

FIG WORKING WEEK 2019

22-26 April, Hanoi, Vietnam

Presented by the FIG Working Week 2019,
April 22-26, 2019 in Hanoi, Vietnam

"Geospatial Information for a Smarter Life
and Environmental Resilience"



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THE MAPPING ACCURACY OF LOW-COST UAV-BASED LASER SCANNER SYSTEM: A CASE STUDY OF HOKUYO UTM30LX LASER SCANNER

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RESEARCH IDEA

- Develop a small UAV- based laser scanner system for monitoring agricultural crops
 - This system can fly at low altitude and collect information with high resolution for instant crop condition monitoring.
 - The whole system is easy to be carried
 - The developed system incurs the lowest possible cost

The mapping accuracy of develop UAV- based laser scanner system must be test

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SYSTEM DESCRIPTION

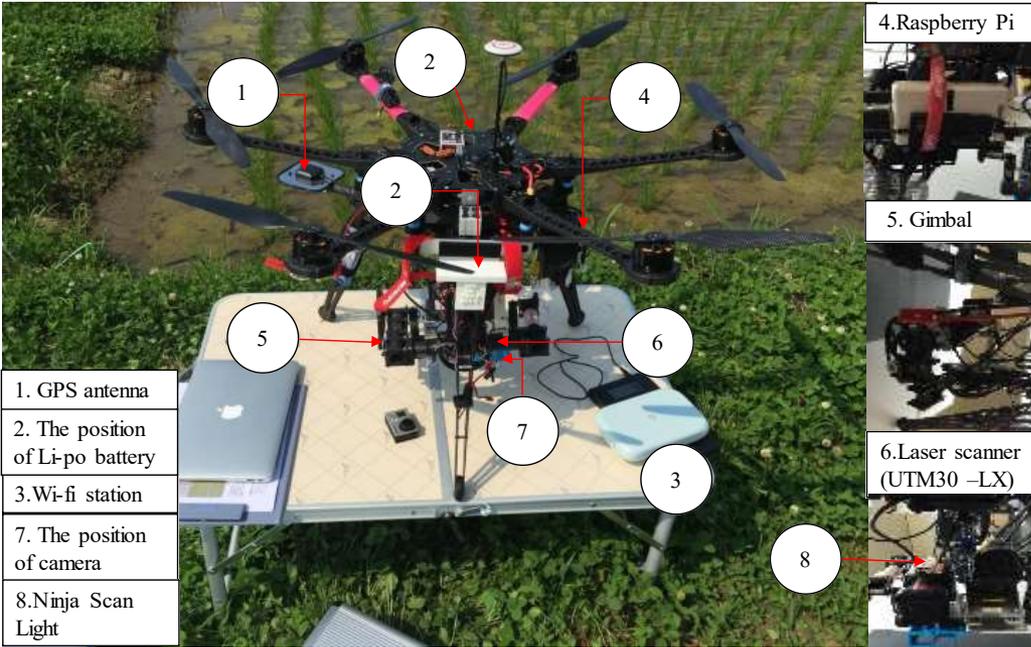


Table 1: UAV- based laser scanner system components

Components	Prices (USD)	Weight (kg)
DJI S800	3000	2.60
Hokuyo UTM 30LX	3300	0.37
TAROD 5D	1100	0.20
Sensor-COM GPS	50	--
NinjaScan- Light	17	0.02
Raspberry Pi 2	35	0.05
Turnigy 5000mAh 6S 40C (Lipo)	60	0.84
Turnigy 3300mAh 4S 30C (Lipo)	30	0.39

The hex-rotor aircraft DJI S800 with the 3-axis gimbal (TAROT 5D) carrying the Hokuyo UTM30LX laser scanner,

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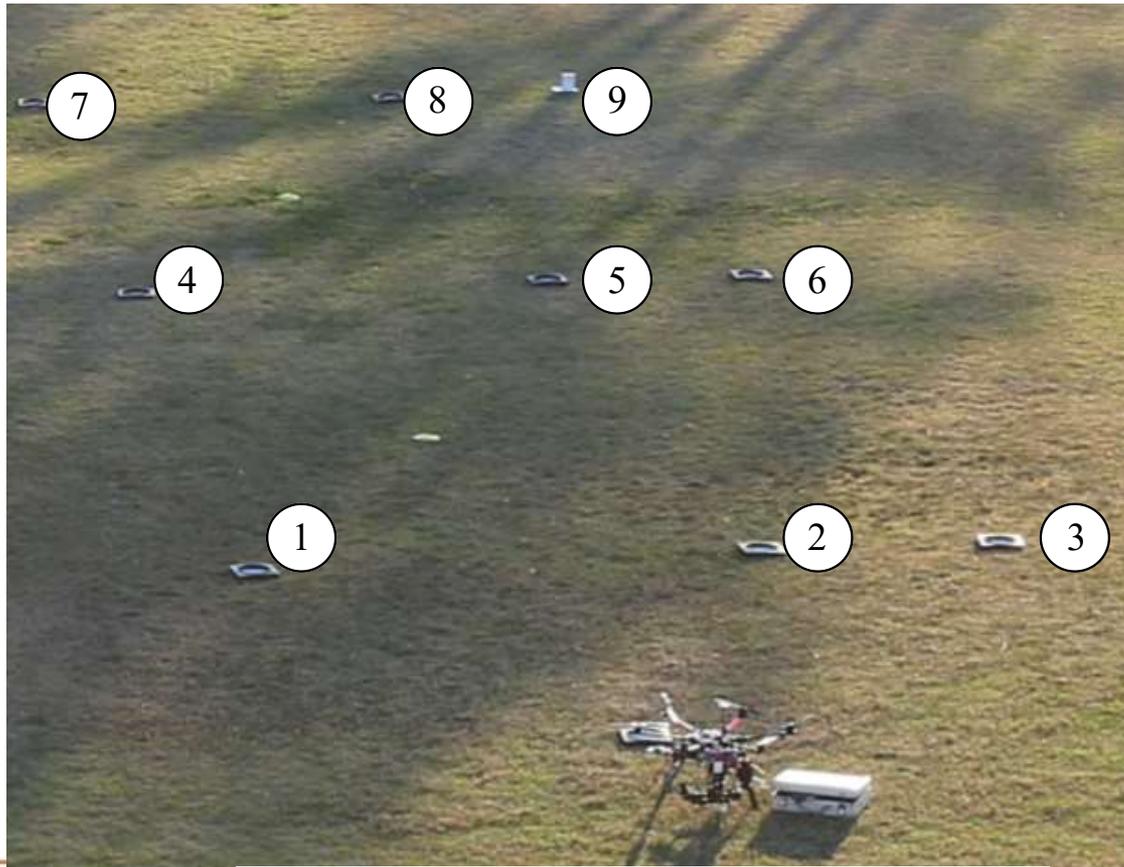
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EXPERIMENTAL SITE



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Experimental site.

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METHODOLOGY

3D laser point clouds generation

- Computation of the GPS antenna coordinates in Japanese mapping coordinate system
- Generation of the 3D coordinates of laser scanning points in laser scanner coordinate system
- Transformation of laser scanner coordinates (LSC) to Japanese mapping coordinates

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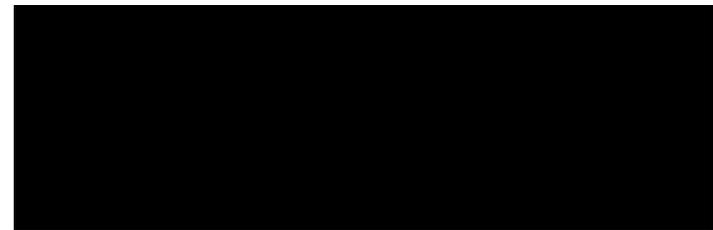
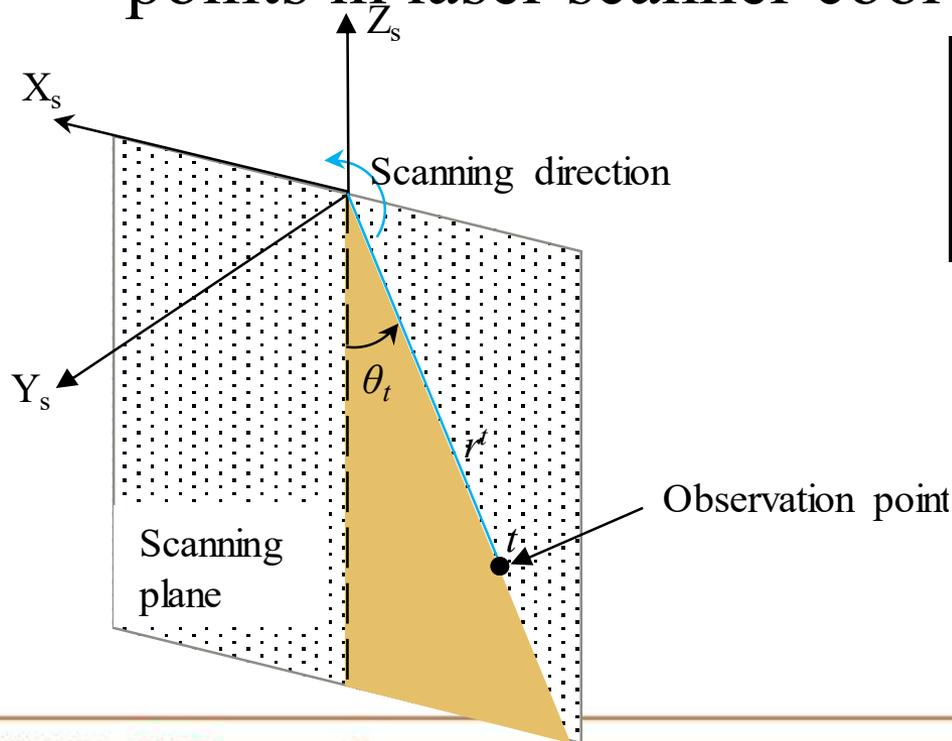
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METHODOLOGY

- Generation of the 3D coordinates of laser scanning points in laser scanner coordinate system



Where: P_t^S : The position of target scanning point t in laser scanner coordinate system

r^t : The observed range
 θ_t : The scanning angle

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FIG WORKING WEEK 2019

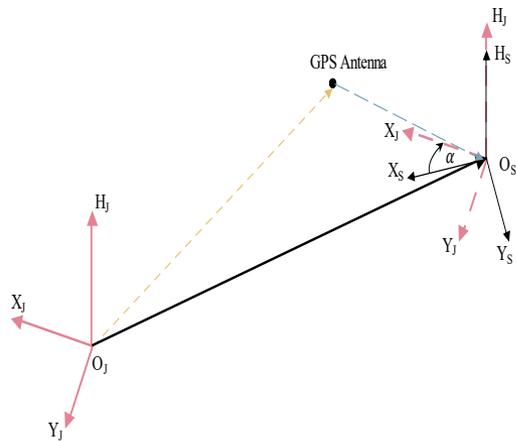
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METHODOLOGY

- Transformation of laser scanner coordinates (LSC) to Japanese mapping coordinates



Where:

P_t^J : 3D coordinates of laser scanning point in JMCS

P_{GPS}^J : The 3D coordinate of GPS antenna in JMCS

O_{GPS}^S : The offset vector from GPS antenna position to original of LSCS

$(P_{GPS}^J + O_{GPS}^S)$: shows the 3D coordinate of the mechanical origin of the line laser scanner in JMCS

R_S^J : The LSCS to JMCS rotation matrix

P_t^S : The 3D coordinates of laser scanning points in LSCS

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FIG WORKING WEEK 2019

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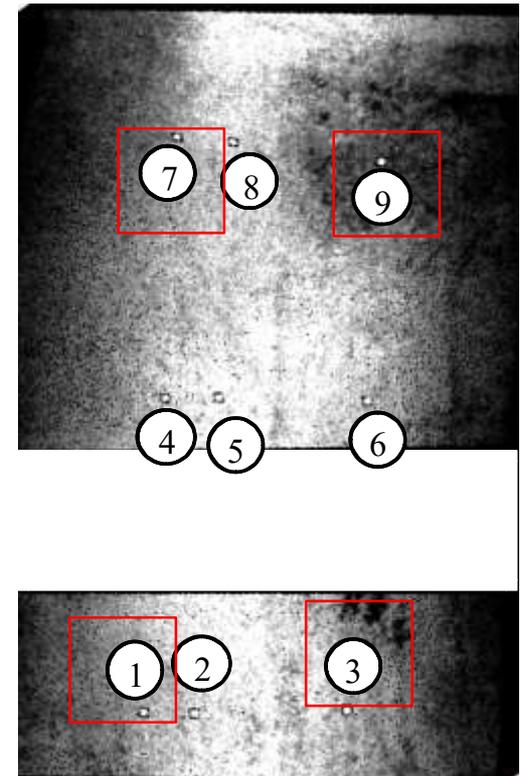
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METHODOLOGY

Point clouds accuracy assessment

- Non-applying translation transformation,
- Applying Helmert transformation with 4 ground control points.



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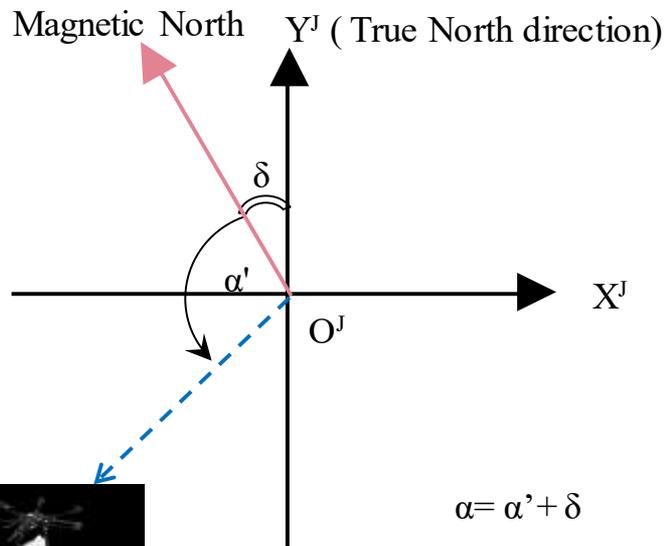
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RESULTS

Trajectory determination



Flight direction

- The rotation angle α ranges from 142.0480° to 146.9768°
- The flight direction was identified with the consideration of -6.884 degrees of magnetic declination angle

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RESULTS

Point cloud accuracy

Non-applying translation transformation

MAE (m)			Standard deviation (m)		
Horizontal	Vertical	Spatial	Horizontal	Vertical	Spatial
1.19	1.09	1.62	0.10	0.09	0.13

Applying Helmert transformation with 4 ground control points

ID	dX (m)	dY(m)	dH (m)
MP2	-0.053	-0.016	-0.023
MP4	0.114	0.020	0.047
MP5	0.119	0.037	0.039
MP6	0.110	0.097	0.023
MP8	0.018	-0.037	-0.011



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CONCLUSION

Achievement

The horizontal accuracy identified with GPS and magnetic data were 1.19 ± 0.10 m and 1.09 ± 0.09 m

Limitation

- Missing scanning lines
- Unstable flight altitude
- The horizontal attitude of laser scanner is not easy to maintained in whole flight

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