Traffic Signs Size Estimation from GPS-tagged Images using a Smartphone-Based System

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Motivation

- The DOT regulates traffic sign sizes to ensure general public's safety
- We present an alternative to tedious manual inspections, by estimating traffic sign sizes using monocular vision

Approach

1. Extract images from video within moving vehicle [1]
2. Find the distance between images taken
3. Estimate real world traffic sign size from images

Results

- The size of a 2.5 foot traffic sign was estimated using raw GPS and EKF calculated distance
- Anomalies in our data conclude there is a problem in our EKF
- This error in distance results in estimation inaccuracy

Sensor Fusion: Extended Kalman Filter

- Using IMU sensor data from our smartphone, we are able to calculate the path of the vehicle and obtain the distance between images [2]

Initial State Estimate

State Model

Estimated State

Initial Estimate Error

Error in Estimate

Kalman Gain

IMU Measurements

Current State

Error in Current State

VisualSFM

- 3D reconstruct scene using images
- VSFM uses an arbitrary scale coordinate system
- We translate this to meters using furthest GPS-tagged images
- Distances are not accurate enough for our model

Sensor Fusion

Kalman Filter

Error in Estimate

Equation: $\hat{x}_{k|k} = \hat{x}_{k|k-1} + K_{k}(z_{k} - H\hat{x}_{k|k-1})$

Kalman Gain

Equation: $K_{k} = P_{k|k-1}H^{T}(HH^{T} + R)^{-1}$

Visual Odometry

Equation: $\Delta P_{k} = \Delta P_{k-1} + V_{k} \Delta t$

GPS Distances

$\Delta d = \sqrt{(x_{2} - x_{1})^2 + (y_{2} - y_{1})^2}$

GPS Error

$\sigma_{GPS} = 0.3347$

EKF Error

$\sigma_{EKF} = 0.3550$

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