

# Reflection Removal via Realistic Training Data Generation

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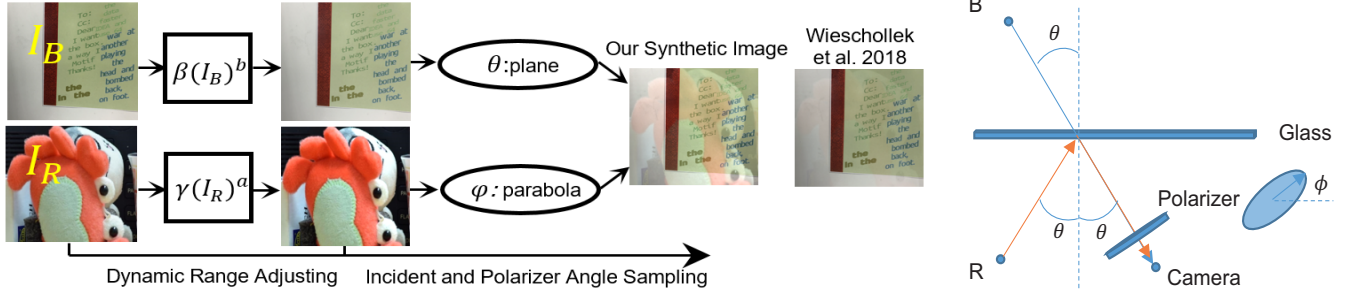


Figure 1: Left: training data synthesis pipeline. (Image courtesy Dennis Sng (Rose Lab)) Right: polarization model.

## ABSTRACT

We present a valid polarization-based reflection contaminated image synthesis method, which can provide adequate, diverse and authentic training dataset. Meanwhile, we enhance the neural network by introducing the reflection information as guidance and utilizing adaptive convolution kernel size to fuse multi-scale information. We demonstrate that the proposed approach achieves convincing improvements over state of the arts.

## KEYWORDS

Reflection removal, Polarization, Network enhancement

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## 1 INTRODUCTION

Recent data-driven reflection removal neural networks [Fan et al. 2017; Wei et al. 2019; Wieschollek et al. 2018] achieve promising results for removing distractive reflection from single image captured behind glass, but their performances show great inconsistency when dealing with real-world scenarios. The challenges stem from : (i) Ground-truths are scant for training, since collecting precise and dense labels in real scenarios is labor-intensive, existing synthetic datasets possess different characteristics comparing with natural

images. (ii) Neither reflection information nor multi-scale context is utilized to regularize the reflection/transmission decomposition.

In this poster, we take the physical polarization property of reflection light into account, thus mimic the attenuation of reflection under different incident and polarizer angles to synthesize more realistic and diverse training data. Furthermore, we integrate reflection information as guidance in training procedure and multi-scale convolution kernel selection units to enhance the neural network. The experiments show the newly constructed dataset and enhanced neural network improve the reflection removal results significantly.

## 2 OUR APPROACH

*Realistic dataset generation.* We first propose a more accurate physically-based dataset construction pipeline to enhance the verisimilitude and diversity of sythetic dataset. Two randomly selected images,  $I_R$  and  $I_B$ , are treated as reflection layer and background layer to compose the target image  $I$ . As shown in Fig. 1(right), placing a polarizer ahead of the camera, with incidence angle  $\theta$  and polarization angle  $\phi$ , the intensity of each pixel  $I(x)$  can be computed according to [Kong et al. 2013] as follows:

$$I(x) = \alpha(\theta, \phi) \frac{I_R(x)}{2} + (1 - \alpha(\theta, \phi)) \frac{I_B(x)}{2}$$

$$\alpha(\theta, \phi) = R_{\perp}(\theta) \sin^2(\phi_{\parallel} - \phi) + R_{\parallel}(\theta) \cos^2(\phi_{\parallel} - \phi) \quad (1)$$

$$R_{\perp}(\theta, \kappa) = \frac{\sin^2(\theta - \theta_t(\theta, \kappa))}{\sin^2(\theta + \theta_t(\theta, \kappa))}, R_{\parallel}(\theta, \kappa) = \frac{\tan^2(\theta - \theta_t(\theta, \kappa))}{\tan^2(\theta + \theta_t(\theta, \kappa))},$$

where  $x$  is the index of input images.  $\alpha(\theta, \phi)$  represents the mixing coefficient.  $\phi_{\parallel}$  is the angle for the orientation of the intersection line between the polarizer and the plane of incidence.  $R_{\perp}$  and  $R_{\parallel}$  are orthogonal decomposing coefficients of reflection light. Moreover, according to Snell's law, we use  $\theta_t(\kappa = \frac{1}{1.474}, \theta) = \arcsin(\frac{1}{1.474} \sin \theta)$ .

To promote the reflection/transmission decomposing capacity of the neural network, we discard the assumption that the intensity of transmitted light should surpass the reflected portion [Wieschollek et al. 2018], and utilize a more flexible formulation to adjust the

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