Material Classification Using Raw Time-of-Flight Measurements (Supplementary Material)

Shuochen Su[3,1] Felix Heide[3,4] Robin Swanson[1] Jonathan Klein[2] Clara Callenberg[2]
Matthias Hullin[2] Wolfgang Heidrich[1,3]
[1]KAUST [2]University of Bonn [3]University of British Columbia [4]Stanford University

In this supplementary material, we provide further details about the way our dataset was collected and how our preprocessing removes unwanted noise and depth variations while leaving intrinsic material properties intact. For convenience all of the corresponding numerical raw data from Figures 1, 2 and 3 are also provided in accompanying .csv files. In the future we plan to make the full dataset publicly available online.

1. Raw Correlation Frames

In Figure 1 we show a subset of raw correlation frames that have been captured by our ToF camera directly using the same method described in the paper. Specifically, we show all 4 materials (rows), *i.e*. paper, styrofoam, towel and wax, observed at two distances from the camera (columns). The specific modulation frequency and phase of each individual frame are specified in the title of each figure. As expected, the raw correlation frames are highly susceptible to both noise and depth variations.

2. Fixed Pattern Noise Removal

Following the description in Section 4.1 of the paper, we show the results of applying our fixed pattern noise removal algorithm to the raw frames in Figure 1. While the fixed pattern noise clearly disappears from Figure 2, the depth ambiguity still remains. Note that these calibration methods are based on the assumption of a purely sinusoidal correlation signal. Nevertheless, our method is very effective thanks to the close approximation of our correlation signal to a pure sinusoid. This relationship can be seen in Figure 5 of the paper.

3. Depth Normalization

To address depth ambiguity we follow the depth normalization method introduced in Section 4.1 of the paper. The resulting measurements after preprocessing are shown in Figure 3. Note that in all figures only the real part is shown. Differences can be more accurately compared using the .csv files provided.

4. Dataset

Finally, after the preprocessing steps, we arrive at the correlation frames where only material discriminative components are left at each pixel. From these, we create the datapoints for training and testing as described in Section 5 of the paper.

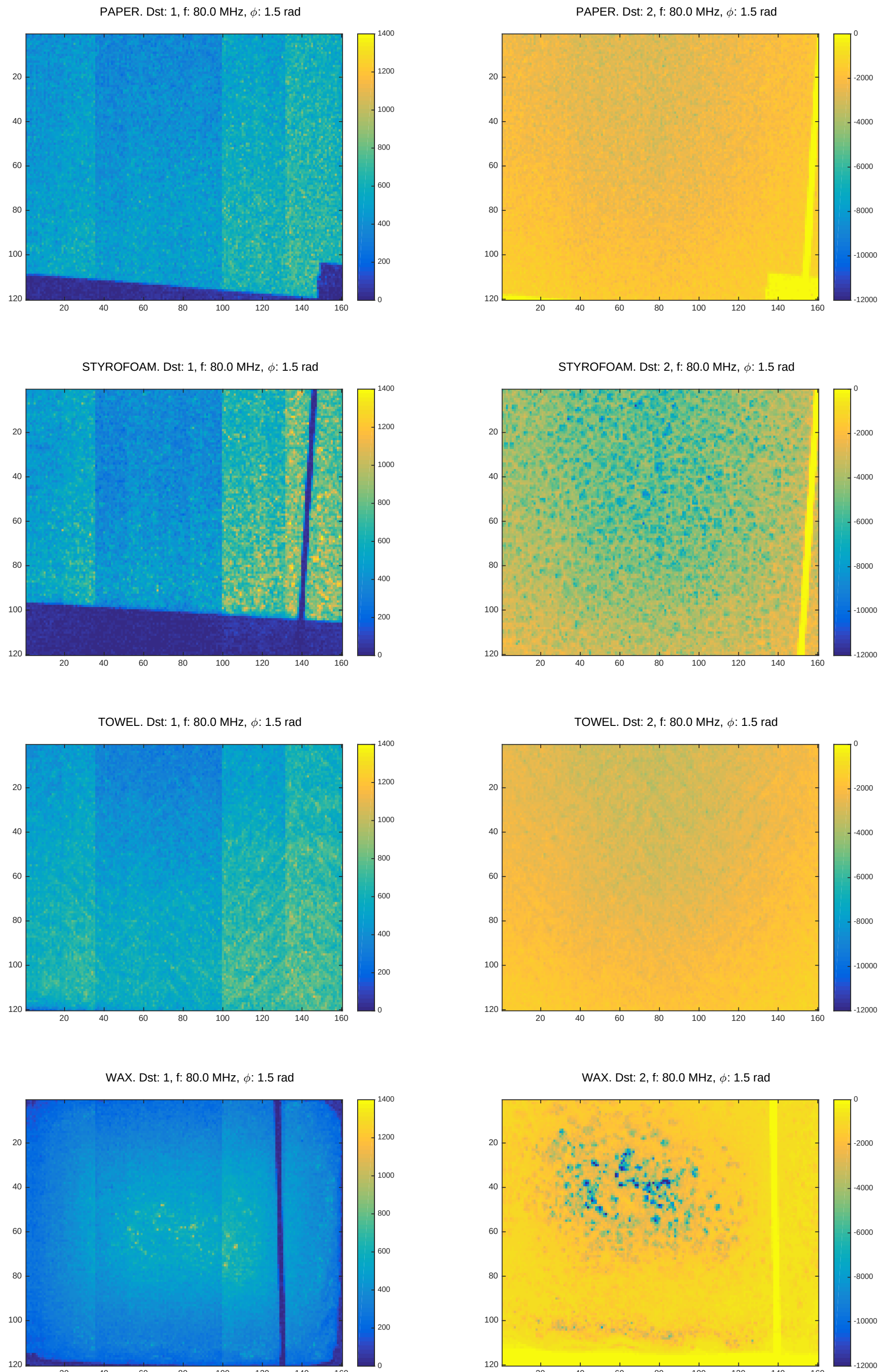

Figure 1: The raw correlation measurements from our ToF camera without any preprocessing. The rows from top to bottom show all 4 materials reported in the paper, *i.e*. paper, styrofoam, towel and wax, observed at two distances, Dst 1 (left) and Dst 2 (right). As expected, the raw correlation frames are susceptible to both fixed pattern noise (left column), and material independent phase offset (comparing the measurements at two distances).

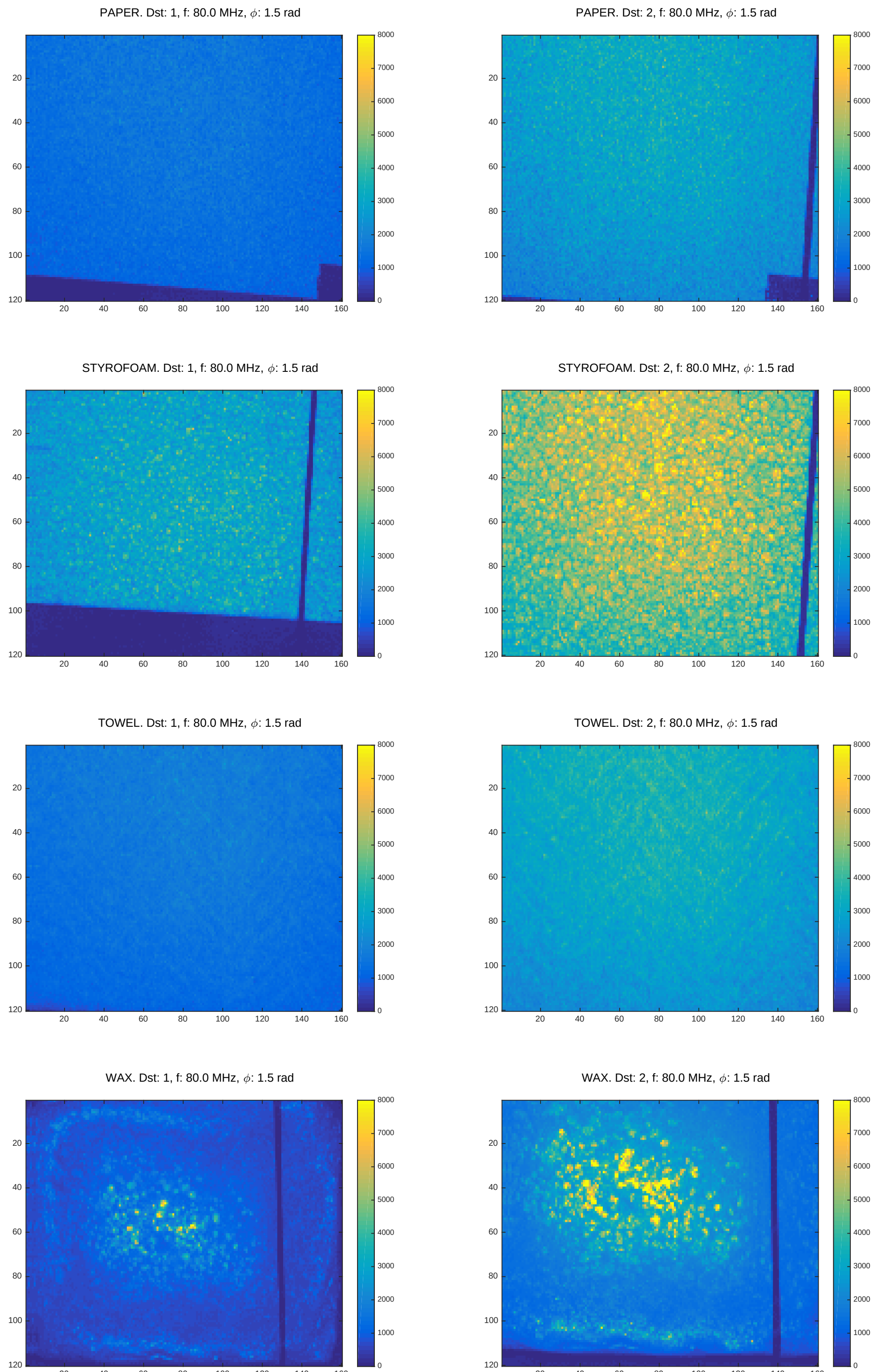

Figure 2: The effectiveness of fixed pattern noise removal described in Section 4.1 of the paper. While the vertical stripes are clearly removed from the frames, material independent depth still affects the measurements.

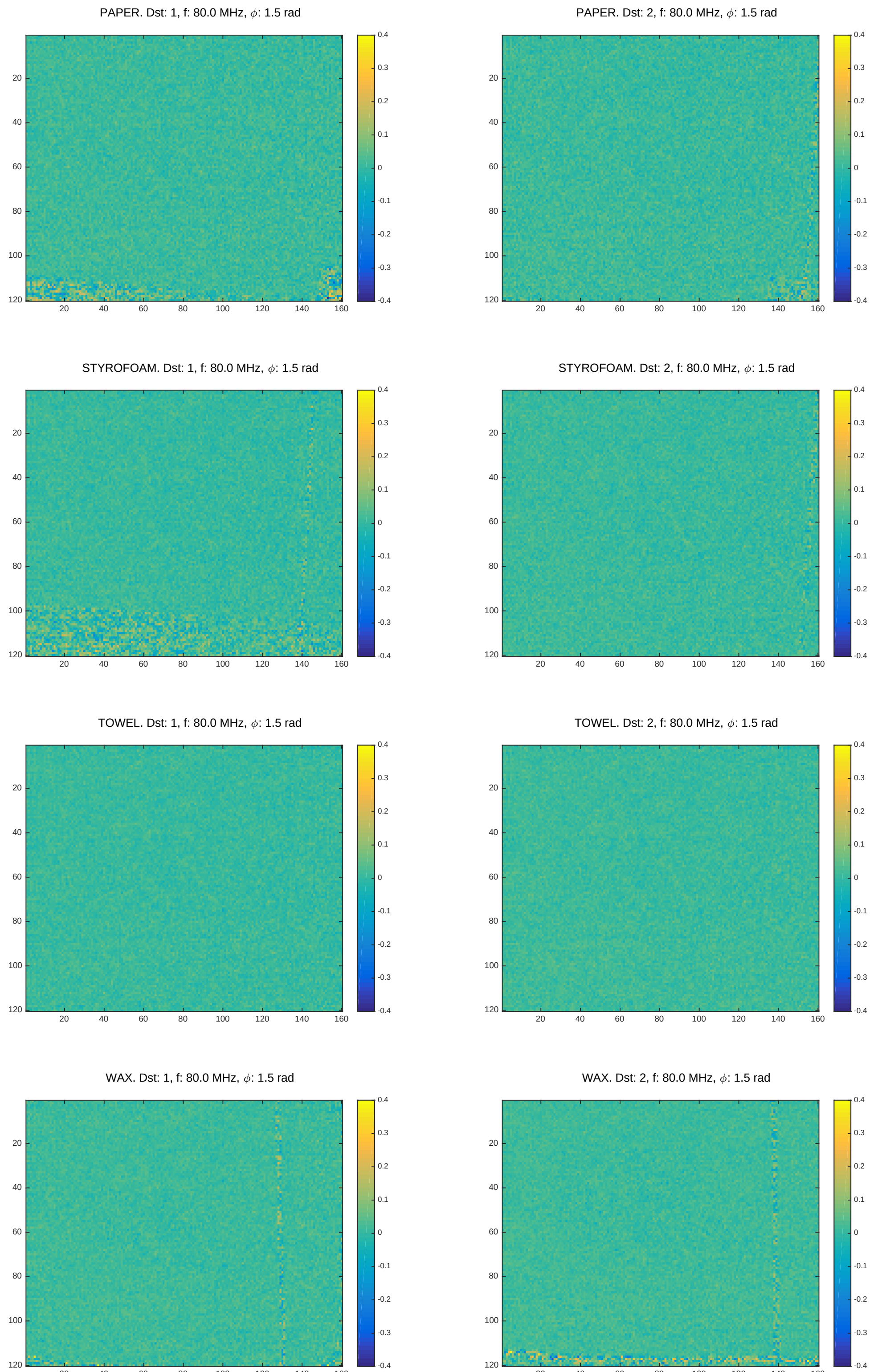

Figure 3: The effectiveness of depth normalization described in Section 4.2 of the paper. Note that in all figures only the real part is shown. Differences can be more accurately compared using the .csv files provided.