Robotik WS 2012/13

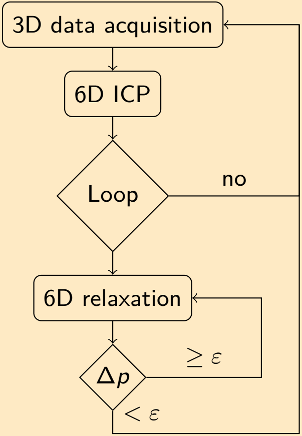
6.4 Vollständiges SLAM Teil 3

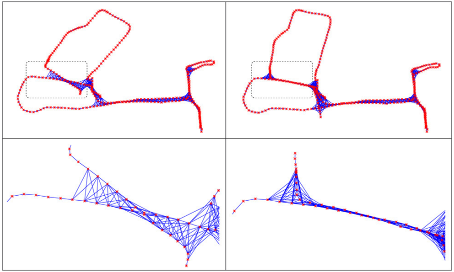
Jochen Sprickerhof

13.12.2012

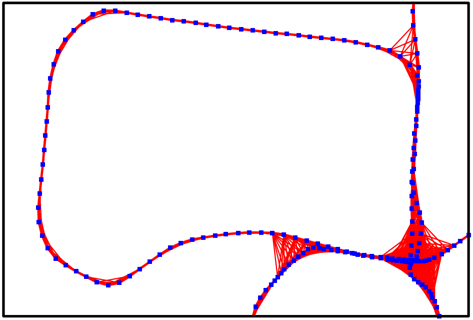
UNIVERSITÄT OSNABRÜCK

6D LUM

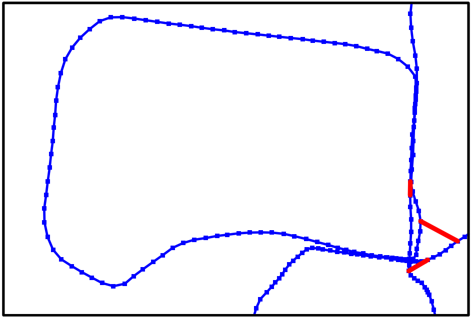




Borrmann et al. 2007

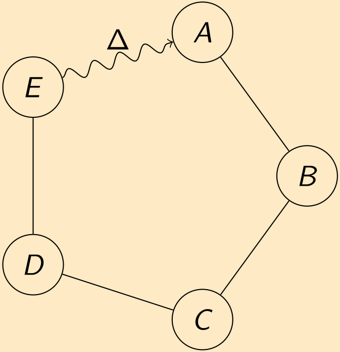


LUM



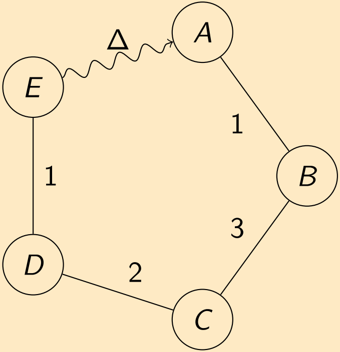
ELCH

Einfache Schleife



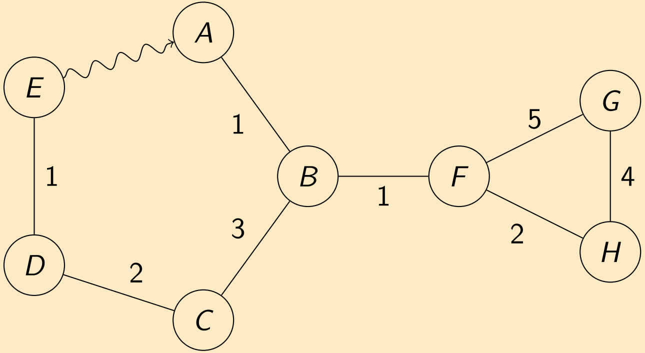
Kante	Gewicht
A	0
B	$^1/_4$
C	$^2/_4$
D	$^3/_4$
E	1

Einfache Schleife

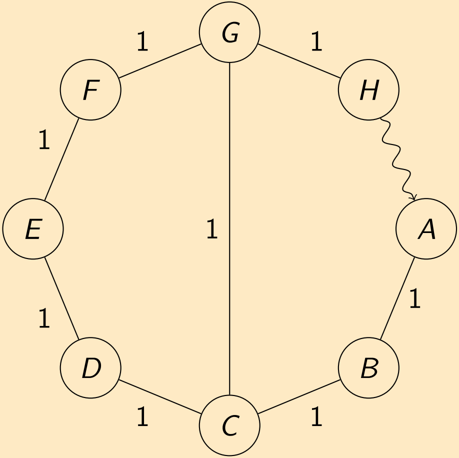


Kante	Gewicht
A	0
B	$1/7$
C	$4/7$
D	$6/7$
E	1

Erweiterte Schleife



Zwei Schleifen



Kante	Gewicht
A	0
B	?
C	?
D	?
E	?
F	?
G	?
H	1

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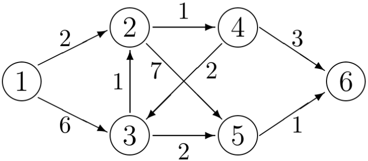
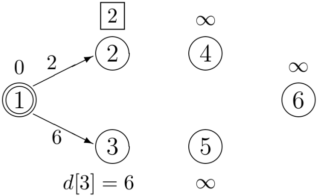
Algorithmus Dijkstra
```

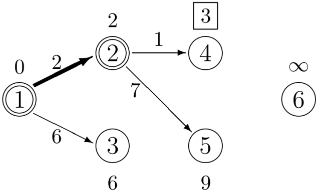
1. $S := \{s\}; \quad \bar{S} := V \setminus S;$
2. $d[s] := 0; \quad d[j] := c_{sj} \ \forall\, j \in \bar{S};$
3. WHILE $S \neq V$ DO
4.   Bestimme $i \in \bar{S}$ mit $d[i] = \min_{j \in \bar{S}} \{d[j]\};$
5. $S := S \cup \{i\}; \ \bar{S} := \bar{S} \setminus \{i\}$
6.   FOR ALL Nachbarn $j \notin S$ von i DO
7. $d[j] := \min\{d[j], d[i] + c_{ij}\};$
8. ENDWHILE



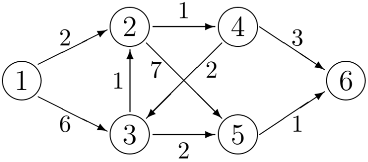
(a) Beispielgraph $G = (V, E)$



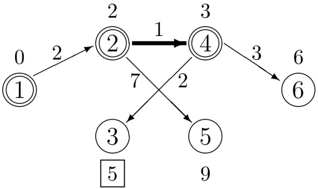
(b) $S = \{1\}$



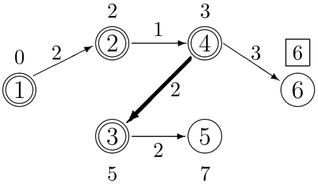
(c) $S = \{1, 2\}$



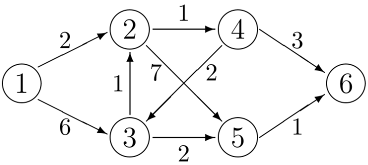
(a) Beispielgraph $G = (V, E)$



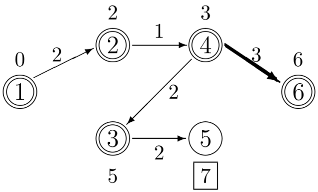
(d) $S = \{1, 2, 4\}$



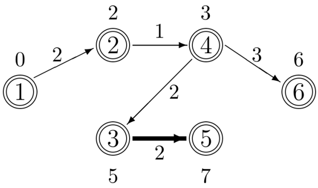
(e) $S = \{1, 2, 4, 3\}$



(a) Beispielgraph $G = (V, E)$

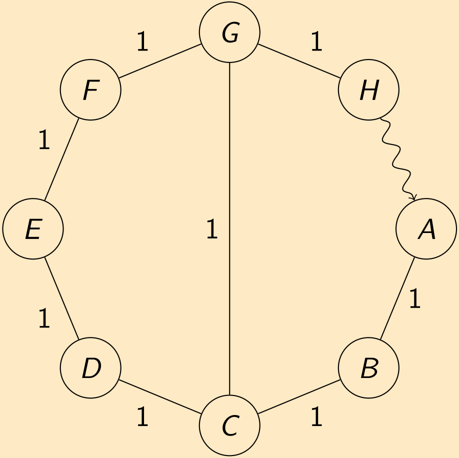


(f) $S = \{1, 2, 4, 3, 6\}$



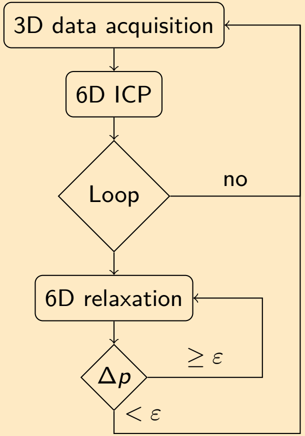
(g) $S = \{1, 2, 4, 3, 6, 5\}$

Zwei Schleifen

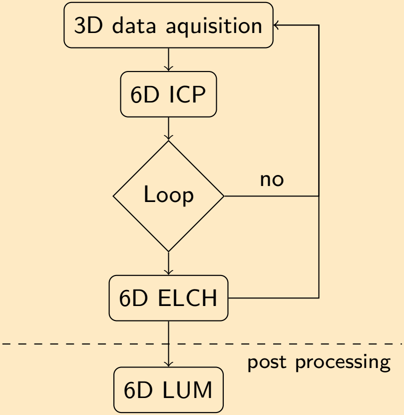


Kante	Gewicht
A	0
B	$1/4$
C	$2/4$
D	$2/4 + 1/16$
E	$2/4 + 2/16$
F	$2/4 + 3/16$
G	$3/4$
H	1

6D LUM

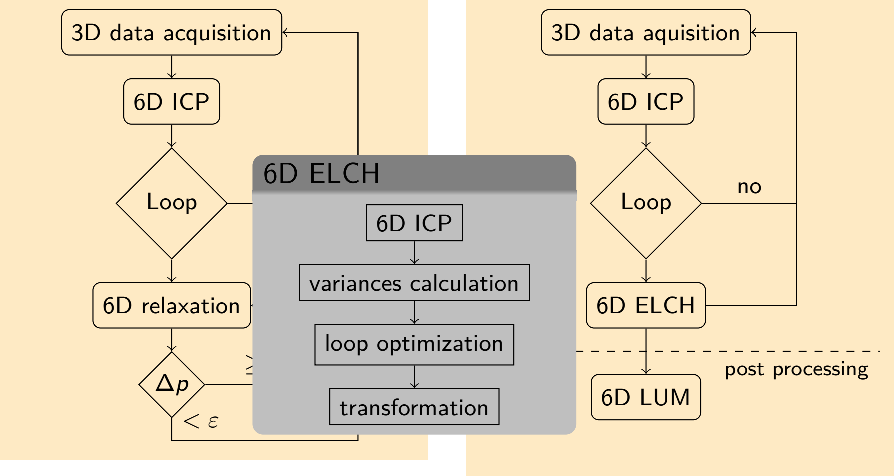


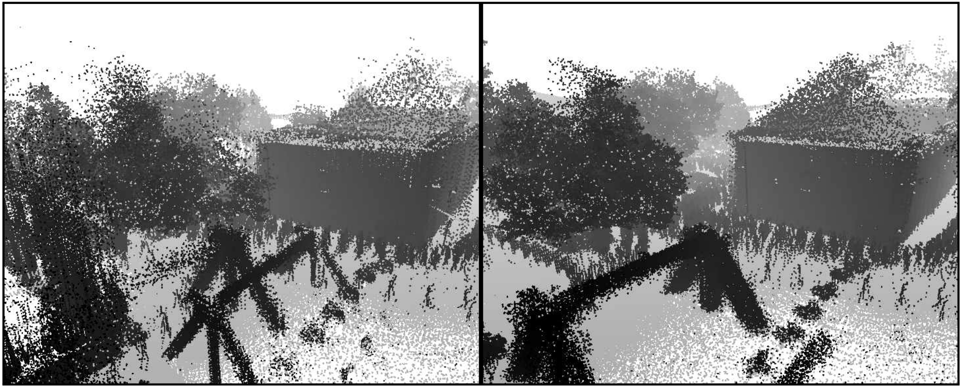
6D ELCH

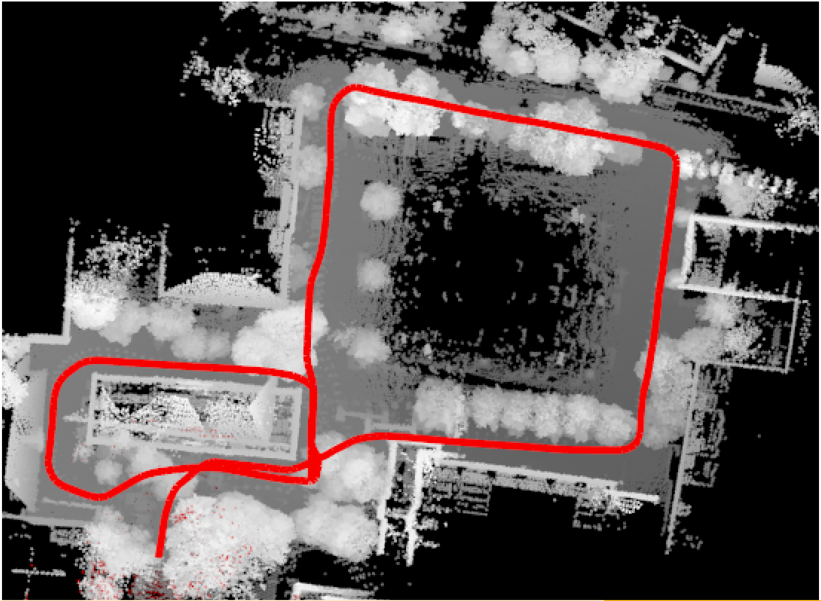


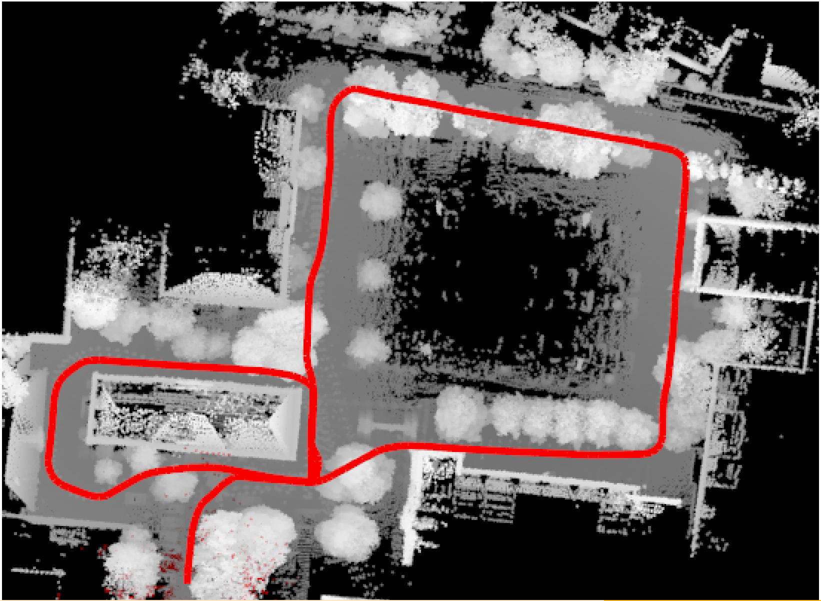
6D LUM

6D ELCH

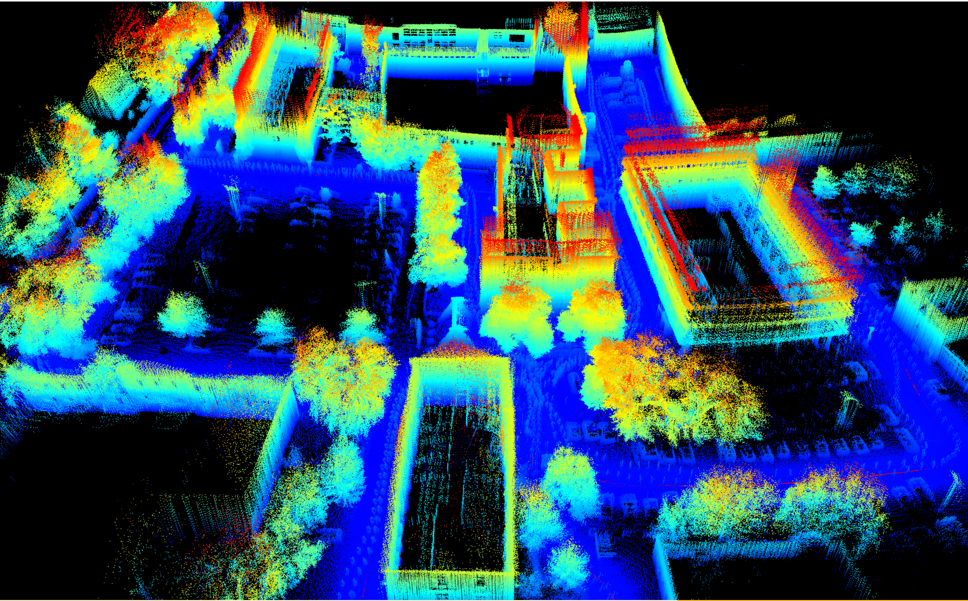


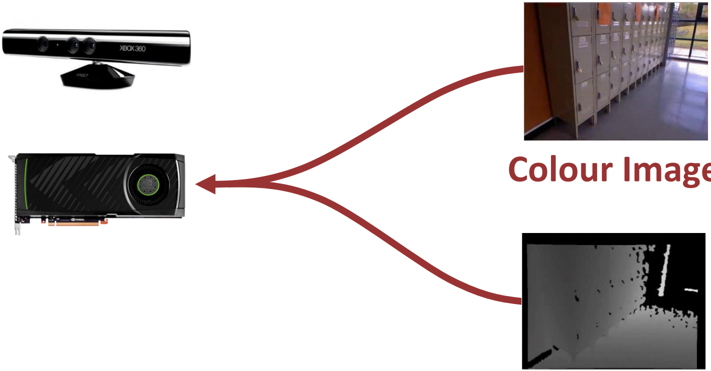






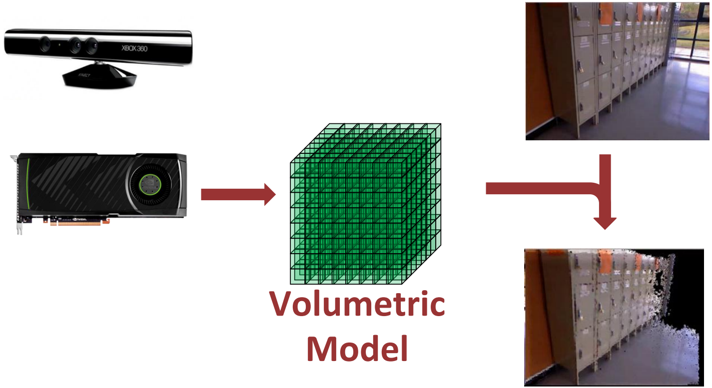

Previous Algorithm
Improved Algorithm
computing time: 00:40:07
computing time: 00:05:37

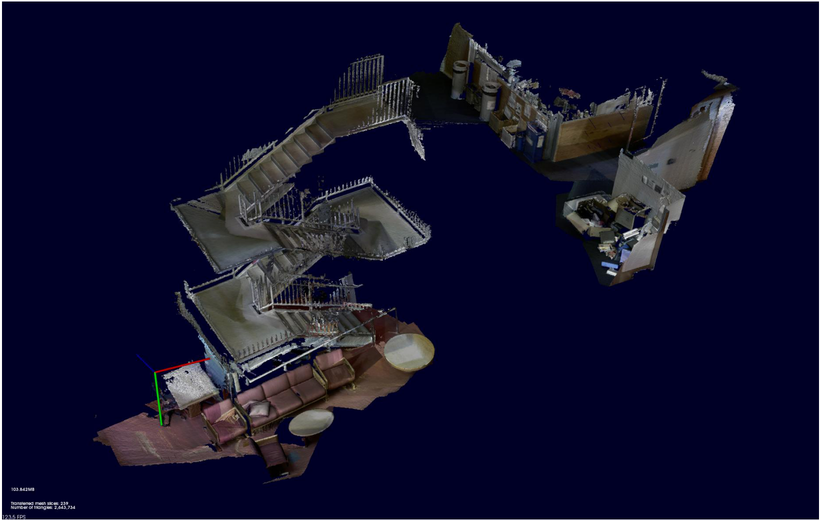


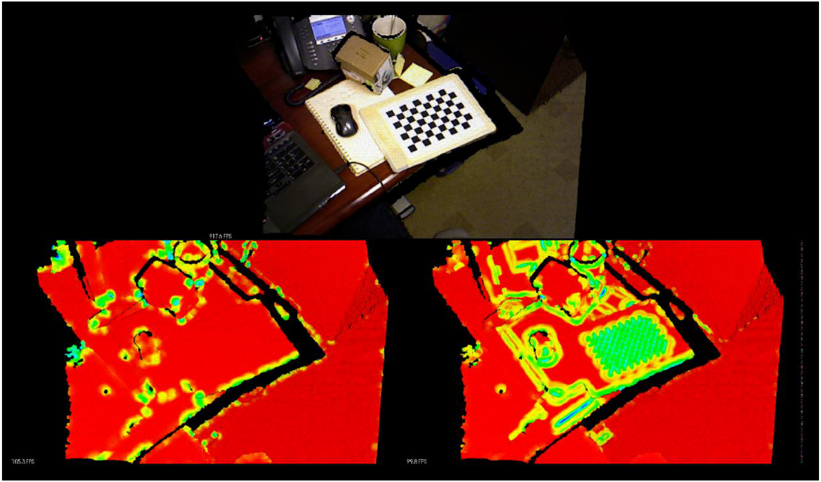


Colour Image

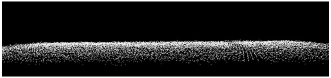
Depth Image


XBOX 360
Volumetric Model

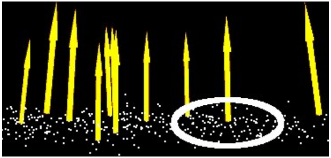

103.842MB
Transferred mesh slices: 239
Number of triangles: 2,643,734
123.5 FPS

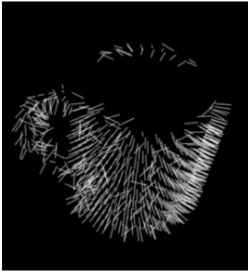


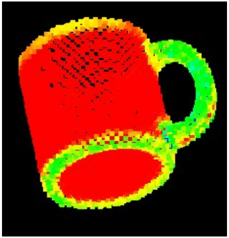
- Given a point cloud with x,y,z 3D point coordinates

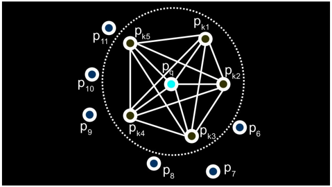


- Select each point's *k*-nearest neighbors, fit a local plane, and compute the plane normal



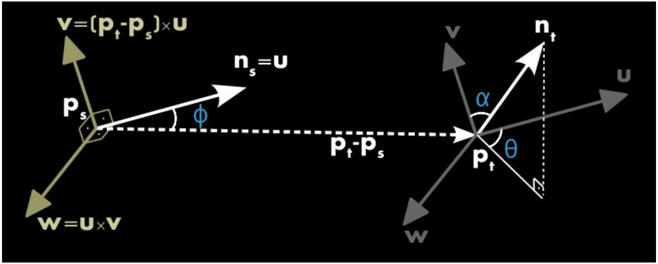




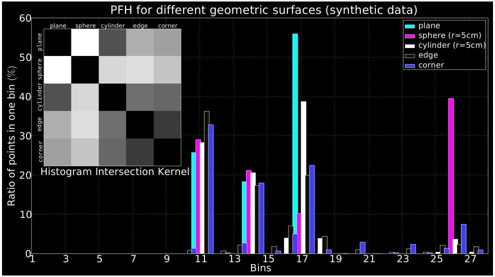


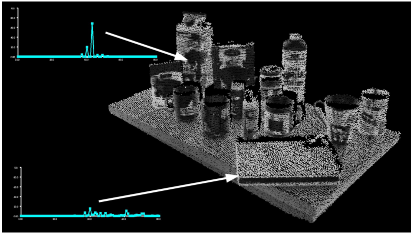
- For every point pair $\langle (p_s, n_s); (p_t, n_t) \rangle$, let $u = n_s,\ v = (p_t - p_s) \times u,\ w = u \times v$

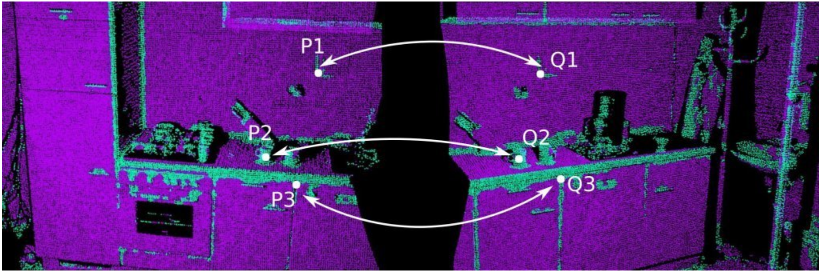
$$\left.\begin{aligned} f_0 &= \langle v, n_j \rangle \\ f_1 &= \langle u,\ p_j - p_i \rangle / ||p_j - p_i|| \\ f_2 &= ||p_j - p_i|| \\ f_3 &= atan(\langle w, n_j \rangle, \langle u, n_j \rangle) \end{aligned}\right\} \quad i_{hist} = \sum_{x=0}^{x \leq 3} \left\lfloor \frac{f_x \cdot d}{f_{x_{max}} - f_{x_{min}}} \right\rfloor \cdot d^x$$

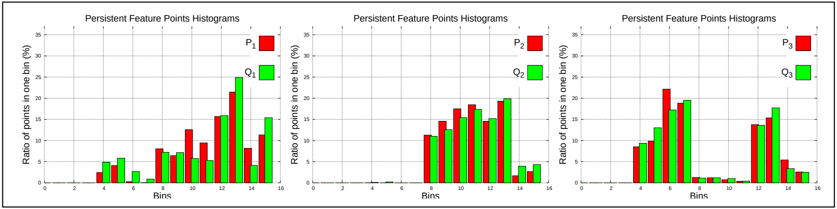


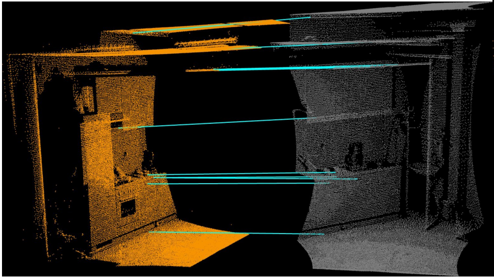
$$\left.\begin{aligned} f_0 &= \langle v, n_j \rangle \\ f_1 &= \langle u,\ p_j - p_i \rangle / ||p_j - p_i|| \\ f_2 &= ||p_j - p_i|| \\ f_3 &= atan(\langle w, n_j \rangle, \langle u, n_j \rangle) \end{aligned}\right\} \quad i_{hist} = \sum_{x=0}^{x \leq 3} \left\lfloor \frac{f_x \cdot d}{f_{x_{max}} - f_{x_{min}}} \right\rfloor \cdot d^x$$

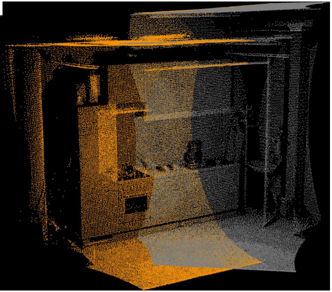

PFH for different geometric surfaces (synthetic data)
Ratio of points in one bin (%)
Bins
plane
sphere (r=5cm)
cylinder (r=5cm)
edge
corner
plane sphere cylinder edge corner
Histogram Intersection Kernel

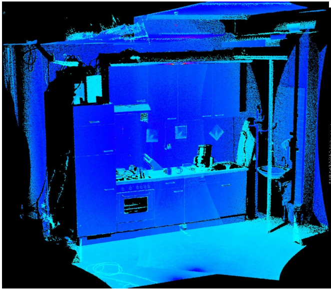


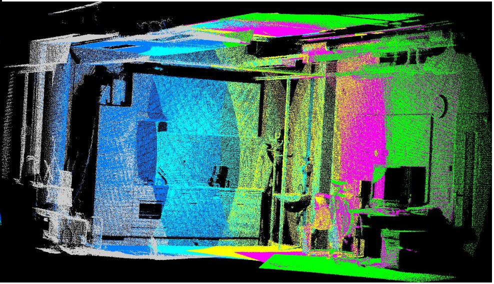

P1
Q1
P2
Q2
P3
Q3

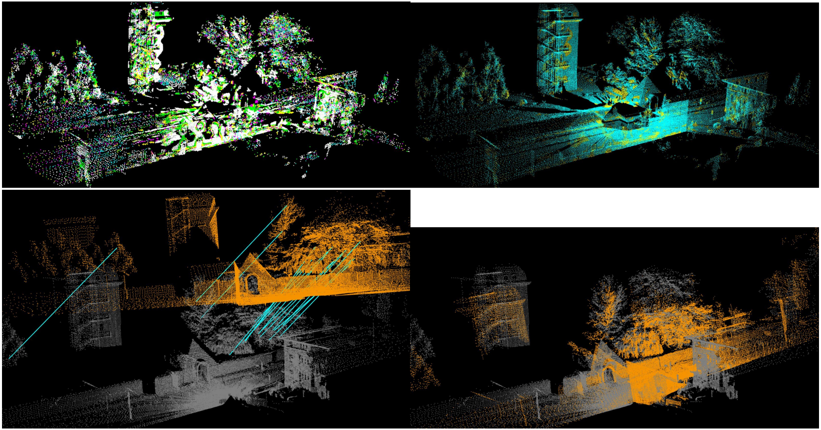

Persistent Feature Points Histograms
Ratio of points in one bin (%)
Bins
P1
Q1
Persistent Feature Points Histograms
Ratio of points in one bin (%)
Bins
P2
Q2
Persistent Feature Points Histograms
Ratio of points in one bin (%)
Bins
P3
Q3

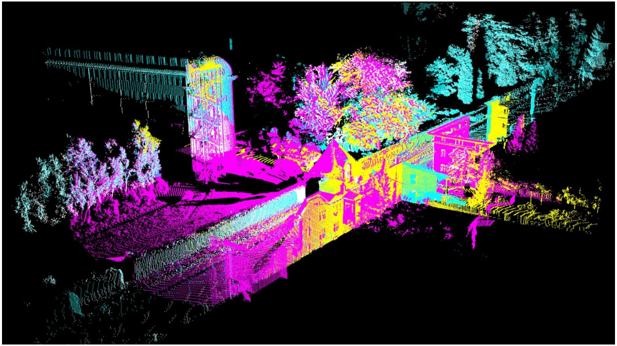













ROS
Celebrating 5 years of ROS