

Estimating the Hourly Solar NIR Irradiance for Sustainable Building Engineering

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Outline

- **Introduction**
- **Methodology**
 - **Data Collection**
 - **Data Processing**
- **Results and Discussion**
- **Conclusions**

Introduction

- Spectral solar radiation data → Solar architecture design
 - UV + VIS + NIR
- Measuring spectral solar radiation
 - Difficult
 - Expensive

Research Gap
Practical Need



Build an estimation model for NIR model

Using existing meteorological data file

Without the addition of new measurements

Methodology

- Data Collection
 - Selected from the SRRL BMS database of the NREL Solar Radiation Research Laboratory
 - Meteorological measurements (TMY3) and outdoor solar spectra data (WISER) were selected
 - Date: 1/1/2018 ~ 12/31/2019
 - Time: 7am ~ 8 pm
 - Variables: GHI, DNI, DHI, cloud coverage, dry-bulb temperature, dew-point, relative humidity, and wind speed etc., NIR

Methodology

- Data Processing

- Clearness index K_t

extraterrestrial
solar radiation

horizontal global
irradiance

$$K_t = \frac{GHI}{I_0 \cos(\zeta)}$$

solar zenith
angle

- Cloud transmittance T_{cld}

translucent sky
cover transmittance

$$T_{cld} = \frac{(1 - 0.1T_{opq})(1 - 0.1T_{tot} + 0.1T_{opq})}{1 - 0.05T_{tot}} = \frac{(1 - 0.1T_{opq})(1 - 0.1T_{trn})}{1 - 0.05T_{tot}}$$

opaque sky cover
transmittance

total sky cover
transmittance

- Predictor variables:
- Dependent variable – NIR/GHI

Results and Discussion

- CART results for the *NIR/GHI* fraction

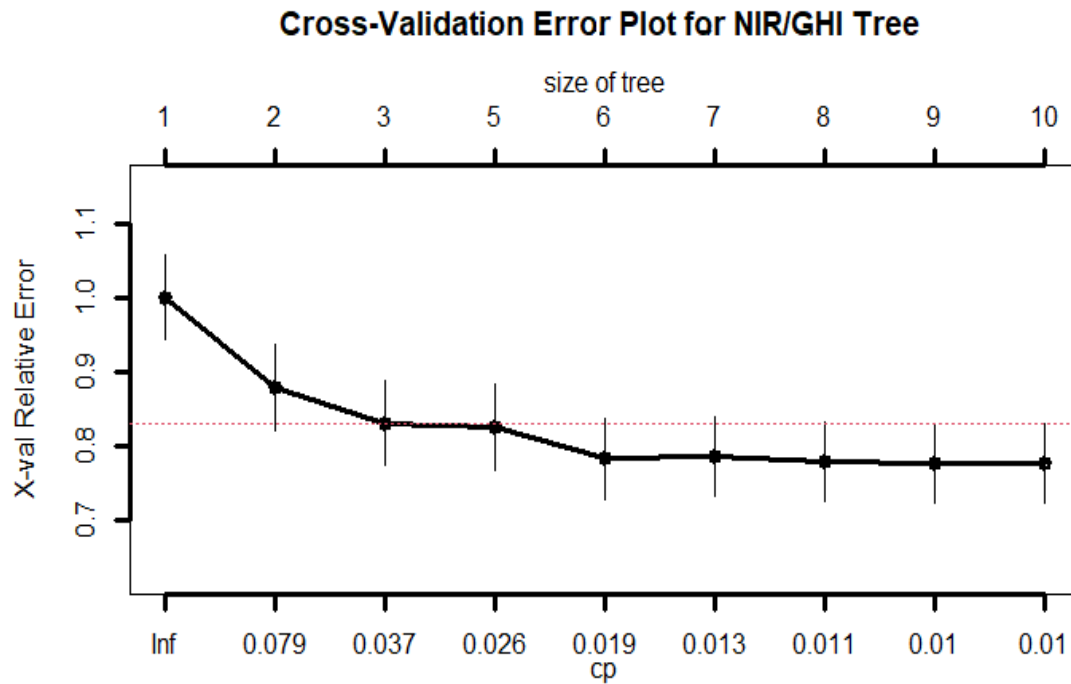


Figure 1. Cross-validation error plot for the *NIR/GHI* tree

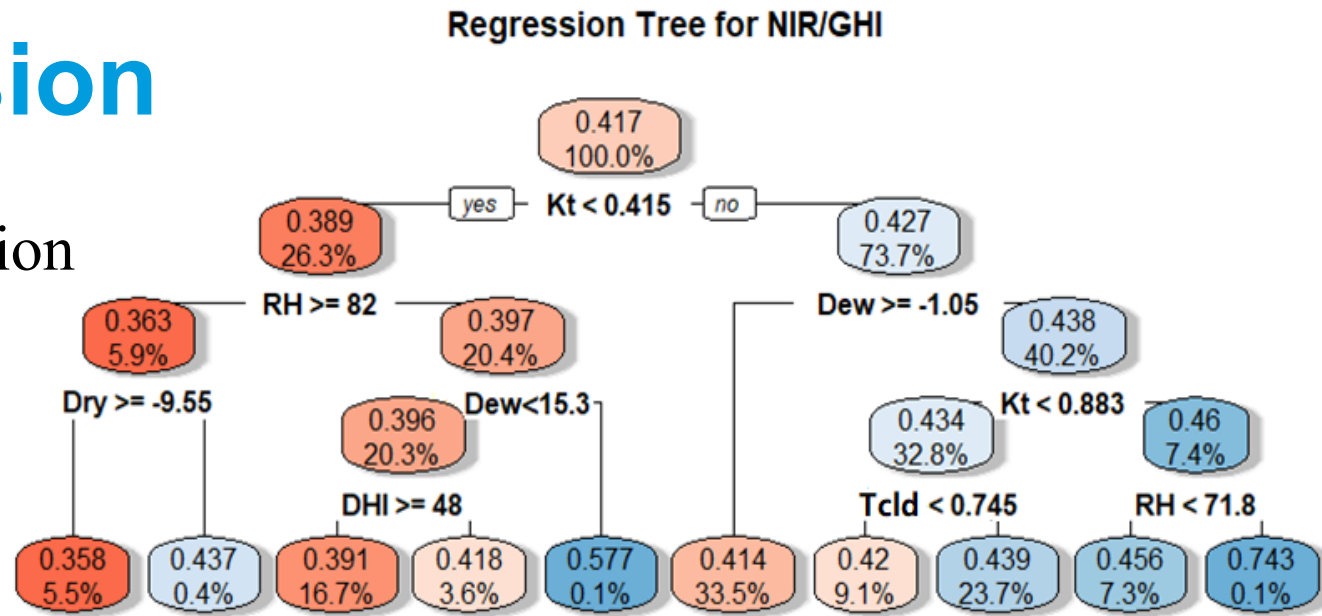


Figure 2. Regression tree model for *NIR/GHI*

Pruned Regression Tree for NIR/GHI

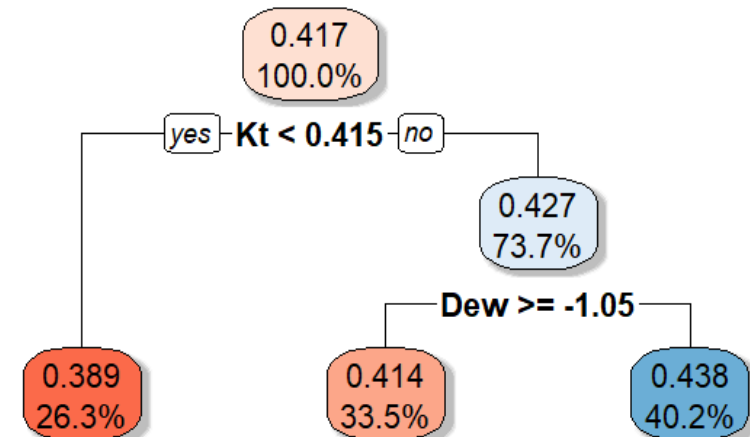


Figure 3. Pruned regression tree model for *NIR/GHI*

Results and Discussion

- Estimation performance evaluation

$$RMSE = \sqrt{\frac{1}{n} \sum_{j=1}^n (y_j - \hat{y}_j)^2}$$

$$MAE = \frac{1}{n} \sum_{j=1}^n |y_j - \hat{y}_j|$$

Table 1 Comparison of RMSE and MAE by Models

	NIR/GHI	
Regression Tree	Model 1	Model 2
Tree size	10	3
RMSE	0.0391	0.0388
MAE	0.0213	0.0216



Conclusions

- The proposed regression tree models for hourly *NIR/GHI* has excellent prediction performance.
- This research provides a statistical method to covert broadband solar irradiance data in weather files into NIR solar component for building energy and performance-related studies.

Next step

- The affects of other atmospheric parameters on NIR components.
- VIS component modelling based on conventional weather dataset.
- The other statistical modelling for VIS, NIR components.

Thank You !

Questions ?



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