Traffic Signs Size Estimation from GPS-tagged Images: Visual Odometry Approach

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Introduction

- ✓ Federal institutions regulate traffic signs to be a certain size. Human inspection are a costly process which can be automated.
- ✓ **The goal is to develop a framework in order to obtain accurate measurements of the traffic signs' sizes.**

Model

- ✓ We used two images, based on the pinhole model, to measure the size of the traffic signs.

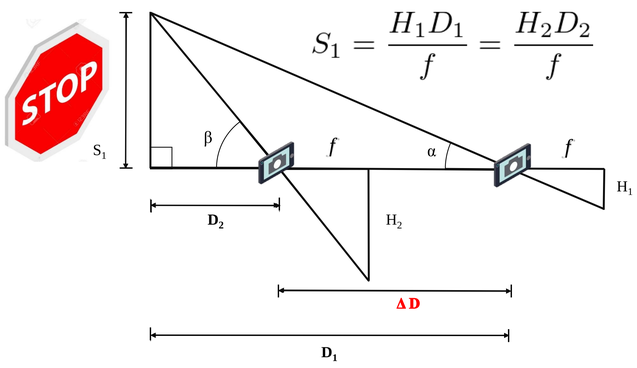

Fig. 1: Dual-Image Pinhole Model

- ✓ A smart camera was mounted on a vehicle for data collection [1].

Fig. 2: Data Collection Sample

Fig. 3: Mounted Smart Camera on Vehicle

Camera's Pose Problem

- ✓ The dual-image model assumes the distance between the images, **Δ**D, in 3D space is known.

$$D_1 = \frac{\Delta D}{1 - \frac{H_1}{H_2}}$$

- ✓ Due to the inaccuracy of raw GPS data in obtaining **Δ**D three other methods are being tested:
  - ✓ **Monocular Visual Odometry (VO)**
  - ✓ **Structure from Motion (SfM)**
  - ✓ **Sensor Fusion**

Results

- ✓ The size estimations provided by the algorithm have a significantly large standard deviation when utilizing the raw GPS data, which is why three different methods are being tested.

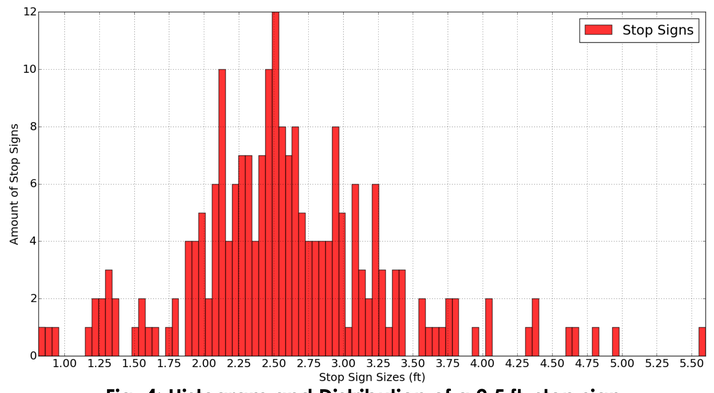

Fig. 4: Histogram and Distribution of a 2.5 ft. stop sign

- ✓ Given Visual Odometry uses images to estimate camera pose a monocular approach was implemented with the eventuality of improving the GPS's trajectory with the VO data.

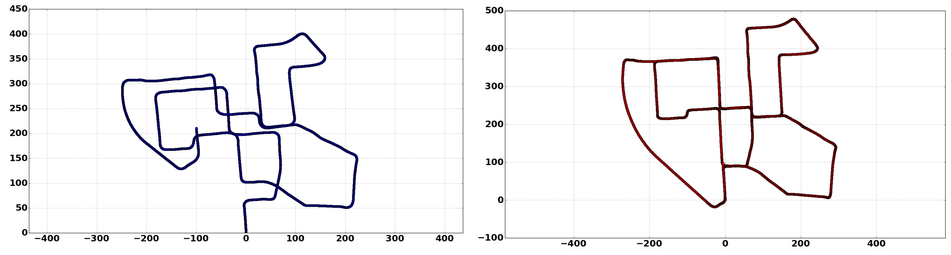

Fig. 5: VO algorithm *(blue)* and KITTI dataset's ground truth *(red)*

Monocular VO Algorithm

- ✓ Feature Detection (SIFT)
- ✓ Feature Matching (KLT Tracker)
- ✓ Essential Matrix Estimation
- ✓ Pose Estimation
- ✓ Scaling: Relative or Absolute

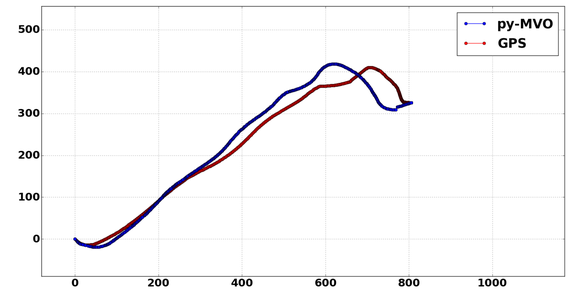

Fig. 6: VO algorithm tested on smart-camera's data

- ✓ Optimization methods will need to be implemented in order to reduce scale drift, small errors which accumulate in the calculations.

Conclusion

- ✓ The implemented model for stop sign size estimation could be implemented in vision based object size measurement algorithms.
- ✓ Visual Odometry will optimize GPS data provided by our smart-camera resulting in better pose estimations.

Future Work

- ✓ We are looking into optimization methods such as Bundle Adjustment and better radial undisrtortion algorithms to improve the performance of our Visual Odometry system.

References

[1] S. Varadharajan, S. Jose, K. Sharma, L. Wander, and C. Mertz *Proceedings of WACV 2014: IEEE Winter Conference on Applications of Computer Vision*, March, 2014.