Forest carbon stock assessment by a UAV technique: case study in Japanese forest

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OBJECTIVE

• Development of forest ecosystem service (ES) assessment with low cost, high resolution methods.
  – Compared with on site field survey, satellite data

As a first step
  – UAV (Unmanned Aerial vehicle)
  – Plantation forest with strength thinning for easy identification of individual tree
  – Several forest sites: Cypress forest, Cedar forest, Deciduous broad-leaved forest, etc.

METHOD

• UAV images
• SFM:
  – DTM, DSM, DCM development
• Tree height estimation based on DCM
• Field survey on trees
  – Height, DBH
• Comparison of two data sets
• Tree volume estimation
• Ecosystem service (ES) supply potential estimation

ES (ecosystem service) supply potential estimation
  - Carbon stock: Inoue and Kurokawa (2001) formula
  - Forest volume
  - Canopy crown coverage: Voronoi division method
  - Aesthetic tree beauty: Cherry trees, autumn leaves
  - Recreation: Onsite visual investigation

Note: SFM (Structure from Motion), DTM (Digital Terrain Model), DSM (Digital Surface Model), DCM (Digital Canopy Model), DBH (Diameter at breast height).

RESULT

<table>
<thead>
<tr>
<th>Date (Takayama Hinoki site)</th>
<th>Photos</th>
<th>AGL(m)</th>
<th>Wind(m/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016/9/21/PM16-17 (leafing stage)</td>
<td>129</td>
<td>80</td>
<td>1.4</td>
</tr>
<tr>
<td>2016/11/2/AM11-13 (autumn leaves stage)</td>
<td>1029</td>
<td>40, 50, 60</td>
<td>1.2-0.2</td>
</tr>
<tr>
<td>2016/12/2/PM14-15 (falling leaves stage)</td>
<td>743</td>
<td>60</td>
<td>3.3</td>
</tr>
</tbody>
</table>

Fig. DSM (2016/09/21)
Fig. Orthophotos (2016/09/21)

A Part of assessment methods was detailed in Katada et al. 2017.
**CONCLUSION and REFERENCES**

- Relatively high accuracy of tree height estimation
- DTM is key for tree height estimation
- Seasonal images are useful for ES assessment
- Future issues
  - Classification of forest type
  - Dense forest assessment
  - Variety of ES assessment

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