Rusting and Corroding Simulation Taking into Account Chemical Reaction Processes

Tomokazu Ishikawa *
Tokyo University of Science / UEI Research

Kousaku Kamata
Tokyo University of Technology

Yuriko Takeshima
Tokyo University of Technology

Masanori Kakimoto
Tokyo University of Technology / UEI Research

Abstract

In recent years, expressions close to realities have become possible thanks to the technologically advanced computer graphics. Secular change and weathering are important factors to create realistic computer graphics images. Metal rust is an important secular change and there are much research work on rust [Kanazawa et al. 2015]. Although the rust forming processes vary according to coating rainwater and seawater, dissolved oxygen contents of them and flowing water effects, no rust forming methods which have examined the object geometry of models and chemical reaction processes exist as far as we know. Our proposed method calculates water flowing on 3D models to reproduce the process of corrosion which advances from the surface region coated with water. Our corrosion simulation model takes into account the quantity of coating water and the chemical reaction processes. As a result, we confirm that the images close to the rust formed in reality can be obtained.

Keywords: Aged deterioration, Rust, Chemical reaction processes

Concepts: •**Computing methodologies** → **Procedural animation;**

Our Method and Result

The flow of our proposed method is shown in Fig. 1. The input information of the proposed system is a 3D model and its UV development diagram. We place the 3D model in the simulation space and the system simulates a particle flow based on [Dorsey et al. 1996]. The hit positions of the particles on the 3D model surface are transformed and recorded as corresponding points on the UV development diagram. After that, we perform a rust simulation on the surface of the 3D model (on the UV development diagram) based on the recorded positions of the water adherence. Taking account of chemical reaction in this rust simulation, we calculate the amount of rust and the surface roughness caused by the corrosion of metal, and then output each of them as a texture. By applying these textures to the 3D model, we can express the generation and the progress of rust.

Fig. 2 demonstrates a simulation process of rust production due to water falling into a bowl model (Fig. 2 (a)). Fig. 2 (c) shows a simulation result of simulation after further adding in water onto the already rusted bowl model as in Fig. 2 (b). The rust is generated at the surface places where water drops adhere and crawl down. In addition, our system also reproduces the phenomenon that the rate of corrosion is faster at the places where more water accumulates.

Fig. 3 shows the comparisons between photographs and simulation results for the transportation and sedimentation of rust due to water flow. It indicates that the amount of sediment is smaller at places with strong water flow since the rust is washed away, and the corrosion progresses at places with weaker water flow on the contrary.

*e-mail: ishikawatm@rs.tus.ac.jp

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By the proposed method, we could create the expressions of corrosion on the 3-dimentional surfaces through coating the model with water and forming rust. Also, we could reproduce the rust closer to realities because our system is based on chemical reaction processes. This research has targeted at simulating only red rust on an iron surface. As a future work, we think that it can handle various metals such as green rust formed in copper and white rust formed in aluminum if we change the chemical reaction process.

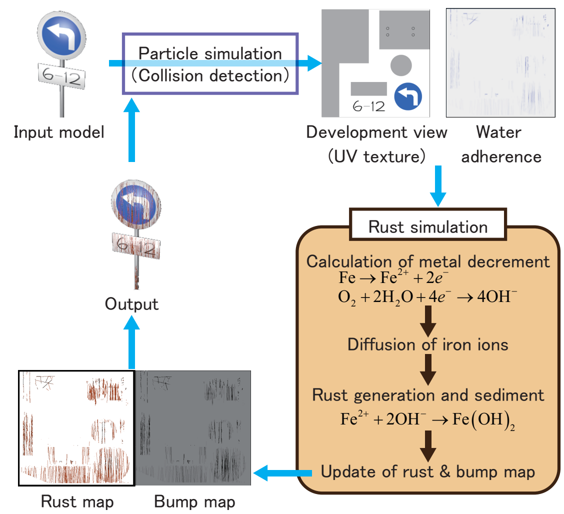
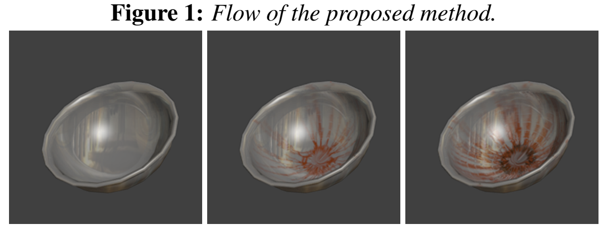
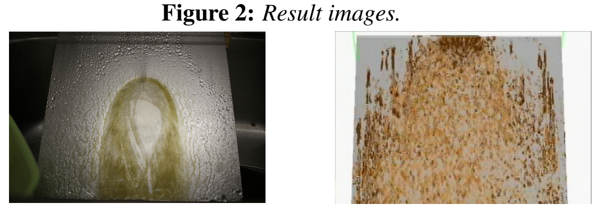


Figure 1: *Flow of the proposed method.*



(a) Original model (b) 200 timesteps (c) 600 timesteps

Figure 2: *Result images.*



(a) Photograph (75 min.) (b) Simulation (7500 timesteps)

Figure 3: *Simulation result of rust generation by water flow.*

References

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