D-KHT: REAL-TIME PLANE DETECTION IN DEPTH IMAGES

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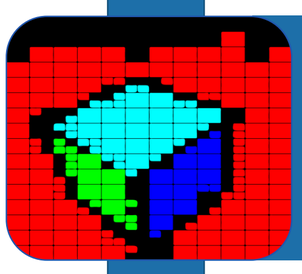
Abstract

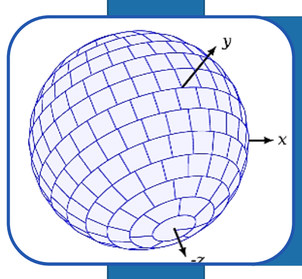
The automatic detection of geometric primitives in depth images provides the basis for solving many computer vision problems. In this paper, we present a real-time deterministic algorithm for plane detection in depth images. By using an implicit quadtree to cluster approximately coplanar points in the 2.5-D space associated with an efficient Hough Transform voting scheme and a hill climbing strategy to find local maxima, we are able to reach real-time detection.

Algorithm Workflow

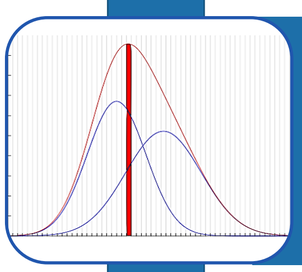
Depth Image



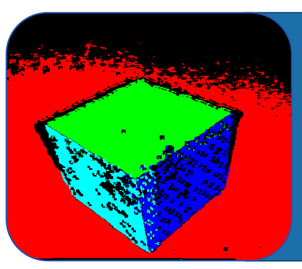
Clustering
- SATs Computation
- Quadtree Subdivision



Voting
- Compute Gaussian Kernel
- Increment Spherical Accumulator Map[1]



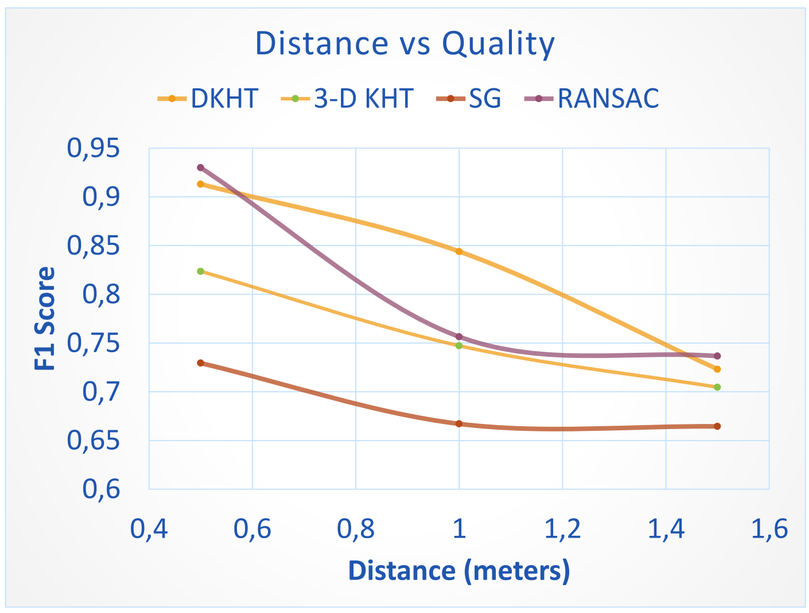
Peak Detection
- Smoothing
- Hill Climbing



Detected Planes

Results

Dataset	D-KHT	3-D KHT[2]	SG[3]	RANSAC[4]
S1	30.7	116.2	186.6	1270.5
S2	25.3	128.0	153.0	1410.3
S3	12.0	120.9	125.5	1327.2
R1	3.6	24.7	193.9	1380.8
R2	5.5	96.5	138.2	1258.9
R3	10.9	32.0	138.4	1308.5
R4	4.4	27.5	135.8	1330.0
R5	8.2	35.2	184.4	1363.3
R6	9.6	22.6	163.8	1698.9
R7	18.1	76.2	119.4	1086.2
R8	1.7	23.3	139.3	995.4



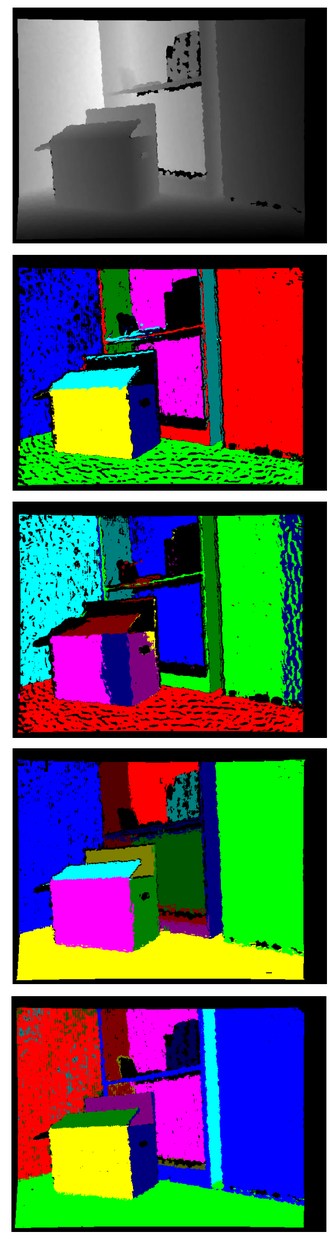


Fig: R2 Dataset. Input image and outputs for D-KHT, 3-D KHT, SG and RANSAC, respectivelly.

Conclusion

In this work, we presented a real-time approach to plane detection in depth images. To ensure the low computational cost of the technique, we took advantage of a few restrictions from the regular structure of the depth images. Experiments shows the effectiveness of the method with its comparison to state-of-the-art techniques when applied to datasets comprised of both synthetic and real images. Besides that, the analyzed datasets also had non-planar surfaces to evaluate algorithms resilience to detecting spurious planes, a common issue in this kind of technique.

[1] Borrmann, Dorit, et al. "The 3D Hough transform for plane detection in point clouds: A review and a new accumulator design." *3D Research* 2.2 (2011): 3.
[2] Limberger, Frederico A., and Manuel M. Oliveira. "Real-time detection of planar regions in unorganized point clouds." *Pattern Recognition* 48.6 (2015): 2043-2053.
[3] Poppinga, Jann, et al. "Fast plane detection and polygonalization in noisy 3D range images." Intelligent Robots and Systems, 2008. IROS 2008. IEEE/RSJ International Conference on. IEEE, 2008.
[4] Schnabel, Ruwen, Roland Wahl, and Reinhard Klein. "Efficient RANSAC for point-cloud shape detection." Computer graphics forum. Vol. 26. No. 2. Blackwell Publishing Ltd, 2007.

Acknowledgments

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