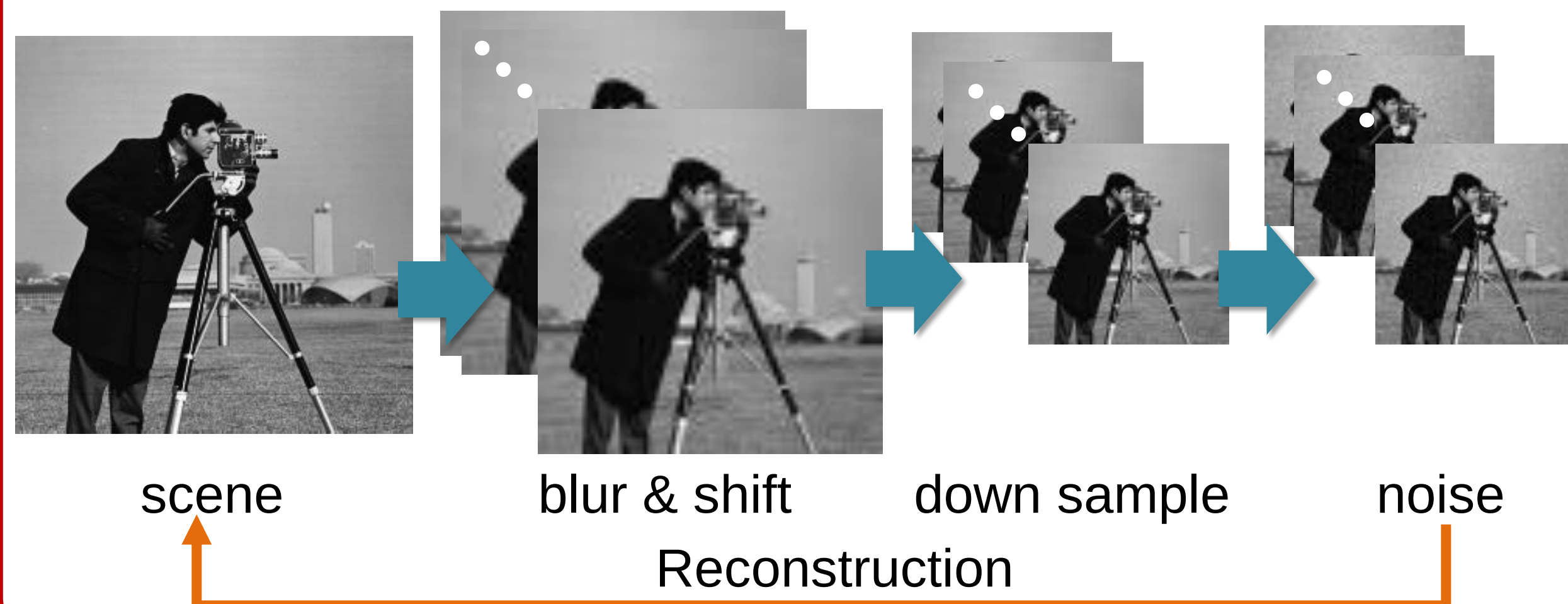


Regularization Methods for Multi-frame Super-resolution

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Motivation

- Applicable when optics outperforms image sensor
- Reconstruct super-resolution (SR) images using low resolution, aliased frames



Related Work

- Total variation (TV) regularized optimization using steepest descent algorithm [1]
- Spatially weighted TV approach using majorization-minimization algorithm [2]
- Generalized non-local means (NLM) for image fusion followed by TV deblurring [3]

References

- [1] Farsiu, et al. "Fast and robust multiframe super resolution", *IEEE Trans. Image Process.* 2004
- [2] Yuan, et al. "Multiframe super-resolution employing a spatially weighted total variation model", *IEEE Trans. Circuits Syst. Video Technol.* 2012
- [3] Protter, et al. "Generalizing the nonlocal-means to super-resolution reconstruction", *IEEE Trans. Image Process.* 2009

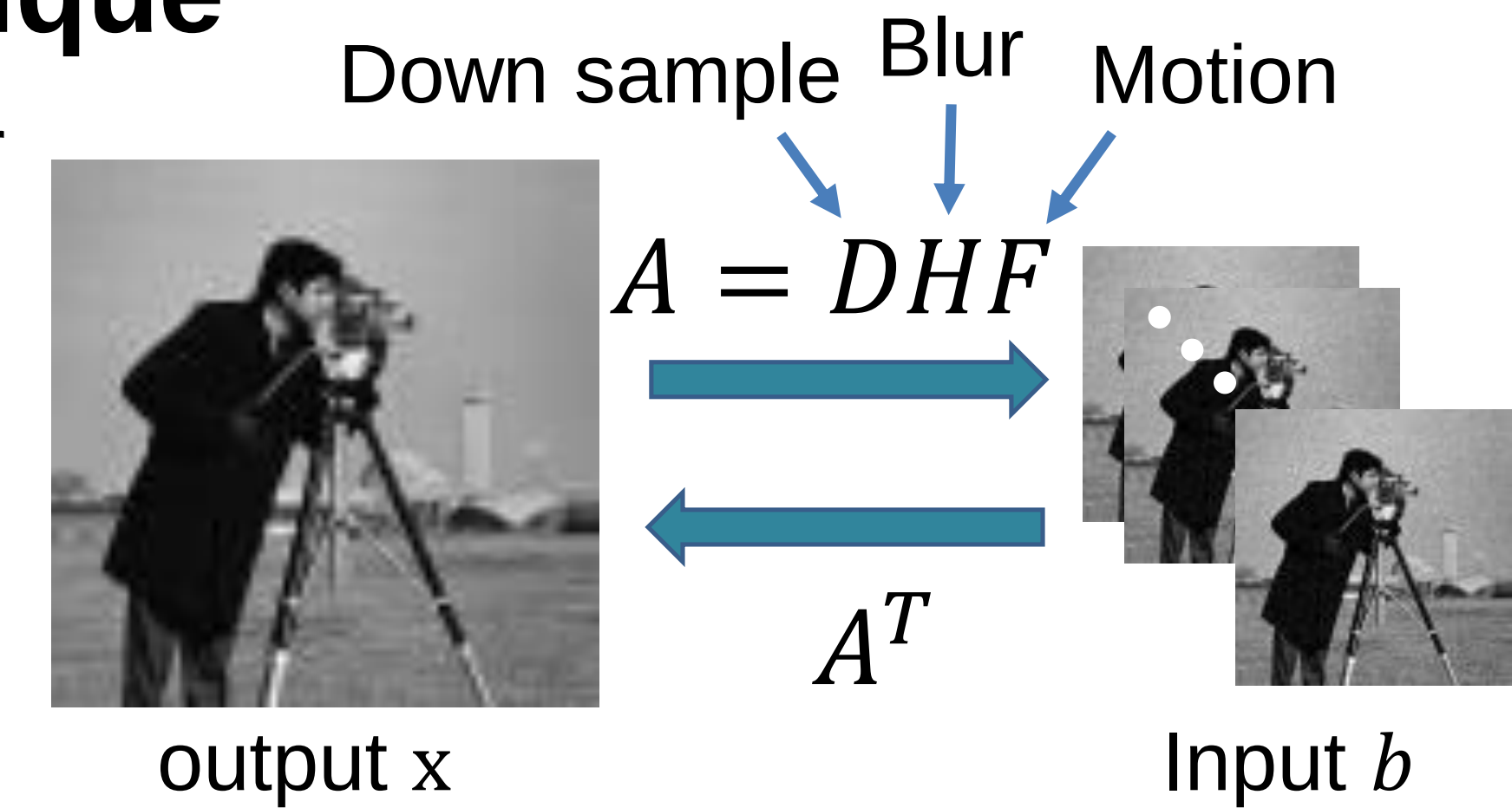
New Technique

- Iterative solution using ADMM with TV/NLM prior
- Hyperparameter tuning using grid search with a greedy approach

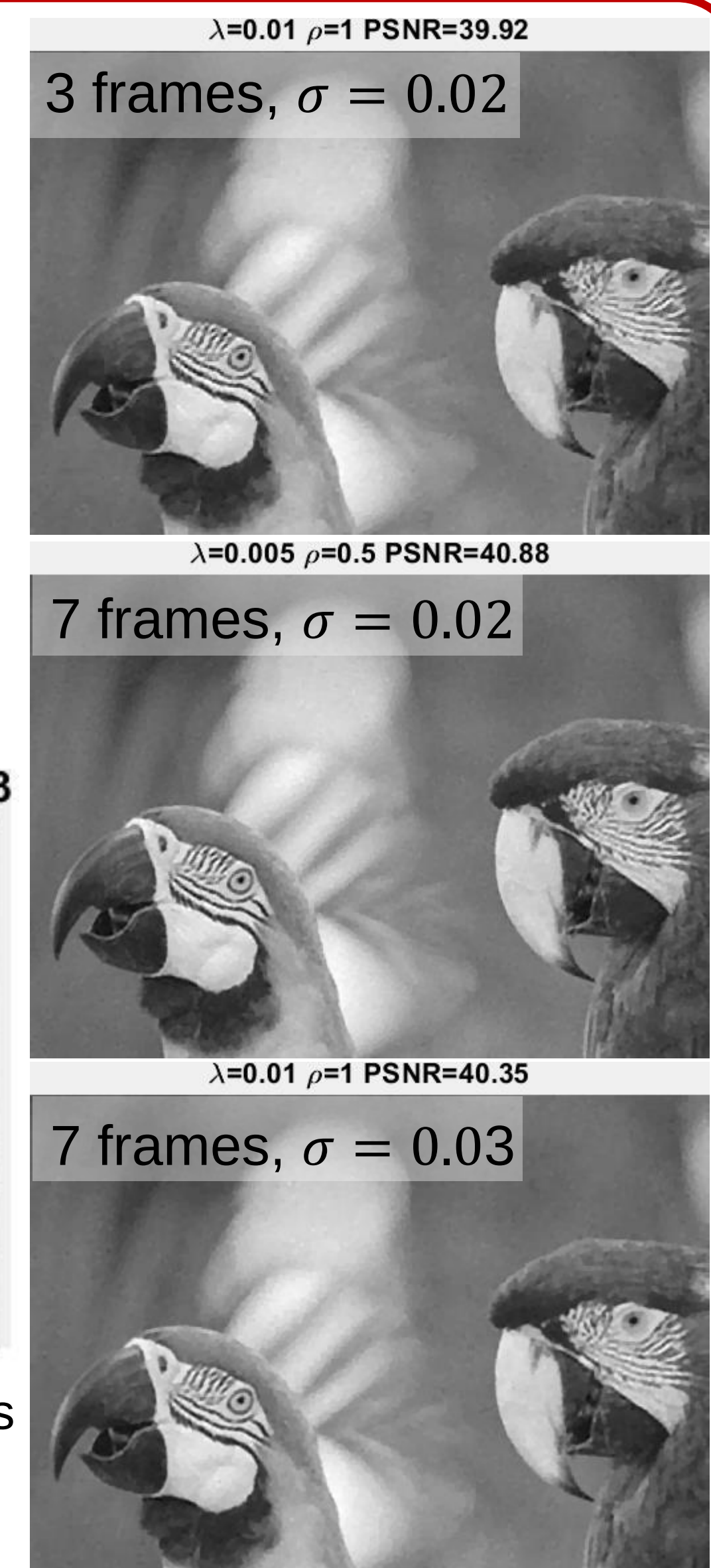
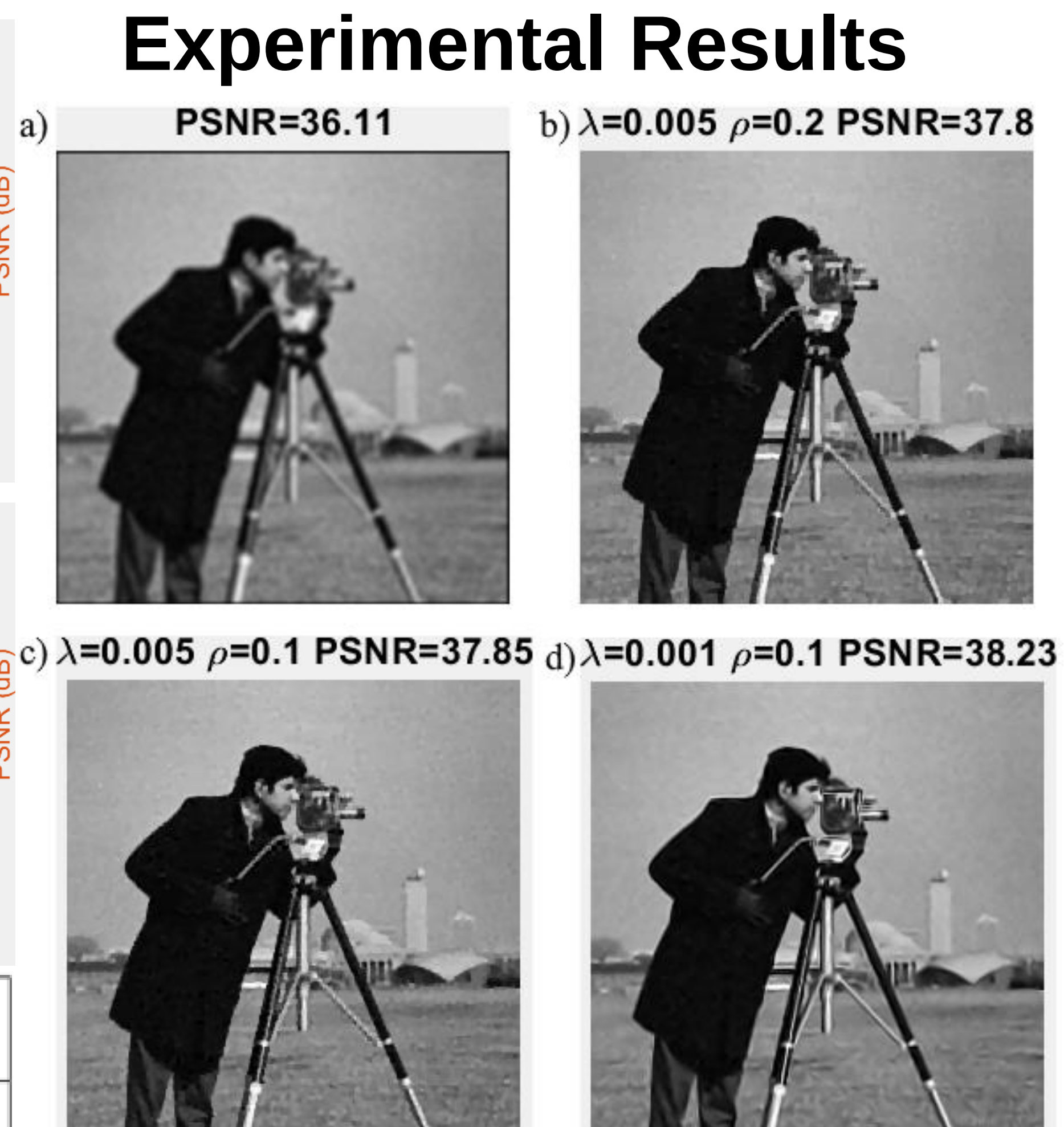
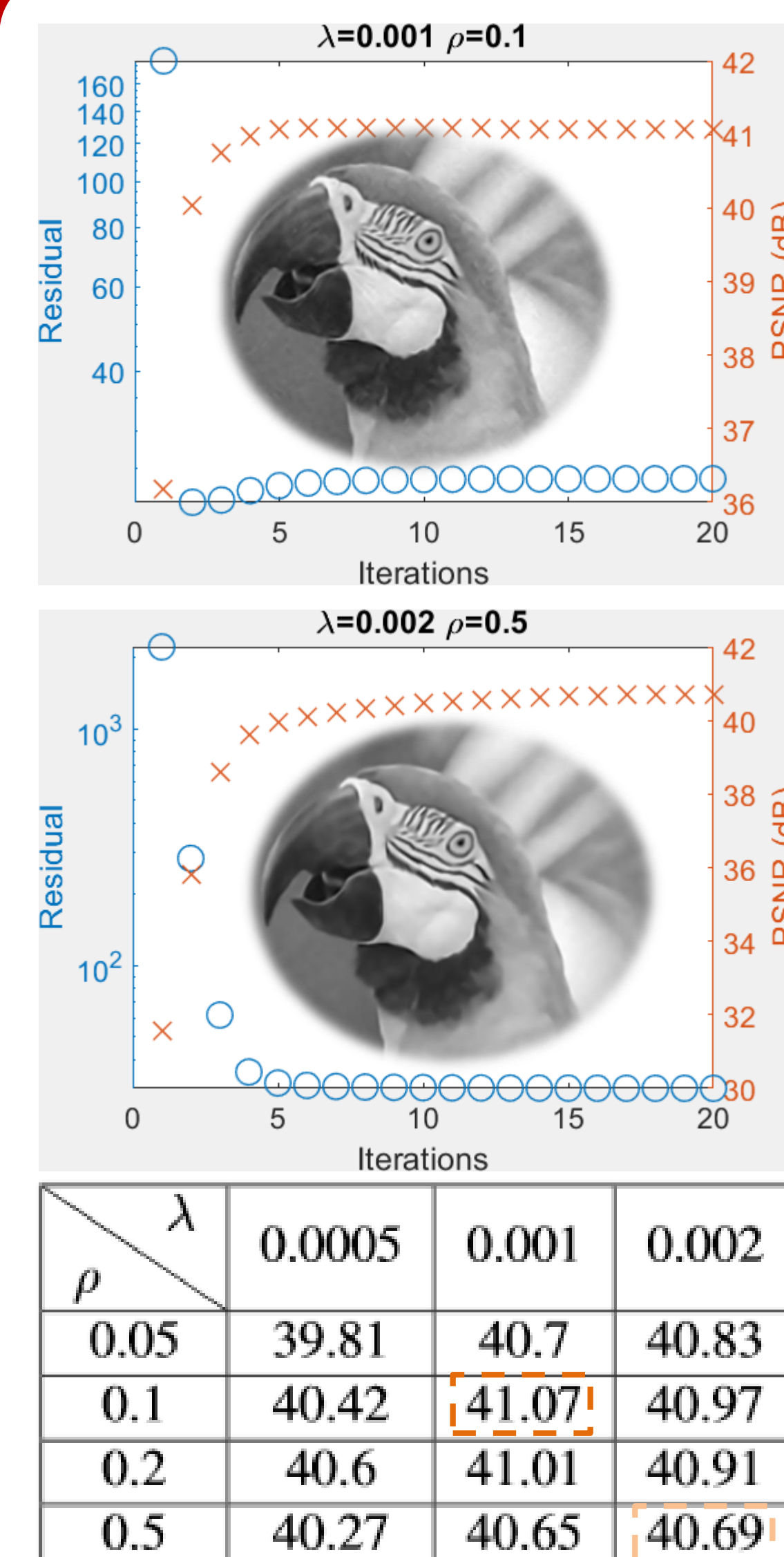
$$\begin{aligned} & \underset{\{x\}}{\text{minimize}} \quad \frac{1}{2} \|Ax - b\|_2^2 + \lambda \Gamma(z) \\ & \text{subject to} \quad Kx - z = 0 \end{aligned}$$

$\Gamma(z) = \begin{cases} \|Dx\|_1 & \text{TV} \\ \|Dx\|_{2,1} & \text{aniso-TV} \\ \text{NLM} & \text{NLM} \end{cases}$

λ (TV), ρ (aniso-TV), PSNR (NLM)



Experimental Results



Left: NLM hyperparameter tuning. Top: optimal results for (a) bicubic (b) aniso-TV (c) iso-TV (d) NLM. Right: changing frame number and noise level (iso-TV).