Segmentation-Free Quantification of Spots on a Homogeneous Background (Supplementary Material)

Max Hermann, Reinhard Klein, and Thomas Schultz

Fig. 1. Overview of visual analytics system where linked views are annotated. Input images are selected either in the data table or map view (top row), while a subsequent detailed inspection is performed in the remaining views (bottom row). Input image and scale estimate views are linked and brushed according to the current selection in the joint histogram view. The flow explorer view allows to investigate the collection of smoothed images in order to find suitable parameters for $T_{\text{start}}$ and $\Theta$.

Abstract—Supplementary material show-casing the visual analytics system and additional results.

1 Visual Analytics System

Fig. 1 shows an overview of our interactive visualization system. The system is organized according to its two main purposes: 1) Provide an overview of the structures contained in STED images in terms of size and density; this is realized via a map view. 2) Allow a detailed investigation of individual images; this is facilitated by brushing structures in the intensity and scale estimate views via a selection in the joint histogram view. In order to produce a useful overview map as in Fig. 2, first suitable parameters for $T_{\text{start}}$ and $\Theta$ have to be found (see Sec. 3.3 in the paper). This can be conveniently accomplished using the detailed views (bottom row in Fig. 1), investigating quickly one or two images of the dataset and adjusting parameters in the data table and the selection in joint histogram view.

- Max Hermann and Reinhard Klein are with University of Bonn, Germany. E-mail: {hermann, rk}@cs.uni-bonn.de
- Thomas Schultz is with University of Bonn and MPI for Intelligent Systems, Tübingen, Germany. E-mail: schultz@cs.uni-bonn.de
2 **Brushing Results**
Additional brushing results to the one shown in the paper are given in Figs. 3 and 4, this time also including scale estimates.

3 **TV Flow Smoothing**
In Fig. 5 the effect of smoothing STED images with total variation flow is visualized.

4 **Parameter Choice**
The impact and relevance of the main parameters for scale estimation, namely starting time $T_{\text{start}}$ and gradient threshold $\Theta$, is illustrated in Fig. 6.
Fig. 2. Larger version of Fig. 2 in the paper.
Fig. 3. Brushing example 1: Potential protein clusters can be identified via brushing. Based on a user selected region in the intensity-scale histogram (red square in top image) the corresponding pixels in the input and scale image are brushed (green overlay in bottom images).
Fig. 4. Brushing example 2: The largest part of the image background is brushed by selecting the pixels with lowest intensity and scale. Note that although the brushed structure has a large size, it ends up in the scale zero bin. This behavior is explained by the gradient threshold parameter and nicely illustrates its effect: The particular choice of $\Theta = \frac{1}{4}$ in this example leads the proposed scale measure (Eq. (6) in the paper) to ignore all structures containing more pixels than a disc of radius $r_{max} = 8$. As a consequence the largest measured structure scale in this result is 8.0. (See also Fig. 6.)
Fig. 5. Result of TV flow smoothing (Eq.(3) in the paper) applied to a STED microscopy image. Shown are smoothed images $u(x,t)$ at different time points $t$. Note how the contrast of smaller structures is reduced faster than that of larger ones. Start and end time for subsequent scale measurement are highlighted.

Fig. 6. Scale estimates for STED image shown in Fig. 5 to illustrate the impact of burn-in time $T_{start}$ and gradient threshold $\Theta$. In (a) both, burn-in time and gradient threshold are used ($T_{start} = 7, \Theta = 0.25$) while (b) omits gradient threshold ($T_{start} = 7, \Theta = 10^{-3}$) and (c) omits burn-in time ($T_{start} = 0, \Theta = 1$). Note that (b) uses the same transfer function as (a) and (b) to allow for visual comparison, although the maximum range of scales in (b) is higher than 8.0; an adjusted transfer function is applied in (d).