Joseph Shumway
830003458

CSCE 181
Spring 2022

Multi-Resolution Shared Representative Filtering for Real-Time Depth Completion
Yu-Ting Wu
https://www.youtube.com/watch?v=eGfX1iWzkh0

Wu started out his presentation talking about how depth maps from depth sensors today contain holes due to their lack of features, the surface properties of the objects in view, the distance to the depth camera, as well as the occlusion of items in the frame. For the typical RGB-D (depth) cameras, aligning the depth map to the rgb color image also creates holes because the cameras are not in the same location. The frame of reference is different. Their goal: to fill in the holes efficiently and correctly. This is difficult for real time applications because the typical application is run at 60fps, which means that they have to fix the frames holes within a 16ms time span at the very minimum. In reality, there will most likely be other data that has to be processed, so even less time should be the goal.

Their solution is a new filtering-based method that is effective for large holes, adapts to hole shapes, better preserves depth boundaries, and has high parallelism so it can retain the advantage of filtering-based methods (i.e can be utilized on a GPU). This is a two pass method called Shared Representative Filtering (SRF). First, the algorithm finds each pixel a valid representative depth. Then, it predicts the depth value of an invalid pixel (hole pixel) using the representatives in a small local filter. Basically what this means is they find the edges of the hole (representative pixels) and fill in the gaps using predictions.

To go into more detail on these steps, the representatives are found by choosing K directions and walking out along those directions from the center until a non hole sample is found. Then they continue outwards another certain amount of extra steps to find another set of samples. Representatives are selected from the first set of samples based on their similarity to the outer samples. What this means is that there is a clear uniform pattern approaching the center point from this direction, and it is good to use the representative value. This approach works well, but for high resolution inputs the cost of searching for a representative increases for each direction. To fix that, they use a multi-resolution scheme which lowers the search cost and increases efficiency.

For Multi-Resolution SRF, they first downsample both the color and the depth images, run the SRF algorigthm, upsample the resulting depth, then check for unreliable pixels using a 3x3 sobel filter. This removes the depth pixels whose gradients are larger than a certain threshold. This method is repeated for the chosen amount of downsample levels. The multi-resolution method improves efficiency, but also gives better results than the default SRF method in almost every instance. There are smoother results and less texture copy artifacts. There is a caveat however. With more levels there are sometimes worse results such as image features becoming lost or blurred. Overall, usually its best to run the algorithm 3-4 times for a good compromise between efficiency and quality.