UMASSCS
SCHOOL OF COMPUTER SCIENCE

MoA-Net: Self-supervised Motion Segmentation

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Motion Segmentation

- P Bideau, E Learned-Miller, ECCV 2016:
  It's moving! A probabilistic model for causal motion segmentation

- P Bideau, A RoyChoudhury, R Menon, E Learned-Miller, CVPR 2018:
  The best of both worlds: Combining CNNs and geometric constraints for hierarchical motion segmentation

- P Bideau, R Menon, E Learned-Miller, Workshop ECCV 2018:
  MoA-Net: Unsupervised Motion Segmentation

Overview

Motivation

How do humans know
what is moving in the world and what is not?

Approach: Motion Segmentation

- Rotation compensation
- Learning Motion Patterns: MoA-Net

Results

Future Research Questions

Motivation

Motivation

- stationary scene
- moving object
- **no** observer motion

- stationary scene
- moving object
- observer motion

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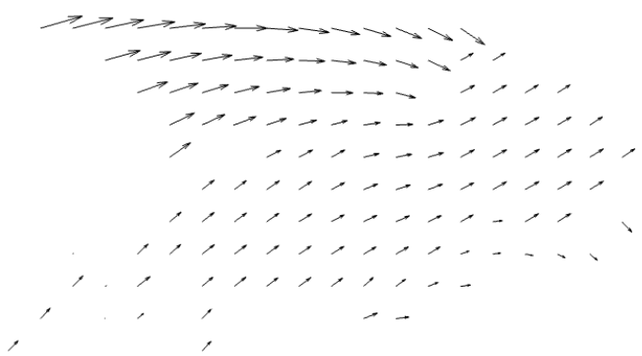
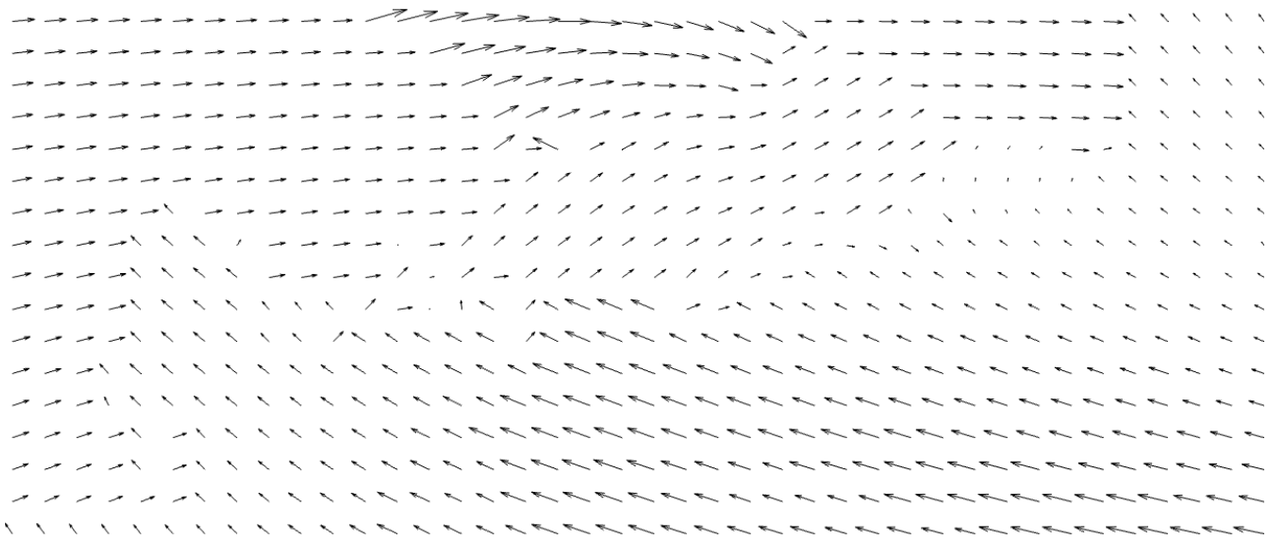
- stationary scene
- moving object
- **no** observer motion



- stationary scene
- moving object
- observer motion

Motivation



- stationary scene
- moving object
- **no** observer motion

- stationary scene
- moving object
- observer motion

Motivation

All motions result in changes of the retinal image.

What is the problem about retinal image motion?

- photoreceptors are slow
- motion detection in our brain is challenging

Need to stabilize the image, to reduce retinal image motion

Motivation

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Approach:
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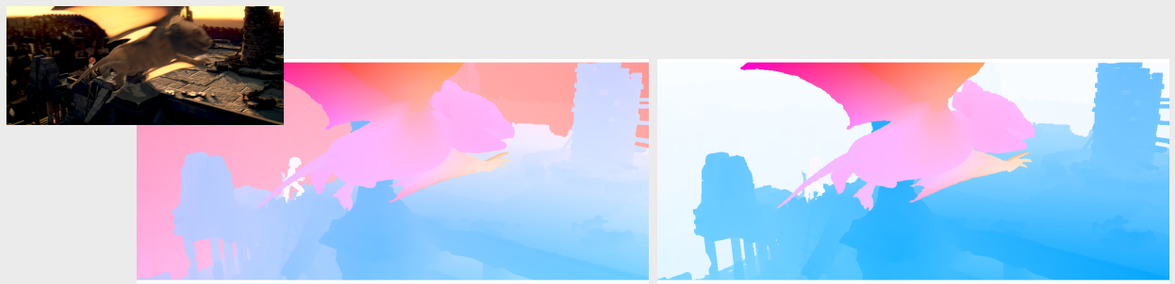
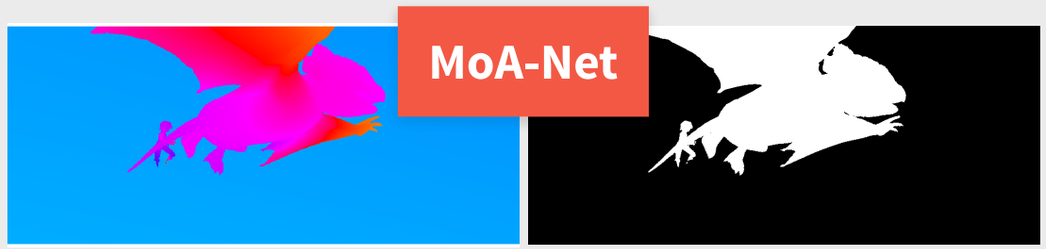


optical flow

rotation compensated flow

step 1: rotation compensation

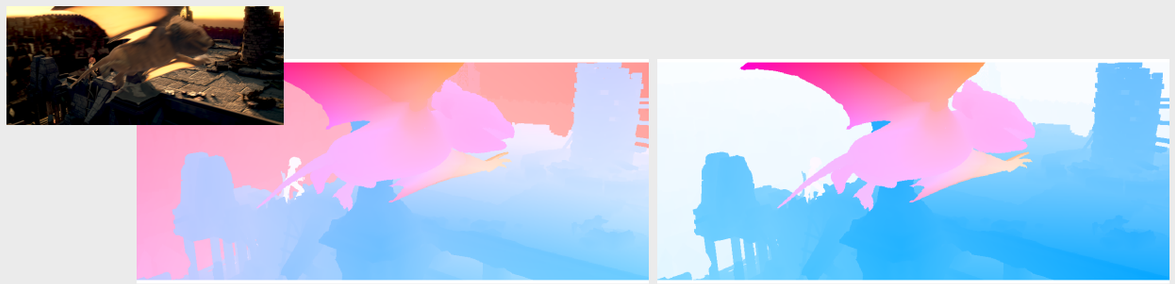


angle field

motion segmentation

step 2: motion segmentation

Approach:
Motion Segmentation



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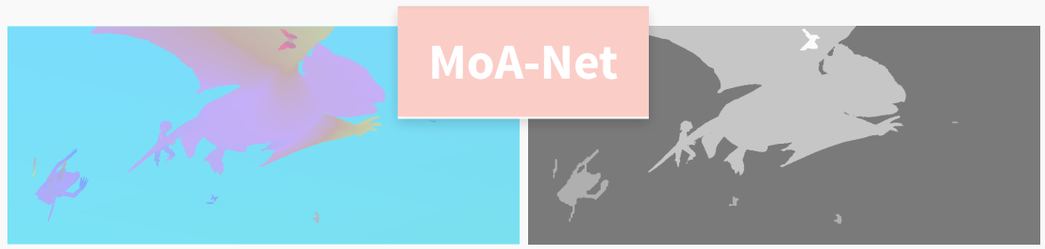


angle field

motion segmentation

step 2: motion segmentation

Rotation Compensation

- rotation + translation
- optical flow **magnitude** is **dependent** on scene depth
- optical flow **angle** is **dependent** on scene depth

- translation
- optical flow **magnitude** is **dependent** on scene depth
- optical flow **angle** is **independent** of scene depth

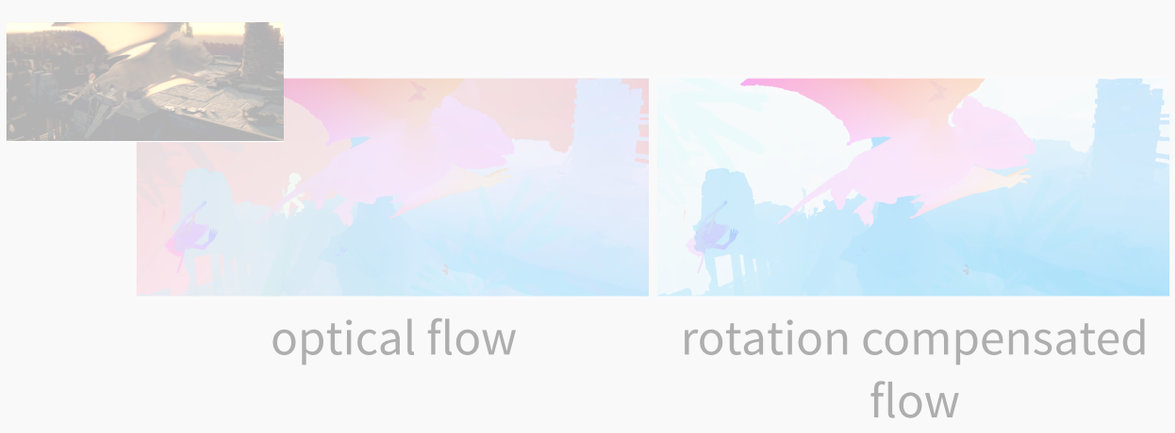
Rotation Compensation

only camera translation and object motion

optical flow

angle field

Motion Segmentation



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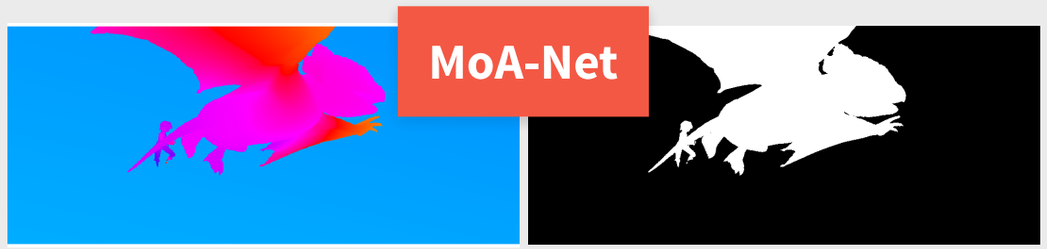

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step 2: motion segmentation

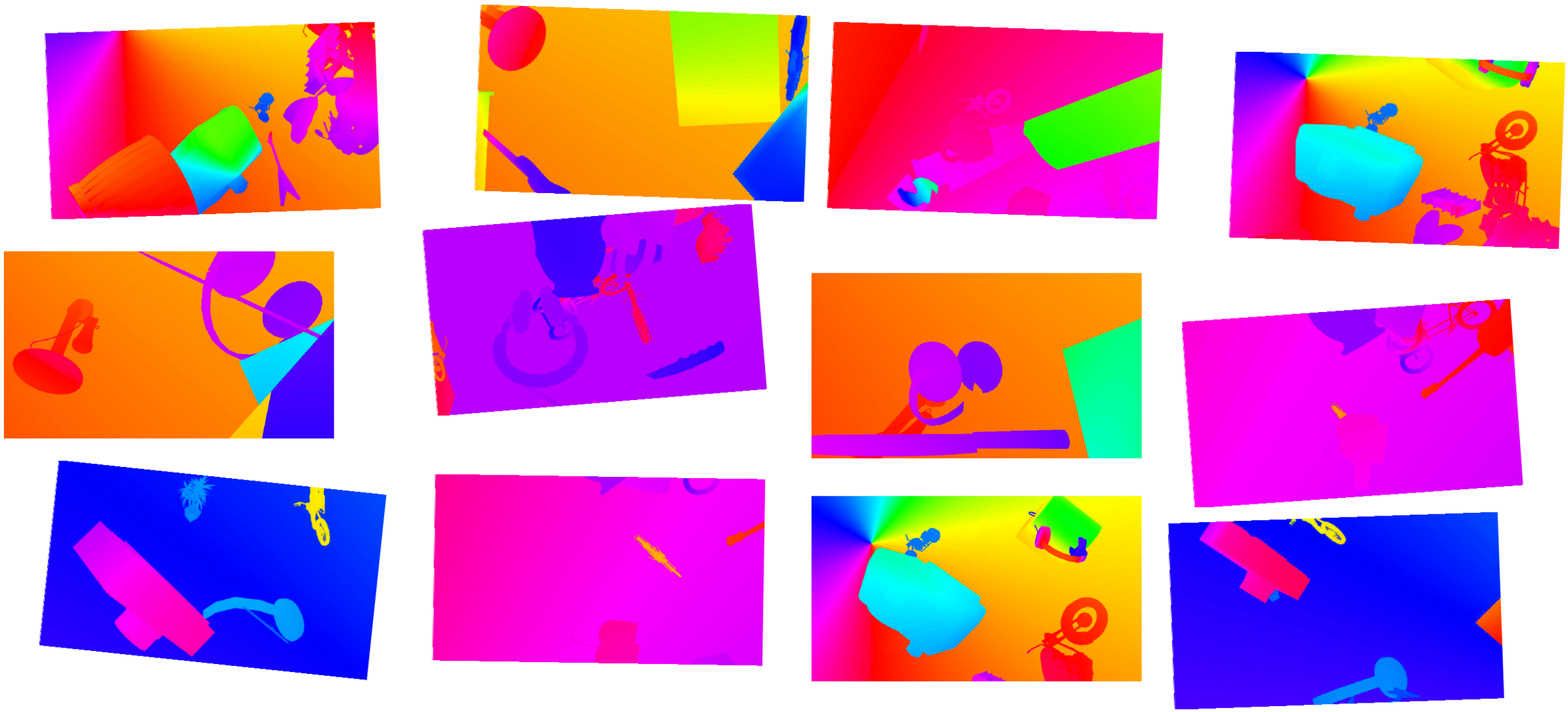
Motion Segmentation
Definition

Def.: Moving Object

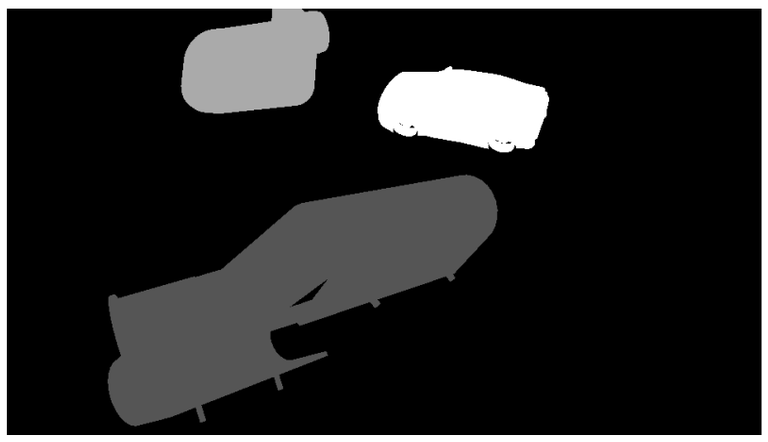
A moving object is a connected image region that undergoes some independent motion. The connected image region can be of any size and shape.

Motion Segmentation

Generating training data

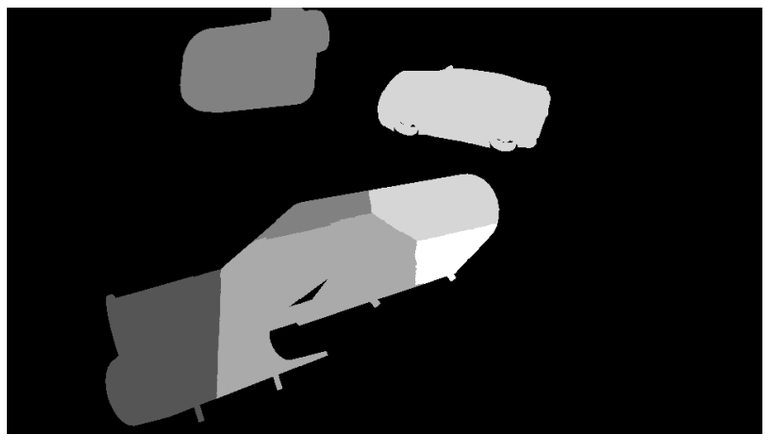


Motion Segmentation
Generating training data



- Generating connected object regions.
- Splitting each object into n subregions.
- Assigning to each motion region a translational 3D direction.
- Smoothing motion boundaries inside moving objects.
- Adding random gaussian noise.

Motion Segmentation
Generating training data



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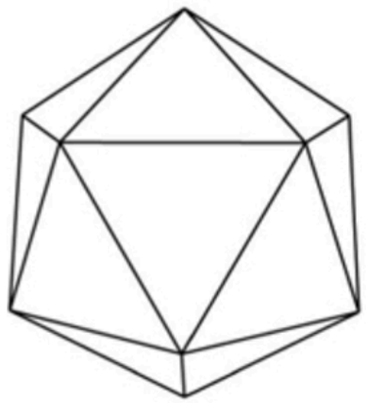

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$$= \texttt{atan}(-V' + yW, -U' + xW)$$

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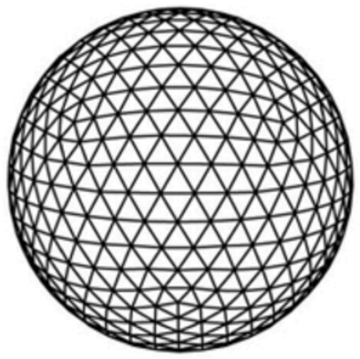

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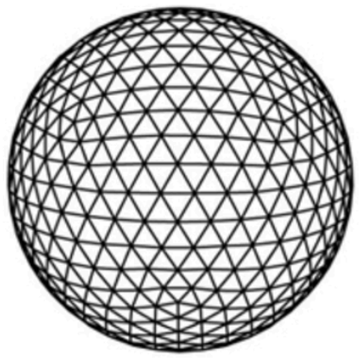

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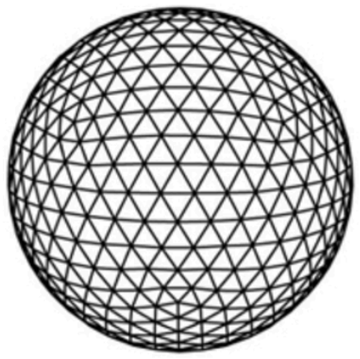

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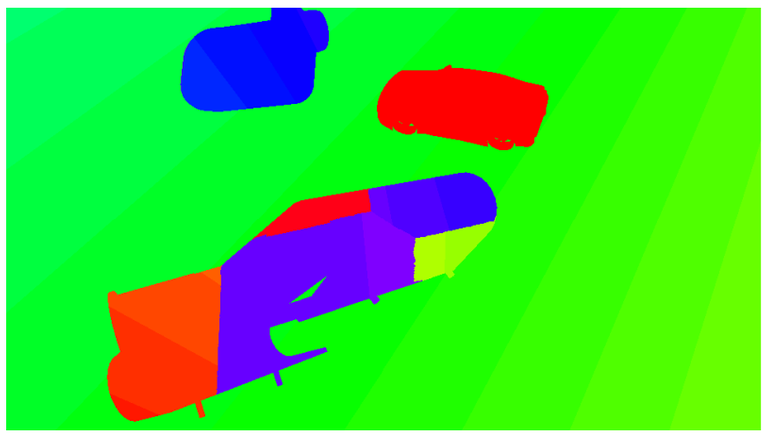

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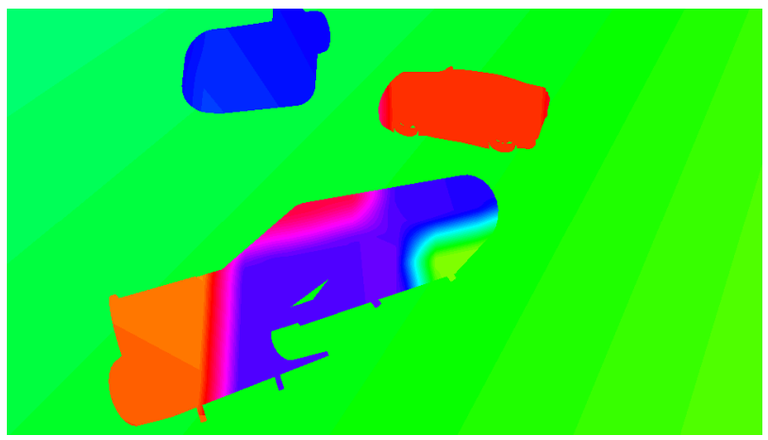

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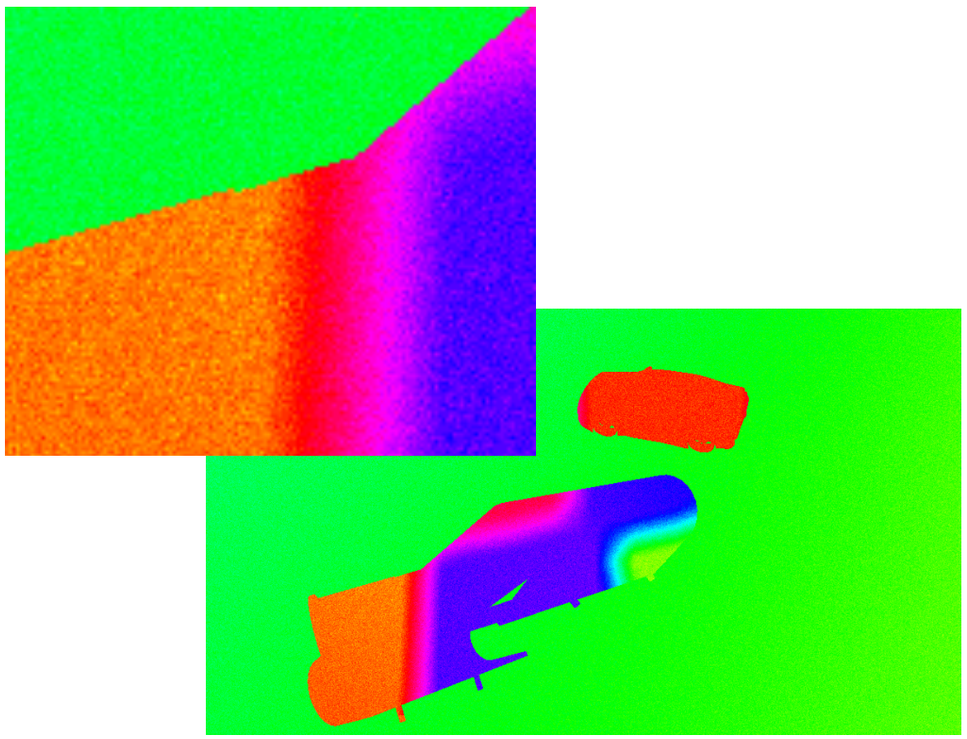

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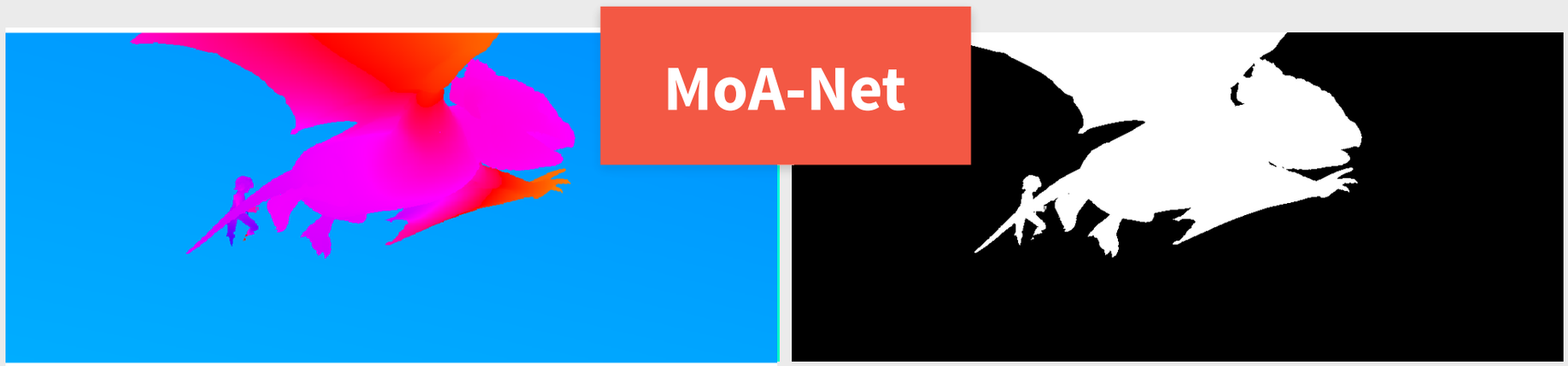

angle field | motion segmentation

step 2: motion segmentation

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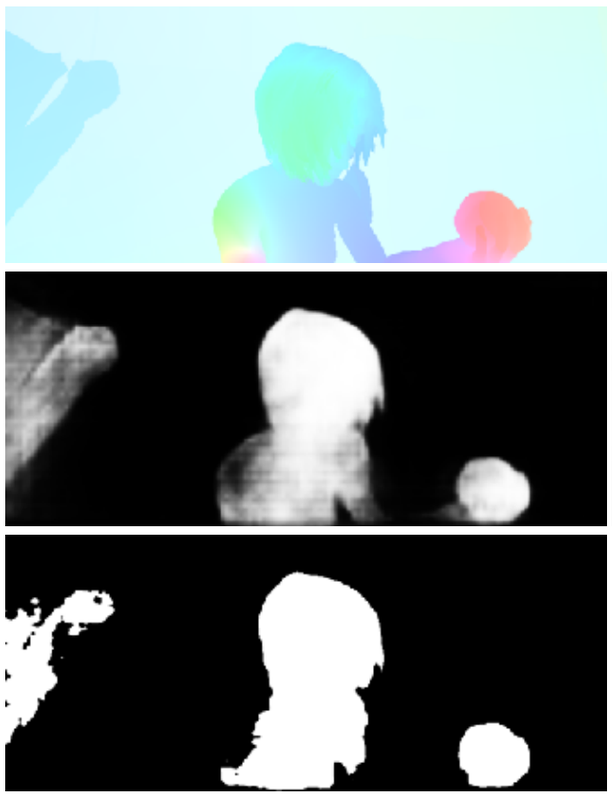
Segmentation Results

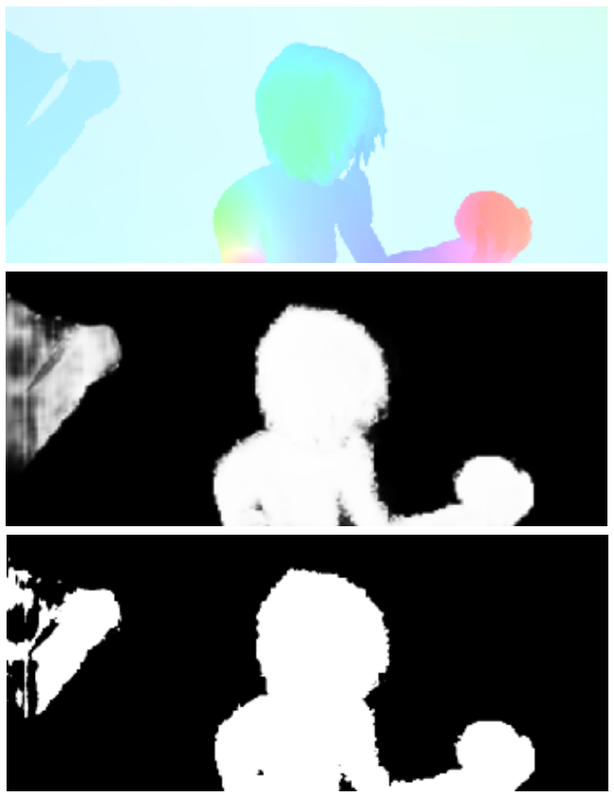
video frame

ground truth

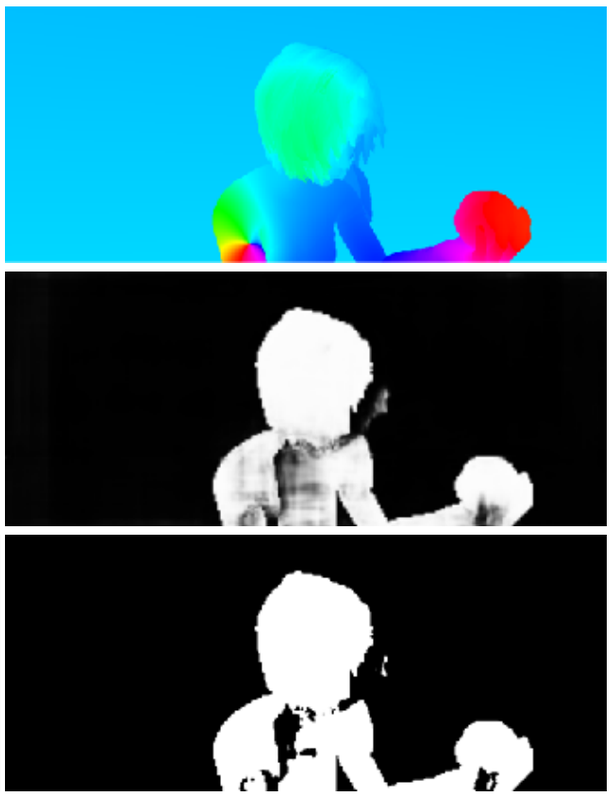
Jain et al.



Tokmakov et al.



ours



Segmentation Results

	Motion Segmentation: Sintel					
	J Mean ↑	J Recall ↑	J Decay ↓	F Mean ↑	F Recall ↑	F Decay ↓
Tokmakov [1, 2]	50.46	**55.43**	44.50	53.43	35.04	39.75
Jain et al. [3]	29.63	24.98	36.07	28.65	14.70	31.20
ours	**54.77**	54.47	**26.57**	**59.71**	**61.38**	**14.79**

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angle field

magnitude

- Importance of the flow **magnitude** for
    - estimating the *scene depth*
    - dealing with *estimated (noisy) optical flow*

-QUESTIONS-