

# Simultaneous Inpainting and Super-resolution Using Self-learning

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## Supplementary Results

This document contains supplementary material showing additional results for the paper #329. Experiments are performed on the dataset in [1] which also contains results of the state-of-the-art methods for image inpainting viz. image melding [2], Photoshop CS5 content aware fill [3], statistics of patch offsets [4], GIMP Resynthesizer plugin [5], planar structure guidance [6, 7] and the method by Komodakis and Tziritas [8]. We show a comparison of the inpainted results of the proposed method with these methods while the simultaneously obtained super-resolved regions are compared with the method in [9]. These results are shown below in figures 1–9 and are organized as follows:

- (a) Input image
- (b) Region to be inpainted marked in red colour
- (c)–(i) show results of inpainting using:
  - (c) image melding [2]
  - (d) method proposed by Komodakis and Tziritas [8]
  - (e) statistics of patch offsets [4]
  - (f) content aware fill [3]
  - (g) planar structure guidance [6]
  - (h) GIMP resynthesizer [5]
  - (i) proposed method
- (j)–(l) show expanded versions after upsampling (the region marked by the yellow box inside the inpainted region in (i)) using the following approaches:
  - (j) bicubic interpolation
  - (k) super-resolution using Glasner *et al.*'s method [9]
  - (l) proposed method for super-resolution

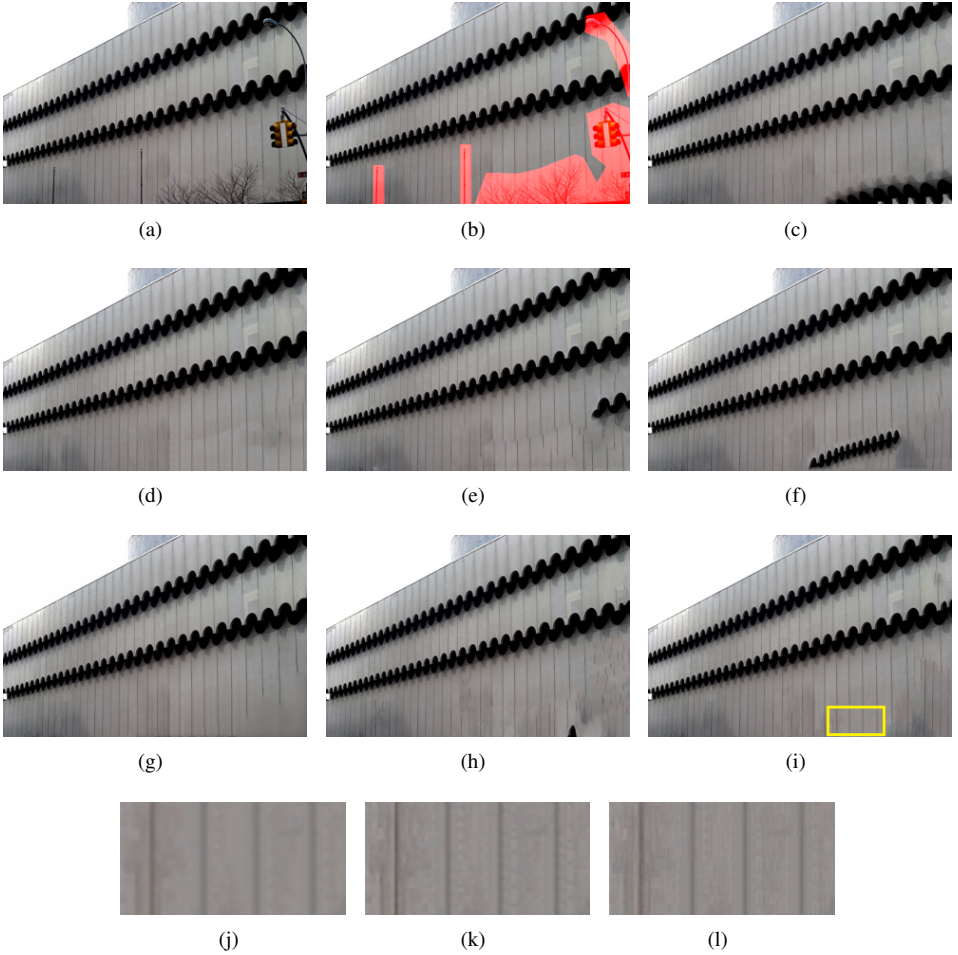


Figure 1: Result 1

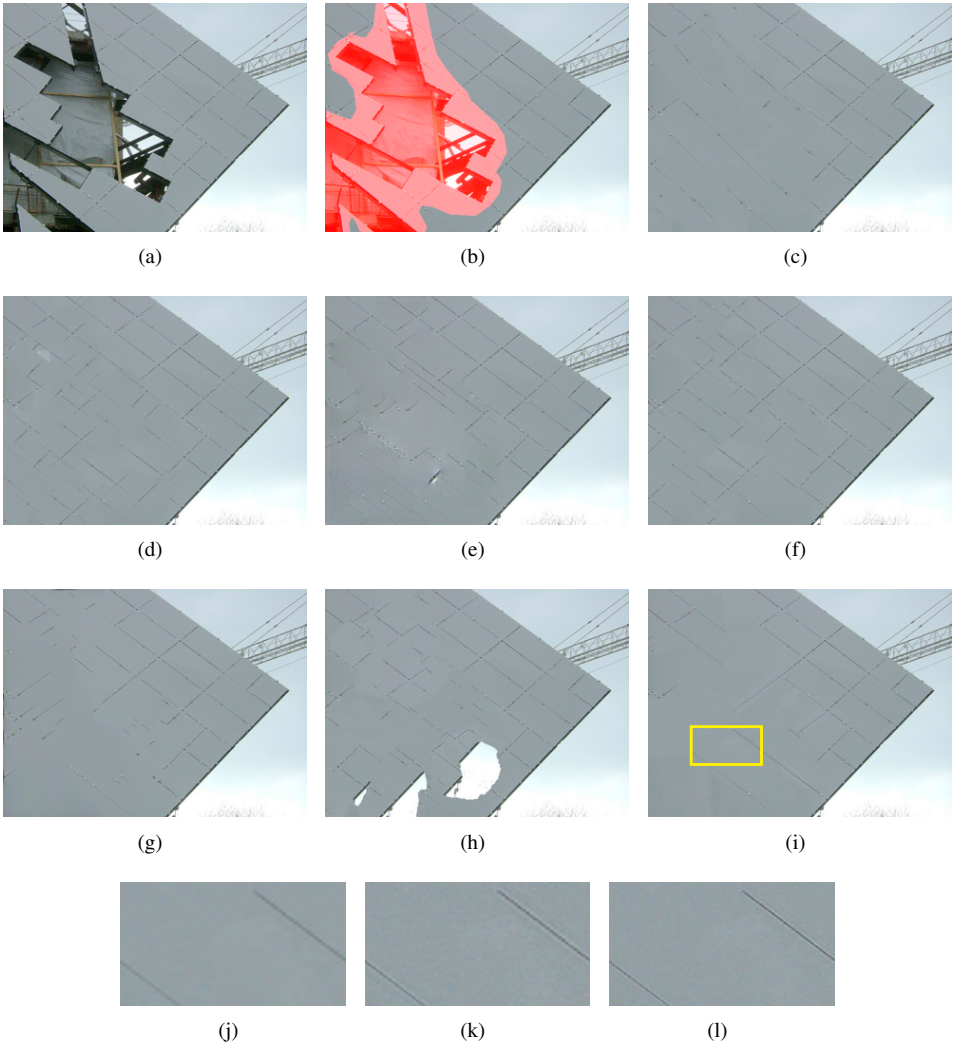


Figure 2: Result 2

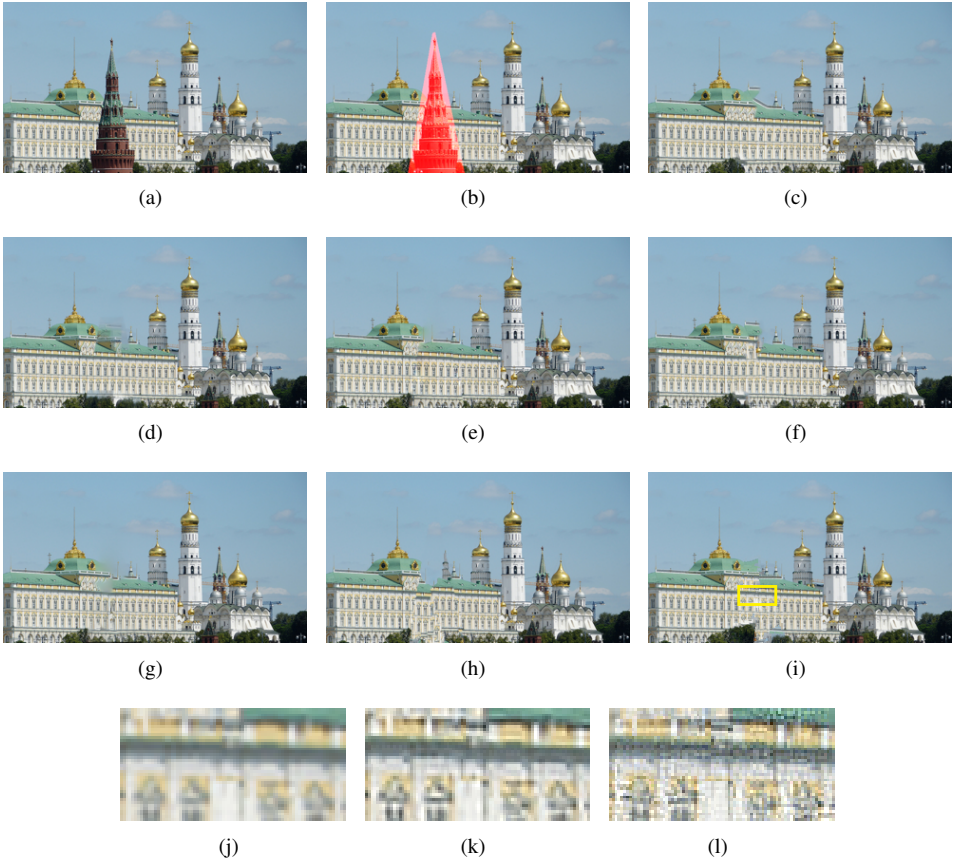


Figure 3: Result 3



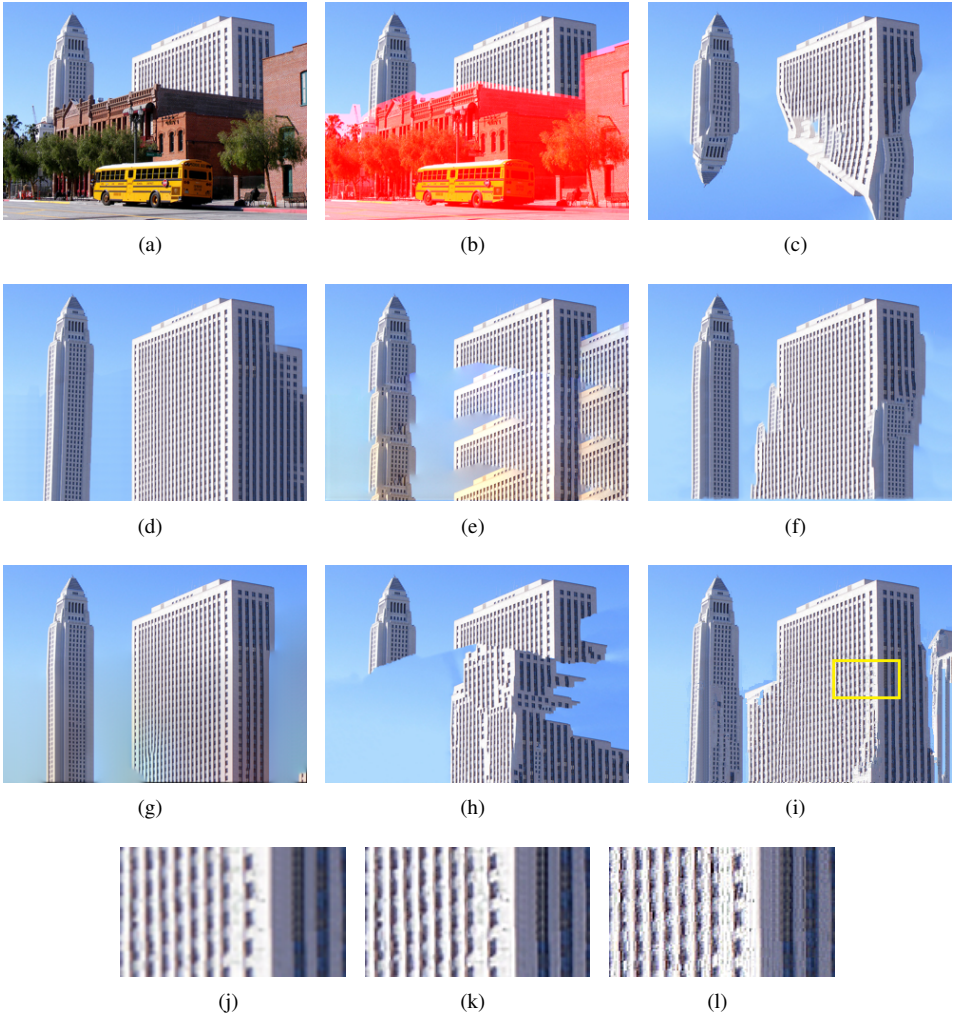


Figure 4: Result 4

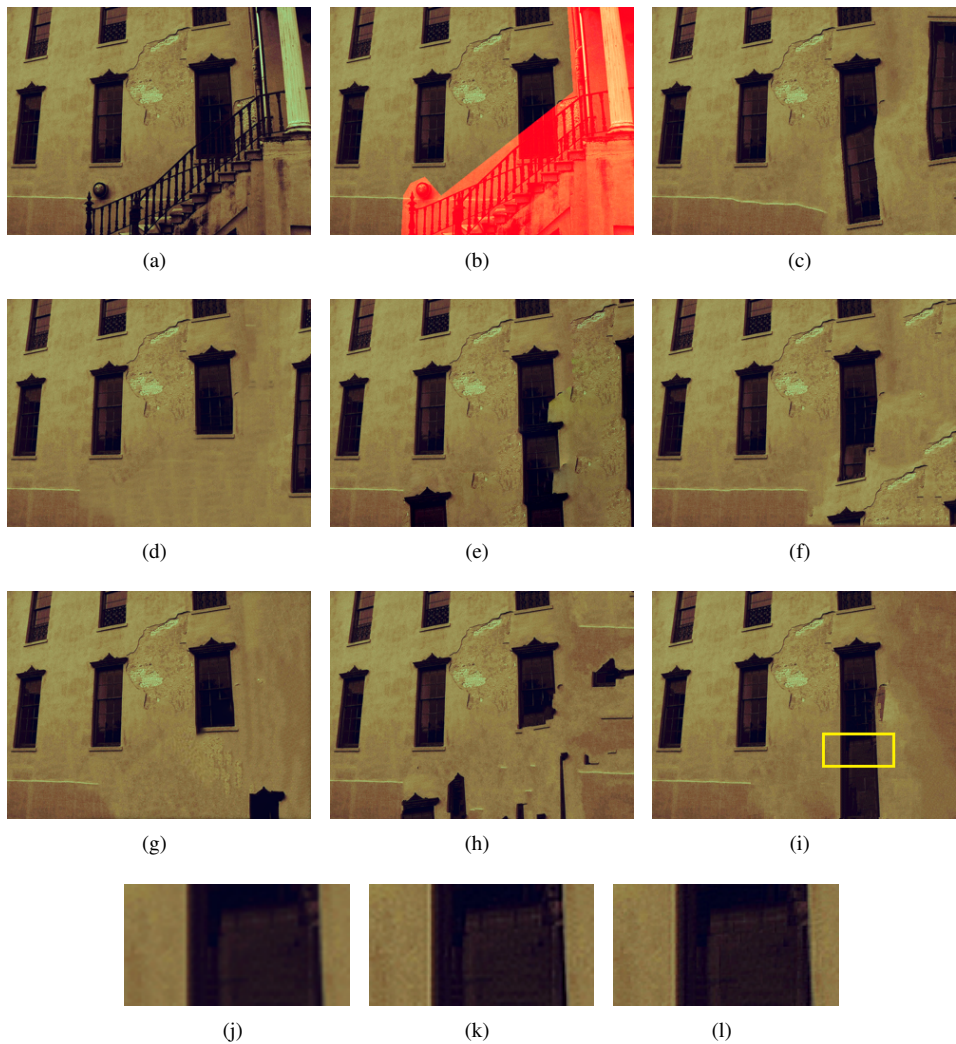


Figure 5: Result 5



(a)



(b)



(c)



(d)



(e)



(f)



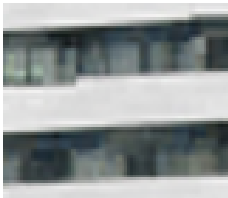
(g)



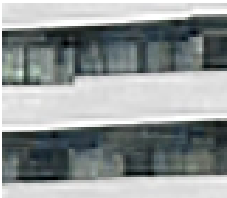
(h)



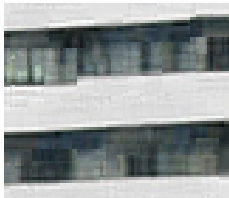
(i)



(j)



(k)



(l)

Figure 6: Result 6

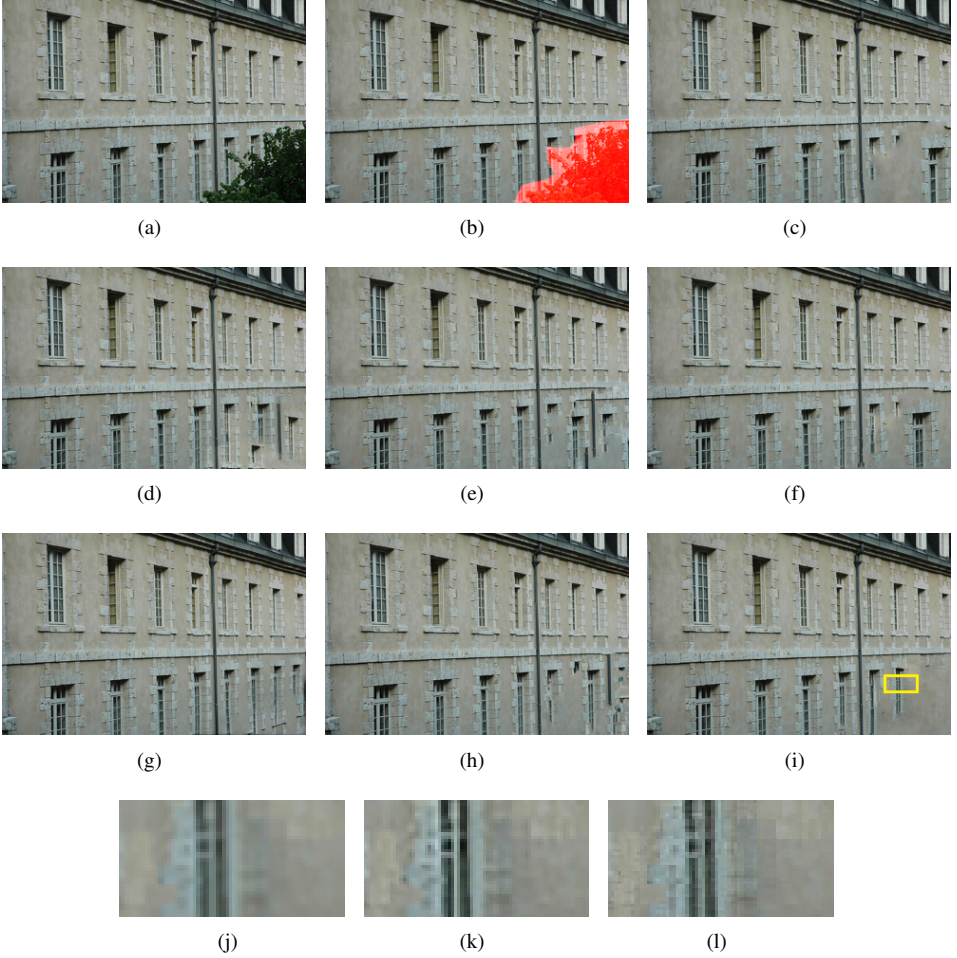


Figure 7: Result 7

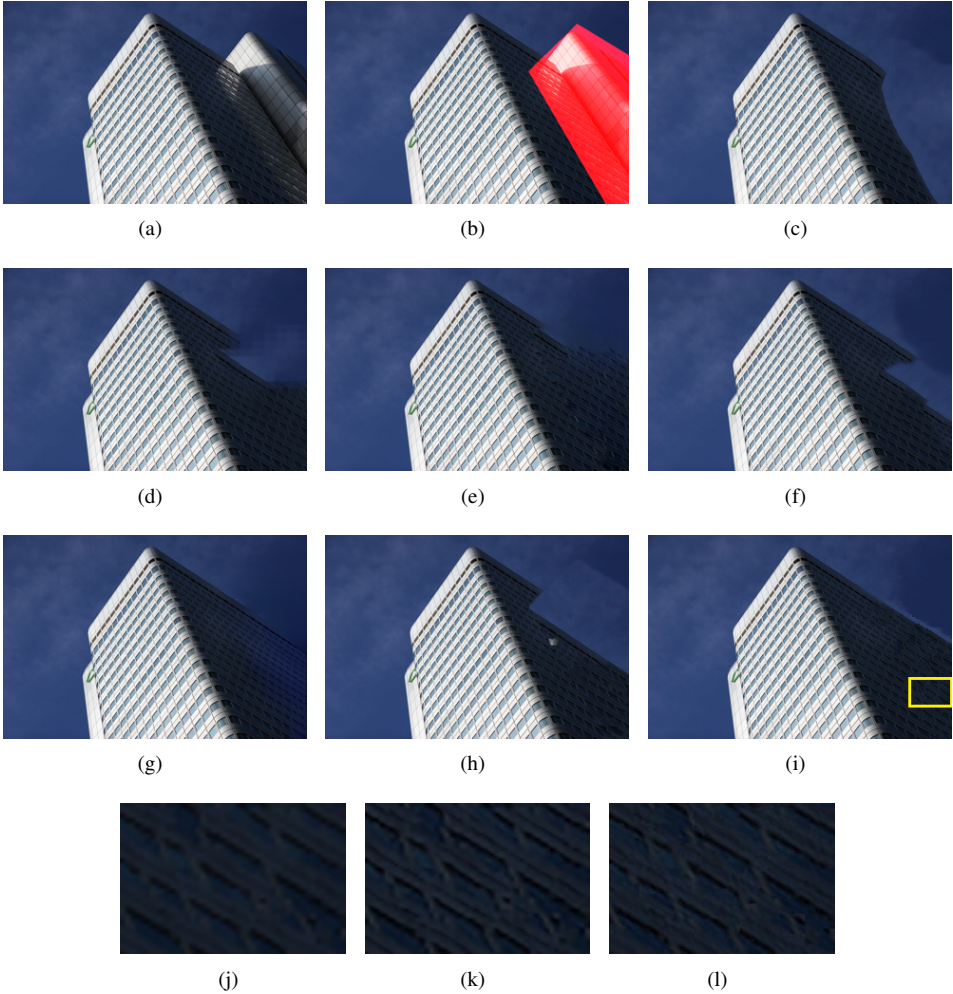


Figure 8: Result 8

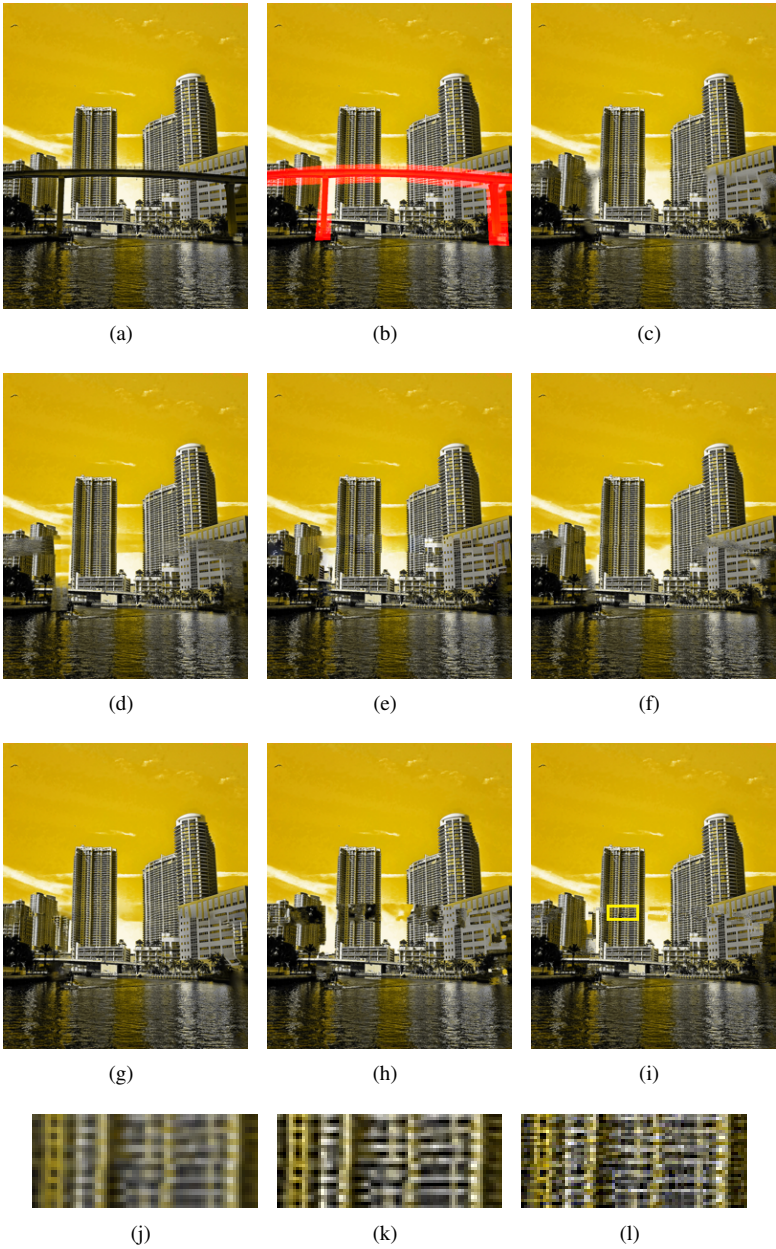


Figure 9: Result 9



## References

- [1] Connelly Barnes, Eli Shechtman, Adam Finkelstein, and Dan B Goldman. Patchmatch: A randomized correspondence algorithm for structural image editing. *ACM Trans. Graph.*, 28(3):24:1–24:11, July 2009.
- [2] Marcelo Bertalmio, Guillermo Sapiro, Vincent Caselles, and Coloma Ballester. Image inpainting. In *Proceedings of the 27th annual conference on Computer graphics and interactive techniques*, SIGGRAPH '00, pages 417–424, 2000.
- [3] Emmanuel J. Candès and Justin Romberg.  $l_1$  – *MAGIC* : Recovery of sparse signals via convex programming, 2005. URL <http://users.ece.gatech.edu/~justin/llmagic/#links>.
- [4] Emmanuel J. Candès and Michael B. Wakin. An introduction to compressive sampling. *Signal Processing Magazine, IEEE*, 25(2):21–30, March 2008.
- [5] Antonio Criminisi, Patrick Pérez, and Kentaro Toyama. Object removal by exemplar-based inpainting. *Computer Vision and Pattern Recognition, IEEE Computer Society Conference on*, 2:721, 2003.
- [6] Antonio Criminisi, Patrick Pérez, and Kentaro Toyama. Region filling and object removal by exemplar-based inpainting. *IEEE Transactions on Image Processing*, 13(9):1200–1212, January 2004.
- [7] Soheil Darabi, Eli Shechtman, Connelly Barnes, Dan B. Goldman, and Pradeep Sen. Image melding: Combining inconsistent images using patch-based synthesis. *ACM Trans. Graph.*, 31(4):82:1–82:10, July 2012.
- [8] Sina Farsiu, M. Dirk Robinson, Michael Elad, and Peyman Milanfar. Fast and robust multiframe super resolution. *Image Processing, IEEE Transactions on*, 13(10):1327–1344, Oct 2004.
- [9] William T. Freeman, Thouis R. Jones, and Egon C. Pasztor. Example-based super-resolution. *Computer Graphics and Applications, IEEE*, 22(2):56–65, Mar 2002.
- [10] Daniel Glasner, Shai Bagon, and Michal Irani. Super-resolution from a single image. In *Computer Vision, 2009 IEEE 12th International Conference on*, pages 349–356, Sept 2009.
- [11] Paul Francis Harrison. Gimp resynthesizer plugin, 2011. URL <http://www.logarithmic.net/pfh/resynthesizer>.
- [12] Kaiming He and Jian Sun. Statistics of patch offsets for image completion. In *Proceedings of the 12th European Conference on Computer Vision - Volume Part II, ECCV'12*, pages 16–29, 2012. ISBN 978-3-642-33708-6.
- [13] Jia-Bin Huang, Sing Bing Kang, Narendra Ahuja, and Johannes Kopf. Image completion using planar structure guidance. *ACM Trans. Graph.*, 33(4):129:1–129:10, July 2014.

- [14] Jia-Bin Huang, Sing Bing Kang, Narendra Ahuja, and Johannes Kopf. Dataset for image completion using planar structure guidance, 2014. URL [https://sites.google.com/site/jbhuang0604/publications/struct\\_completion](https://sites.google.com/site/jbhuang0604/publications/struct_completion).
- [15] Nilay Khatri and Manjunath V. Joshi. Image super-resolution: Use of self-learning and Gabor prior. In *Proceedings of the 11th Asian Conference on Computer Vision - Volume Part III*, ACCV'12, pages 413–424, 2013.
- [16] Nikos Komodakis and Georgios Tziritas. Image completion using efficient belief propagation via priority scheduling and dynamic pruning. *Image Processing, IEEE Transactions on*, 16(11):2649–2661, Nov 2007.
- [17] Olivier Le Meur and Christine Guillemot. Super-resolution-based inpainting. In *Computer Vision – ECCV 2012*, volume 7577 of *Lecture Notes in Computer Science*, pages 554–567. Springer Berlin Heidelberg, 2012.
- [18] Simon Masnou and Jean-Michel Morel. Level lines based disocclusion. *Image Processing, 1998. ICIP 98. Proceedings. 1998 International Conference on*, pages 259–263, 1998.
- [19] Patrick Pérez, Michel Gangnet, and Andrew Blake. Poisson image editing. In *ACM SIGGRAPH 2003 Papers*, SIGGRAPH '03, pages 313–318, 2003.
- [20] Pulak Purkait and Bhabatosh Chanda. Super resolution image reconstruction through bregman iteration using morphologic regularization. *Image Processing, IEEE Transactions on*, 21(9):4029–4039, sept. 2012.
- [21] Jing Tian and Kai-Kuang Ma. A survey on super-resolution imaging. *Signal, Image and Video Processing*, 5(3):329–342, 2011.
- [22] Yonatan Wexler, Eli Shechtman, and Michal Irani. Space-time completion of video. *Pattern Analysis and Machine Intelligence, IEEE Transactions on*, 29(3):463–476, March 2007.
- [23] Qiangqiang Yuan, Liangpei Zhang, and Huanfeng Shen. Regional spatially adaptive total variation super-resolution with spatial information filtering and clustering. *Image Processing, IEEE Transactions on*, 22(6):2327–2342, June 2013.