

Domain Generalized RPPG Network: Disentangled Feature Learning with Domain Permutation and Domain Augmentation

Wei-Hao Chung, Cheng-Ju Hsieh, Sheng-Hung Liu and Chiou-Ting Hsu
National Tsing Hua University, Taiwan

Remote Photoplethysmography (rPPG) Estimation

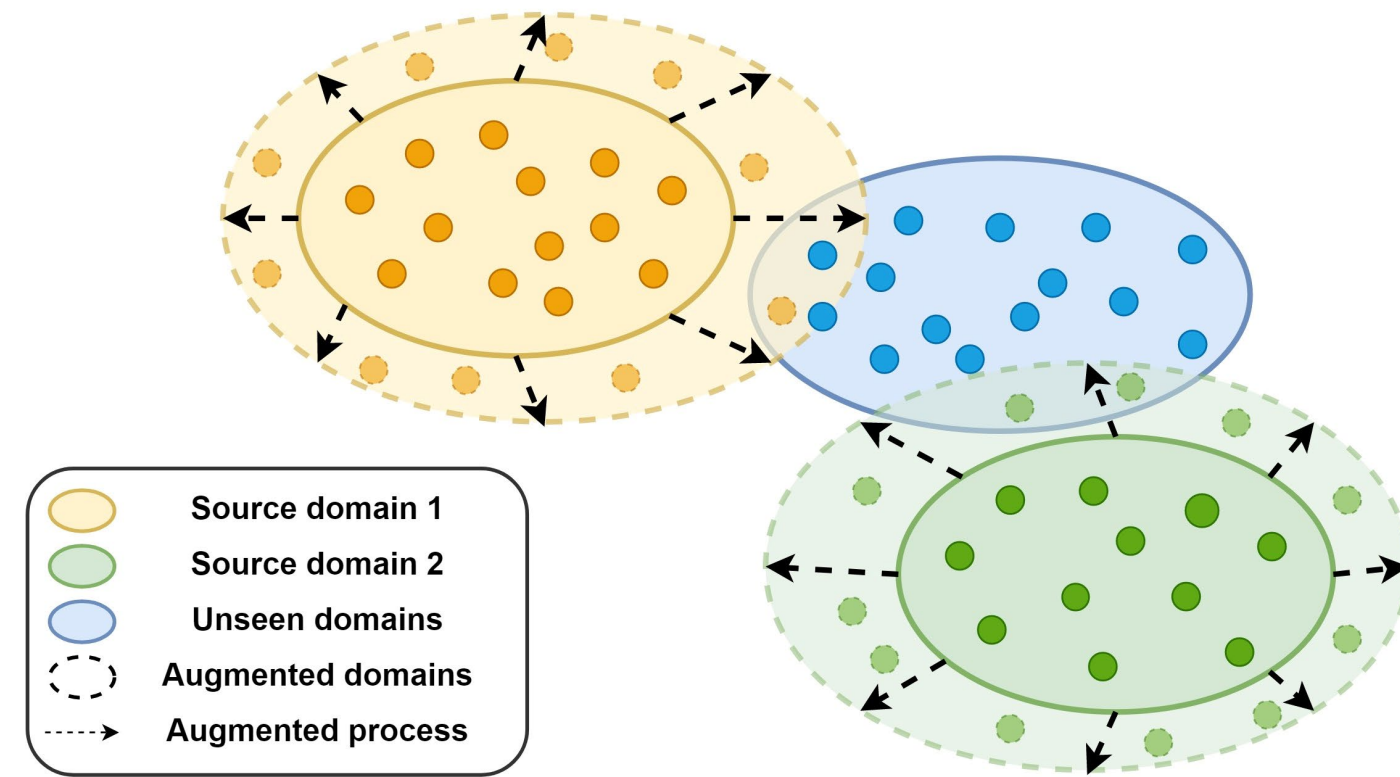
Performance degrades on cross-domain inference

- Illuminance variances
- Various capturing devices and settings

Goal

Domain generalization

- Learning to generalize to unseen target domains
- Enlarging the domain sphere



DG-rPPGNet

Proposed method

- Feature disentanglement
 - rPPG signal feature
 - Identity feature
 - Domain feature

Disentanglement

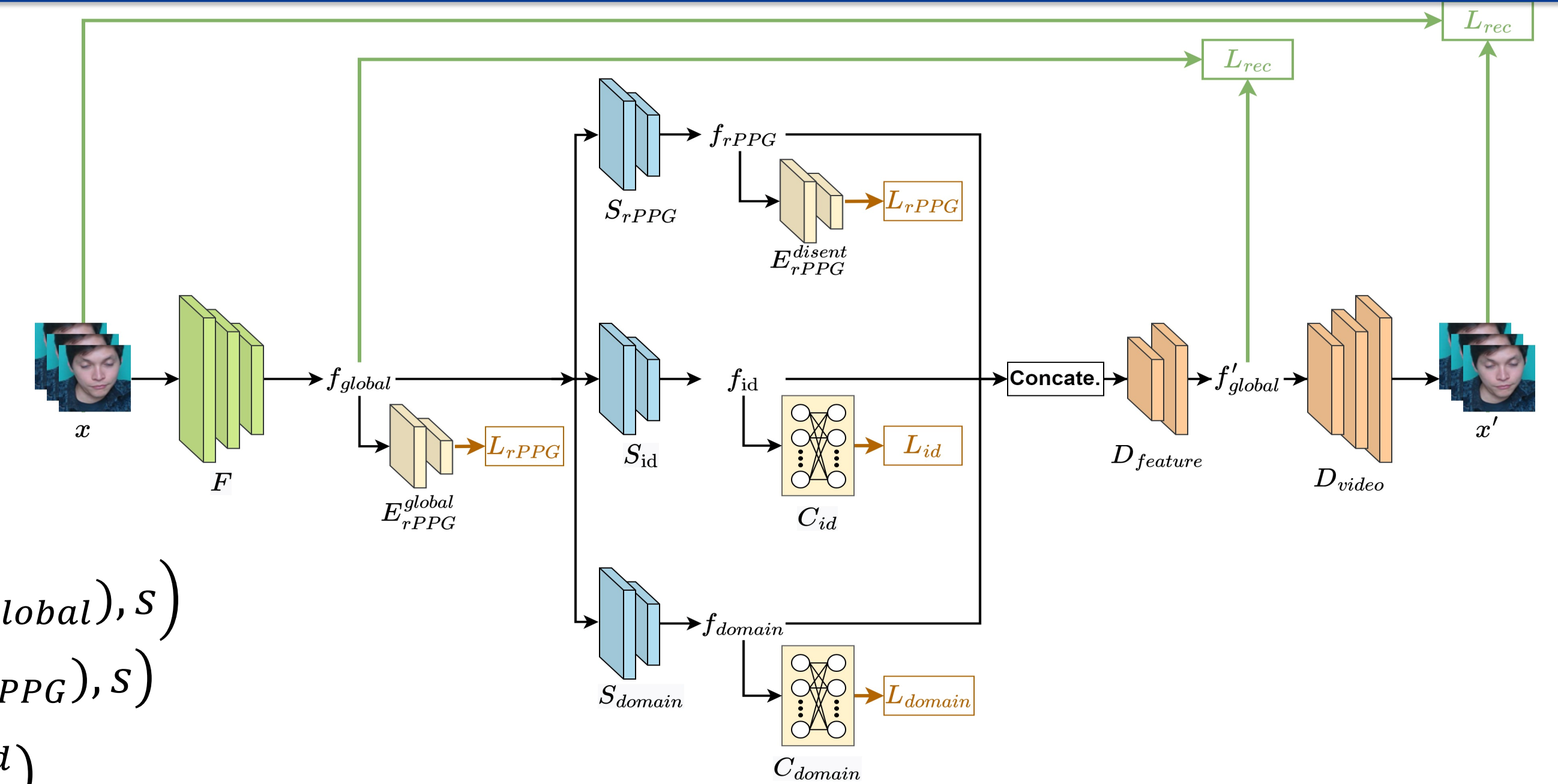
$$L_{rPPG}^{disent} = L_{np}(E_{rPPG}^{global}(f_{global}), s) + L_{np}(E_{rPPG}^{disent}(f_{rPPG}), s)$$

$$L_{id}^{disent} = CE(C_{id}(f_{id}), y^{id})$$

$$L_{domain}^{disent} = CE(C_{domain}(f_{domain}), y^{domain})$$

Reconstruction

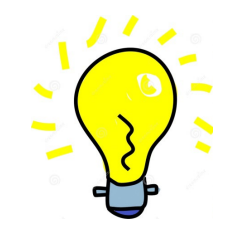
$$L_{global}^{disent} = \|f_{global} - f'_{global}\|_1 + \|x - x'\|_1$$



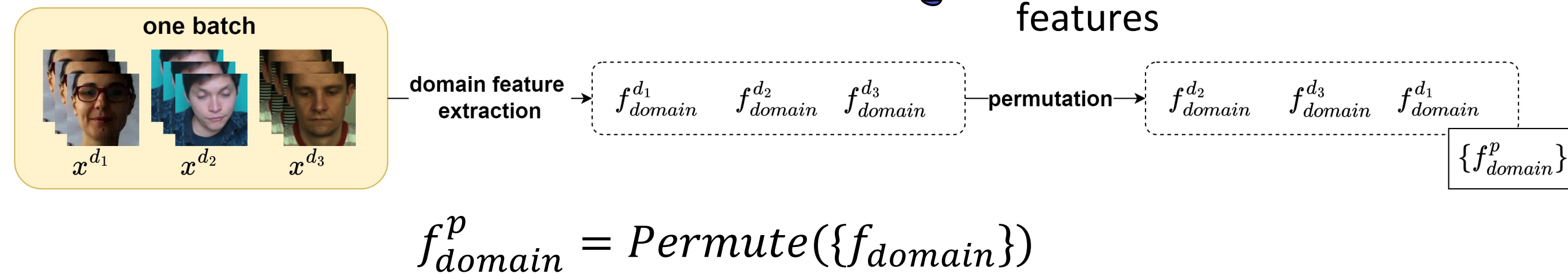
Domain Permutation and Domain Augmentation

Domain Permutation

- Domain feature invariant learning

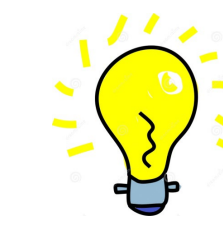


“Permute” the domain features

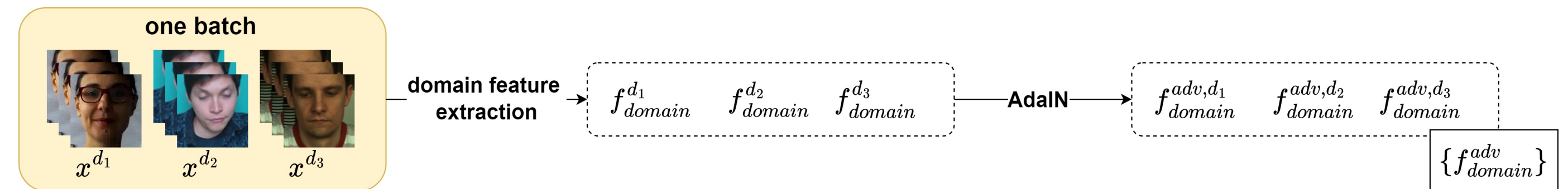


Domain Augmentation via AdaIN

- Adversary domain learning



“Maximize” the rPPG prediction loss L_{np}



$$(\alpha, \beta) = \underset{\alpha, \beta}{\operatorname{argmax}} L_{np}(E_{rPPG}^{global}(f_{global}^{adv}), s) + L_{np}(E_{rPPG}^{disent}(f_{rPPG}^{adv}), s)$$

Experiments

Training on two datasets
Testing on the remaining one

Datasets

- **UBFC-rPPG**: 42 subjects
- **PURE**: 10 subjects x 6 motions
- **COHFACE**: 40 subjects x 2 environments
- **VIPL-HR**: 107 subjects x 9 scenarios x 3 devices

P + C → U			U + C → P			U + P → C			VIPL-HR		
Method	MAE↓	RMSE↓	Method	MAE↓	RMSE↓	Method	MAE↓	RMSE↓	Method	MAE↓	RMSE↓
GREEN† [2]	8.29	15.82	LiCVPR† [5]	28.22	30.96	POS† [4]	19.86	24.57	Averaged GT	22.21	26.70
ICA† [3]	4.39	11.60	POS† [4]	22.25	30.20	LiCVPR† [5]	19.98	25.59	DG-rPPGNet (U+P)	18.38	18.86
POS† [4]	3.52	8.38	ICA† [3]	15.23	21.25	ICA† [3]	14.27	19.28	DG-rPPGNet (U+C)	18.23	18.81
CHROM† [1]	3.10	6.84	GREE† [2]	9.03	13.92	GREEN† [2]	10.94	16.72	DG-rPPGNet (P+C)	15.95	17.47
Multi-task* [10]	1.06	2.70	CHROM† [1]	3.82	6.8	CHROM† [1]	7.8	12.45			
Dual-GAN* [14]	0.74	1.02	Multi-task* [10]	4.24	6.44	DG-rPPGNet	7.19	8.99			
DG-rPPGNet	0.63	1.35	DG-rPPGNet	3.02	4.69						