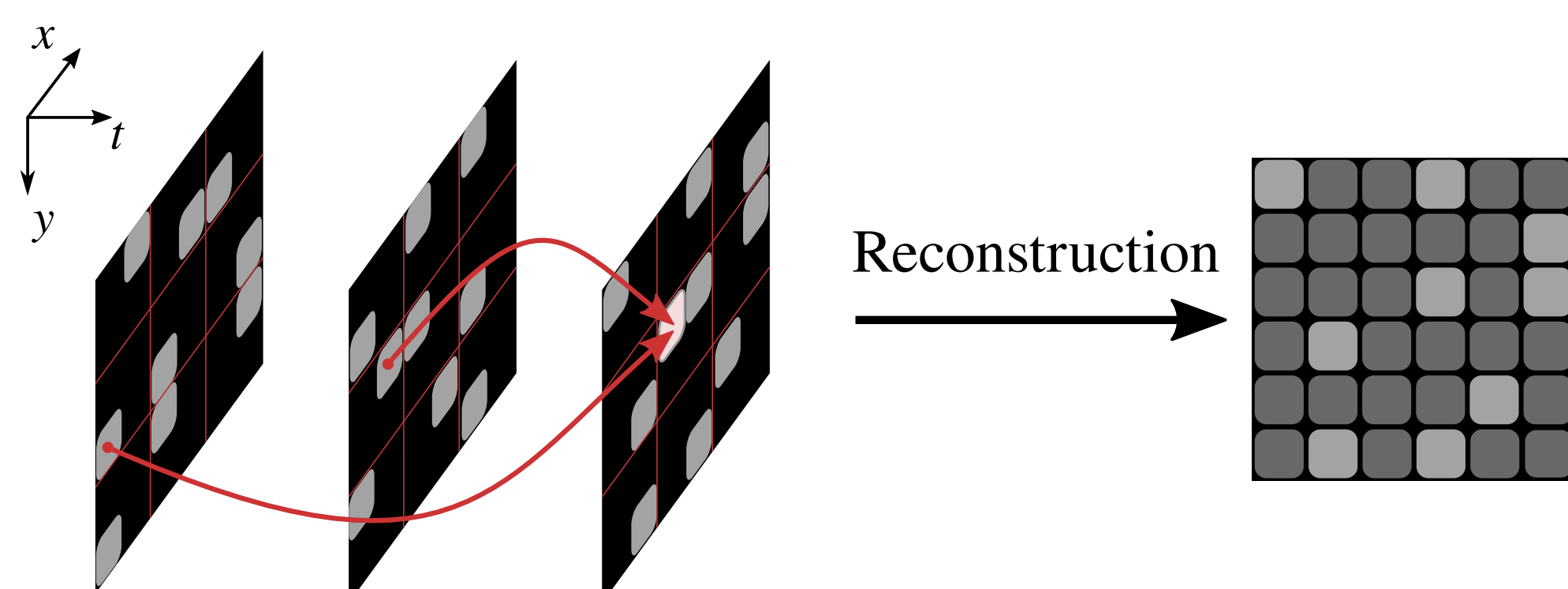


Novel Consistency Check for Fast Recursive Reconstruction of Non-Regularly Sampled Video Data

1. Problem Statement

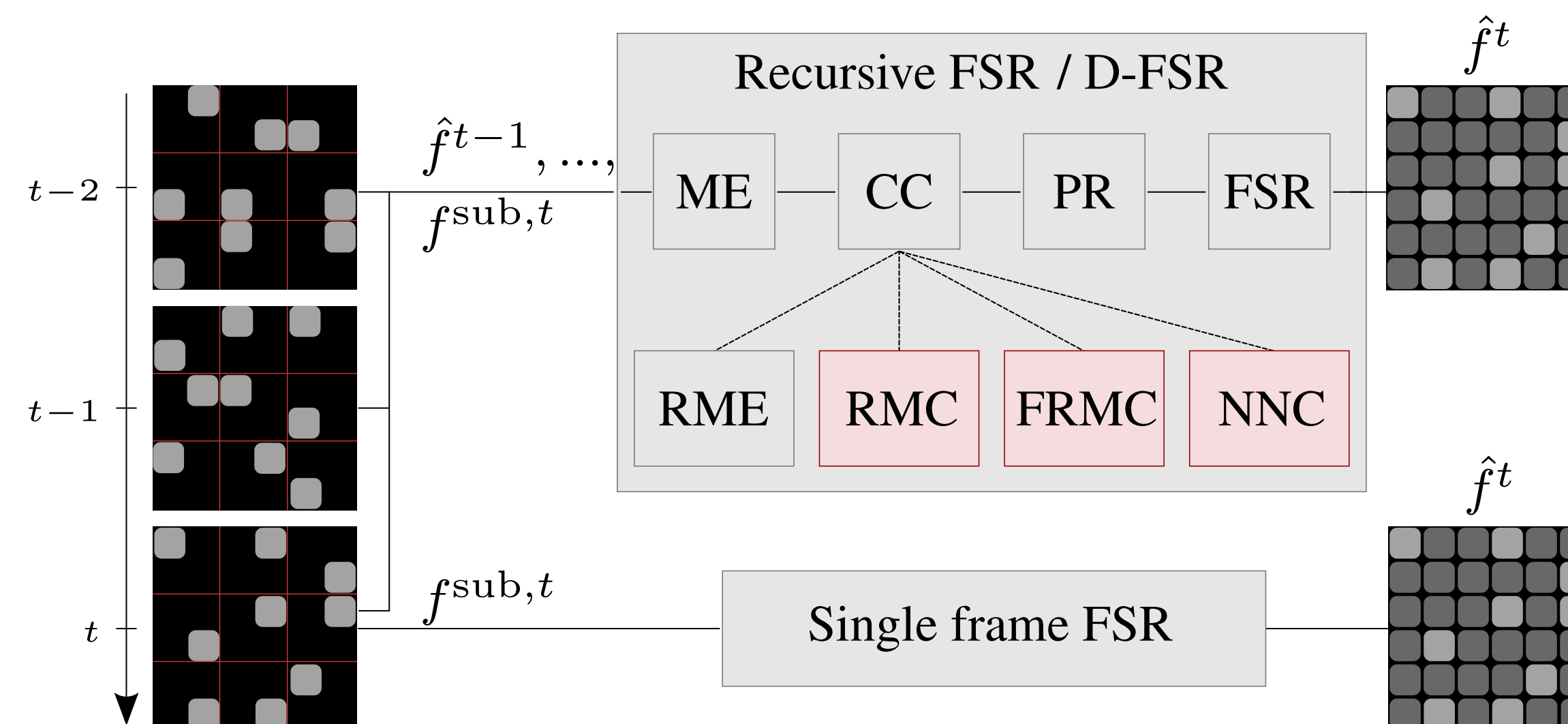
- Using non-regular quarter sampling [Schöberl2011], the spatial resolution per pixel of an imaging sensor can be increased. Special case of Compressed Sensing [Grosche2020].
- For video data, additional information can be used from past frames.



- Perform motion estimation with non-regularly sampled data
- Use consistency checks to sort out low-quality projections

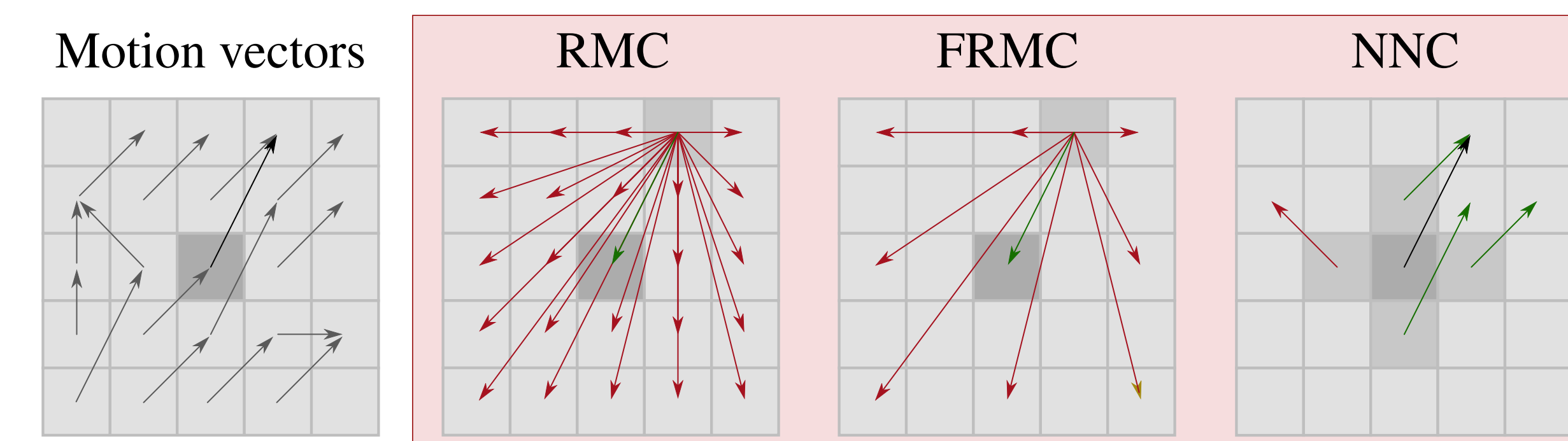
2. State of the Art

- Single-frame FSR [Seiler2015] (no projections)
- Recursive FSR (R-FSR) [Jonscher2016] (fixed mask only)
 - Motion estimation (ME) w.r.t. reconstructed past frames
 - Projection (PR) of pixels from past frames to current frame
 - Reverse motion estimation (RME) as consistency check (CC) before projection (PR)



3. Novel Contributions

- D-FSR: Generalization to dynamically changing sampling masks
- Novel, faster consistency checks
 - Reverse Motion Check (RMC): Test motion vectors around candidate
 - Fast RMC (FRMC): Faster version testing only few motion vectors
 - Nearest Neighbor Check (NNC): Test consistency with neighboring motion vectors neighbors



4. Simulations and Results

- Image quality in terms of PSNR in dB for a fixed sampling mask

(fixed mask)	FSR	R-FSR + RME	D-FSR + RME	D-FSR + RMC	D-FSR + FRMC	D-FSR + FRMC + NNC
Spincalendar	30.38	31.66	32.67	32.72	33.00	32.68

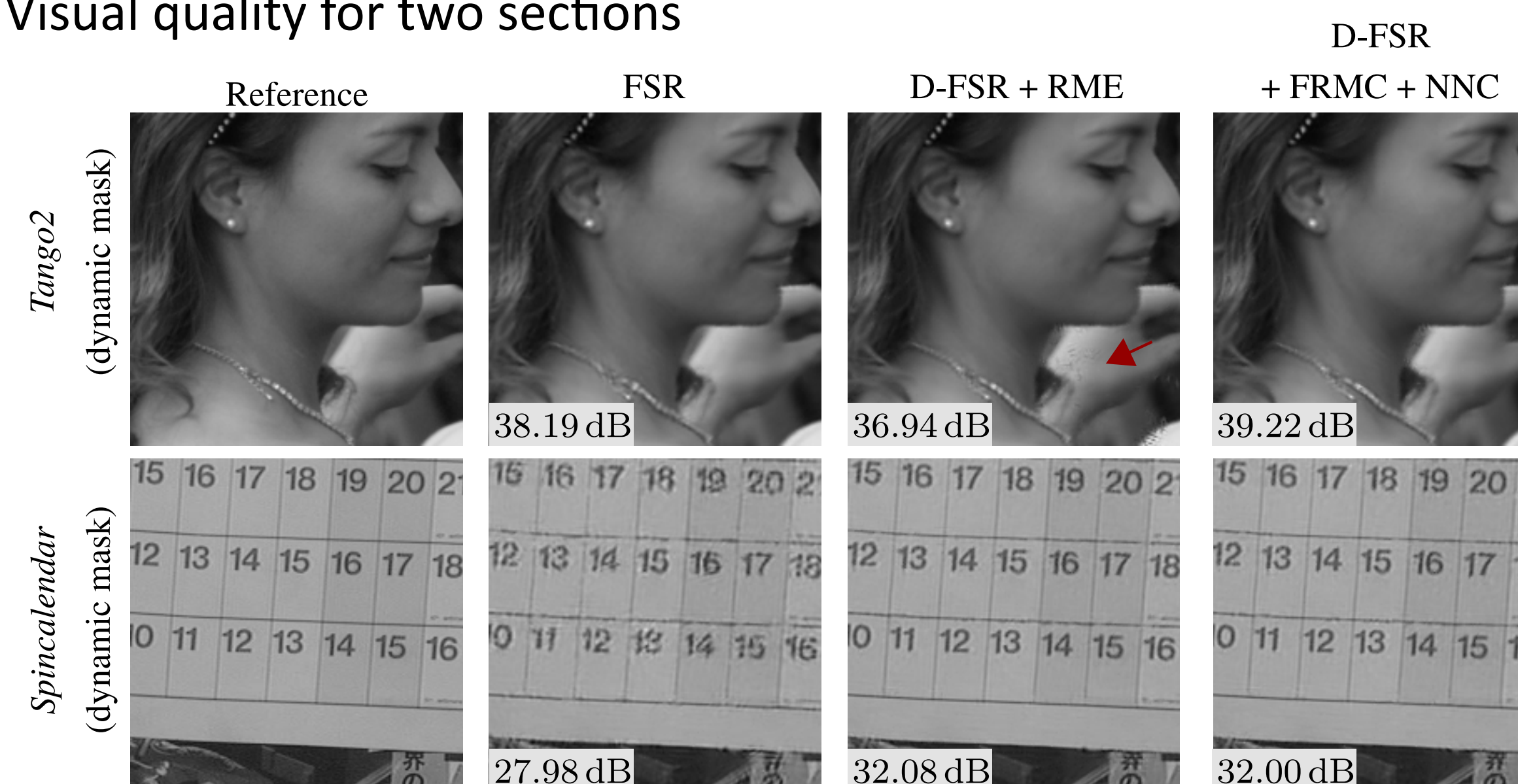
+1.02 dB

- Image quality in terms of PSNR in dB and SSIM for a dynamic sampling mask

(dynamic mask)	FSR	D-FSR + RME	D-FSR + RMC	D-FSR + FRMC	D-FSR + FRMC + NNC	
Spincalendar	30.43	33.20	33.26	33.56	33.21	
Class C	BasketballDrill	31.30	33.62	34.28	34.37	34.31
	BQMall	27.53	30.01	30.14	30.39	30.27
	PartyScene	23.23	24.64	24.70	25.05	24.92
	RaceHorses	28.71	28.34	29.02	28.92	29.22
A	Tango2	39.84	37.59	40.69	40.51	40.73
	ParkRunning3	30.19	31.36	31.42	31.34	31.58
	FoodMarket4	47.28	41.56	46.58	45.78	46.38
Average (PSNR)	32.31	32.54	33.76	33.74	33.83	
Average (SSIM)	0.9338	0.9477	0.9510	0.9520	0.9524	

+1.29 dB

- Visual quality for two sections



- Runtime in seconds

	ME	CC	FSR	Total
D-FSR + RME	21.56	33.80	6.02	61.37
D-FSR + RMC	23.11	40.19	6.11	69.41
D-FSR + FRMC	21.49	21.02	6.05	48.56
D-FSR + NNC + FRMC	23.14	2.56	6.07	31.77

-48%

5. Conclusions

- Novel D-FSR makes use of pixels measured in past frames even for dynamic sampling masks
- Novel consistency checks (RMC, FRMC, NNC) improve reconstruction quality and are faster than RME used in R-FSR [Jonscher2016]
- PSNR gains of +1.02 dB (fixed mask, w.r.t R-FSR + RME) and +1.29 dB (dynamic mask, w.r.t D-FSR + RME)
- Visual improvements
- Total computation time reduced by -48%

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[Jonscher2016] M. Jonscher, K. Jaskolka, J. Seiler, and A. Kaup, "Recursive Frequency Selective Reconstruction of Non-Regularly Sampled Video Data," in *Proc. Picture Coding Symposium*, Nuremberg, Germany, Dec. 2016, pp. 1–5.

[Schöberl2011] M. Schöberl, J. Seiler, S. Foessel, and A. Kaup, "Increasing imaging resolution by covering your sensor," in *Proc. 18th IEEE International Conference on Image Processing*, Brussels, Sept. 2011, pp. 1897–1900.

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