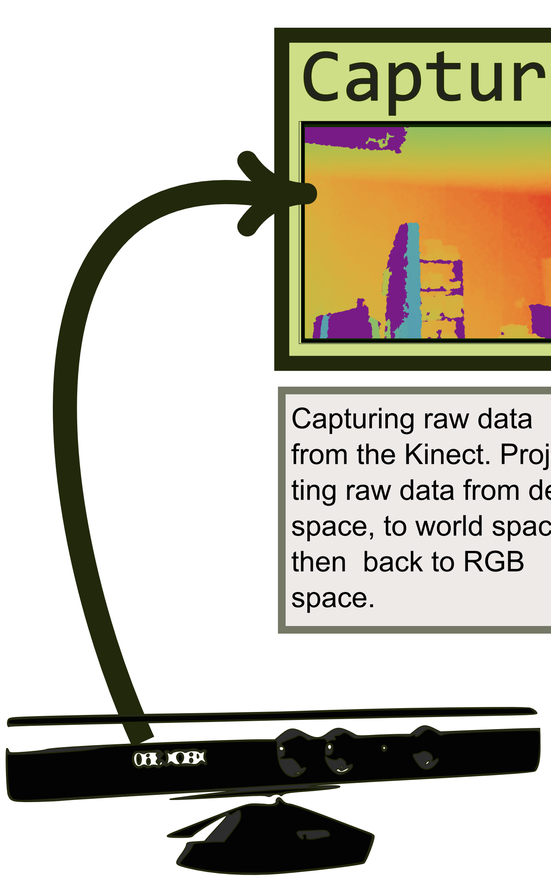
Recovering Missing Depth from Microsoft Kinect

Motivation

Microsoft's Kinect is a piece of hardware that captures both RGB and Depth data. Unlike laser based time-of-flight image captures, the Kinect projects patterned infrared points and measures their distortion. While this solves some of the problems associated with time-of-flight capturing devices, it does introduce both noise and missing data. Reducing the noise and filling missing data will allow the Kinect to be more widely used as a depth capturing device.

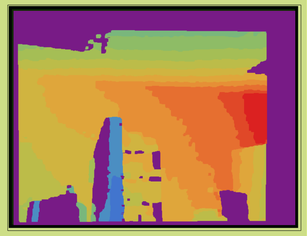
Algorithm



Capture

Capturing raw data from the Kinect. Projecting raw data from depth space, to world space, then back to RGB space.

Filter



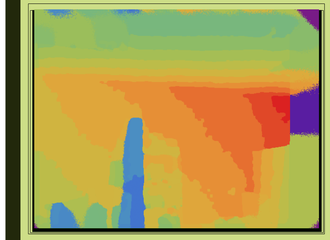
Mean Filter is applied with radius 5, and depth is converted to meters and quantized into 20 bins.

Segment

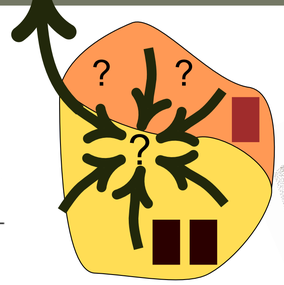
Use QuickShift with RGBD data and defined Parzen density, taking into account the depth values.

$$P[x] = \frac{\sum_{i=-r}^{r}\sum_{j=-r}^{r} e^{-\frac{Abs[x-x_{ij}]^2}{4\sigma^2}} + e^{-\frac{Max[d_{ij}]}{2\sigma^2}}}{2\pi\sigma^2 N}$$

Recover

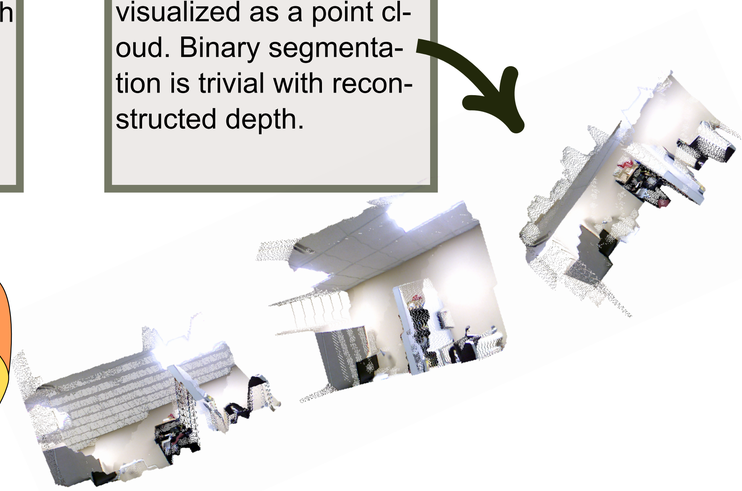


Clustered segments are used to fill missing depth data by performing an iteratively expanding search window and hough voting scheme.



3D Plot

Recovered depth can be visualized as a point cloud. Binary segmentation is trivial with reconstructed depth.



Results

By incorporating depth information into the Parzen density function, we get a better RGB segmentation. This is used to get more accurate depth recovery. The recovered depth data can be used for object segmentation in near real time. The technique can also be used to augment existing time-of-flight methods where the input data is both noisy and not complete. Finally, binary segmentation is made trivial using this method, by a simple clustering method.

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