

# UnDeepVO: Monocular Visual Odometry through Unsupervised Deep Learning

Bolaños T.  
Kilkkilä M.  
Kurki L.  
Rehn A.  
Zaka A.  
Zhao Z.

October 14, 2020

# Outline

- 1 Introduction
- 2 System Overview
- 3 Objective Losses
- 4 Experimental Evaluation
- 5 Conclusion
- 6 Contributors

# Introduction

## UnDeepVO

- A monocular visual odometry system

# Introduction

## Visual odometry

- Goal
  - Robot localization using only visual information



# Introduction

## Visual odometry

- Goal
  - Use consecutive monocular images to construct a path of robot movement



# Introduction

## UnDeepVO

- Based on deep learning
- Unsupervised
  - No need for labeled training data
- Pose estimation
- Depth estimation

# System Overview

## Architecture

- Maybe that figure on the paper ...

# System Overview

## Training Scheme





# Objective Losses

## Spatial Losses

The spatial losses are based on the fact that, given the structure of stereo cameras, for a pixel  $p_l(u_l, v_l)$  on the left image and  $p_r(u_r, v_r)$  on the right image:

$$u_l = u_r \quad \text{and} \quad v_l = v_r + D_p$$

- Photometric Consistency Loss (Image reconstruction)

$$L_{pho} = \lambda_s L^{SSIM}(I, I') + (1 - \lambda_s) L^h(I, I')$$

- Disparity Consistency Loss (Depth)

$$L_{dis} = L^h(D_{dis}, D'_{dis})$$

- Pose Consistency Loss (Camera orientation)

$$L_{pos} = \lambda_p L^h(t_l, t_r) + \lambda_o L^h(R_l, R_r)$$

# Objective Losses

## Temporal Losses

This is based on the reconstruction of pixels on time  $k$  and  $(k + 1)$  as

$$p_{k+1} = K T_{k,k+1} D_{dep} K^{-1} p_k$$

- Photometric Consistency Loss (Image reconstruction)

$$L_{pho} = \lambda_s L^{SSIM}(I, I') + (1 - \lambda_s) L^1(I, I')$$

- 3D Geometric Registration Loss (Adding depth with  $P(x, y, z)$ )

$$L_{geo} = L^1(P, P')$$

# Evaluation

## Trajectory



# Evaluation

## Depth



- UnDeepVo ...

# Contributors

- Bolaños Tlahui
  - Objective Losses
- Kilkkilä Miikka
  - ...
- Kurki Lauri
  - ...
- Rehn Aki
  - Slide organization, introduction, conclusions
- Zaka Ayesha
  - UnDeep VO Key Contributions
- Zhao Zhao
  - System Overview