

# Supplementary Physical Materials

## Cascaded Displays: Spatiotemporal Superresolution using Offset Pixel Layers

Felix Heide    Douglas Lanman    Dikpal Reddy    Jan Kautz    Kari Pulli    David Luebke  
NVIDIA Research

The supplementary physical materials provide a direct demonstration of spatial superresolution using cascaded displays: stacks of printed films are manually aligned to achieve the necessary lateral offsets. Since these films are static, only single-frame (i.e., rank-1) factorizations can be presented; however, this proof-of-concept dispenses with the temporal multiplexing common with prior superresolution display systems—achieving significant enhancement by the multiplicative superposition of multiple layers, rather than the additive superposition of multiple frames.

### A How to View the Demonstration Kit

The unpackaged demonstration kit contained two sets of aligned multi-layer films (enclosed in acrylic sheets), four loose films (placed in an envelope), and this instruction manual. The film sets must be illuminated with a uniform backlight for viewing. A mobile phone, tablet, or computer monitor can be used as a backlight by viewing a blank image (e.g., by using a solid white background). Alternatively, the films can be placed on a white sheet of paper or viewed against strong environmental lighting (e.g., overhead lights or a bright sky). Two sample sets are provided: Film Set A and Film Set B. These films can be printed and aligned to replicate the demonstration kit provided to the reviewers. Predictions for the appearance of the properly aligned film sets are reproduced in Figures S.1 and S.2.

### B Film Set Specifications

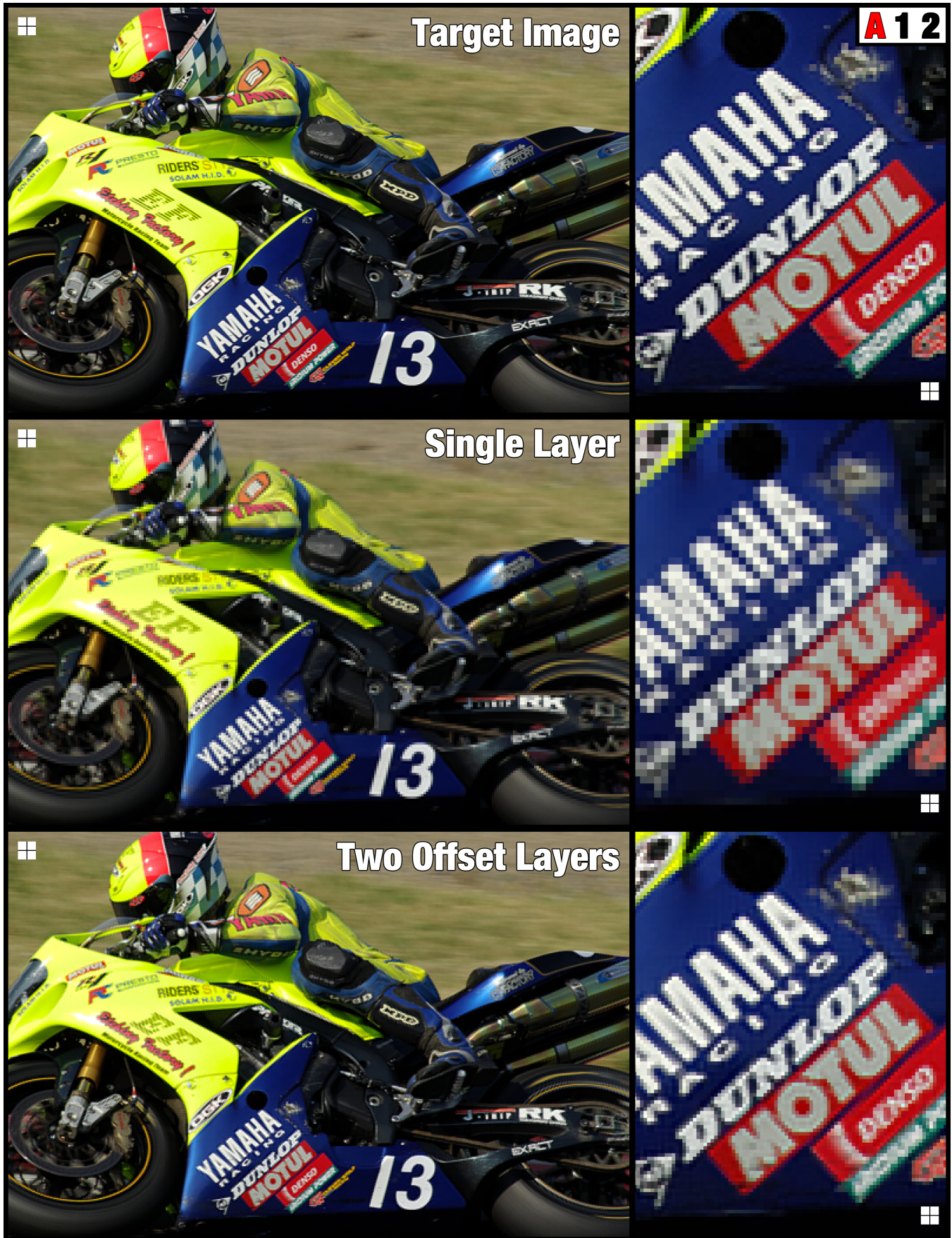
The films were produced using Apollo VCG7070 laser printer transparencies and were printed at  $1,200 \times 1,200$  dots per inch (DPI) using a Ricoh Aficio MP C2551. Descriptions of the film set contents follow below.

**Film Set A** As shown in Figure S.1, this set demonstrates the superresolution performance for the “motorcycle” image. The target image, single-layer depiction (conventional display), and two-layer factorization (cascaded display) are shown from top to bottom. The left and right sides depict a wide view and a magnified inset, respectively. Note that the legibility of the text is enhanced using the two-layer cascaded display, as well as the sharpness of silhouette boundaries. Also note the degree of overlap between the offset pixel layers in the magnified regions.

**Film Set B** As shown in Figure S.2, this set shows inset regions of the “bird”, “Porsche”, “lizard”, and “baba” images, from top to bottom. The target images, single-layer depictions (conventional display), and two-layer factorizations (cascaded display) are shown from left to right. Note the enhancement of fine details achieved by cascaded displays, relative to the single-layer depictions, especially the features in the “bird”, the scales on the “lizard”, and the beard in “baba”. In the “Porsche” image, notice that the text is more legible and the fine structures of the grill are only apparent with the two-layer factorization.

### C How to Manually Align the Film Sets

The films are labelled to facilitate alignment: the top-right and bottom-left corners of Film Set A and Film Set B are numbered to indicate their order. For example, the first layer of Film Set A is labelled as A 1, whereas the second layer is labelled as A 2. The optimal offsets between the pixel grids have been rendered into the printed films; as a result, proper alignment is obtained when all the printed crosshairs intersect. For optimal registration, we suggest beginning by taping down the first transparency to the backlight.



**Figure S.1:** Predicted appearance of the aligned Film Set A. Note the improved legibility of text using two layers. Individual pixels are visible in the insets, for which the lateral offset between the layers becomes apparent.



**B 1 2**

**Figure S.2:** Predicted appearance of the aligned Film Set B. Note the improved legibility of text and the sharpness of fine details, including the feathers in the “bird”, scales in the “lizard”, and the beard in the “baba” images.