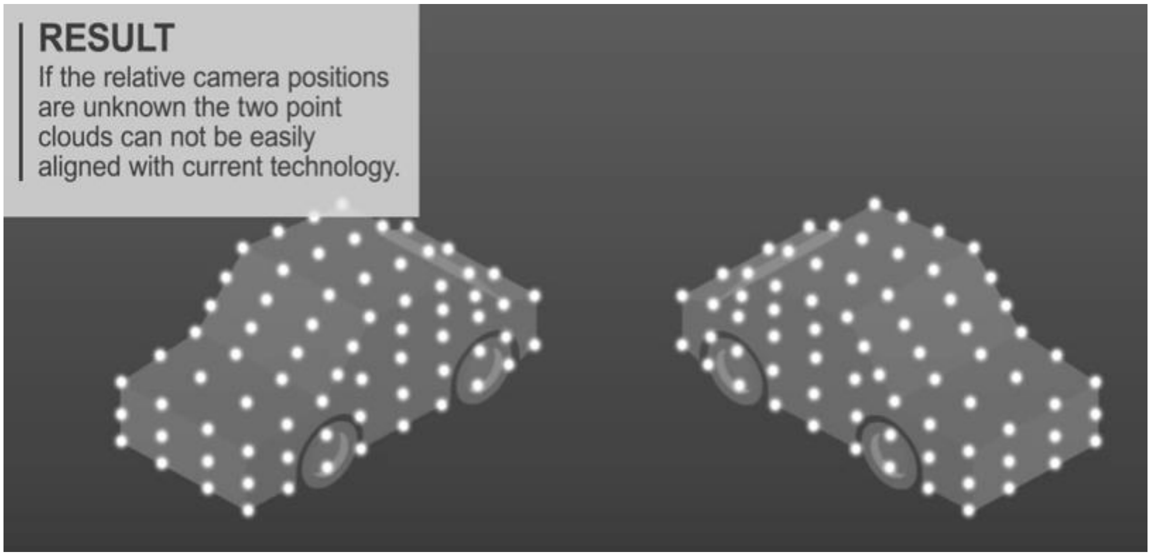
Initial Point Cloud A



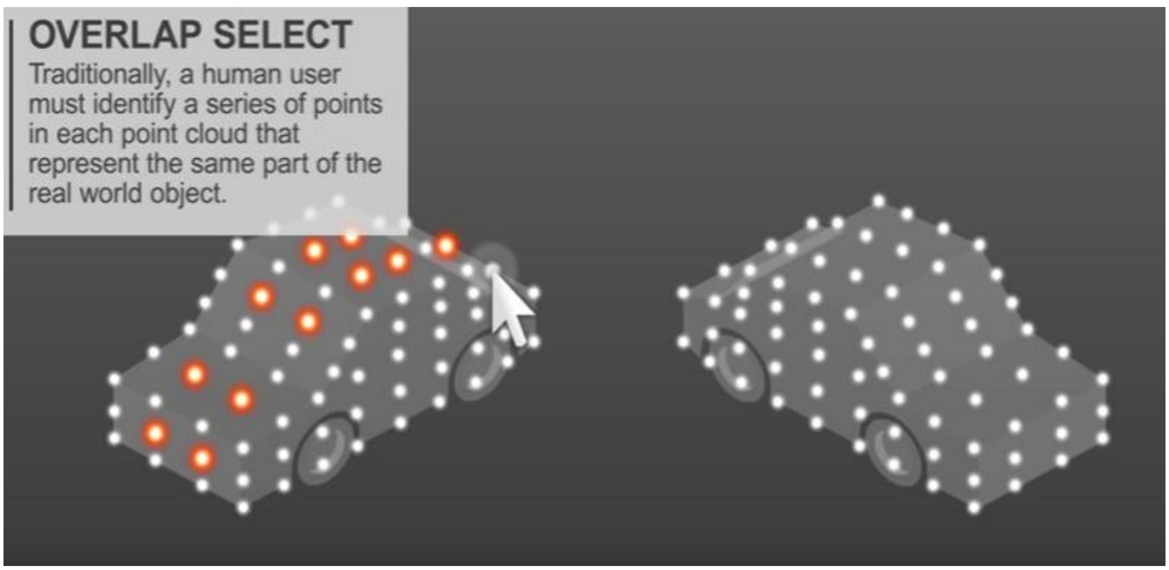
Initial Point Cloud B

As any registration problem, range registration consists of the steps of matching and estimation of the rigid transformation. Depending on the displacement and orientation between point clouds, we differentiate between crude and fine. alignment. The challenge in crude registration lies in performing it automatically and consistently even when there is very small overlap. The golden standard for fine registration is the Iterative Closest Point algorithm and its variants. ICP techniques either assume a rough alignment of the two-point sets or run the algorithm multiple times by sampling the space of initial conditions. In commercial products, initial alignment is achieved manually or using characteristic markers in the scene. They further rely on a significant percentage of overlap between the two-point sets. Another group of techniques depend on the extraction of local features with such distinguishable attributes that correspondence becomes a non-iterative task. Robust variations like RANSAC reject outliers and improve the estimation of the rigid transformation.

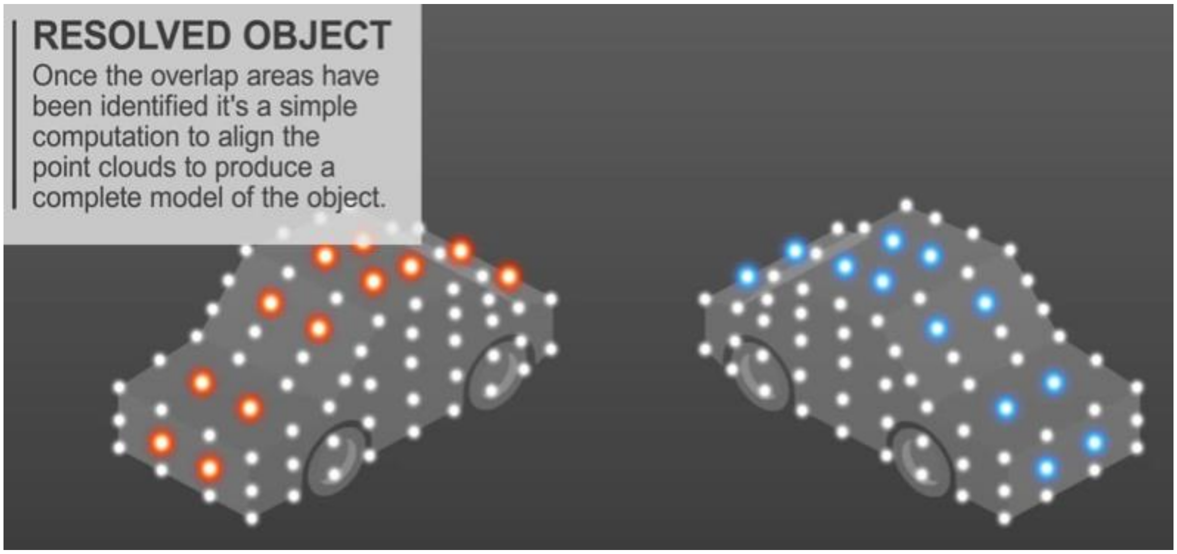
Traditionally a human user must identify a series of points in each point cloud that represent the same part of the real-world object.



Two frames of object

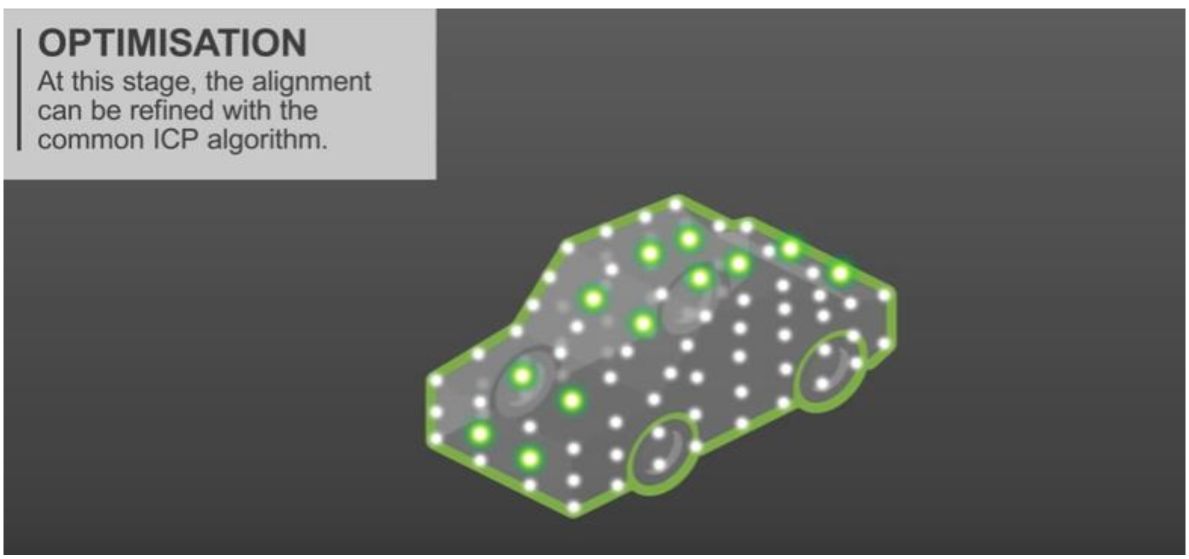


Identification of Series of point on Cloud A.



Identification of Series of point on Cloud B.

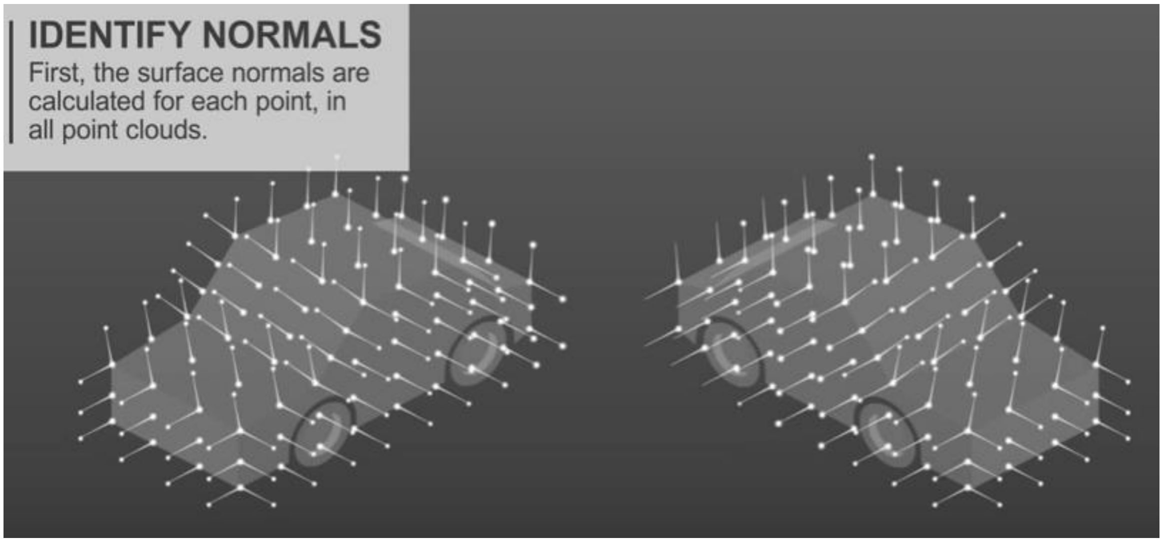
This process has the potential to be time consuming and incorrect. It also becomes impractical processing multiple point clouds such as in video. Once the overlapped areas have been identified it is a simple computation to align the point clouds to produce a complete model of the object.



At this stage the optimization needs to be done and so the alignment can be refined with the common ICP algorithm.

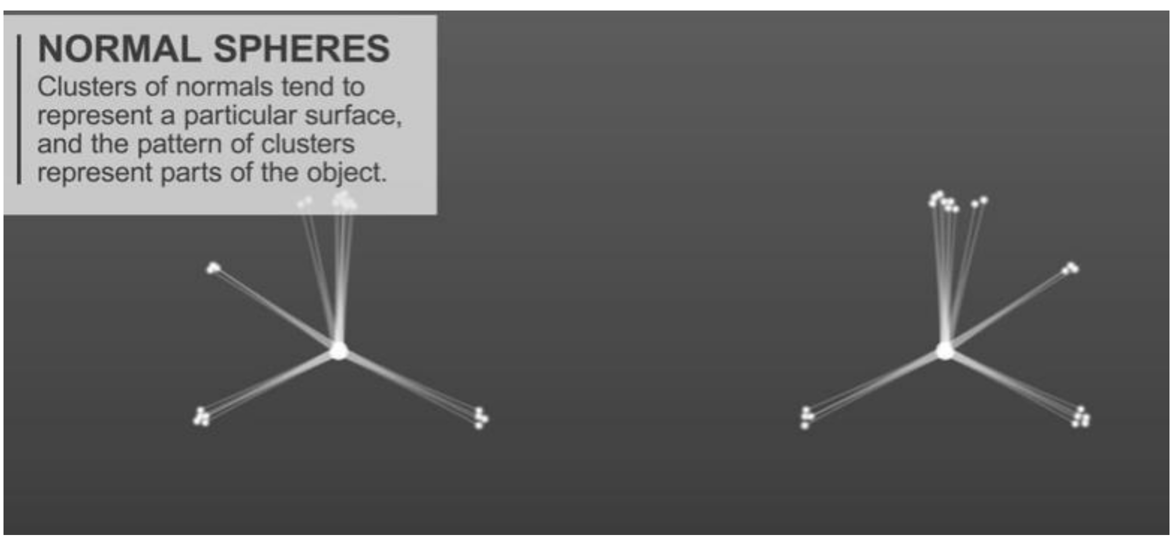
Proposed Modern Technique for Point Cloud Alignment: -

In a different technique the 3D point cloud registration can be done using identifying normal. First the surface normal are calculated for each point, in all point clouds, the normal are collected on a common origin forming clusters on a sphere.



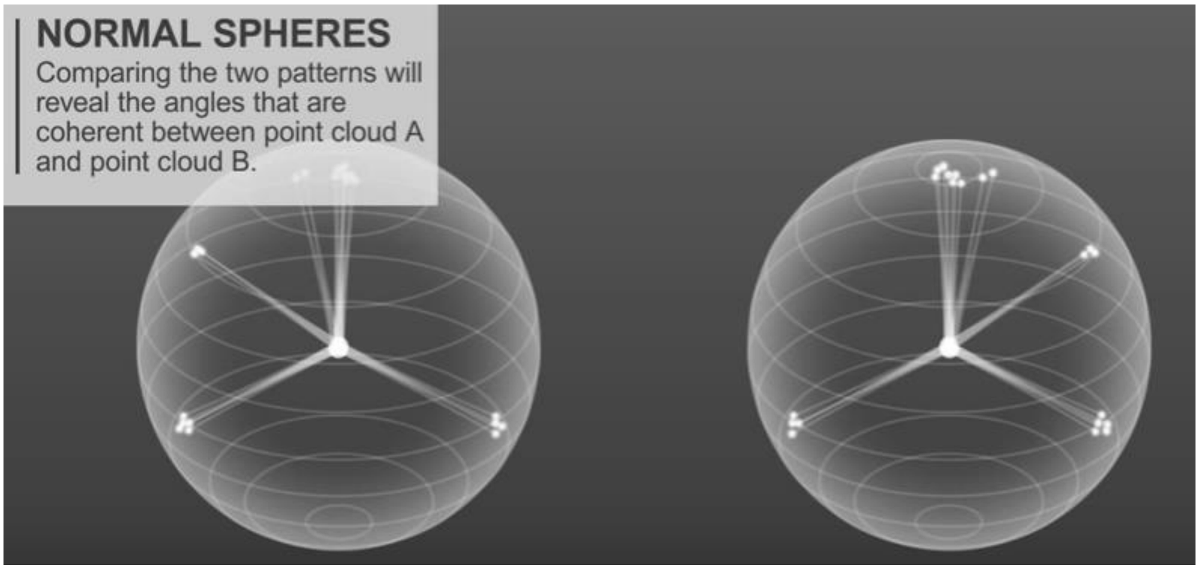
Surface Normal for all Points

Clusters of normal tend to represent a surface, and the pattern of clusters represent part of the object. Comparing the two patterns will reveal the angles that are coherent between point cloud A and point cloud B.



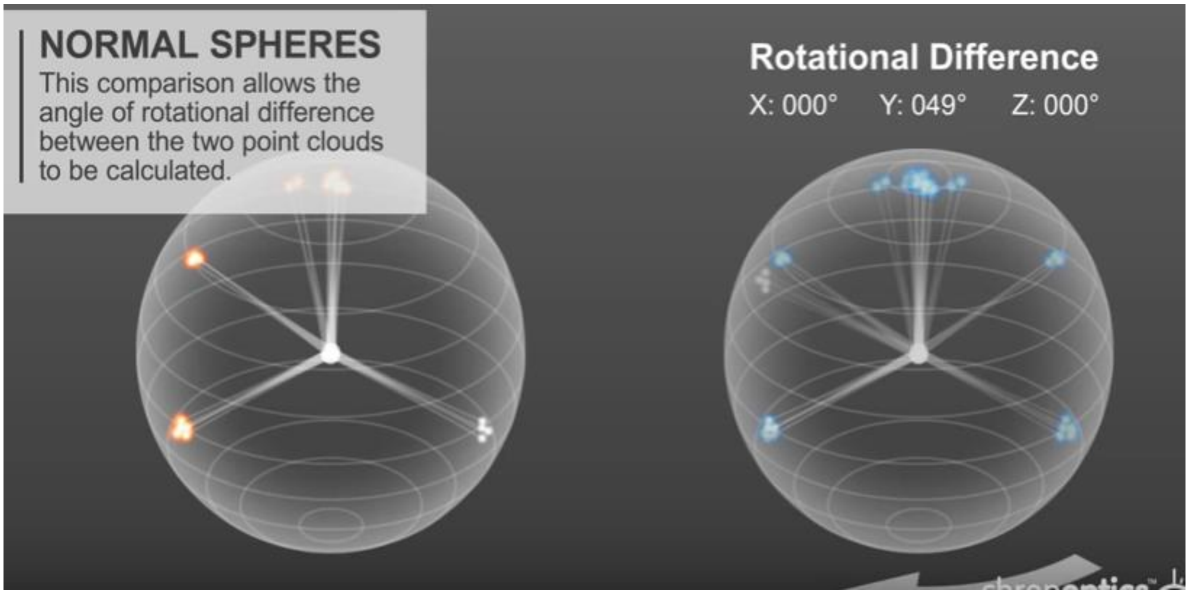
Clustering at Origin

This comparison allows the angle of rotational difference between the two-point clouds to be calculated.

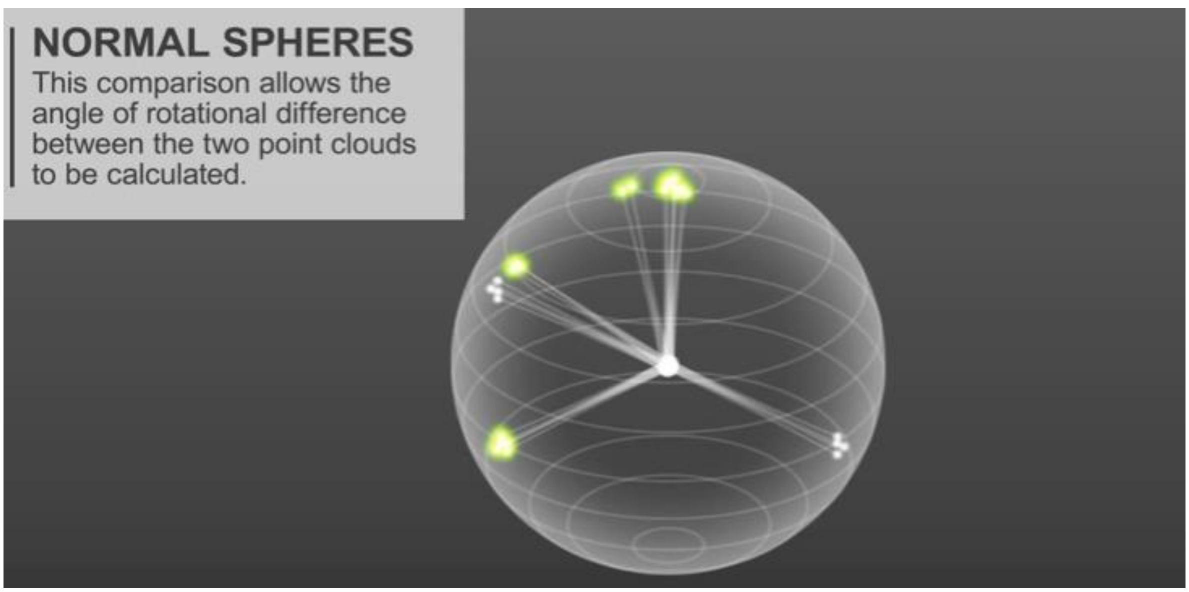


Comparison of Normal Spheres

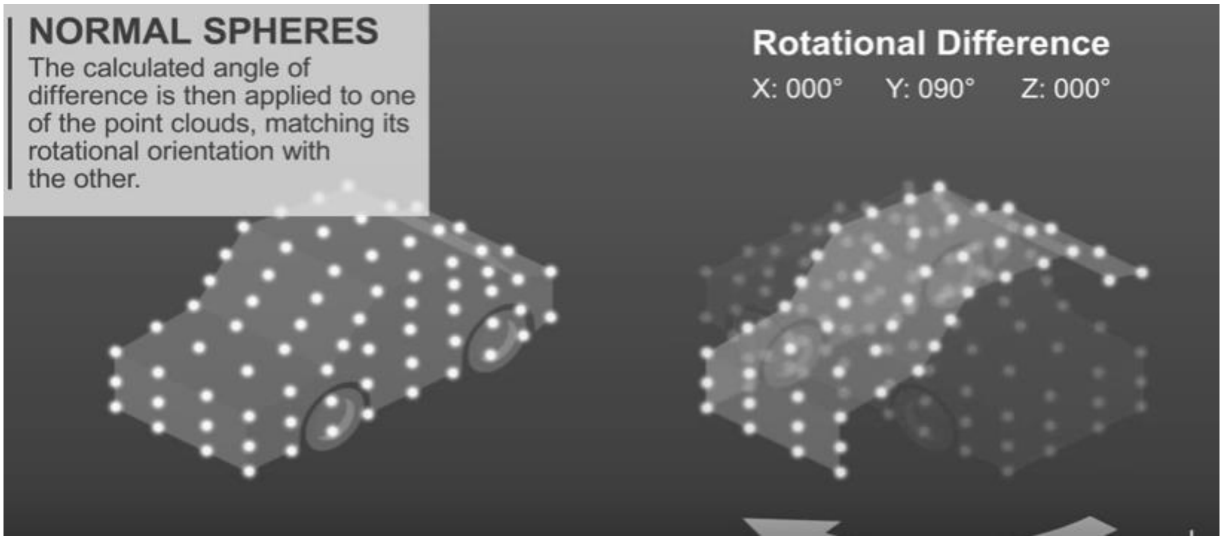
The calculated angle of difference is then applied to one of the point clouds, matching its rotational orientation with the other. The final step is simply to translate one-point cloud over to the other until it overlaps.



Rotational Difference Calculation

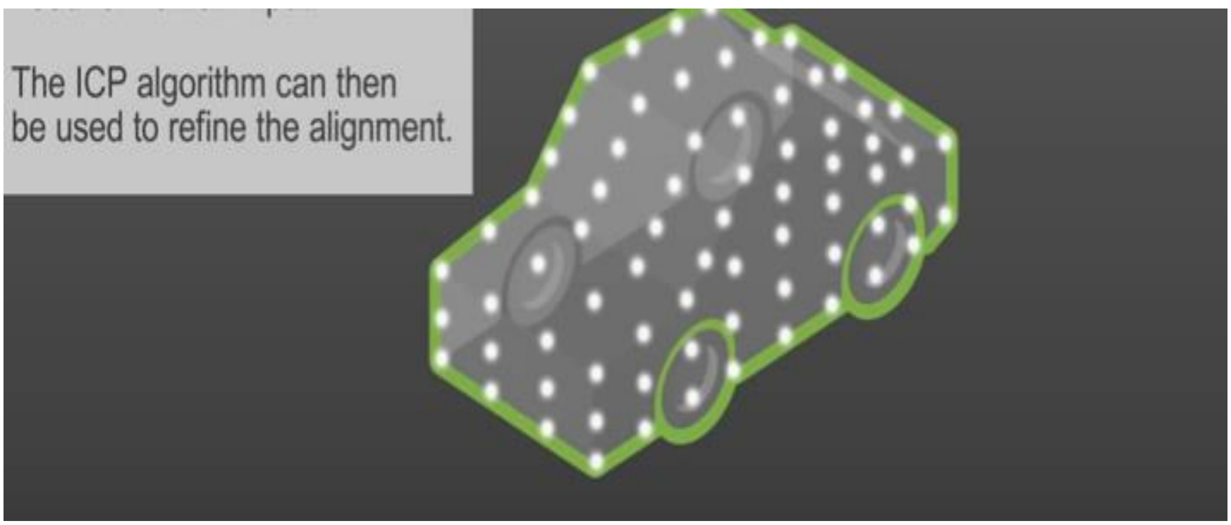


Overlapping of two Normal Spheres.



Difference angle applied to point clouds.

The result is a course alignment of point clouds with large unknown separation angles. The ICP algorithm can be then used to refine the alignment



ICP algorithm for refinement