REFLECTANCE SIMULATIONS OF VOXEL-BASED VIRTUAL CHINESE CABBAGE FARMS

S. SHAO[1], T. FUJIWARA[2], W. TAKEUCHI[3]

[1] PhD student, Department of Civil Engineering, The University of Tokyo, Tokyo, Japan,
[2] PhD student, Department of Civil Engineering, The University of Tokyo, Tokyo, Japan,
[3] Professor, Institute of Industrial Science, The University of Tokyo, Tokyo, Japan,
Correspond to Mr. S. SHAO (sshuai@g.ecc.u-tokyo.ac.jp)

***Keywords**: Chinese cabbage, Shadow effects, Reflectance simulation, Virtual farm, Cultivation ways*

1. Introduction

Chinese cabbage has been an essential daily vegetable supply both for human and livestock meals in Asian countries as it has various nutrients and is easy to cultivate. However, as global climate changes and anthropogenic industrialization bring challenges to global food security, monitoring the growth status of Chinese cabbage from a macroscopic way can be of much importance to ensure its yield [1]. Remote Sensing has a great potential to provide timely, ubiquitous, and frequent observations of the land surface at a large range of spatial scales, nevertheless the effects of shadows could also result in incorrect estimation of object properties such as reflectance, especially for the sensors of the middle or high-resolution satellite images [1]. A voxel-based simulation way has been a potential tool for compensating shadow effects which considers the shielding ratio of direct and diffuse solar irradiance categorized as Cast Shadow (CS) and Self Cast Shadow (SCS), since it consumes comparably less storage space than point cloud data and without a limitation of triangles being as a discrete 3D containing elements compared to mesh model [2].

The overall goal of this study is to develop a precise satellite image based Chinese Cabbage growth monitoring methodology for its entire growing season and different farms layouts which relies on the reflectance comparison analysis between Sentinel-2 imagery and virtual farms.

2. METHODOLOGY & RESULTS

A voxel was constructed by registering the point cloud data obtaining from SfM, then shadows effects calculation of voxels defined as Cast Shadow (CS), and Self Cast Shadow (SCS) is carried by SMARTS (Simple Model of atmospheric Radiative Transfer of Sunshine) 2.9.5 [2]. This spectral model is aiming to predict the direct beam, diffuse, and global irradiance incident on surfaces of any geometry at the Earth surface [2]. In this study, CS and SCS were calculated as the shielding ratio of direct and diffuse solar irradiance and reproduced with a spatial resolution by voxels.

Table 1. Information of layouts of six virtual Chinese cabbage farms

Simulation	Row Interval	Column Interval	Survival percentage
a	0.5m	0.7m	0.8
b	0.3m	0.4m	0.8
c	0.7m	0.9m	0.9
d	1.0m	1.0m	1.0
e	1.5m	1.2m	0.9
f	1.5m	1.5m	1.0

Six virtual Chinese cabbage farms with different layouts which illustrated in Table 1 have been simulated as Figure 1 showed. By upscaling the mean value of each farm to 10m, the reflectance of red bands (645nm-6895nm) of 6 virtual Chinese cabbage farms ranges from 0.045186 to 0.124521, showing the potential availability of the comparison analysis between reflectance results and sentinel-2 imageries.

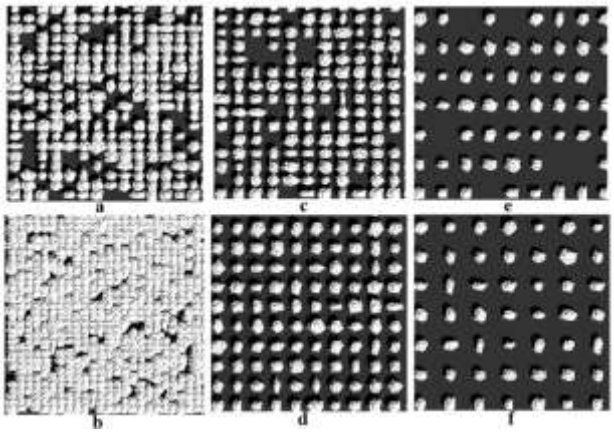

Figure 1. Simulated reflectance of six virtual Chinese cabbage farms

3. CONCLUSIONS

In this study. six voxel-based virtual Chinese Cabbage farms with lengths and widths of 10m of different cultivation ways were simulated the reflectance of the red band (645-685nm) ranging from 0.045186 to 0.124521. Such result showed the available accessibility of this methodology for the comparison analysis with global available Sentinel-2 imagery with corresponding reflectance of real Chinese cabbage farms.

REFERENCES

[1] D. Kim, H. S. Yun, S. J. Jeong et al. Modeling and Testing of Growth Status for Chinese Cabbage and White Radish with UAV-Based RGB Imagery. Remote. Sens., 10 (2018), 563.

[2] T. Fujiwara & W. Takeuchi. Simulation of Sentinel-2 Bottom of Atmosphere Reflectance Using Shadow Parameters on a Deciduous Forest in Thailand. ISPRS Int. J. Geo Inf., 9 (2020), 582.