

AGING DISCOLORATION SIMULATION OF EXPOSED WOOD SURFACE COLORS

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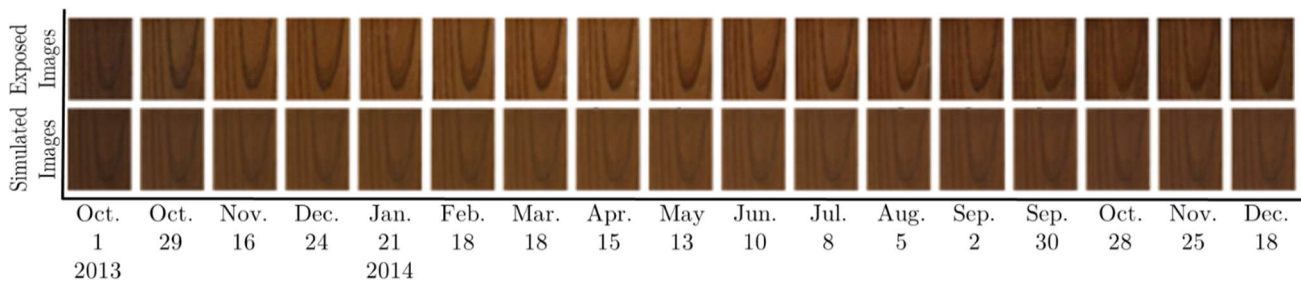


Figure 1. Comparison between measured and simulated images of aging discoloration of exposed wood surface colors

ABSTRACT

It is hard that building owners predict aging discoloration of wood surface colors before attempting to order a building using wood as exterior fences. Thus, a method to share predicted colors of wood aging discoloration among building owners and constructors is required. We derive a prediction equation for aging discoloration of wood surface colors by collecting colors of exposed woods scanned at fixed intervals and regression analyzing these images. And we propose a simulation method to generate aging discolored wood image by the prediction equation.

1. INTRODUCTION

Wood is a strong and light building material for exterior fences. Its thermal insulation effectiveness is high, and its environmental load is small. Recently, buildings whose exterior fence materials are wood have been increasing. Materials and colors of the exterior fences are important to determine the impression of the buildings. However, due to aging, the colors of the wood have changed greatly. It is difficult to predict the color changes of the wood since they are caused by various meteorological factors such as sunlight, rain, wind and so on. In this paper, we propose an aging simulation method of wood surface colors based on regression analysis on measured exposure data considering various meteorological factors.

2. PREVIOUS WORK

[1], [2], and [3] measured color values of exposed wood

pieces, then interpolated them to simulate the aging of wood surface colors. Since elapsed exposure time is only a parameter in these methods, surface colors of the wood pieces are uniformly changed. However, in actual buildings, parts of the wood surface are irradiated by the sun and other parts are occluded by eaves. Thus, the conventional aging simulation results differ from real wood pieces.

3. PROPOSED METHOD

3.1. Overview of Proposed Method

We derive a prediction equation on the color changes of wood surfaces based on regression analysis, where exposure test data are as objective variables, and various meteorological factors are as explanatory variables.

Then, we pre-compute ambient occlusion values (Figure 4) of a 3D model (Figure 3). By varying the values of meteorological factors referring to the pre-computed ambient occlusion values, it is possible to simulate color changes of the occluded portions of the wood piece by eaves or irradiated portions by the sun.

3.2. Exposure Test of Wood Pieces

Exposure test has been continuing for over 430 days since October 1st, 2013 in Tsukuba. Exposed wood pieces are thermally modified wood pieces of *cryptomeria japonica* (Japanese cedar) without painting. CIELAB L^* , a^* , b^* values of surface colors of wood pieces have been measured by CR200 color meter (KONICA MINOLTA). Exposed wood pieces have been scanned and saved as

images.

3.3. Prediction Equation of Wood Color Changes

Based on regression analysis of the exposure test data, we derive a prediction equation of wood color changes.

$$\begin{cases} L^* = At + Br + Cs + D \\ a^* = Et + Fr + Gs + H \\ b^* = It + Jr + Ks + M \end{cases} \quad (1)$$

Here, L^* , a^* , b^* are the predicted colors of the wood piece. t , r , and s are the cumulative daily mean temperature, rainfall, solar radiation, respectively. t , r , and s are explanation variables. $A \sim K$, and M are coefficients determined by regression analysis.

4. RESULTS

Upper images in Figure 1 are scanned timber images (exposure test wood pieces), and lower are simulation results. We used the meteorological data of the exposure test site. As shown in Figure 1, our simulation results are quite similar to the scanned images.

Figure 2 shows our exposure test stand frame in

Tsukuba.

Figure 3 is a 3D model used in our simulation. Figure 4 is its pre-computed ambient occlusion map. This map is used to estimate the amount of both solar radiation occluded by eaves and of raindrops bounced from the ground as shown by white color map in Figure 5. Simulation results shown in Figure 6 verify that our method can simulate aging color changes of real wood.

REFERENCES

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- [2] S. Kimura, et al., ACM SIGGRAPH Asia: "Modeling techniques of wooden buildings for cyberscapes of Edo," Technical Sketches, Article No. 35 (2009)
- [3] T. Schnabel, and A. Petutschnigg, "Modelling colour changes of wood for architectural CAD simulations," Computer-Aided Design, Vol. 43, Issue 12, pp. 1849-1853 (2011)



Figure 2. Exposure test stand frame

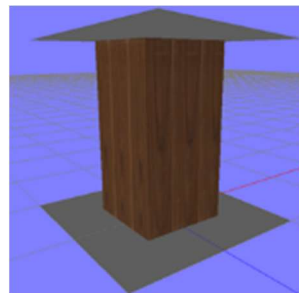


Figure 3. 3D model

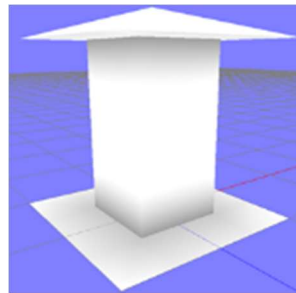


Figure 4. Ambient occlusion

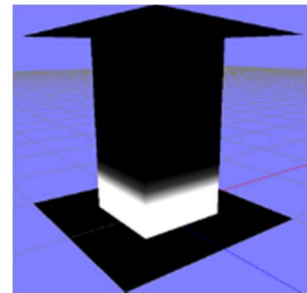
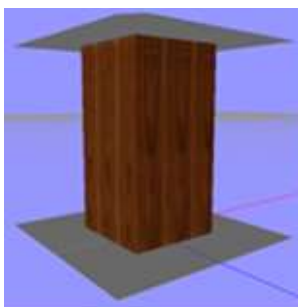
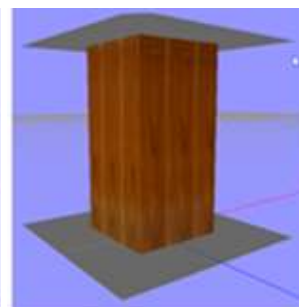


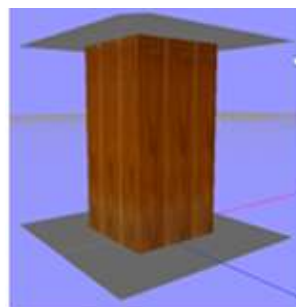
Figure 5. Raindrop rebounding



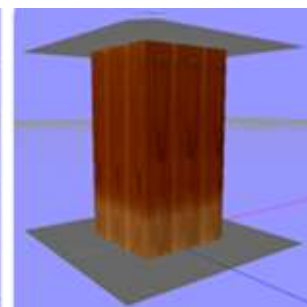
(a) 1st day



(b) 110th day



(c) 220th day



(d) 430th day

Figure 6. Aging simulation results by using a simple 3D model