Project Extension

Digital Image Processing

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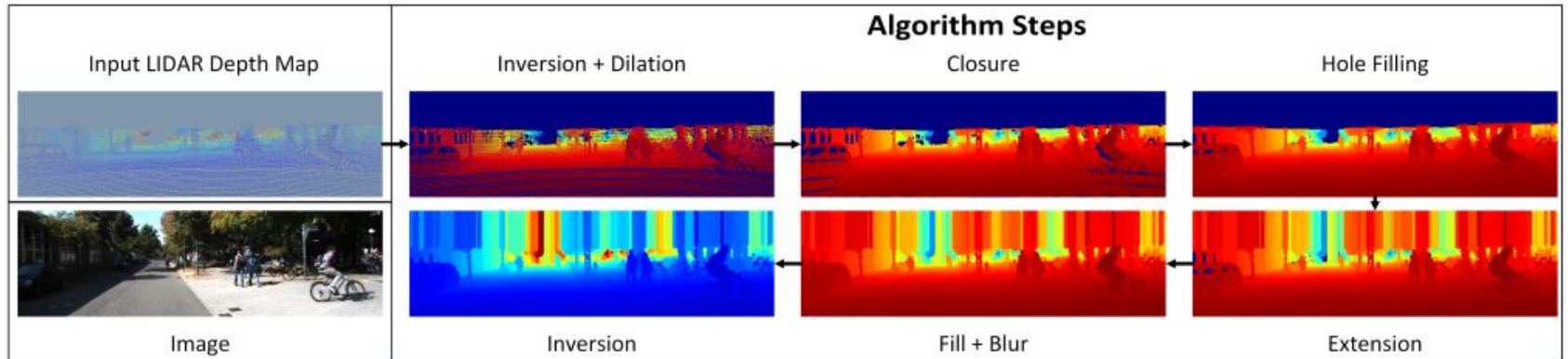
In Defense of Classical Image Processing: Fast Depth Completion on the CPU

Original Project

Recapping

Simple and easy algorithm for filling depth maps using classic image processing, which runs on the CPU and requires no training.

Algorithm Steps

Input LIDAR Depth Map   Inversion + Dilation   Closure   Hole Filling

Image   Inversion   Fill + Blur   Extension

Proposed tests

Proposed tests

- Original work does not specify any tests regarding the format of used kernels, except for the initial dilation step.
- We applied different kernels for the remaining steps.
- The use of a guided filling approach was also tested in conjunction with the original algorithm

Full

1	1	1	1	1
1	1	1	1	1
1	1	1	1	1
1	1	1	1	1
1	1	1	1	1

0	0	1	0	0
0	0	1	0	0
1	1	1	1	1
0	0	1	0	0
0	0	1	0	0

Cross

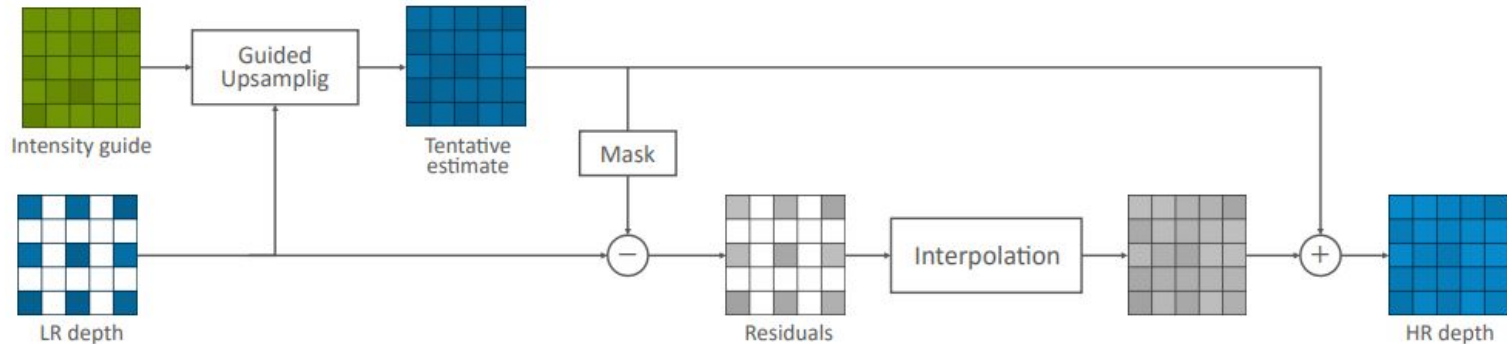| 0 | 0 | 1 | 0 | 0 |
0	1	1	1	0
1	1	1	1	1
0	1	1	1	0
0	0	1	0	0

Diamond

Guided approach

The guided filter is derived from a local linear model and generates output considering the content of a guide image.

$$q_i = \sum_j W_{ij}(I)p_j,$$

Results

Small hole closure

Fechamento de pequenos buracos

	MAE (m)	RMSE (m)	Execution time (ms)
Original	0.305	1.345	10.5
Diamond 3x3	0.316	1.395	11.4
Diamond 5x5	0.314	1.369	11.2
Diamond 7x7	0.319	1.357	11.5
Full 3x3	0.301	1.349	10.8
Full 7x7	0.314	1.364	11.2
Cross 3x3	0.316	1.395	11.6
Cross 5x5	0.311	1.360	11.1
Cross 7x7	0.317	1.348	11.1

Small hole fill

Preenchimento de pequenos buracos

	MAE (m)	RMSE (m)	Execution time (ms)
Original	0.305	1.345	10.5
Diamond 3x3	0.318	1.446	10.7
Diamond 5x5	0.310	1.395	11.1
Diamond 7x7	0.307	1.366	11.3
Full 3x3	0.316	1.431	10.9
Full 5x5	0.308	1.371	10.9
Cross 3x3	0.318	1.446	11.0
Cross 5x5	0.310	1.395	10.9
Cross 7x7	0.307	1.366	10.8

Large hole fill

Preenchimento de grandes buracos

	MAE (m)	RMSE (m)	Execution time (ms)
Original	0.305	1.345	10.5
Kernel 15x15	0.305	1.341	10.5
Kernel 19x19	0.305	1.338	10.3
Kernel 23x23	0.305	1.339	10.4
Kernel 27x27	0.305	1.342	10.5
Kernel 35x35	0.305	1.349	10.8
Kernel 39x39	0.306	1.354	10.7
Kernel 43x43	0.306	1.358	11.0
Kernel 47x47	0.306	1.362	11.0

Median and Gaussian Blurring

Borramento mediano e gaussiano

	MAE (m)	RMSE (m)	Execution time (ms)
Original	0.305	1.345	10.5
Median 3x3	0.307	1.351	8.3
Gaussian 3x3	0.304	1.368	10.6
Gaussian 7x7	0.313	1.331	10.8

Combinations

- Combining the configurations
- Results

	MAE (m)	RMSE (m)	Execution time (ms)
Kernel 19x19	0.305	1.338	10.3
Gaussian 7x7	0.313	1.331	10.8

Conclusion

- The best configuration
- Results

	MAE (m)	RMSE (m)	Execution time (ms)
Kernel 19x19	0.305	1.338	10.3