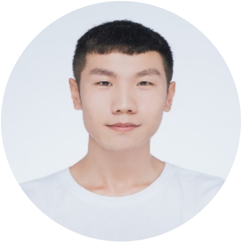
2021 ICCV OCTOBER 11-17 VIRTUAL

MSR-GCN: Multi-Scale Residual Graph Convolution Networks for Human Motion Prediction





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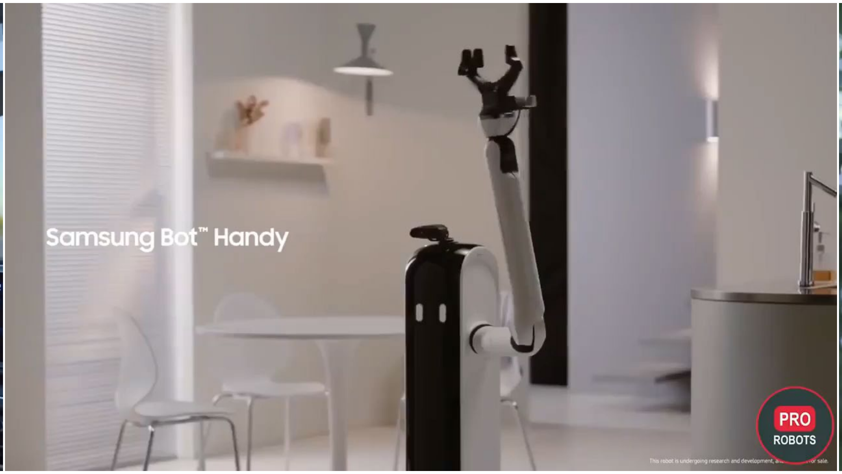
Applications

autonomous driving

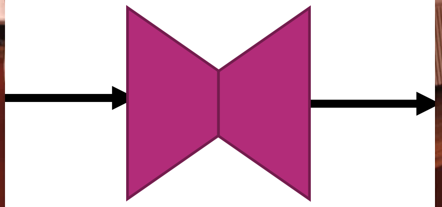


human-computer interaction

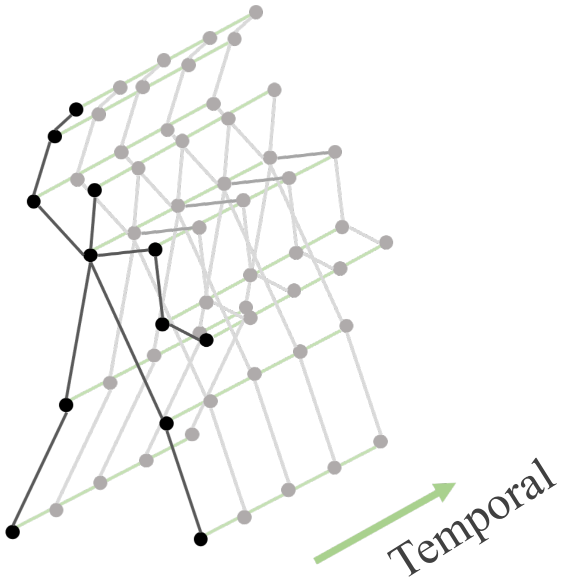
intelligent security

Introduction & Problem

Observed Seq



Future Seq



spatiotemporal dependencies

Related Works

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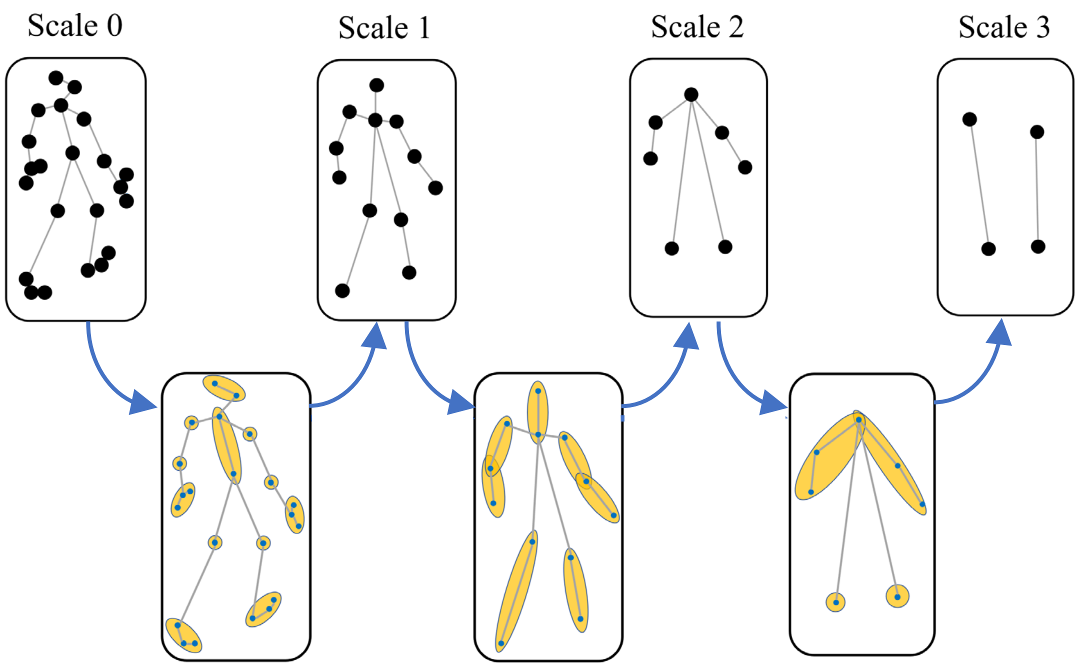
- Prior efforts neglect the inner-frame kinematic dependencies
- Frame-by-frame prediction manner causes error accumulation
- Graph Convolution Networks (GCNs) exhibit promising results, but not sufficient for more high-quality human motion prediction.

Key Insights

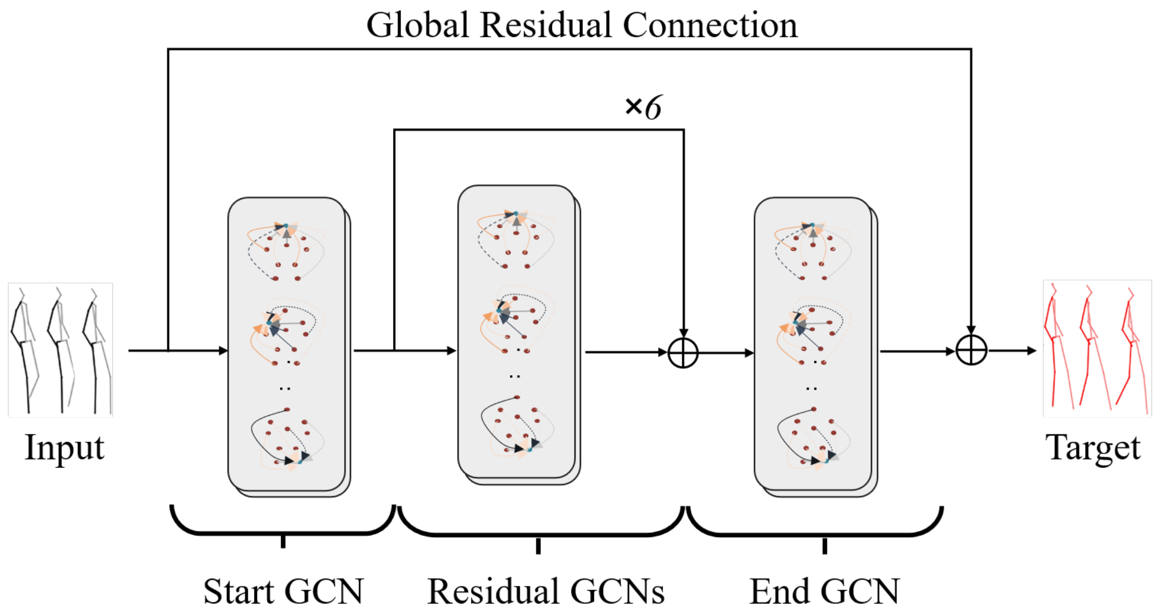
- Stabilize the motion pattern by gradually abstracting body parts
- Predict the poses in the coarsest level firstly, and then go up to finer levels gradually



multi-scale joints groping manner from finer levels (left) to coarser levels (right)

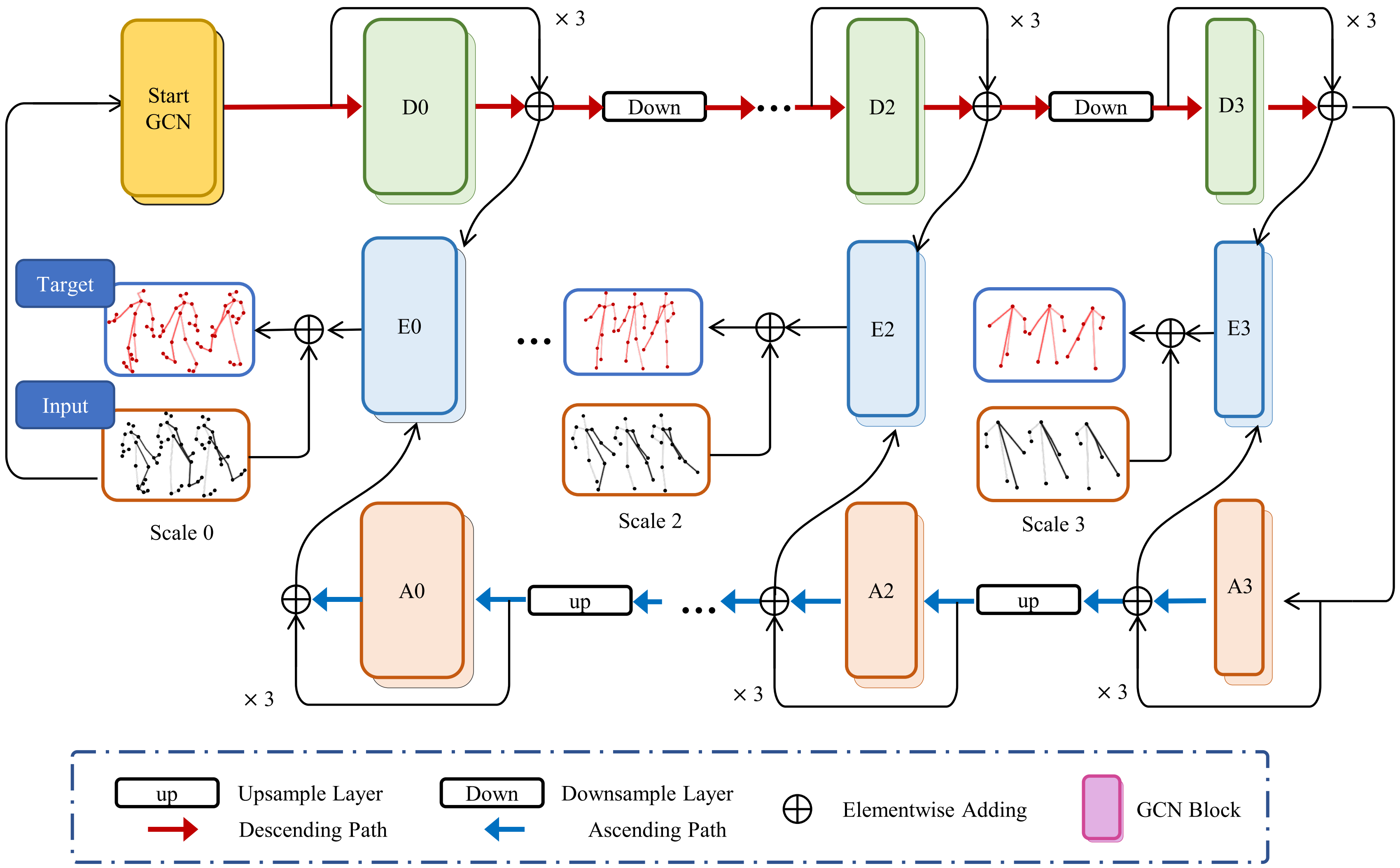
Key Insights

- GCNs based on learnable fully connected graph
- Start GCN, Residual GCNs, End GCN
- Residual connection helps to simplify the prediction process



the basic GCN model

MSR-GCN Architecture



- Descending Path
- Ascending Path
- End GCNs and Intermediate Loss
- Residual Connections

loss function:

Mean Per Joint Position Error (MPJPE)

$$\mathcal{L}_{\mathrm{MPJPE}} = \frac{1}{J \times T} \sum_{t=1}^{T} \sum_{j=1}^{J} \left\| \hat{p}_{j,t} - p_{j,t} \right\|^2$$

Quantitative Results

Short-term errors on Human3.6M (H3.6M)

scenarios	walking				eating				smoking				discussion			
millisecond (ms)	80	160	320	400	80	160	320	400	80	160	320	400	80	160	320	400
Residual sup. [34]	29.36	50.82	76.03	81.51	16.84	30.60	56.92	68.65	22.96	42.64	70.14	82.68	32.94	61.18	90.92	96.19
DMGNN [27]	17.32	30.67	54.56	65.20	10.96	21.39	36.18	43.88	8.97	17.62	32.05	40.30	17.33	34.78	61.03	69.80
Traj-GCN [33]	12.29	23.03	39.77	46.12	**8.36**	**16.90**	33.19	40.70	**7.94**	**16.24**	31.90	38.90	12.50	27.40	58.51	71.68
MSR-GCN	**12.16**	**22.65**	**38.64**	**45.24**	8.39	17.05	**33.03**	**40.43**	8.02	16.27	**31.32**	**38.15**	**11.98**	**26.76**	**57.08**	**69.74**
scenarios	directions				greeting				phoning				posing			
millisecond (ms)	80	160	320	400	80	160	320	400	80	160	320	400	80	160	320	400
Residual sup. [34]	35.36	57.27	76.30	87.67	34.46	63.36	124.60	142.50	37.96	69.32	115.00	126.73	36.10	69.12	130.46	157.08
DMGNN [27]	13.14	24.62	64.68	81.86	23.30	50.32	107.30	132.10	12.47	25.77	48.08	58.29	15.27	29.27	71.54	96.65
Traj-GCN [33]	8.97	19.87	43.35	**53.74**	18.65	38.68	77.74	93.39	10.24	21.02	42.54	52.30	13.66	29.89	**66.62**	**84.05**
MSR-GCN	**8.61**	**19.65**	**43.28**	53.82	**16.48**	**36.95**	**77.32**	**93.38**	**10.10**	**20.74**	**41.51**	**51.26**	**12.79**	**29.38**	66.95	85.01

Residual sup. Martinez J, *et al.*, CVPR 2017 **DMGNN** Li M, *et al.*, CVPR 2020 **Traj-GCN** Mao W, *et al.*, ICCV 2019

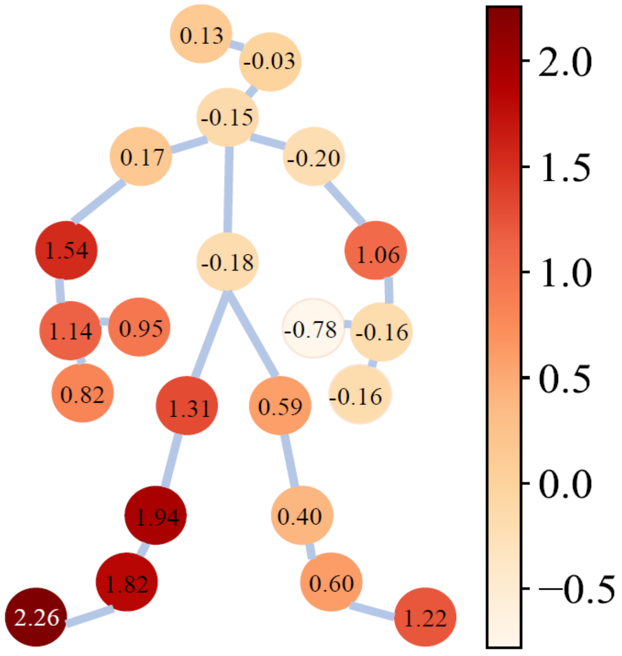
Quantitative Results

Short-term errors on CMU Mocap

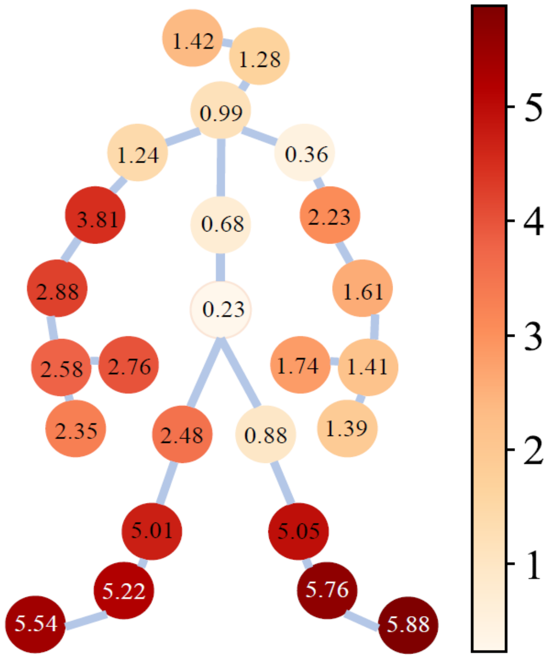
scenarios	basketball				basketball signal				directing traffic				jumping			
millisecond (ms)	80	160	320	400	80	160	320	400	80	160	320	400	80	160	320	400
Residual sup. [34]	15.45	26.88	43.51	49.23	20.17	32.98	42.75	44.65	20.52	40.58	75.38	90.36	26.85	48.07	93.50	108.90
DMGNN [27]	15.57	28.72	59.01	73.05	5.03	9.28	20.21	26.23	10.21	20.90	41.55	52.28	31.97	54.32	96.66	119.92
Traj-GCN [33]	11.68	21.26	40.99	50.78	3.33	6.25	13.58	17.98	6.92	13.69	30.30	39.97	17.18	32.37	60.12	72.55
MSR-GCN	**10.28**	**18.94**	**37.68**	**47.03**	**3.03**	**5.68**	**12.35**	**16.26**	**5.92**	**12.09**	**28.36**	**38.04**	**14.99**	**28.66**	**55.86**	**69.05**
scenarios	running				soccer				walking				washwindow			
millisecond (ms)	80	160	320	400	80	160	320	400	80	160	320	400	80	160	320	400
Residual sup. [34]	25.76	48.91	88.19	100.80	17.75	31.30	52.55	61.40	44.35	76.66	126.83	151.43	22.84	44.71	86.78	104.68
DMGNN [27]	17.42	26.82	38.27	40.08	14.86	25.29	52.21	65.42	9.57	15.53	26.03	30.37	7.93	14.68	33.34	44.24
Traj-GCN [33]	14.53	24.20	37.44	41.10	13.33	24.00	43.77	53.20	6.62	10.74	**17.40**	**20.35**	5.96	11.62	**24.77**	**31.63**
MSR-GCN	**12.84**	**20.42**	**30.58**	**34.42**	**10.92**	**19.50**	**37.05**	**46.38**	**6.31**	**10.30**	17.64	21.12	**5.49**	**11.07**	25.05	32.51

Residual sup. Martinez J, *et al.*, CVPR 2017 **DMGNN** Li M, *et al.*, CVPR 2020 **Traj-GCN** Mao W, *et al.*, ICCV 2019

Quantitative Results



H3.6M

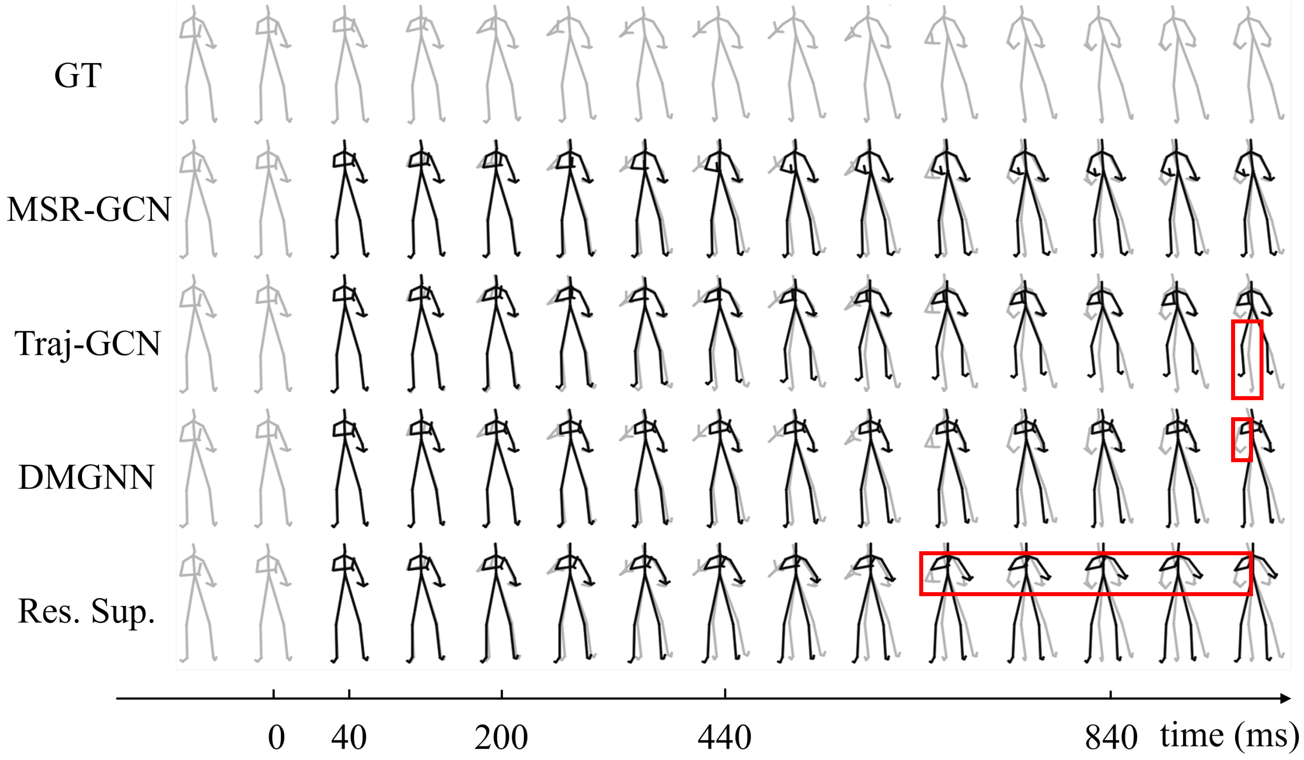


CMU Mocap

performance gain over **Traj-GCN** Mao W, *et al.*, ICCV 2019

MSR-GCN can better handle high-frequency motions

Quantitative Results



Visualization on H3.6M

Traj-GCN Mao W, *et al.*, ICCV 2019 **DMGNN** Li M, *et al.*, CVPR 2020 **Res. Sup.** Martinez J, *et al.*, CVPR 2017

QR Code for our project:

https://github.com/Droliven/MSRGCN

Thank you!

Acknowledgement

This research is sponsored in part by the National Natural Science Foundation of China (62072191, 61802453, 61972160), in part by the Natural Science Foundation of Guangdong Province (2019A1515010860, 2021A1515012301), and in part by the Fundamental Research Funds for the Central Universities (D2190670).