Bilateral Cyclic Constraint and Adaptive Regularization for Unsupervised Monocular Depth Prediction

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### Introduction

**Goal:** Learn a function \( f : I \rightarrow \alpha \) to recover the scene from a single image \( I \).

Recovering 3D geometry from a single image is an ill-posed problem. We must rely on a prior, e.g., piecewise smoothness. We formulate this as an energy minimization problem:

\[
\mathcal{L} = \mathcal{D}(\hat{d}) + \alpha \mathcal{R}(\hat{d})
\]

where \( \mathcal{D} \) denotes data fidelity, \( \mathcal{R} \) regularization, and \( \alpha \) a static scalar.

To better modulate the amount of regularity imposed: \( \alpha \) should be adaptive.

### System Diagram

Exploiting stereo pairs and view synthesis loss for training.

Given a single image we predict its left and right disparities.

\( \mathcal{D} \) relies on data-fidelity residual. To ensure we have the necessary features to satisfy \( \mathcal{D} \), we

- Dedicate one branch to minimizing just the data-fidelity term
- Give its features and coarse prediction to a second branch to minimize entire loss

We use \( rdisp \) as our final output.

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**Results**

<table>
<thead>
<tr>
<th>Method</th>
<th>Approaches</th>
<th>Accuracy [m]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ours</td>
<td>-</td>
<td>0.0044</td>
</tr>
<tr>
<td>Godard</td>
<td>-</td>
<td>0.0045</td>
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</tbody>
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