ARTISTIC AUGMENTATION OF PHOTOGRAPHS WITH DROPLETS

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BACKGROUND




In nature photography, water droplets resting on objects such as flowers and leaves or hanging from objects such as tree branches make photos look vivid, and alive.




However, capture such sparkling and shimmer droplets is not easy in an outdoor environment, because such visual effects depend heavily on the weather. In this paper we propose a framework for inserting rendering droplets into a photograph seamlessly.

Zhang MH, Yu JH, Zhang K et al. Artistic augmentation of photographs with droplets. JOURNAL OF COMPUTER SCIENCE AND TECHNOLOGY 34(6): 1294–1306 Nov. 2019. DOI 10.1007/s11390-019-1976-y

ILLUMINATION ESTIMATION

Illumination function:

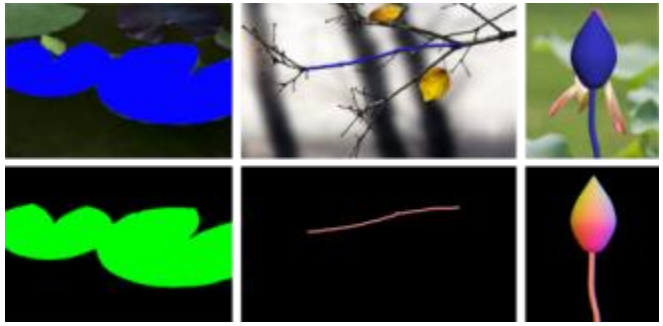
$$I_p = [\rho_p(\boldsymbol{n}_p \cdot \boldsymbol{l}) + k_p(\boldsymbol{n}_p \cdot \boldsymbol{h}_p)^{\alpha}]\ E^{sun} s_p{}^{sun} + \rho_p\ s_p{}^{env} E_p{}^{env}$$

$$s_p{}^{env} \in [0,\ 1],\ s_p{}^{sun} \in [0,\ 1]$$

Geometry estimation:

Camera Calibrated : [Geoffroy17]

Sunlight Direction: [Lalonde12]



We can estimate the 3d structures and normal maps using simple models, and we could acquire camera intrinsic and sunlight direction by existing works.

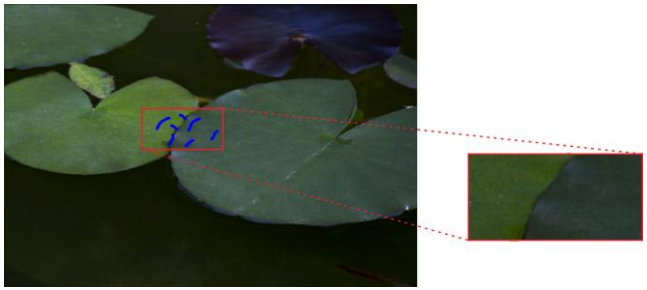
Parameters Initialization:

$$E_p{}^{env} = L^{env} \int (n_p \cdot e_w)\, dw$$

$$I_p = \rho_p(\boldsymbol{n}_p \cdot \boldsymbol{l})\ E^{sun} + \rho_p\ C_p{}^{env} L^{env}$$

$$E^{sun}(R) > E^{sun}(G) > E^{sun}(B)$$

$$L^{sun}(R) < L^{sun}(G) < L^{sun}(B)$$



Parameters Estimation:

$$arg\ min \sum_{p \in \Theta} |I_p - I_p{}^*|^2 + \gamma_1 w_p |\nabla \rho_p|^2 + \gamma_2 |\rho_p + \rho_p{}^0|^2 + \gamma_3 |\nabla k_p|^2 \quad \gamma_1 = 5.0\ \gamma_2 = 3.0\ \gamma_3 = 5.0$$

$$arg\ min \sum [\rho_p(\boldsymbol{n}_p \cdot \boldsymbol{l}) + k_p(\boldsymbol{n}_p \cdot \boldsymbol{h}_p)^{\alpha}]\ E^{sun} s_p{}^{sun} + \rho_p\ C_p{}^{env} L^{env} - I_p$$

Obtain: $E^{sun}, L^{env}, \rho_p, k_p$

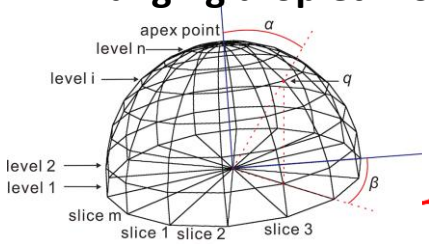
ENVIARONMENT LIGHT ADJUSTMENT & DROPLET MODELING

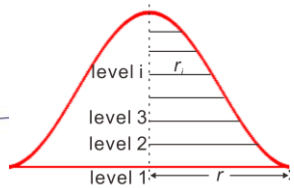
Environment light adjustment:

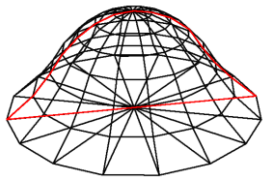
$$arg\ min \sum |\mu E'^{env} - C_p L^{env}|^2$$

We select a new image to construct the environment map and adjust the brightness and colors with the radiance of the environment light. The images are comparison of rendering droplets with and without adjustments of the environment map.

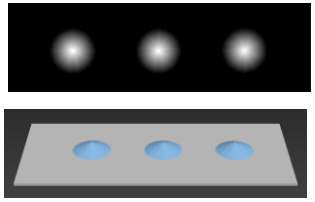
Hanging droplet modeling:

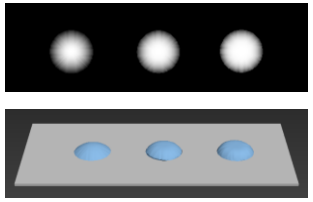


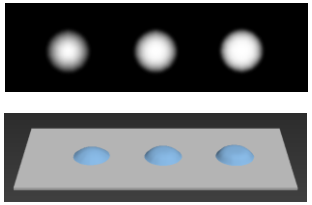


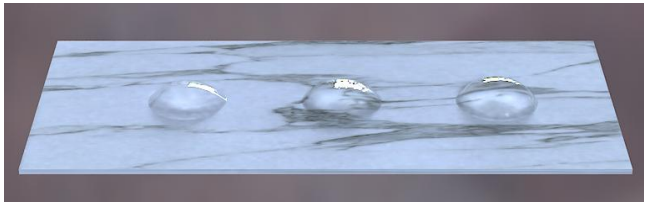


Resting droplet modeling:





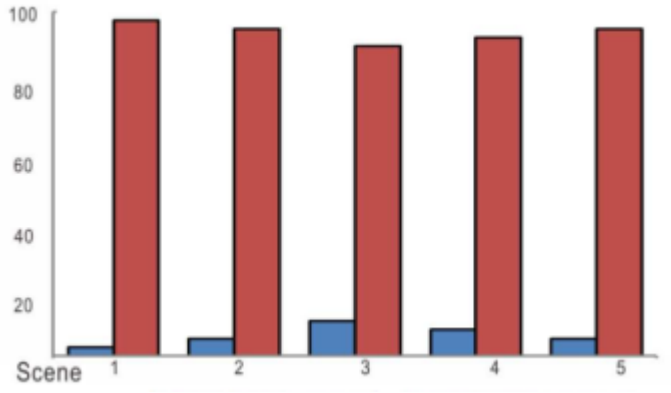




We adopt geometry constraint to model the hanging droplet and image based method to model the resting droplet.

RESULT AND CONCLUSION

This paper has presented a novel approach to artistic augmentation of photographic images with droplets. The new environment map allows users to add additional visual information on the virtual droplet surfaces to achieve aesthetic results. Furthermore, the use of hand-drawn templates in our approach allows users to extend the design space to include various artistic aspects in the resultant augmentation.



We adopt different environment maps to the same image, and the surroundings are reflect or refract on the surface of droplets. The result of the user study shows that the majority of the users think images with droplets are more appealing and artistic than original ones.