Rust Aging Simulation Considering Object Geometries

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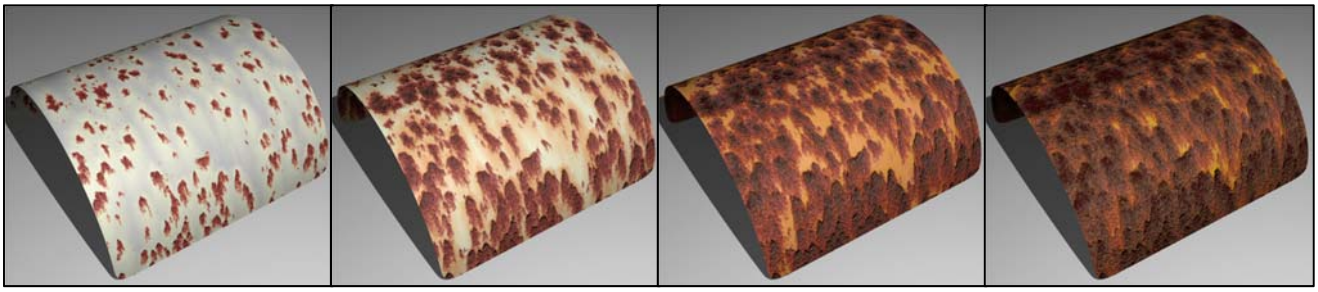

Figure 2: *Generated rusty appearance by using our method.*

1 Introduction

Realistic representation of nature scenes is one of the most challenging areas in computer graphics community. There are important factors to synthesize realistic scenes in 3D CG which are aged materials such as dead trees, weathered statues, rusty metals and so on. We are interested in the methodology for simulating its decaying processes. In this paper, we propose a simple method for rust aging simulation based on a probabilistic cellular automaton model taking into account object's geometries.

2 Proposed Method

Rust aging is a progressive phenomenon that rust iteratively grows and propagates while causing new rust. We have modeled growth and propagation of rust as a probabilistic cellular automaton model [Tanabe et al. 2015]. In this paper, we extend our previous method, in which simulated rust can grow and propagate toward arbitrary direction. This mechanism enables to control rust growth considering surface orientation as well as the gravity direction. In this section, we describe details of our method.

2.1 Probabilistic Cellular Automaton

We consider two types of rusts: *main-rust* and *sub-rust*. Main-rust means a part of a material surface that is grossly corroded. Sub-rust is its adjacent areas that are eroded by exfoliation, water exuded from a main-rust, and mixture of them. Actually, a stain spot spreads from a rusty spot. These rusty spots and stain spots are corresponding to main-rust and sub-rust, respectively.

We modeled this structure as a probabilistic cellular automaton. In our model, each cell has four attributes: χ, ψ, ρ, and $\boldsymbol{d}$. χ and ψ is a main/sub-rust growth levels that indicate how the cells are corroded by main/sub-rust. χ and ψ are set to 0 initially and are incremented at some simulation conditions are matched. ρ is a corrosion probability that indicates corrosiveness, and it is in the range [0,1]. A cell with greater ρ tends to cause main-rust. $\boldsymbol{d}$ is a 2D vector that indicates growth direction of rust. Main and sub-rust propagate toward this direction $\boldsymbol{d}$.

1. Iterate following steps for all cells a certain number of times.
   - The current cell is described as `C`.
2. Increment χ of `C` with probability ρ.
3. If χ of `C` is greater than 1:
   3.1 Choose a cell `C'` from `C`'s neighbouring cells.
   3.2 Increment χ of `C'`.
   3.3 Increment χ of cells in an area spread from `C'` along $\boldsymbol{d}$.
4. If χ or ψ of `C` is greater than 1:
   4.1 Choose a cell `C"` from `C`'s neighbouring cells.
   4.2 Increment ψ of cells in an area spread from `C"` along $\boldsymbol{d}$.

List 1 : *The outline of our simulation algorithm.*

2.2 Simulation Algorithm

We used 512x512 cells for our simulation. Once cells are set up, the update process is applied iteratively to all cells. The outline of this process is described in List 1. There are applicable ways to select a cell randomly from its neighbouring cells at steps 3.1 and 4.1. Here, the neighbouring cells are cells in a circle with a certain radius. There are also applicable areas spreading from `C'`/ `C"` in steps 3.3 and 4.2 along the direction $\boldsymbol{d}$. Here, the spreading area is an oblique ellipsoid as illustrated in Figure 1.

2.3 Visualization

After repeating the update process a predetermined number of times, χ and ψ of each cells have natural gradients. It is possible to get a texture image by visualizing these gradients of χ and ψ by appropriate color scales.

4 Results

Figure 2 shows rust aging generation results by our method. In this experimental generation, $\boldsymbol{d}$ of each cell is determined by referring a gradient of a face corresponding to a cell in targeted 3D model. Different appearances of rust propagation can be observed on top and side faces of this half cylinder as shown in Figure 2.

References

TANABE, R., MORIYA, T., MORIMOTO, Y., AND TAKAHASHI, T. 2015. A Generation Method of Rust Aging Texture Considering Rust Spreading. Proc. In *Proc. 2015 Joint Conference of IWAIT and IFMIA*, https://db.tt/0lqfUR2P

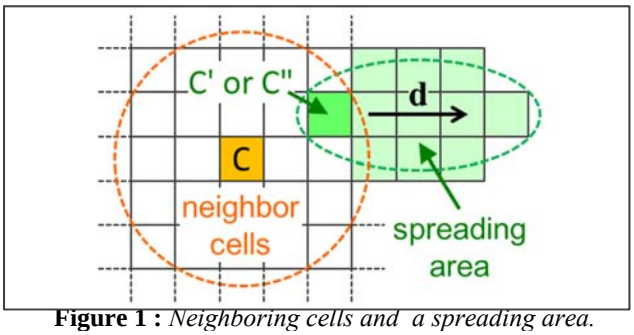

Figure 1 : *Neighboring cells and a spreading area.*