O, What an Iridescent Web We Weave: Rendering Physically Inspired Spider Webs for Visual Effects

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Figure 1: Two spider webs, rendered using our proposed method under slightly different lighting conditions.

ABSTRACT

The presence of realistic spider webs can be used to establish plausible, visually appealing environments, providing a sense of immersion and authenticity to computer generated worlds. When lit, cobwebs transform into displays of iridescent colors and patterns, resulting from the interaction between the light and the structure of the silk fibers.

We propose a straightforward, physically inspired method for rendering cobwebs using common VFX production software, replicating the iridescent visual appearance of spider webs for added realism in virtual environments.

CCS CONCEPTS

• **Computing methodologies → Rendering**; **Reflectance modeling**.

KEYWORDS

Appearance Modeling, Natural Phenomena

ACM Reference Format:
Vaya Simeonova and Eike F. Anderson. 2024. O, What an Iridescent Web We Weave: Rendering Physically Inspired Spider Webs for Visual Effects. In *Special Interest Group on Computer Graphics and Interactive Techniques Conference Posters (SIGGRAPH Posters '24), July 27 - August 01, 2024.* ACM, New York, NY, USA, 2 pages. https://doi.org/10.1145/3641234.3671069

SIGGRAPH Posters '24, July 27 - August 01, 2024, Denver, CO, USA

ACM ISBN 979-8-4007-0516-8/24/07
https://doi.org/10.1145/3641234.3671069

1 INTRODUCTION & RELATED WORK

For computer generated imagery to be perceived as real, computer generated scenes must not be sterile but need to include the types of imperfections found in the real world, such as aged or weathered materials, dirt [Reinhard et al. 2013] and similar small details, which make the depicted virtual world appear to be 'alive'. Viewers have been found to actively look for such real-world elements that can add plausibility to CG images [Beneš et al. 2017]. One of these real-world elements are cobwebs, the absence of which might go unnoticed, but the presence of which adds layers of intricacy, natural presence, and depth to virtual worlds.

It is therefore surprising, that there is only limited literature on the topic of rendering realistic spider webs, such as the work by Xia et al. [Xia et al. 2020], who instead of a ray-based method employed a wave optics based fiber scattering model to render a spider web with realistic iridescence.

When light hits a spider web, intricate patterns of light, shadow and iridescence can be observed as the light passes through the spider webs' threads and, through refraction, diffraction and thin film effects [Greenler and Hable 1989], interacts with the physical structure of the silk fibers. Replicating these effects, which are similar to the interaction of light with soap bubbles [Zawischa 2022], is essential for creating plausible spider webs in computer graphics.

Attempting to address the lack of existing methods, our approach for rendering spider webs (Fig. 1) exploits this similarity to the visual appearance of soap bubbles by employing a soap bubble shader [Glassner 2000] as its starting point.

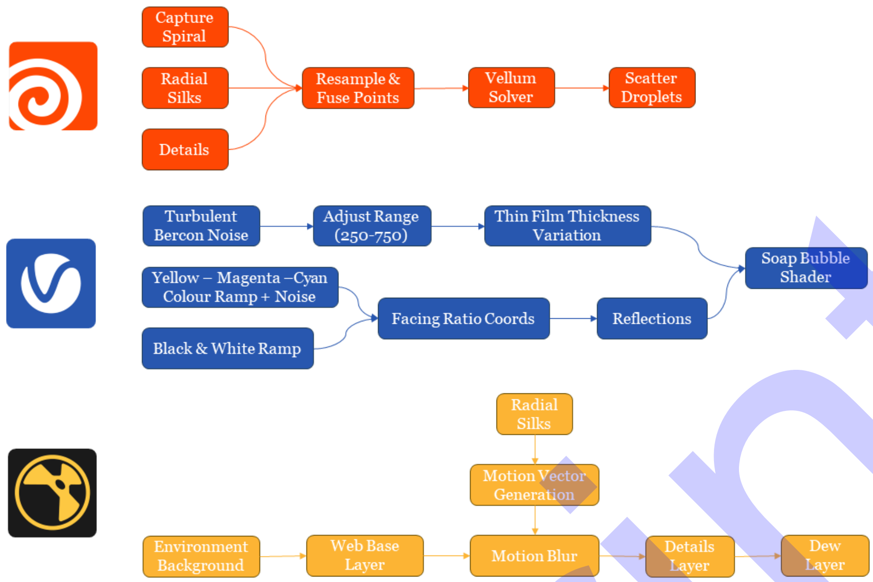

Figure 2: Our three-stage VFX production software pipeline for creating plausible spider webs: Houdini (https://www.sidefx.com/products/houdini/) for cobweb modeling & simulation, V-Ray for Maya (https://www.chaos.com/vray/maya) for material definition & rendering and the Nuke (https://www.foundry.com/products/nuke-family/nuke) for post-processing.

2 RENDERING PLAUSIBLE SPIDER WEBS

Our proposed method consists of a three-stage pipeline (Fig. 2), namely modeling and simulation, then by shading (material definition) and rendering, which is then followed by a post-processing stage:

(1) The cobweb is modeled in Houdini and converted to Houdini's 'Vellum hair simulation', which provides users with control of the simulated spider web threads' weight, stiffness, and self-collision. We assign different properties to the two different types for spider silk threads (radial threads for maintaining the web's shape and spiral prey-capture silks [Craig et al. 1994]), providing radial threads with higher stiffness values (reducing bending and deformation) than to the spiral capture threads, which require greater flexibility. We then randomly distribute small spheres, provided with a displacement noise-map, across the webs' threads to simulate both the presence of dewdrops, as well as the sticky droplets that naturally form on spider silk threads [Greenler and Hable 1989].

(2) The base material for the spider silk threads is a translucent material (IOR of 1.00), converted to a thin film soap-bubble, using noise maps being to vary the layer's thickness of the layer, with the webs' radial silk threads being coated with a slightly thicker layer. To accurately replicate the iridescent colors of real spider webs [Kane et al. 2011; Schlichting 2004], an additional shiny coat layer with a color ramp (a cycle of 7% cyan, 3% green, 15% orange, 50% magenta – the dominant color – and then reversing the sequence to 15% orange, 3% green and finally 7% cyan) is added to the material.

(3) Finally, we post-process our rendered spider webs in Nuke to replicate the effect of environmental forces, such as wind, which real cobwebs are subjected to, causing their threads to vibrate and making them appear blurred. To achieve this, we extract motion vectors from the cobweb's radial silk threads and apply motion blur.

The result of our proposed method are cobwebs that replicate the appearance of real world spider webs (Fig. 1). Due to its simplicity, integrating this approach into visual effects production pipelines should be fairly easy and straightforward.

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