Physics-Based Simulation of Analog Color Photography

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1 Motivation

The analog photography aesthetic has seen a strong resurgence in contemporary visual art, with many artists seeking to reproduce the distinctive look of film. In particular, disposable cameras have resurged in popularity for their unique aesthetic. However, shooting on physical films can be expensive and challenging for non-experts. Many people turn to adding noise and adjusting saturation in post-processing to mimic the analog look, but these methods are often too simplistic and fail to capture the complex physical processes that give film photography its distinctive character.

In this project I would like to create a simple physics-based simulation pipeline for simulating the analog color photography aesthetic from an input image.

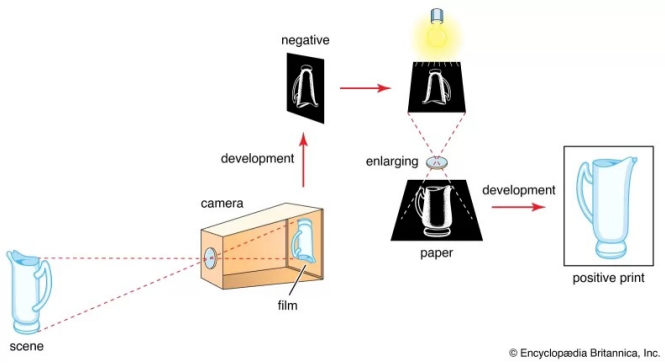

Fig. 1. A figure of an analog camera process. Reference: https://radlabstudio.com/what-is-analogue-photography/

2 Related Works

Camera simulation has a long history in computer graphics. [1] introduced a physically-based camera to accurately capture the irradiance on the film in the scene. [2] describes the general pipeline for a digital camera.

Film grain is an artifact of the silver-halide photographic process. [3] approximates the simulation of film grain by approximating the physical process via a stochastic model to achieve resolution independent rendering of realistic film grain.

[4] models the analog pipeline by simulating the negative and print stages. They model film grain by modeling the chemical reponses of the film and incorporating couplers (chemicals that are produced in the development along side the actual CMY dyes). They also incorporate halation by adding different amounts of blur to each color channel to emulate the film process.

Partly what inspired this project is a paper in music – [5] achives real-time audio effect of analog tape machines by modeling tape magnetisation using hysteresis loops and considers the effect of play heads in the simulated sound.

3 Milestones

I will begin by doing more literature review/gaining basic knowledge on film photography and the printing process. I will also begin to implement the film negative and print simulation with producing benchmarks as in [4]. Film grain simulation will also be implemented. I will then create datasets for some representative films stocks like Kotak and Fujifilm films. Then I will make some examples and write the report and poster.

References

[1] C. Kolb, D. Mitchell, and P. Hanrahan, "A realistic camera model for computer graphics," in *Proceedings of the 22nd annual conference on Computer graphics and interactive techniques*, 1995, pp. 317–324.

[2] J. E. Farrell, P. B. Catrysse, and B. A. Wandell, "Digital camera simulation," *Appl. Opt.*, vol. 51, no. 4, pp. A80–A90, Feb 2012. [Online]. Available: https://opg.optica.org/ao/abstract.cfm?URI=ao-51-4-A80

[3] A. Newson, N. Faraj, B. Galerne, and J. Delon, "Realistic film grain rendering," *Image Processing On Line*, vol. 7, pp. 165–183, 2017.

[4] A. Volpato, "Agx emulsion," https://discuss.pixls.us/t/spectral-film-simulations-from-scratch/48209, 2026.

[5] J. Chowdhury, "Real-time physical modelling for analog tape machines," in *Proc. Int. Conf. Digital Audio Effects (DAFX)*, 2019, p. 7.