How to Train a CAT: Learning Canonical Appearance Transformations for Direct Visual Localization Under Illumination Change

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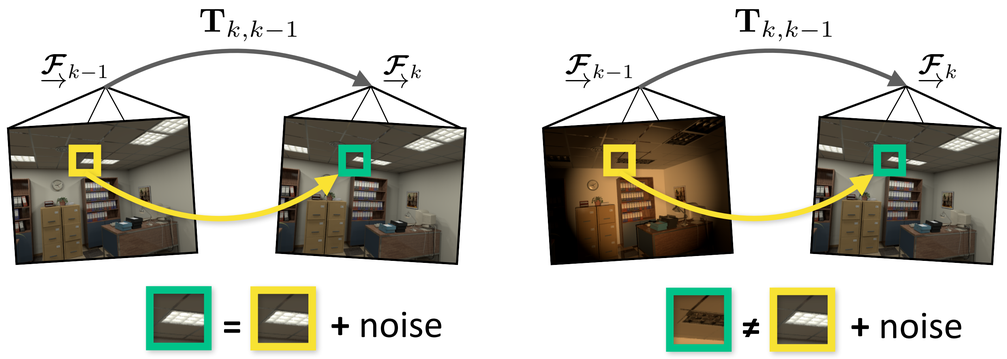
Motivation

Visual localization under appearance change

In this work we are interested in improving the robustness of standard visual localization algorithms to appearance change such as variable illumination.

Direct vision and photometric (in)consistency

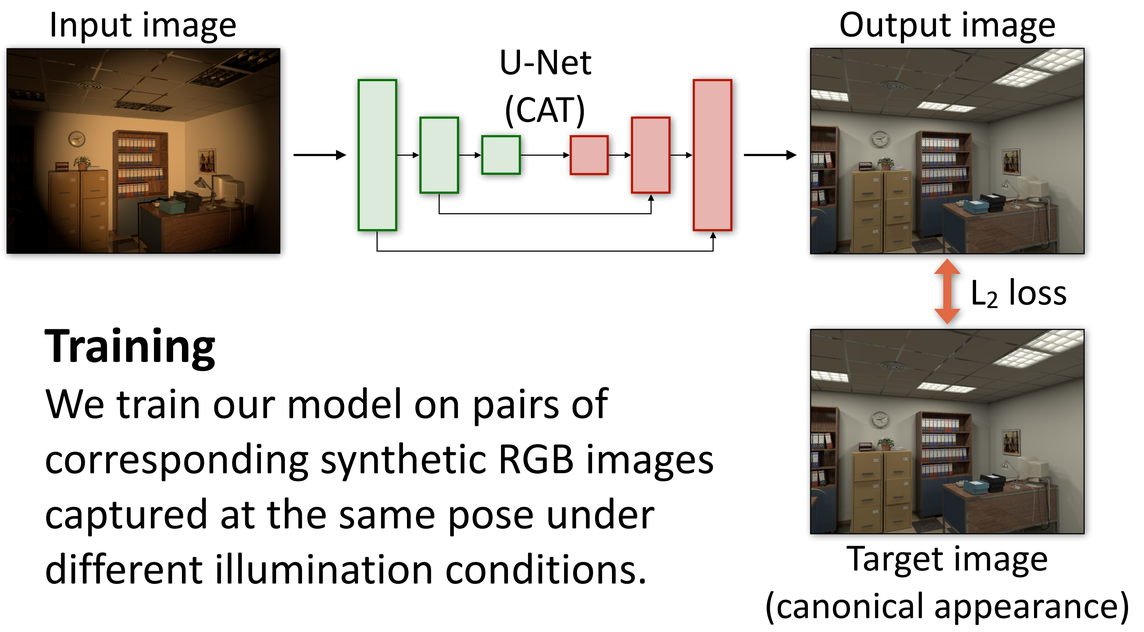
Unlike feature-based vision, direct vision relies on the photometric consistency assumption, which is commonly violated. This is especially problematic for localizing under appearance change.



Approach

Image-to-image translation

We propose a deep convolutional U-Net to learn a Canonical Appearance Transformation (CAT) that transforms images to correspond to a previously seen "canonical" appearance.



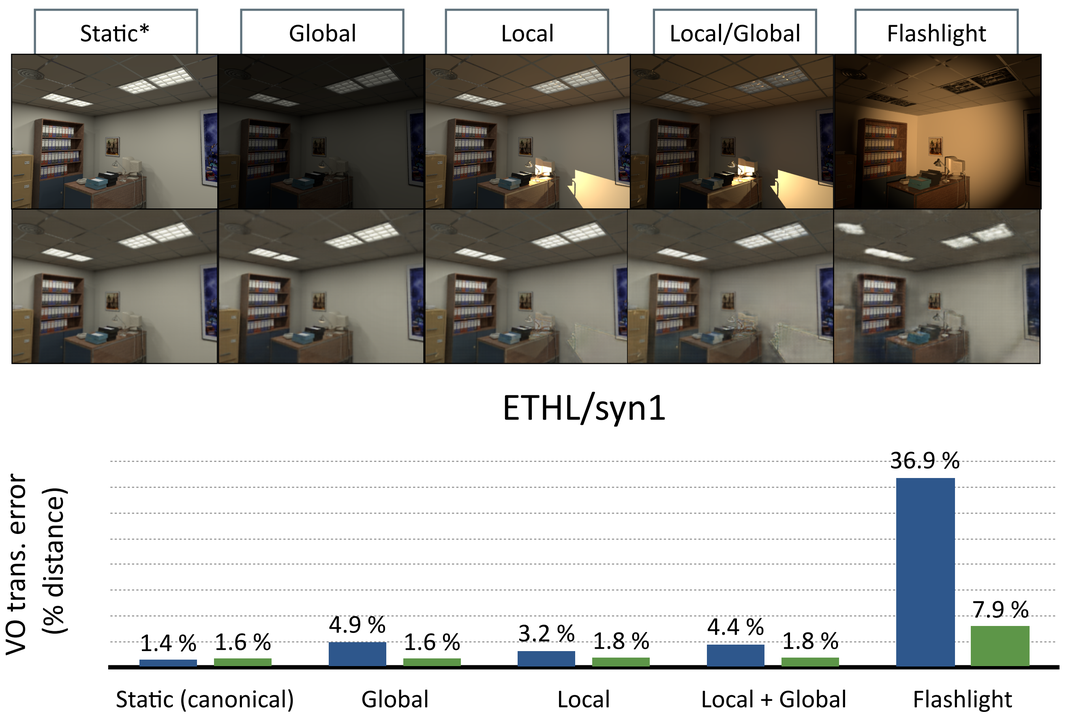
Training

We train our model on pairs of corresponding synthetic RGB images captured at the same pose under different illumination conditions.

Results

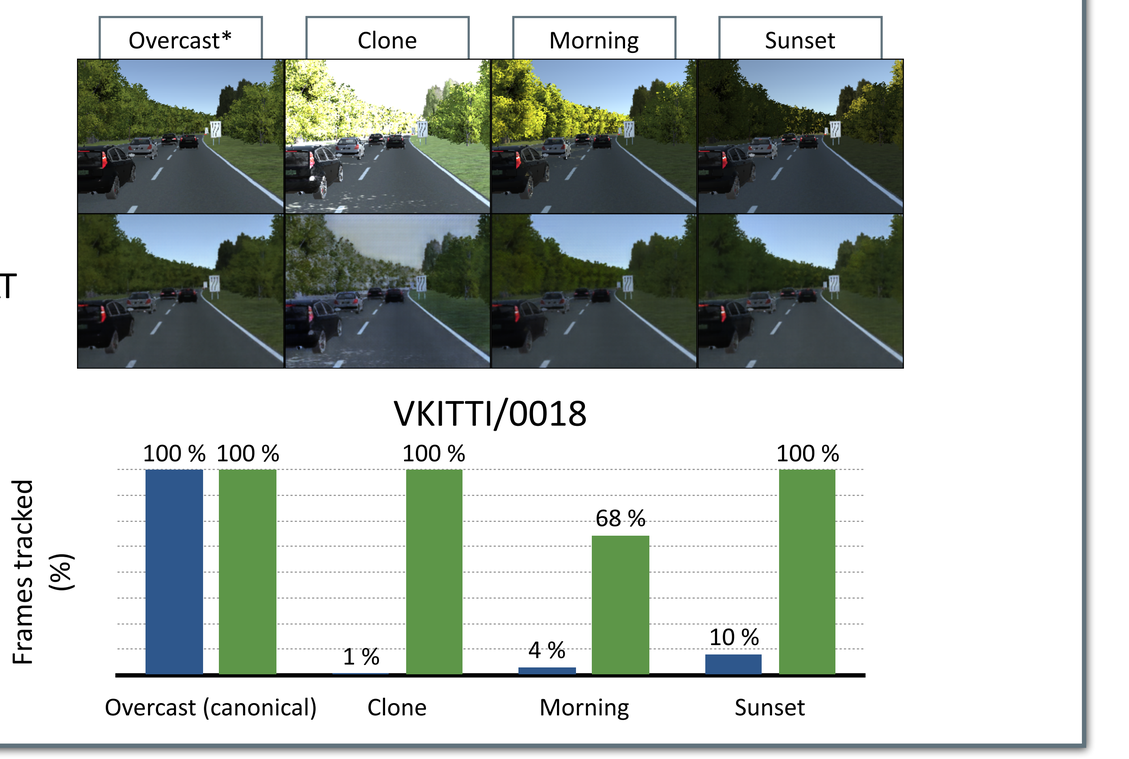
Direct visual odometry

We compare the results of computing visual odometry using imagery with rapidly time-varying illumination, both with and without using a CAT model to transform the images into a static illumination condition.



Direct metric mapping and localization

We also compare the results of localizing against a map created in a static canonical condition using images captured under different illumination conditions both with and without a CAT model.



Conclusions

Improved robustness to illumination change

Both direct visual odometry and metric mapping and localization can benefit from using CATs.

Synthetic-to-real transfer learning

We achieved limited success in transferring synthetic-trained CAT models to real data. Further investigation is needed to establish the limits of transfer learning.

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github.com/utiasSTARS/cat-net

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