Point cloud to 3D object map

An automatic approach for map data reduction

Autonomous systems need to be able to carry out localization and navigation accurately in real-time. This can be done with help from highly accurate sensors. However, this is expensive and not an option for production cars. Therefore, an accurate and highly resolved 3D map can be explored as a cheaper option.

A dense XYZIRGB point cloud of the AstaZero city area has been obtained from WSP as base for a 3D map. The point cloud consists of 80 million points and requires 2 GB storage memory. Hence, the data need to be reduced to for example a map consisting of objects in order to carry out real-time calculations such as positioning algorithms. The work here has focused on making as many parts as possible of this reduction automatic.

At first, different areas such as road, vegetation, grass, road side and buildings are detected using simple statistical analysis. The points are divided into a two dimensional grid and the patches in the grid are classified accordingly. Then, different objects are detected. The objects are poles (cylinders), walls (rectangles), lane markings (rectangles) and road edges. The objects are identified and described by their respective shape parameters; cubes or cylinders. When the objects have been detected and parameterized as different shapes, the objects are stored in a binary object map which can be viewed in different layers. The map can also be described in OpenDRIVE format, but this requires more processing and some manual input.

The result shows a promising procedure for fast scanning and mapping. The object map is compared to the original point cloud, and the comparison shows that the objects are located very accurately. The error between the map and the point cloud is at most 2 cm. The initial data has been greatly reduced from a 2 GB point cloud to either a 900 kB OpenDRIVE map or a 9 kB object map. Moreover, the algorithms have been tested on other data, such as the surrounding rural road and parts of Västerleden in Gothenburg. The results show a possibility of using the algorithms on real data.

The map has been used for positioning with camera and LiDAR. For camera positioning, the lines of the map are used, and for LiDAR positioning, the corners and edges are used. The compact form of the map and objects speeds up the map matching process significantly. The camera positioning extracts lines from the camera and matches with the map lines by comparing line parameters. The map format seems to contain enough features for the positioning purposes.