



Creating Artificial Bokeh Blur

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Abstract

- Many of today's amateur photographers need to create *artistic photos on a budget*. One such artistic effect is the Bokeh Blur.
- We chose this project as the creation of toolkits for these effects falls under computational photography.
- Two of the most popular methods utilize either a measured depth ground truth map, or stereo pairs to infer a depth ground truth map.
- For the project we try both these approaches after which we defocus the image based on the generated depth map.

Introduction

We take two approaches to the problem.

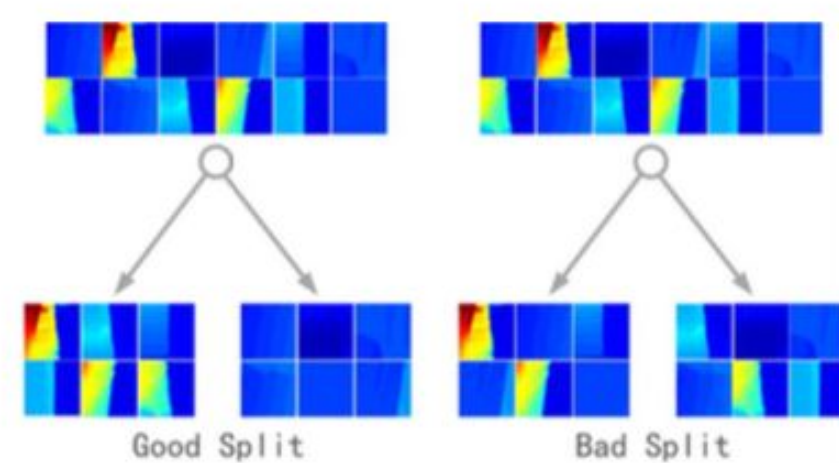
- We apply the defocus based on a depth map generated from a machine learning algorithm. The algorithm trained on the make3d using a forest cluster approach.
- We devised our own setup to perform FOV matching to generate the depth maps with stereo cameras, and then applying blurring based on the depth map generated.

Approach 1: Machine Learning

- The machine learning model we based our extraction was based on random decision forests algorithm suggested in the "Fast estimation single image using structured forests by Shuai Fang, Ren Jin, Yang Cao."
- The trained forest infers a patch of structured labels that are accumulated across the image to obtain the final depth map.

Dataset

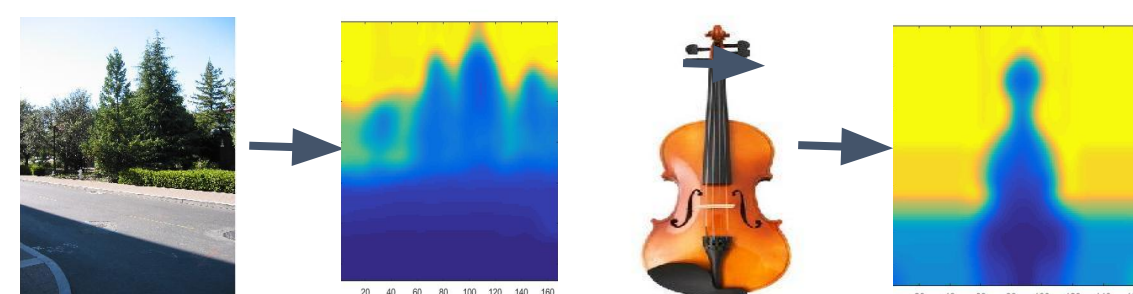
- The Make3D dataset contained 534 images with corresponding depth maps.
- 400 images were used for training and 134 images for testing.



Error Metrics

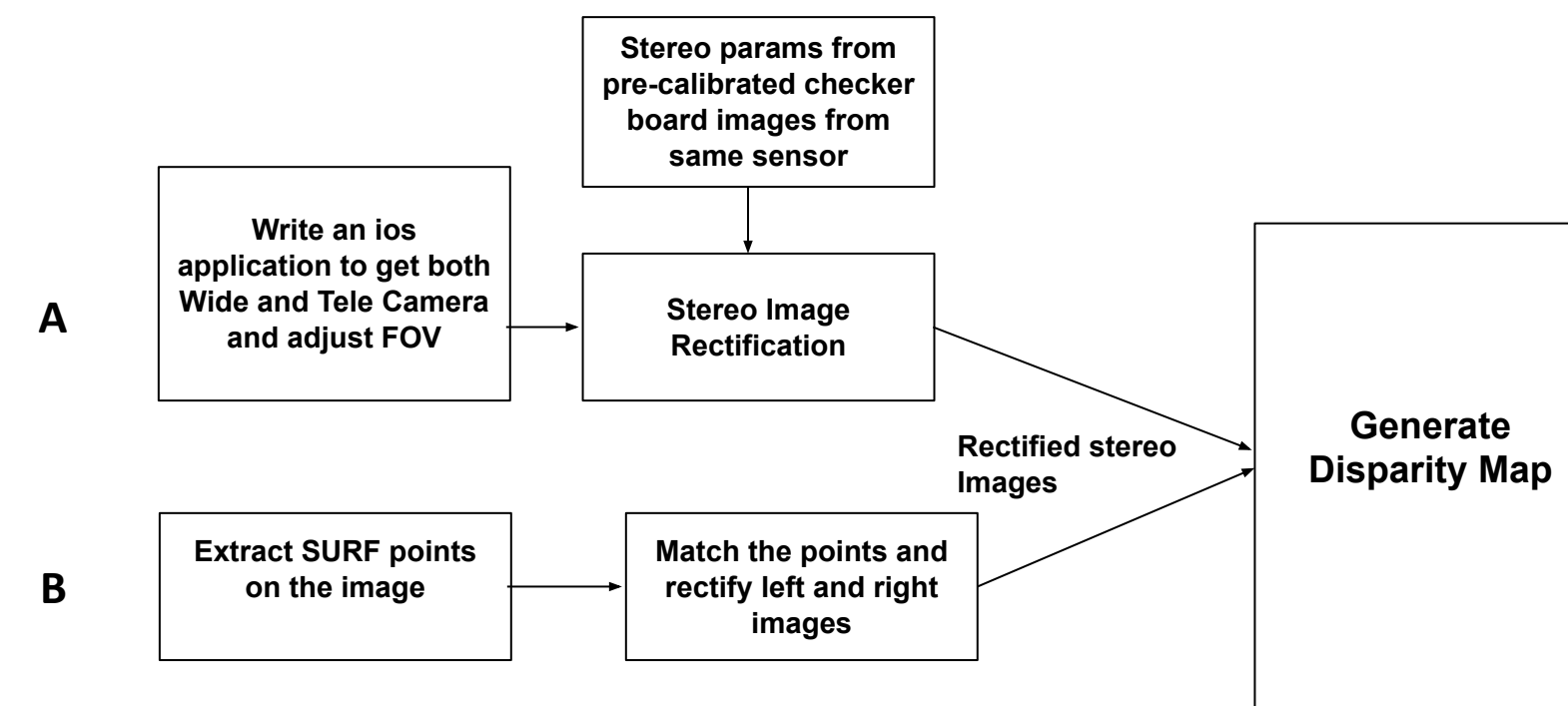
	M1	M*
Avg. Relative Error	0.44	0.353
RMS Error	10.35	8.17

M1 - Our implementation of 1 tree RF
M* - Shuai Fang et al Implementation of 1 tree RF

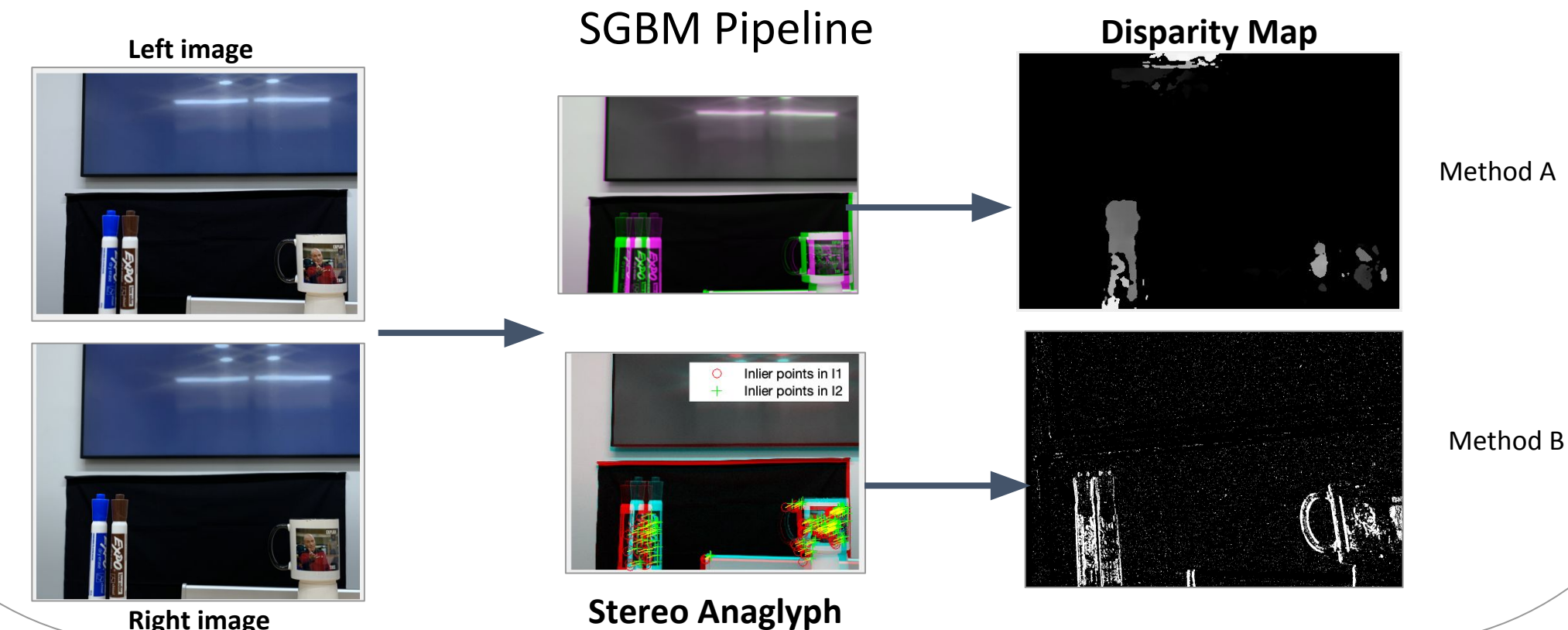
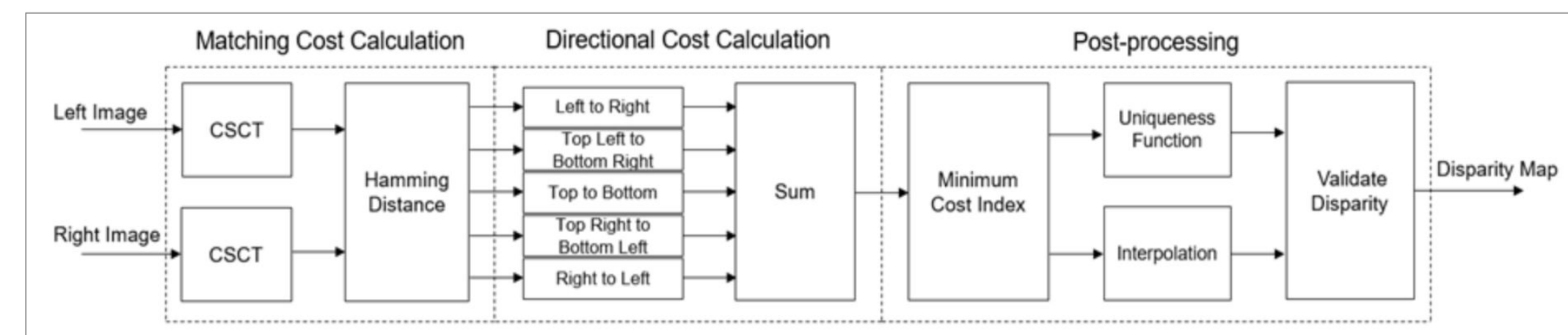


Results from the depth estimator

Approach 2: Stereo Rectification and SGBM based disparity computation

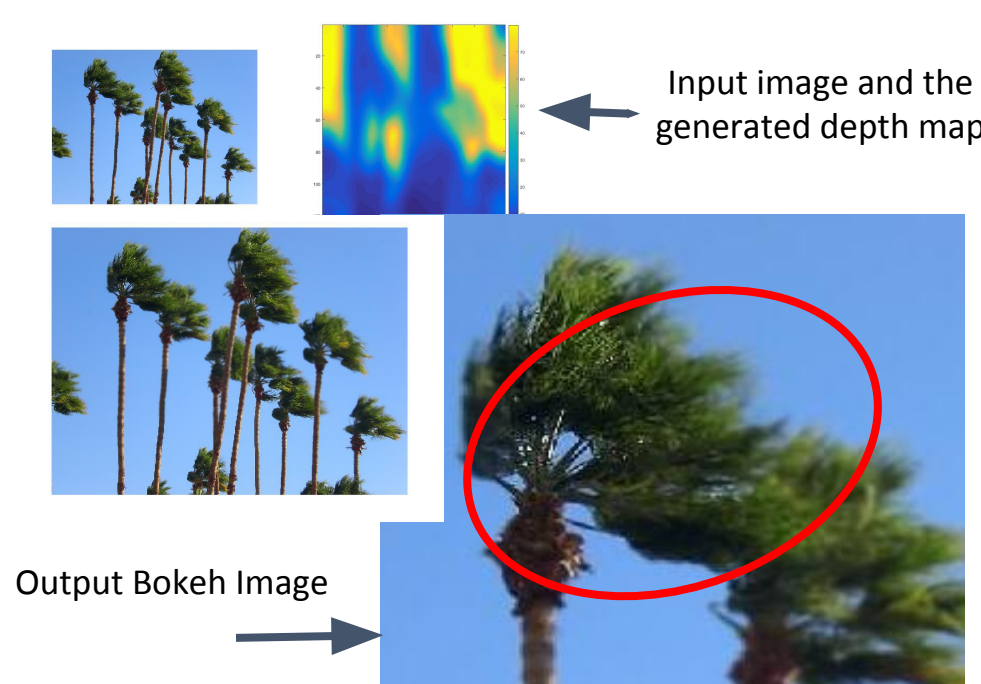


Stages in generating Depth Map

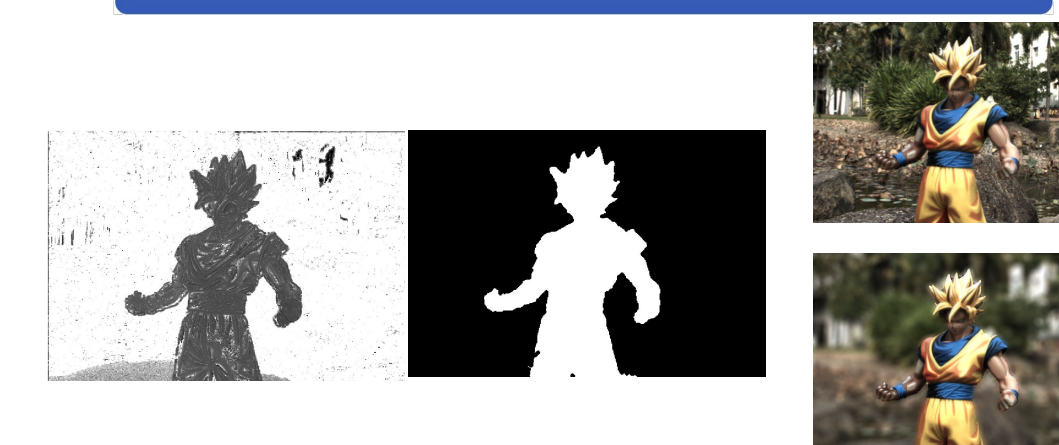


Defocus algorithm

The defocus algorithm should take care of creating the blur from either of the methods. (Depth/Disparity). The flow of the algorithm is as follows:

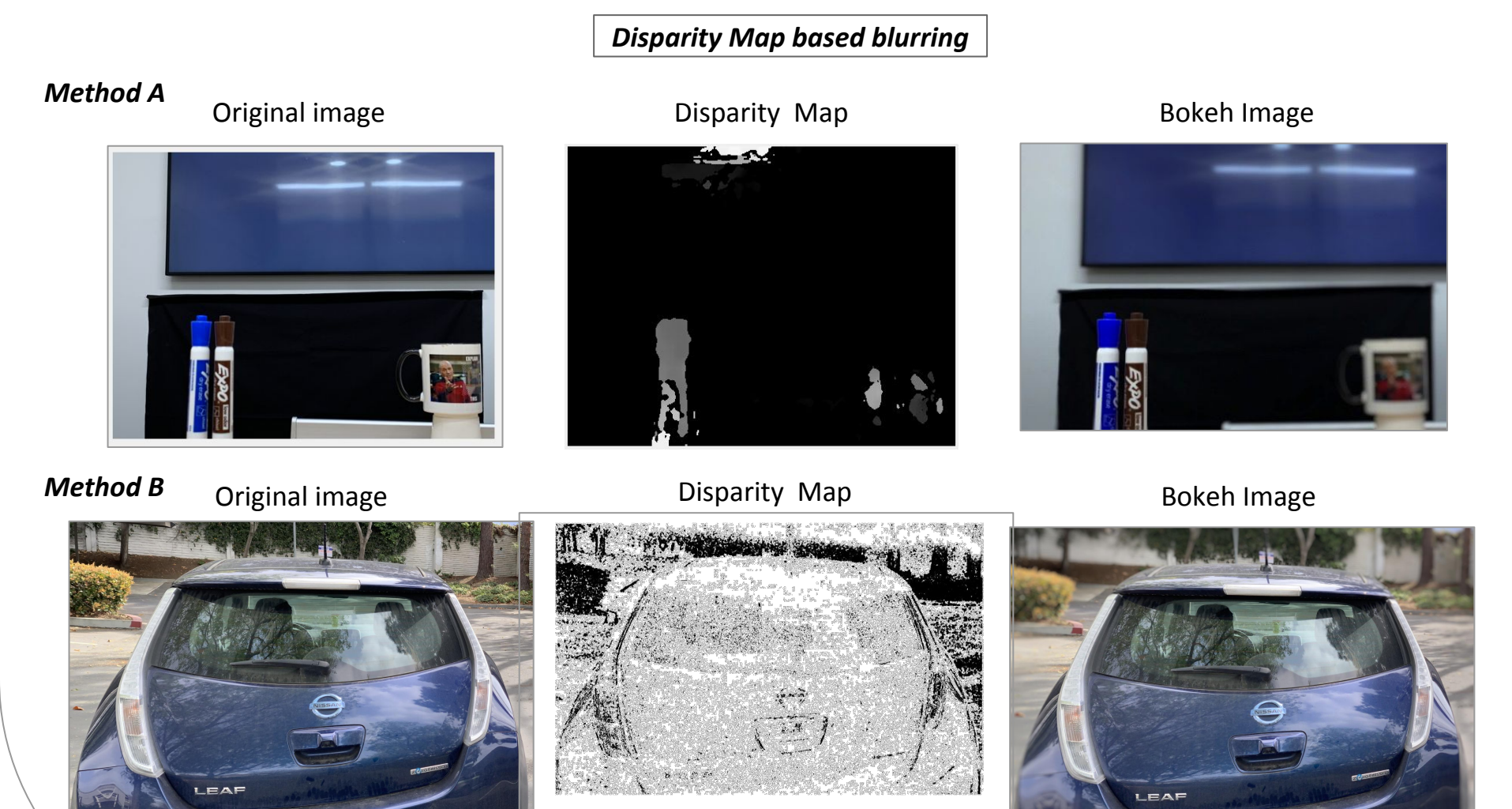
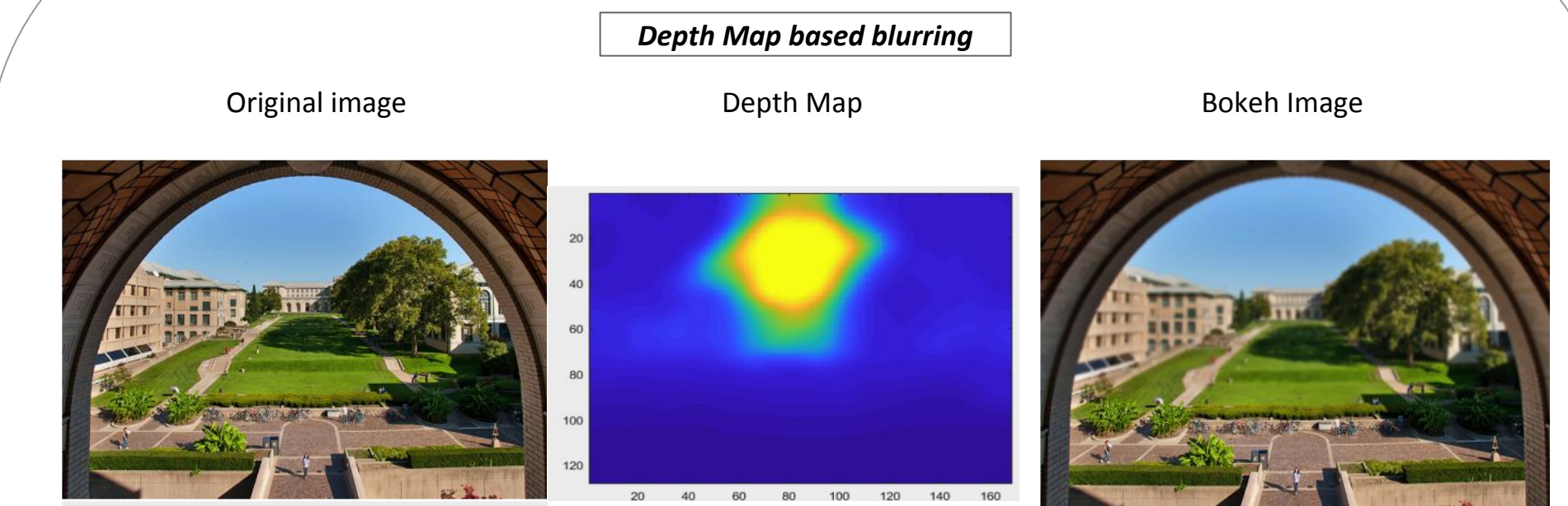


- 1 K-means to segment the depth image into 2 labels
- 2 Create a mask of all pixels at the prescribed depth (usually the max disparity -> minimum depth)
- 3 Extract the largest connected component
- 4 Create a distance transform matrix from the mask with {mask(D>depth_threshold) = Value}
- 5 Apply the gradient onto the image



Results

These results show the full flow for both methods opted here:



Future Directions

An interesting future work would be to incorporate multiple points of focus in the image - and two blur based on the distance from both points. This would allow pictures to have bokeh effects perhaps around two subjects or two parts of a scene, with an artistic effect around them both.

References

- [1] <https://jonbarron.info/BarronCVPR2015.pdf>
- [2] <http://www.cs.cornell.edu/asax-ena/learningdepth/NIPSLearningDepth.pdf>
- [3] Friedrich, Nadine et al. "Faking It : Simulating Background Blur in Portrait Photography using a Coarse Depth Map Estimation from a Single Image." (2018).
- [4] https://web.stanford.edu/class/ee368/Project_Autumn_1617/Reports/report_gong_liu_vukkadala.pdf
- <https://www.mathworks.com/help/visionhdl/examples/stereoscopic-disparity.html>