Realistic Rendering of Material Aging for Artwork Objects

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1. Objectives

1. Modeling the effect of aging is a computationally intensive task.
2. Specialized tools are needed to expedite the simulation process.
3. Production of artificial aging models due to small deformations in the surface.
4. Creation a plausible realistic model intended for computer graphics applications.

2. Introduction

Material aging has a significant effect on the realistic rendering of artwork objects. Small deformations of the surface structure, color or texture variations contribute to the realistic look of artwork objects. These aging effects depend on material composition, object usage, weathering conditions, and a large number of other physical, biological, and chemical parameters. We present a method for:

1. Deriving a model for **simulating aging**,
2. Based on **micro-profilometry** measurements taken on material sample plates.

Relating results from accelerated aging to those obtained in **actual-use conditions** is difficult because laboratory tests do not reproduce all the exposure stresses experienced by materials exposed in **actual-environment** conditions. Although artificial aging have been used as a research tool in the past decades, there are still several open problems regarding the **reliability** and **accuracy** of the results.
Figure 1 illustrates the initial artwork object used for the experiments.

Figure 1: Original object.

3. Method for Predicting Dents & Bumps

Modeling the **frequency** of dents/bumps :

1. Detect large deviations from the **mean** value (distance from the metal plate plane).
2. Dents and bumps are formed around a vertex with large deviation and manifest themselves by **translating** the neighboring vertices.
3. Follow an **RBF** function to attenuate the displacement in the neighborhood.

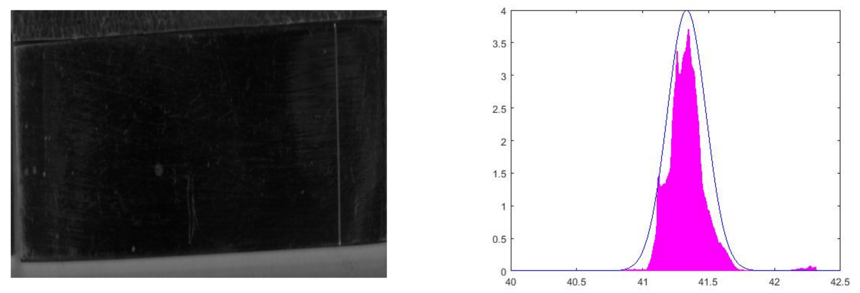

Figure 2: Micro-profilometry sample silver plate.

Figure 2 illustrates an example of statistically analyzing the microprofilometry measurements from a silver sample plate by deriving a **fitted distribution** function drawn upon six different sets of measurements for various time instances of the artificial aging process.

Figure 3: Simulated local deformations.

A completed **artificial aging step** consists of :

1. Statistically analyze the micro-profilometry measurements from each sample plate that has undergone emulated (artificial) aging.
2. Determine the set of values that maximize the likelihood function.
3. Derive the MLE distribution for each pair of (type of material, artificial aging time).
4. Compute the parameters of the Gaussian pdf that best fits each set of measurements.
5. Predict the occurrence of local deformations (dents/bumps) during a prediction process.

4. Method for Predicting Cracks

Modeling the **frequency** of cracks :

1. When extreme deviations from the mean value (distance from the metal plate plane) are obtained.
2. Are more likely to occur when bumps or dents are present.
3. Where geometry of the crack depends on the geometry of the existing object and the local deformations that have occurred in previous aging steps.

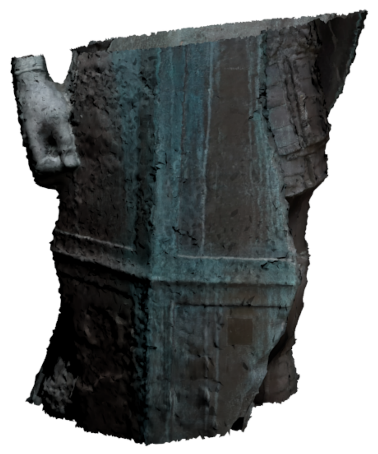

Figure 4: Simulate local deformations and cracks.

Algorithm 1 Compute Cracks

```
procedure COMPUTE-CRACKS
    MPdist ← compute MP data fit distribution
    CT ← compute crack theshold
    myMesh ← import your mesh
    for each vertex v_i of myMesh do
        rand ← random number according to MP-dist
        if rand ≥ CT then
            Choose a random direction d_c
            Compute crack length l_c
            Starting form v_i determine a path p_i
            from v_i of length l_c towards d_c
            Along p_i create a wedge
    end for
```

5. Conclusion

We have reported on the design and development of a method for **predicting** and **rendering** the aging effect on artwork objects based on micro-profilometry measurements taken on material samples during an **artificial aging process**.

6. Future Research

1. Using a **segmentation** method to evaluate aging results.
2. Employ **Gaussian Mixture Model** to derive better results from some sample plates.
3. Validate different **minimization** methods to find the best fit for the data.
4. Try to **correlate** our simulation result with a actual result from an aged artwork object.

7. References

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