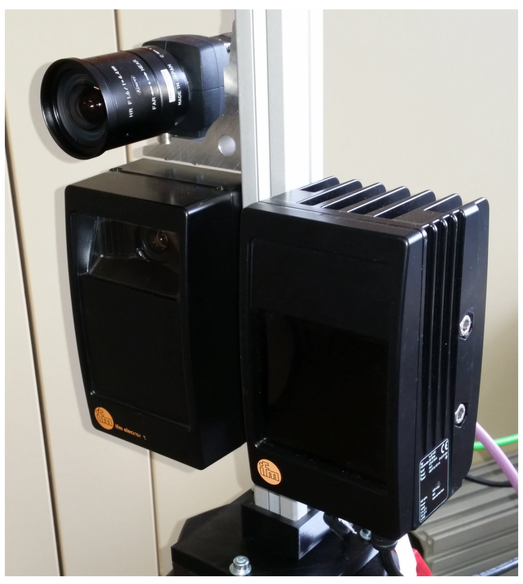
HOCHSCHULE RAVENSBURG-WEINGARTEN UNIVERSITY OF APPLIED SCIENCES

Institut für Künstliche Intelligenz

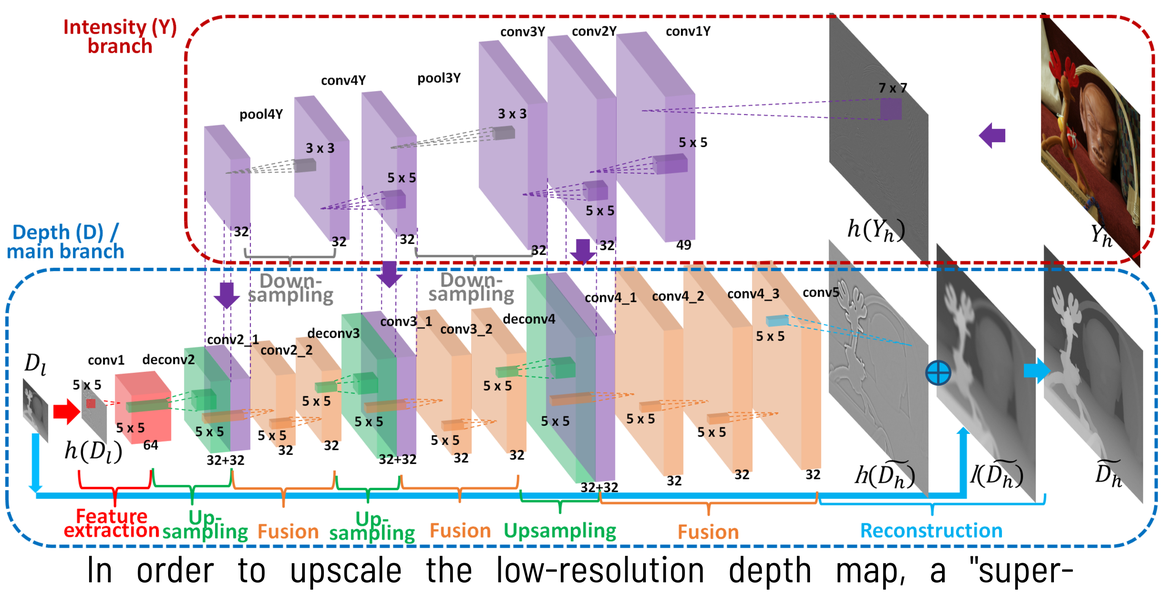
SMART3D

The SMART3D project seeks to find and develop competitive alternatives to LiDAR sensors, primarily through the investigation of PMD sensors and stereo camera sensors.

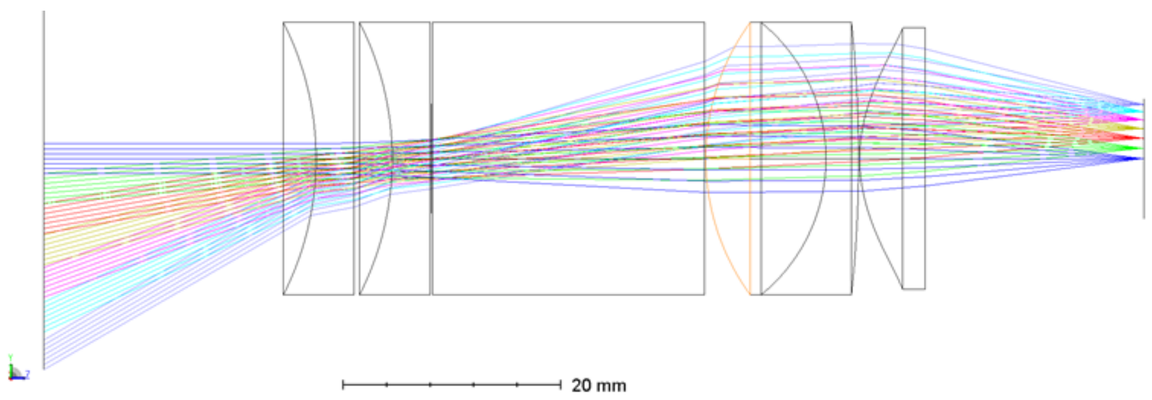
PMD (Photonic Mixing Device) sensors are short-to-medium range active sensors which typically have low resolution. However, a neural network may be used to implement image upscaling. Upscaling uses a low-resolution depth map and a high-resolution image to create a high-res depth map. The system was proven to work with self-made scenes. Due to very few public datasets containing PMD sensor data, priority was given to investigating another means of generating depth estimations.



Physical setup: a low-res PMD sensor and a high-res color camera were used to capture each scene. A high-resolution LiDAR sensor (not pictured) was used to provide ground truth information.



In order to upscale the low-resolution depth map, a "super-resolution" network (MSG-Net, Hui et al (2016)) was used. The network progressively downsamples the photo while using this information to upscale the depth map resolution.



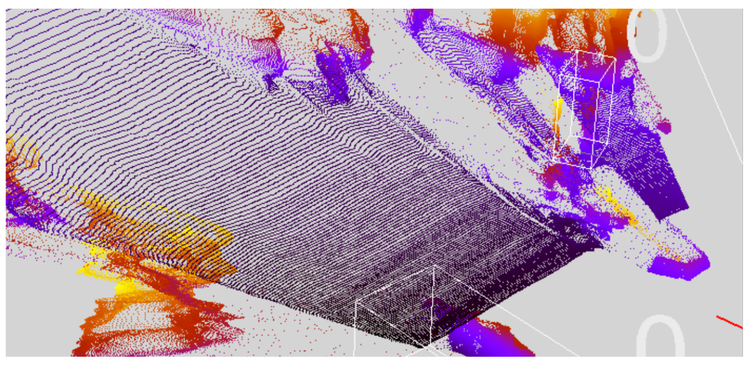
In addition to the network, a classical approach to upsampling was taken. This approach also performed similarly.

Stereo camera sensors are short-to-medium range passive sensors that rely on parallax to estimate distance, similar to the human eye.

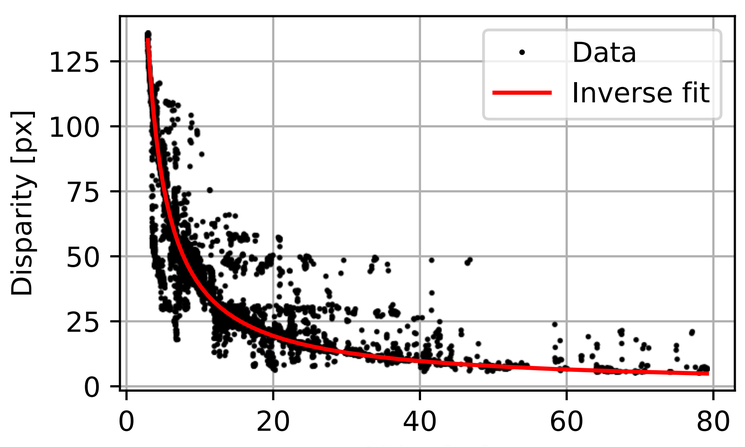
1) Left image and right image taken from KITTI dataset. The two cameras are spaced 0.54 meters apart.

2) The color image pair are fed into a stereo network, PSMnet (Chang et al (2018)). The result is a disparity map

3) The disparity map is reconstructed into a point cloud using epipolar equations. The result is a very dense set of data.



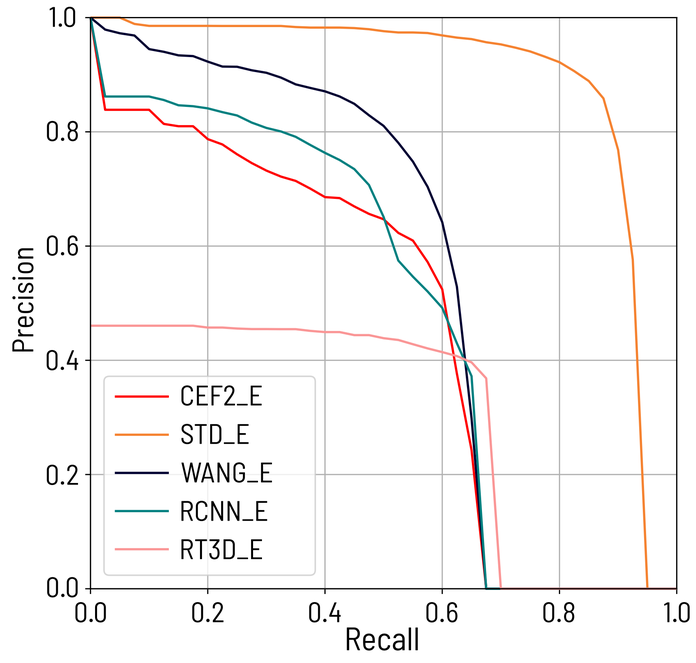
4) The point cloud is used by Frustum Pointnet (Qi et al (2017)) to identify instance level bounds for each object in the scene.



There is an inverse relationship between stereo camera disparity and reference lidar distance. The quality of this relationship directly affects the accuracy and precision of a stereo-based system.

A precision-recall curve comparing various neural networks on the KITTI dataset.

- CEF2: Self-made, stereo-based network
- STD: LiDAR-based network (reference)
- WANG: best-performing stereo network
- RCNN: stereo-based network
- RT3D: stereo-based network



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