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Rethinking Optical Flow from Geometric Matching Consistent Perspective



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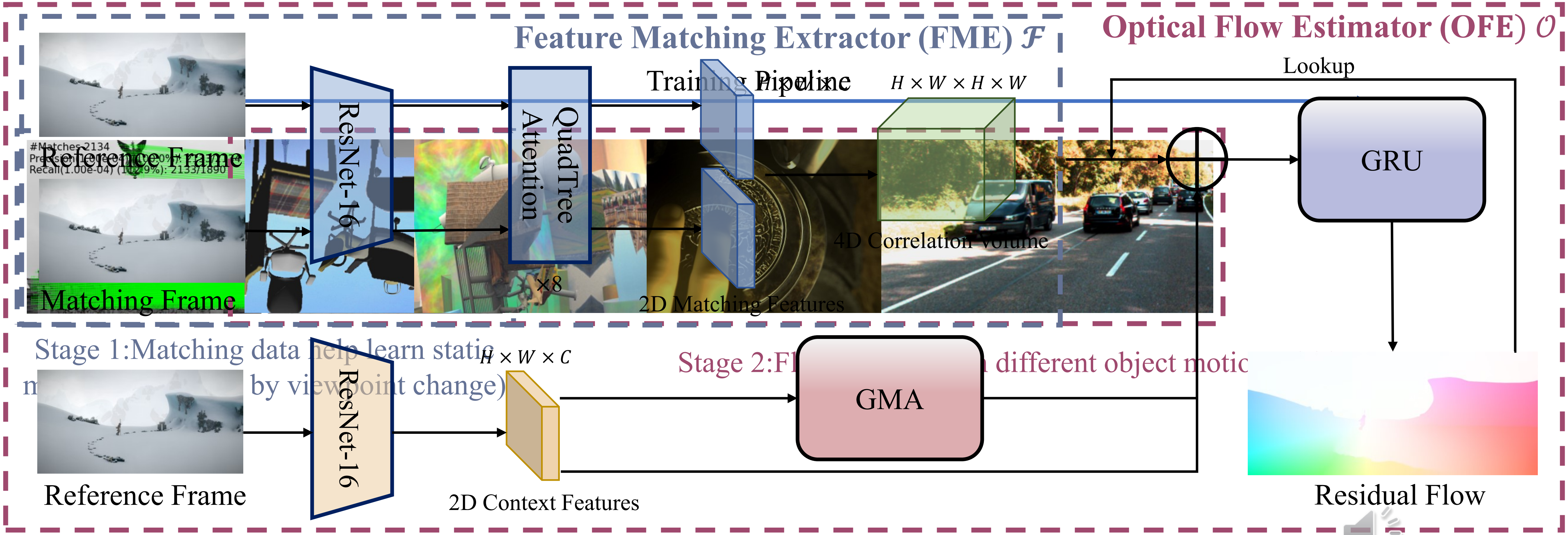
Paper Tag: **TUE-AM-127**

Codes:

Quick Review



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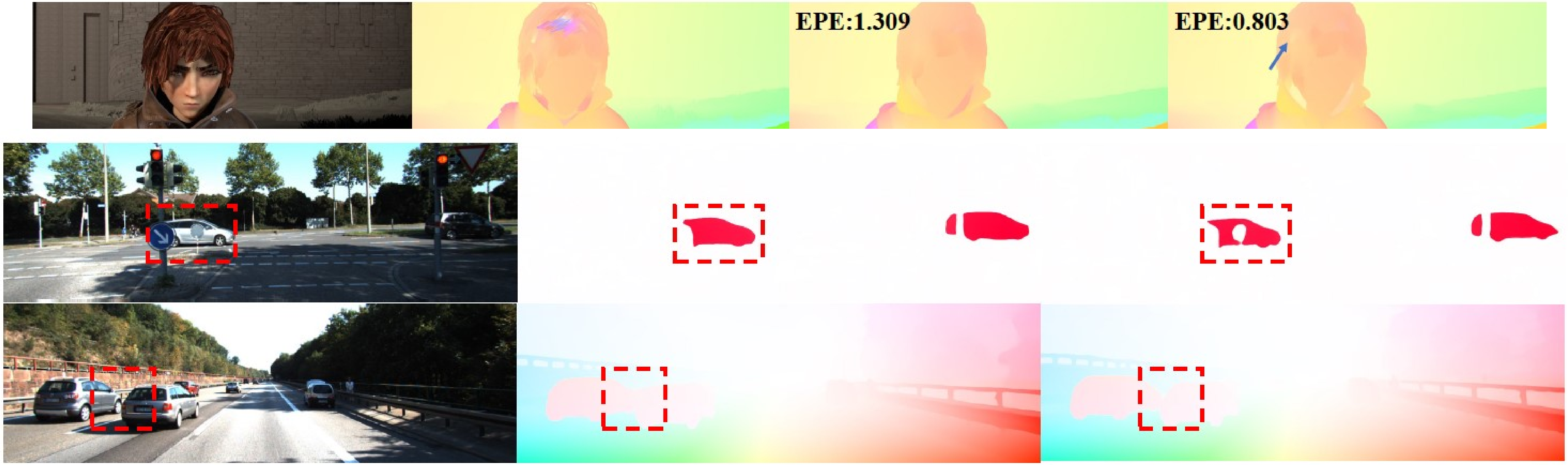

(a) Reference Frame (b) GMA (c) MatchFlow(G)

(a) Reference Frame (b) Ground Truth (c) GMA (d) MatchFlow(G)

Quick Review

https://github.com/DQiaole/MatchFlow

Introduction

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Training Pipeline

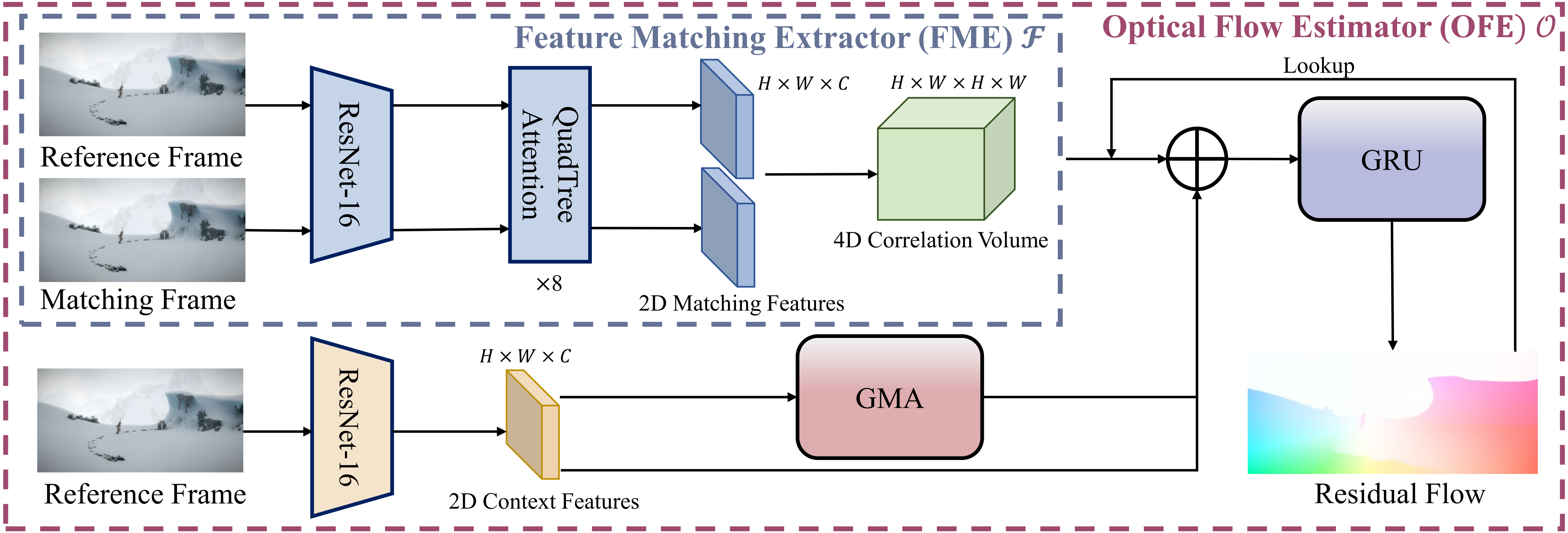
Stage 1:Matching data help learn static match (e.g. caused by viewpoint change)

Stage 2:Flow data to learn different object motion within scene

Motivations

- Geometric Image Matching (GIM) shares some common challenges with optical flow estimation.
- It is much easier and simple to collect the real-world GIM data.
- Rethinking of the general training pipeline of optical flow.

Methodology



$$C(i,j) = \langle F_1(i), F_2(j) \rangle \in \mathbb{R}^{H \times W \times H \times W}$$

Methodology

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Pre-training Loss:

$$C(i,j) = \langle F_1(i), F_2(j) \rangle \in \mathbb{R}^{H \times W \times H \times W}$$

$$\mathcal{P}_c(i,j) = \mathrm{softmax}(C(i,\cdot)/\tau)_j \cdot \mathrm{softmax}(C(\cdot,j)/\tau)_i$$

$$\mathcal{L}_c = -\frac{1}{|\mathcal{M}_c^{gt}|} \sum_{(i,j)\in\mathcal{M}_c^{gt}} \log \mathcal{P}_c(i,j)$$

Optical Flow Loss:

$$\mathcal{L} = \sum_{i=1}^{N} \gamma^{N-i} ||f_{gt} - f_i||_1$$

Experiments

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Datasets:

- MegaDepth
- FlyingChair (C) + FlyingThings3D (T)
- Sintel (S) + KITTI (K) + HD1K (H)

Experiments

Qualitative results:

(a) Reference Frame (b) GMA (c) MatchFlow(G)

(a) Reference Frame (b) Ground Truth (c) GMA (d) MatchFlow(G)

Experiments

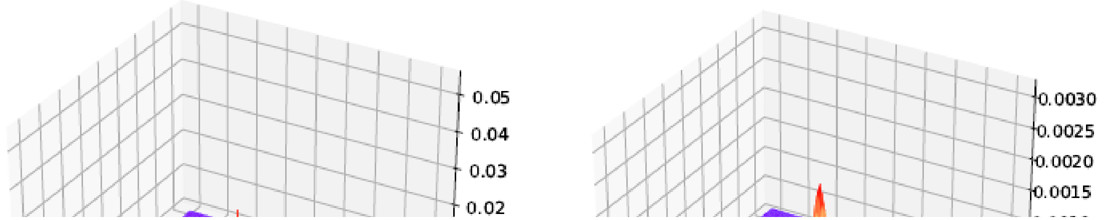
Quantitative results:

Training	Method	Sintel (train) Clean	Sintel (train) Final	KITTI-15 (train) Fl-epe	KITTI-15 (train) Fl-all	Sintel (test) Clean	Sintel (test) Final	KITTI-15 (test) Fl-all
	Perceiver IO [23]	1.81†	2.42†	4.98†				
	PWC-Net+ [45]	(1.71)	(2.34)	(1.50)	(5.3)	3.45	4.60	7.72
	RAFT [50]	(0.76)	(1.22)	(0.63)	(1.5)	1.61⋆	2.86⋆	5.10
	RAFT-A [43]	-	-	-	-	2.01	3.14	4.78
	Separable Flow [56]	(0.69)	(1.10)	(0.69)	(1.60)	1.50	2.67	4.64
	GMA [25]	(0.62)	(1.06)	(0.57)	(1.2)	1.39⋆	2.47⋆	5.15
C+T+S+K+H	AGFlow [30]	(0.65)	(1.07)	(0.58)	(1.2)	1.43⋆	2.47⋆	4.89
	KPA-Flow [29]	(0.60)	(1.02)	(0.52)	(1.1)	1.35⋆	2.36⋆	4.60
	DIP [58]	-	-	-	-	1.44⋆	2.83⋆	**4.21**
	GMFlowNet [57]	(0.59)	(0.91)	(0.64)	(1.51)	1.39	2.65	4.79
	GMFlow [54]	-	-	-	-	1.74	2.90	9.32
	CRAFT [42]	(0.60)	(1.06)	(0.58)	(1.34)	1.45⋆	2.42⋆	4.79
	FlowFormer [20]	(0.48)	(0.74)	(0.53)	(1.11)	1.20	**2.12**	4.68†
	SKFlow [47]	(0.52)	(0.78)	(0.51)	(0.94)	1.28⋆	2.23⋆	4.84
	MatchFlow(R) (Ours)	(0.51)	(0.81)	(0.59)	(1.3)	1.33⋆	2.64⋆	4.72†
	MatchFlow(G) (Ours)	(0.49)	(0.78)	(0.55)	(1.1)	**1.16**⋆	2.37⋆	4.63†
	MatchFlow(R) (Ours)	1.14	2.61	4.19†	**13.6**†	-	-	-
	MatchFlow(G) (Ours)	1.03	2.45	**4.08**†	15.6†	-	-	-

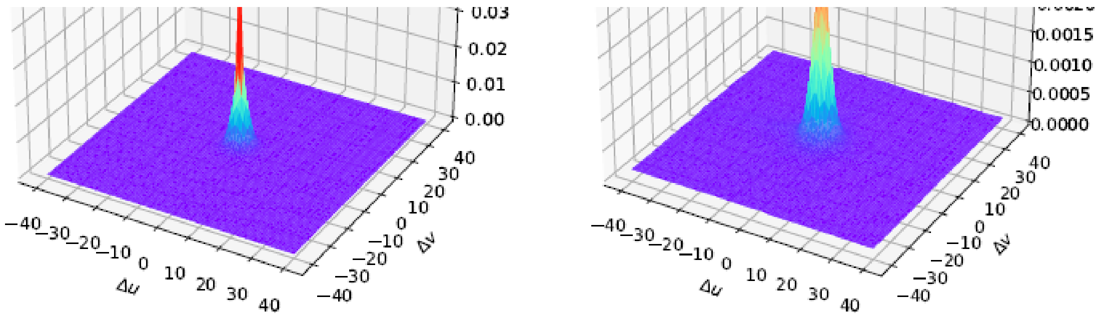
Experiments

Ablation Study:

Experiment	I-15 (train) Fl-all	Parameters
Baseline	17.1	5.9M
	15.9	17.0M
Local Matching Pre-trair	**14.4**	15.4M
	15.6	15.4M
Number of Attention Blo	16.3	5.9M
	15.6	9.1M
	15.6	15.4M
Attention Type	15.6	14.3M
	15.6	15.4M
	15.0	18.7M
Global Matching	17.4	15.4M
	16.1	15.4M
	15.6	15.4M



Method	Dataset	Sintel		KITTI-15	
		Clean	Final	Fl-epe	Fl-all
Baseline	C+T	1.27	2.84	4.12	14.4
Depthstill	C+T+dMegaDepth	2.10	3.47	**3.41**	**10.9**
DINO	ImageNet+C+T	1.52	3.08	5.50	19.2
Twins-SVT	ImageNet+C+T	1.15	2.73	4.98	16.8
Ours	MegaDepth+C+T	**1.03**	**2.45**	4.08	15.6



(a) Noc

(b) Occ

Experiments

Parameters, Timing, and GPU Memory:

Model	Para.	Infer.	Train.	Memory
GMA [25]	5.9M	74 ms	30 h	11.7 G
FlowFormer [20]	18.2 M	149 ms	107 h	43.7 G
MatchFlow(R)	14.8 M	110 ms	53 h	22.1 G
MatchFlow(G)	15.4M	126 ms	58 h	23.6 G

Conclusion

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- Employing GIM as the ptical flow.
- A novel matching-base flow model – MatchFlow.
- Massive real-world mat ur model.

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