Development of multi-linear regression model of meteorological data for temperature estimation of outdoor structures

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1. Introduction

The temperature of outdoor structures is one of the main factors affecting reliability. There are many error factors to utilize the measured temperature history at the nearby weather station. Distances too far away or in direct sunlight can cause big differences. In this study, we analyzed the correlation between the temperature data measured over a month on the roof of a building and the weather data of the nearby weather station. This identifies key parameters that affect the temperature of the target area and shows that a multiple linear regression model alone can achieve a correlation coefficient level. In addition, we assessed the degree of accuracy improvement by adding weather data from nearby weather stations.

2. Development of multi-linear regression model

The weather data of the nearby weather station that is most relevant to the temperature of outdoor structures is ground temperature. However, when comparing the temperature of a building with the ground temperature of nearby weather station, a maximum temperature difference of 28℃ occurs. Therefore, in order to develop a regression model that can predict the temperature of outdoor structures, we performed the regression analysis between the ground temperature and temperature of outdoor structures. As a result of the regression analysis, the R^2 value was 91% and the maximum temperature difference is 22℃. The residual graph for the regression model is shown in Fig. 1.

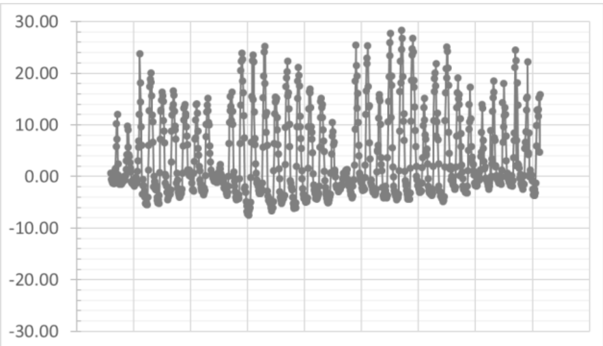
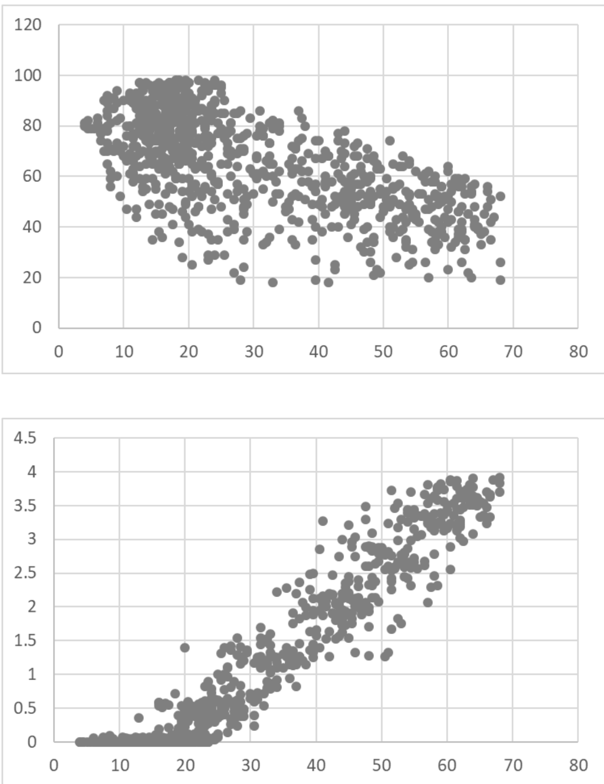


Fig.1 Residual plot of regression analysis between measured temperature data of building and ground temperature of weather station

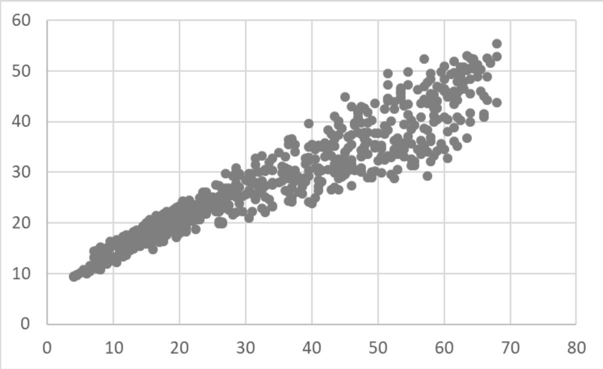
To increase the accuracy, we analyzed the correlation between the temperature of the building and the weather data of nearby weather station. From the correlation analysis, we found that humidity, insolation and ground temperature were highly correlated variables. Fig. 2 shows the scatter plots of the weather data that is high correlation with the measured temperature.

Regression analysis with these variables, humidity, insolation and ground temperature, resulted in an R^2 value of up to 96%. When the temperature calculated by the regression equation was compared with the actual temperature, the maximum temperature difference was 16℃. The residual analysis results of the corresponding regression model are illustrated in the graph in Fig. 3.

(a)



(b)



(c)

Fig.2 Scatter plot of correlation analysis between measured temperature data of building and highly correlated variables of weather station (a. Humidity b. Insolation c. Ground temperature)

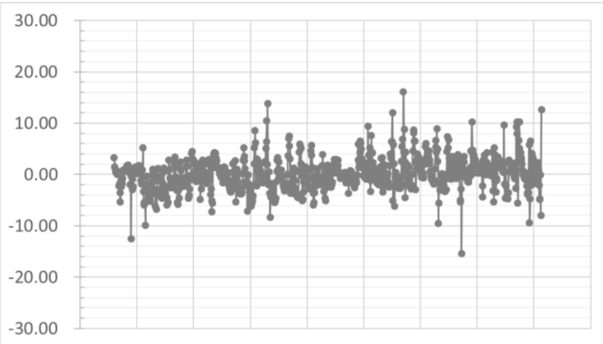


Fig.3 Residual plot of regression analysis between measured temperature data of building and highly correlated variables of weather station

3. Conclusion

We developed a linear regression model to predict the temperature of outdoor structures through correlation analysis and multi-linear regression analysis of the weather data of the nearby weather station and the actual temperatures measured on outdoor structures. A result of regression analysis between the ground temperature and measured temperatures reveals an R^2 value of 90%. To increase the accuracy, the addition of highly correlated weather data increases the accuracy of the multi-linear regression model from 90% to 96%.

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