Motivation

- Visual-Inertial Odometry (VIO) enables ubiquitous mobility for mobile robots by providing accurate pose information.
- Recent deep learning approaches for VIO have proven successful. Previous work rarely focus on incorporating robust fusion strategies for dealing with imperfect input sensory data.
- Real issues include camera occlusion or operation in low-light conditions, measurement noises, temporal or spatial misalignment between two sensors.
- The learning-based methods are not explicitly modelling the sources of degradation in real-world usages.
- Naively using all features before fusion will lead to unreliable state estimation.

Contributions

- A generic framework to learn feature selections from two modalities, enabling robust and accurate ego-motion estimation.
- Our selective sensor fusion masks can be visualised and interpreted.
- A new and complete systematic research on the accuracy and robustness of deep sensor fusion in presence of corrupted data.

Neural Visual-Inertial Odometry Framework


Selective Sensor Fusion - Deep Features Selection

Soft Fusion (Deterministic):

- Re-weights each feature by conditioning on both the visual and inertial channels
  
  \[ s_v = \text{Sigmoid}(a_v | \alpha_v) \]
  
  \[ s_i = \text{Sigmoid}(a_i | \alpha_i) \]

Hard Fusion (Stochastic):

- Generates a binary mask that either propagates the feature or blocks it

  \[ s_v \sim \text{Bernoulli}(\alpha_v) \]
  
  \[ s_i \sim \text{Bernoulli}(\alpha_i) \]

Feature Fusion:

- Features are element-wise multiplied with their corresponding soft or hard masks

  \[ g(a_v, a_i) = [a_v \odot s_v] \odot [a_i \odot s_i] \]

Intuition

- The fusion masks can be viewed as similar to the gain and covariance matrix in classical filtering methods.

Evaluation

- The trajectories on the Sequence 05 of KITTI dataset are from the ground truth (GT), neural vision-only model (VO), neural visual-inertial models with direct (VIO), soft (Soft), and hard fusion (Hard).

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