Developing An Affordable Alternative For Autonomous Vehicle Localization Using High-Definition Radar Images

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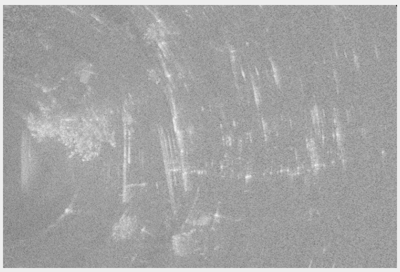
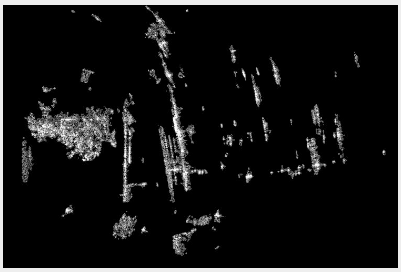
Localization of autonomous vehicles on the road currently relies on LiDAR (using lasers) and camera sensors which simultaneously map the environment around the car. Using high-definition radar images, we propose an algorithm to achieve an equivalent performance with a technology that is cheaper, easier to install, and less susceptible to adverse weather conditions such as rain, fog, and snow. This solution, which is based on the hardware and software suite of our partner Zendar, breaks the traditional reliance on costly LiDARs.



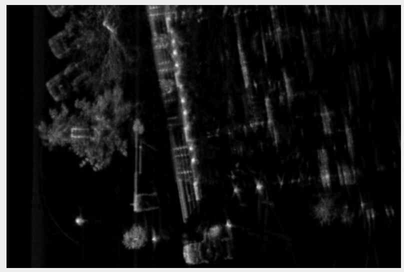
Raw data

Zendar hardware uses high-precision radar technologies that were initially developed for airplanes and UAV remote sensing, and implements them for the first time on autonomous vehicles.



Preprocessing

In order to make the radar images clearer, our algorithm performs a foreground detection with a specially designed normalization and clustering of the most informative image pixels.



Mapping

After fusing GPS positions and consecutive image transformation measurements obtained through correlation algorithms, our method generates a 2D map that gets rid of the initial radar noise.

Localization:

- Mapping of the surroundings is performed as described above when the car first discovers an environment.
- When driving in an already mapped location, our localization algorithm provides a way to get a more precise position of the autonomous vehicle.
- Even without any help of the GPS, our method can give a good estimation of the position of the car based only on its radar measurements.

Trajectory of the car in a superposition of a Google map and our generated 2D map

Performance summary:

- Our preprocessing and correlation algorithms can measure the translation and rotation between two consecutive radar images with **an average accuracy of 1.3 centimeters and 0.03 degrees**.
- When using our 2D generated map, our localization algorithm makes **an average error of 8.2 centimeters in position** and **0.24 degrees in orientation** with respect to the real trajectory.