Using Unmanned Aerial Vehicle to Obtain Digital Images and Estimating In-Situ Soil Water Content

Materials and methods - Soil analysis

Soil sampling method:

For this experiment, a setup of 25 m × 25 m sampling range was selected. It was divided in grids of 5 m × 5 m (25 grids in total).

The sampling location, that is a rice field is in Jhuweizih, Douliu City, Yunlin County, Taiwan (R.O.C.).

In 8 fold cross validation, the data is divided into 8 subsets. Now the holdout method is repeated 8 times, such that each time, one of the 8 subsets is used as the validation set and the other 7 subsets are put together to form a regression set.

For this experiment, the DJI phantom 4 pro drone was used for a duration of 8 days. The drone was flying 30 m above the sampling location and it was operating 4 times per day at 9 a.m., 11 a.m., 13 h, and 15 h, respectively.

When all 4 photoshooting operations were completed in a day, the produced images were modified in the Adobe Photoshop Lightroom 5 program in order to match with the analysis rate (25 m × 25 m).

Figure 1. The sampling location

Soil analysis:

A sampling ring (8cm diameter) was used for the soil sampling.

For this experiment, the ASTM D422-63, (2007) was used as a reference.

The sampling range was determined and divided in 25 grids. In every grid 500g of soil were sampled.

Materials and methods - Image analysis

Aerial Photoshooting:

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When all 4 photoshooting operations were completed in a day, the produced images were modified in the Adobe Photoshop Lightroom 5 program in order to match with the analysis rate (25 m × 25 m).

After modifying the images, they were imported in the Matlab so to be divided in 25 grids. Next, the mean and median of the GL were investigated.

Figure 2. Flow chart of this study

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Figure 3. GL-SWC estimation model

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Figure 5. GL-SWC estimation model

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Figure 6. The results of 8 fold cross validation in median GL value. (a) 9h, (b) 11h, (c) 13h and (d) 15h

Materials and methods - Image analysis

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Image process:

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Materials and methods - 8 fold cross validation

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Figure 4. The 8 fold cross validation.

Materials and methods - Regression

In this experiment, 8 GL-SWC estimation models were deduced using the inverse relationship between GL-squared and SWC. (Zhao et al. 2010).

\[ \theta = aGL^2 + b \]

where a, b: Regression coefficient

GL: Gray level, range 0-255

\( W \) is weight of water in soil column (w)

\( \theta \) is weight of dry soil in soil column

Materials and methods - Soil sampling analysis

Soil water content:

Soil sampling method:

For this experiment, the ASTM D422-63, (2007) was used as a reference.

Soil water content:

\[ \text{Soil water content (w/w)} = \frac{W}{W + \theta} \]

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