**Overview**

1. Adaptive 3D sensors via focused mutual information (MI) maximization.
3. Estimate MI, demonstrate pattern selection for
   - (a) Pose estimation ("localization")
   - (b) Range estimation ("mapping").

**Model**

- $A, G$ - Global appearance and geometry, respectively.
- $A_k, G_k$ - Local (viewpoint-) appearance and geometry.
- $I$ - the decision of which pattern to project.
- $I_p$ - the projector image
- $I_c$ - camera image.

We use an affine-Gaussian illumination model per pixel,

$$I(x) = a(x)I_p(b(x)G + l(x) + y(x)),$$

$a, b, y$ have a Gaussian distribution.

Using this model we compute pixelwise mutual information

$$I(G, \theta) = \sum_{l,i,j} \log \frac{p(I, G, \theta)}{p(I, l)}.$$

Computation per pixel via GPU – two loops:

- Estimate $p(I_c)$.
- Estimate $p(I_c|G, \theta)$, aggregate $I(G, \theta) = \sum_{l,i,j}.$

**Greedy MI Pattern Selection**

Estimate MI gain for the next pattern, then project the best one:

**Results - Range Estimation**

- (Mapping phase in SLAM)
  - Uncertainty in XY plane
  - Isotropic Uncertainty
  - Uncertainty in Z

**Results - Pose Estimation**

- (Localization phase in SLAM)
  - Assume scene is approximately known.
  - Localize scanner with some initial uncertainty. (look at translation because it is intuitive).

- Initial uncertainty is in XY translation

- Informative areas are the sloped regions. (depends on initial uncertainty)
- Analogue to the aperture problem.

**Conclusion**

- Sensor planning at the sensor level for 3D scanners.
- Adapt sensing to context and task. Examples: Localization and mapping. Applicable to other tasks / modalities.
- Focused-information for range sensing - 50% reduction in required frames.
- Focused-information for pose estimation - shows the informative areas.

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