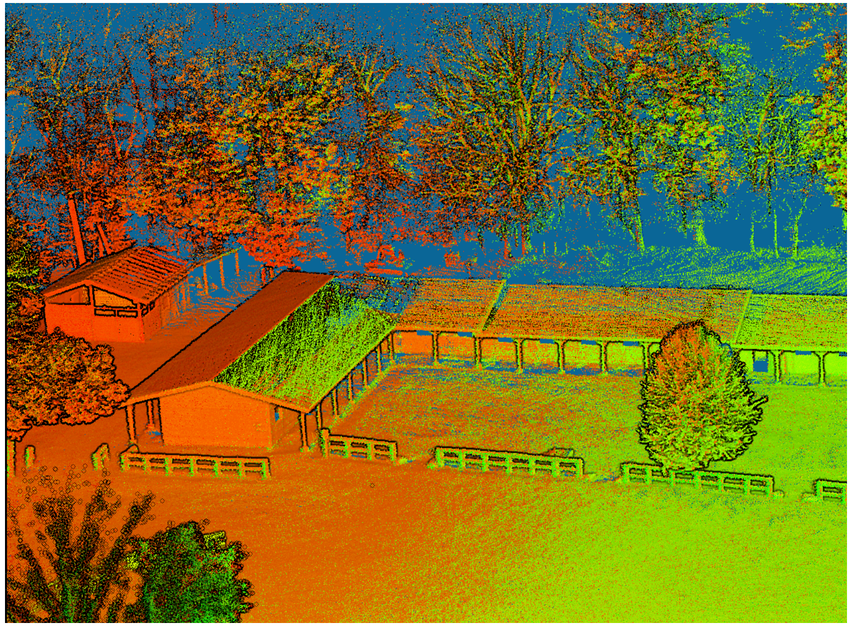
WHAT WE HAVE LEARNED FROM USING SLAM IN CHALLENGING ENVIRONMENTS

April 03, 2023



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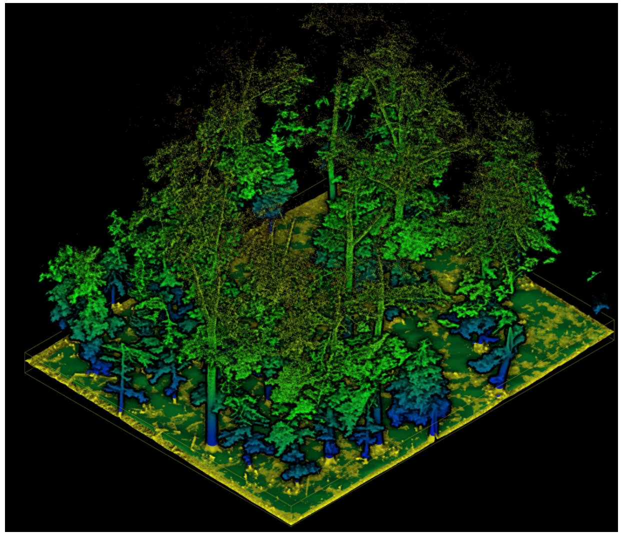
What is SLAM Technology?

→ Simultaneous Localization and Mapping (SLAM) is a technology that uses a combination of lidar, sensors, and odometry to gather data about its surroundings to make a map or 3D image.

Why is SLAM useful for geophysics?

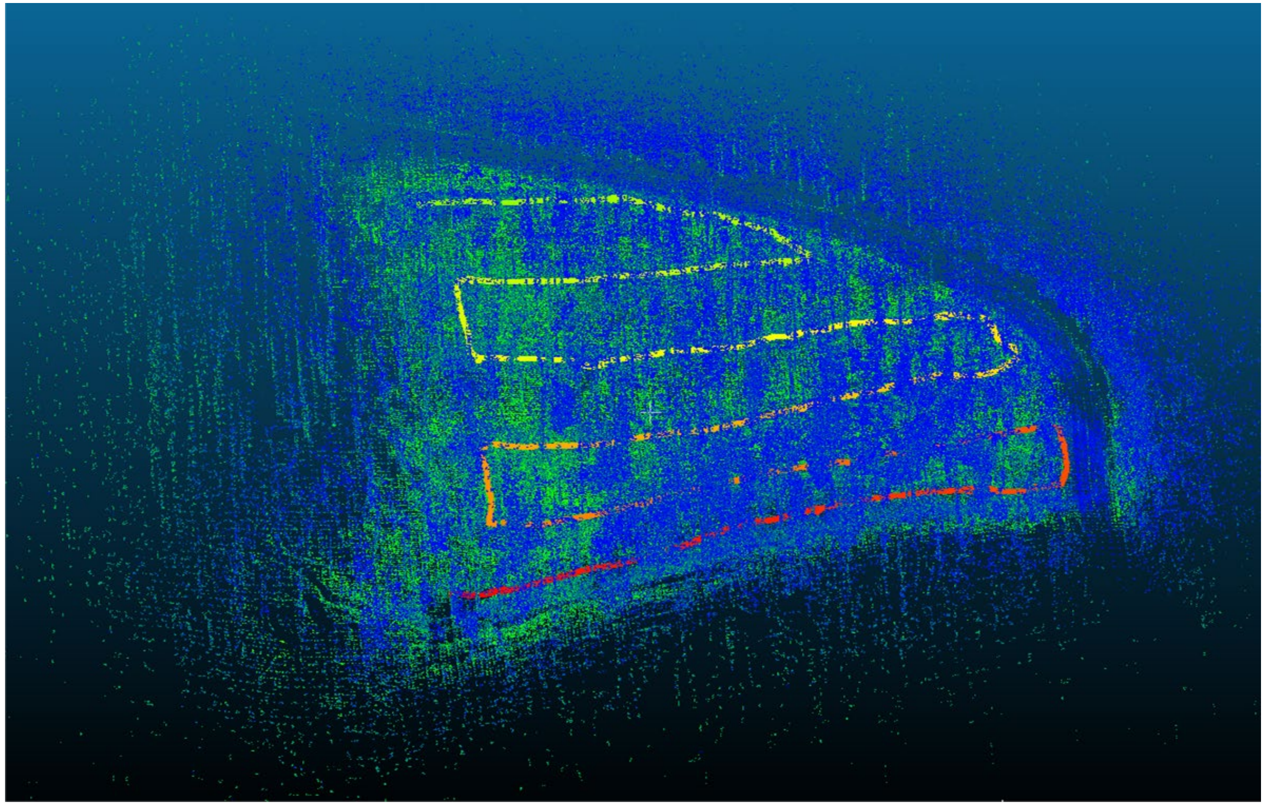
→ Continuous positional data stream in GPS deficient environments where traditional systems such as RTS or RTK are inefficient or impossible to use.

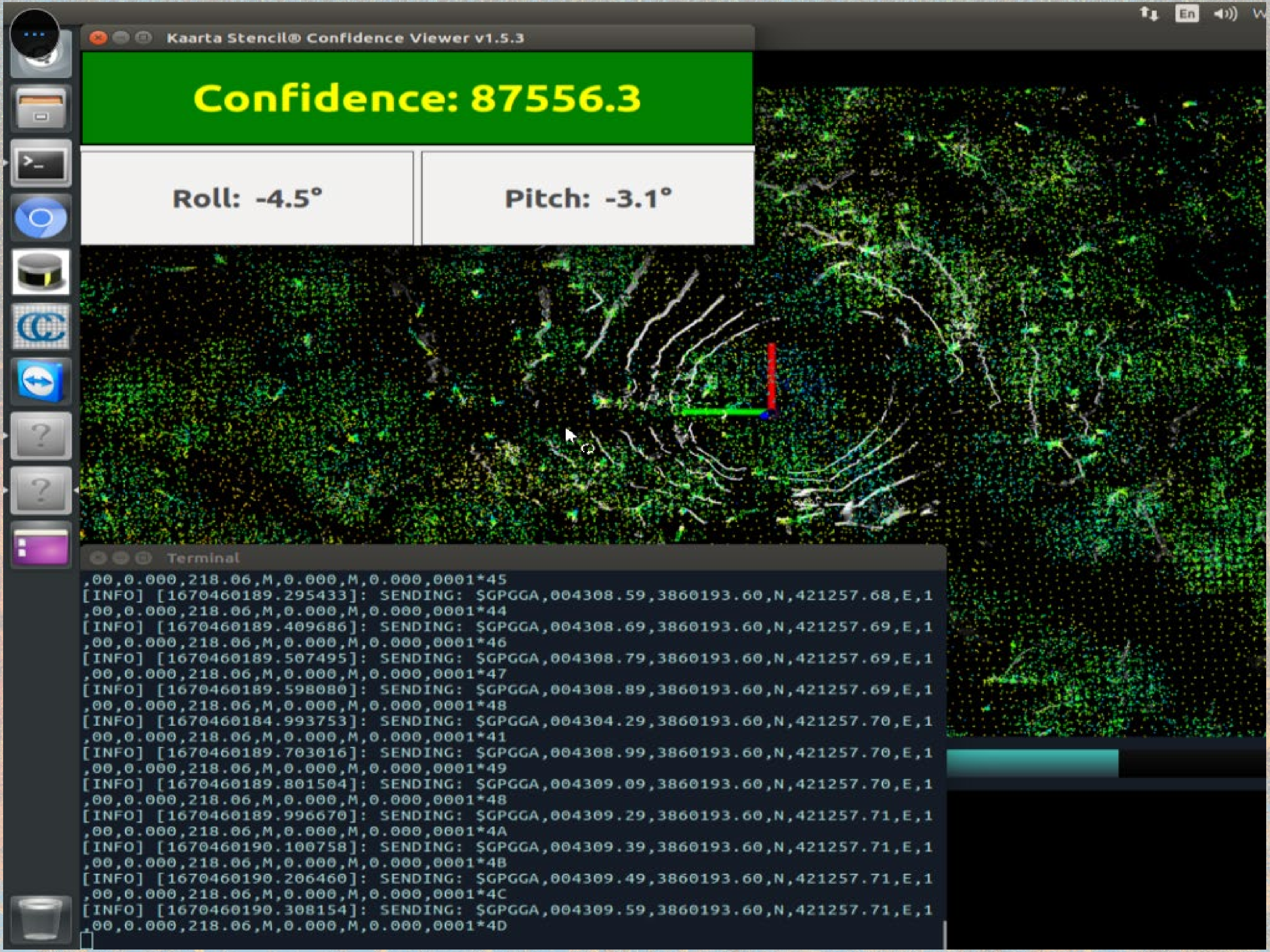


SLAM Point Cloud Mapping

Using PLS Grid Corners to Create Geo-Referenced Maps

- Walk and scan desired survey area in an ordered fashion
- Take ''key pose'' recording on PLS points
- Process data to assign global positioning




Kaarta Stencil® Confidence Viewer v1.5.3
Confidence: 87556.3
Roll: -4.5°
Pitch: -3.1°
Terminal
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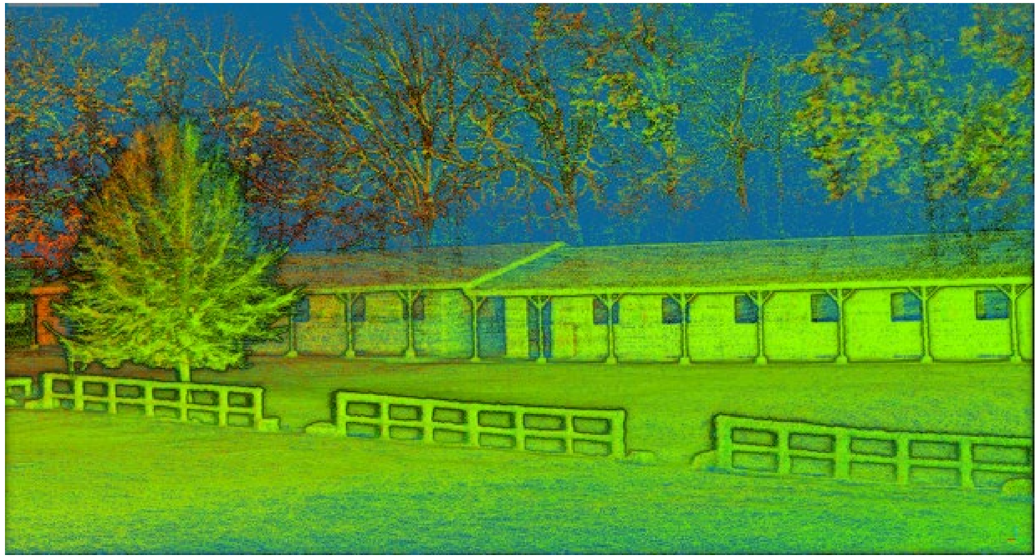
Starting Off – Lessons Learned

Updated our point cloud collection technique

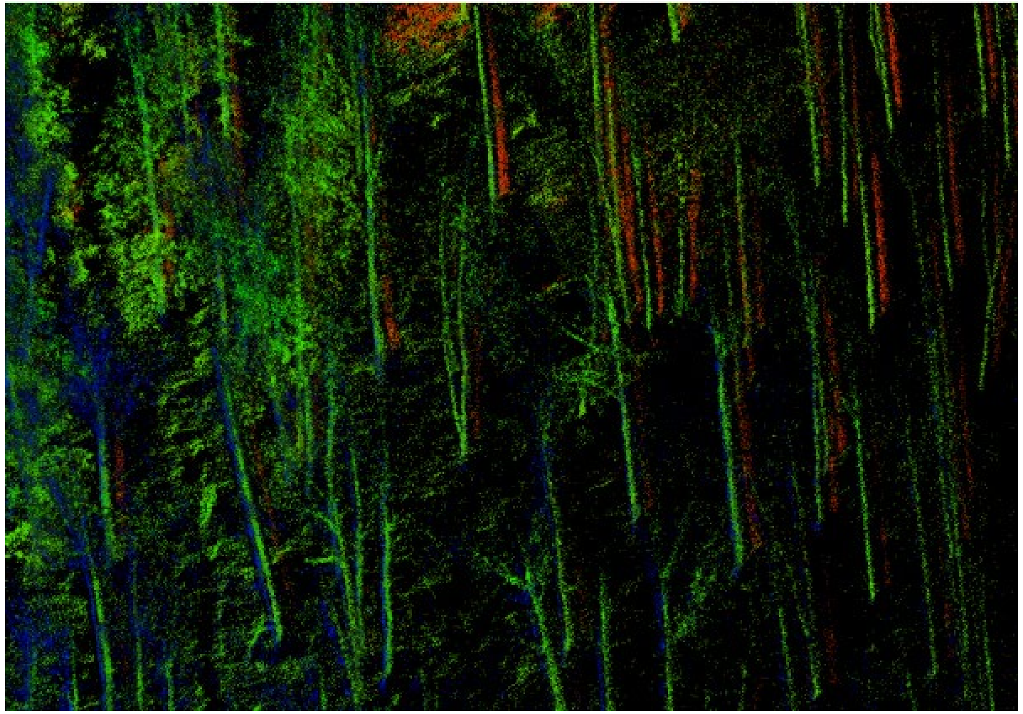
- → Increased # of key pose measurements
- → Decreased distance between key poses
- → Changes in processing params
  - → Examples: 2 loop closures max, sharpen PC map



Lessons Learned – Cont'd

Implemented QC measures to reduce risk of rework

- Checking for double registrations
- UXOQC tool, provides information on map accuracy by comparing trajectory file to geo-referenced base map
- Physical ground checks on 50% of all survey nails within each cloud, <10cm metric for pass / fail of entire cloud



UXOQC Tool Example

Grid_ID	Time	dX	dY	dZ	dXY	dXYZ	Roll(deg)	Pitch(deg)	Yaw(deg)
BP41	97.454	0	-0.002	0.004	0.002	0.004	0.203	-0.264	-164.928
BO41	243.057	-0.035	0.004	0.011	0.035	0.037	-0.601	-0.375	65.333
BO40	548.46	-0.009	0.005	-0.014	0.011	0.018	0.24	-0.371	-57.707
BP40	628.36	0.039	0.007	0.003	0.04	0.04	0.421	-0.162	-76.629
BP39	805.362	-0.012	0.006	-0.004	0.014	0.014	-0.609	-0.34	158.218
BN39	1037.465	-0.03	-0.025	-0.003	0.039	0.039	-0.476	-0.526	120.895
BN38	1232.966	0.01	-0.05	0.007	0.051	0.052	-0.561	-0.379	-95.604
BO38	1458.568	0.039	-0.004	-0.03	0.039	0.05	0.261	-0.272	-91.683
BP38	1570.67	-0.002	0.017	-0.002	0.017	0.017	-0.542	-0.146	-96.296
BP37	2025.074	-0.006	0.026	0.015	0.027	0.031	-0.743	-0.25	-167.543
BN37	2224.676	-0.021	-0.014	-0.016	0.025	0.03	-0.492	-0.5	100.763
BN36	2409.478	0.013	-0.019	0.009	0.023	0.025	0.545	-0.057	-73.856
BP36	2632.279	0.007	0.04	0	0.041	0.041	-0.146	-0.311	-68.485
BO35	2850.082	-0.023	0.01	0.007	0.026	0.027	-0.384	-0.69	66.266
BN35	2989.583	0.021	-0.003	0.004	0.021	0.022	-0.379	-0.262	118.913
MEAN					0.027	0.03			
STDEV					0.013	0.013			
MIN		0	-0.002	0	0.002	0.004			
MAX		0.039	-0.05	-0.03	0.051	0.052			

Ground Check Results Example

Passing Results

Easting	Northing	Altitude	Confidence	Timestamp	Notes	Easting - Real	Northing - Real	Altitude - Real	X Offset	Y Offset	Z Offset	XY Offset
421014.8	3860042.5	216.93	108247.51	93.513	BN38	421014.803	3860042.423	215.37	-0.017	-0.077	0.04	0.08
420953.9	3860042.4	218.28	171543.23	291.013	BN36	420953.866	3860042.443	216.686	-0.014	0.013	0.006	0.02
420954.9	3860012.6	215.9	204312.92	402.118	BO35	420954.915	3860012.65	214.278	0.015	0.01	-0.022	0.02
420954.9	3860012.6	215.89	209459.22	499.156	BO36	420954.915	3860012.65	214.278	0.005	0.02	-0.012	0.02
421015.9	3860012.7	212.25	146733.69	682.137	BO38	421015.855	3860012.636	210.618	0.005	-0.044	-0.032	0.04
421076.8	3860012.6	213.18	130685.94	832.225	BO40	421076.793	3860012.619	211.574	0.013	-0.011	-0.006	0.02

Failing Results

Easting	Northing	Altitude	Confidence	Timestamp	Notes	Easting - Real	Northing - Real	Altitude - Real	X Offset	Y Offset	Z Offset	XY Offset
423148.5	3858549.6	190.32	81259.27	182.451	DK108	423148.357	3858549.531	188.74	-0.103	-0.039	0.02	**0.11**
423085.4	3858549.6	181	76170.97	486.401	DK106	423085.432	3858549.549	179.34	0.002	-0.031	-0.06	0.03
423085.4	3858549.6	181	86484.25	537.081	DK106	423085.432	3858549.549	179.34	0.012	-0.031	-0.06	0.03
423087.5	3858610.5	179.65	77980.92	755.661	DI106	423087.436	3858610.49	178.087	-0.034	-0.05	0.037	0.06
423118	3858641.1	172.23	89551.07	1359.079	DH107	423117.911	3858640.949	170.6	-0.079	-0.111	-0.03	**0.14**
423087.6	3858671.5	176.94	109196.48	1552.619	DG106	423087.449	3858671.427	175.335	-0.101	-0.053	-0.005	**0.11**

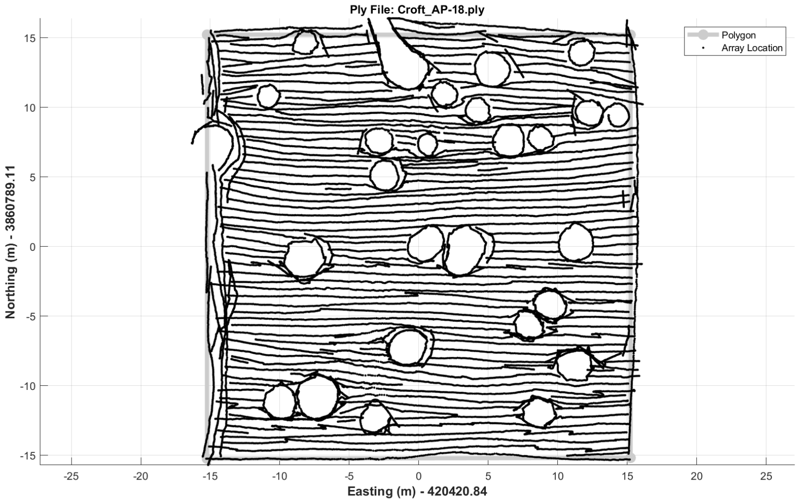
Field Efficiency / Data Quality

Increased productivity in densely wooded environment

- Increased data collection production rates by 116% in terms of acreage covered per day when compared to RTS
- Increased data quality/efficiency, continuous files, less gaps, more constant line spacing with less overlap

Not ideal for every situation

- Areas with little or non-permanent features
- No line of site issues
- Rain sensitive
- More repairs needed (more hardware using SLAM)



Optimization

Outputting SLAM confidence value in the Pseudo NMEA String

- Positional accuracy can fluctuate with SLAM vs RTS

Upgraded battery type

- Less battery swaps = less localizations
- More durable for field use
- Hot swap capability

Improvements needed for Reacquisition feature

- Visuals/Audio for navigation

Conclusion

Preferred approach with line of site issues and unreliable GNSS signal

Necessary QC implementation

Improved production and data quality!

Questions & Answers

Contact Us

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