Variance-driven U-Net Training and Chroma-scale-based Multi-exposure Image Fusion

Chang-Woo Son, Young-Ho Go, Seung-Hwan Lee, Sung-Hak Lee *

School of Electronic and Electrical Engineering, Kyungpook National University

E-mail karl3203@knu.ac.kr, gyh7454@knu.ac.kr, hyo98120@knu.ac.kr, shak2@ee.knu.ac.kr *

Abstract— We propose a multi-exposure fusion framework that integrates variance-driven U-Net training which suppresses data imbalance and noise amplification. To further enhance visual fidelity, we introduce a chroma-map strategy that redistributes the ab channel chroma scale. Combining variance-driven learning with chroma-guided correction, the proposed method produces high-quality HDR synthesis with improved detail and faithful color reproduction while maintaining computational efficiency. Compared with Conv MSR, DSIFT_EF, DEM, and DBM, the results demonstrate improvements in preservation of detail.

I. INTRODUCTION

Traditional MEF methods rely on complex pipelines and long processing times. Deep learning approaches offer faster computation but often suffer from weight imbalance when high-quality datasets are scarce. We propose a U-Net-based MEF framework that dynamically adjusts training weights using the variance of patches generated by Random Crop, suppresses weight imbalance issues. In addition, chroma-scale information extracted from the CIE-Lab color space is redistributed to preserve the original color fidelity.

II. PROPOSED METHODS

Figure 1 illustrates the overall pipeline of the proposed method. During training, the output of the MITM[1] module, which provides superior tone-mapping performance but requires long processing time, is employed as the label. The variance of patches generated through Random Crop is used to assign learning importance. The larger the variance of the label patch, the more detailed information it contains, and the larger the difference in variance between the two input patches, the higher the learning importance. Consequently, the training weights are optimized by focusing on patches with more detailed information, and tone mapping performance in bright and dark areas with large exposure differences also enhanced.

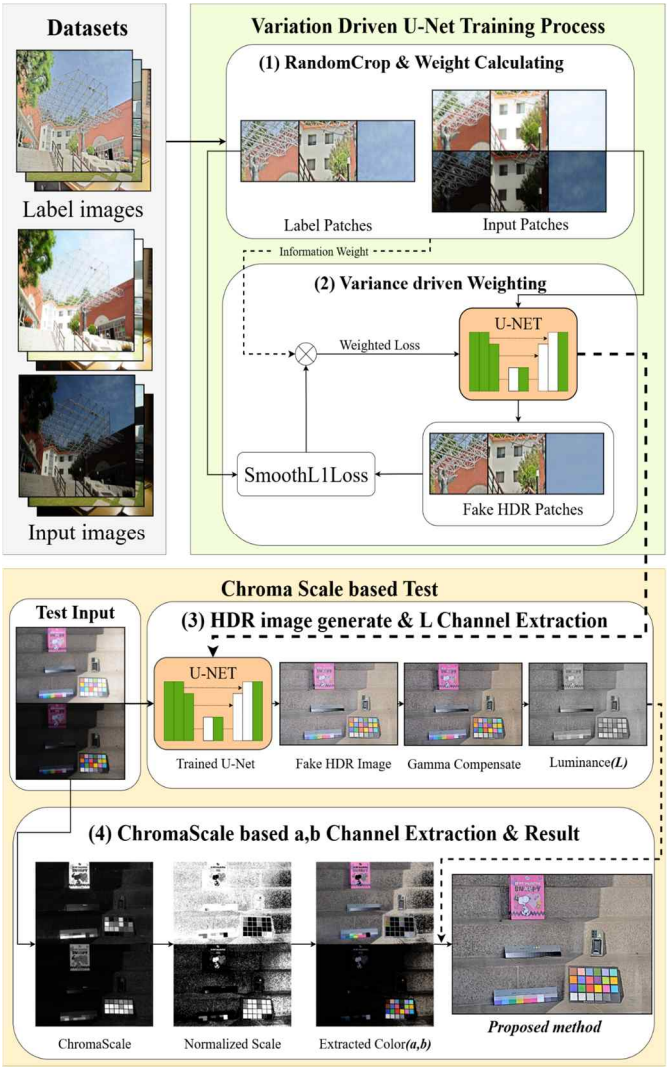

Fig. 1. Flow chart of proposed method.

During test process, the chroma scales of corresponding regions in the two input images are compared, and the ab-channel information is obtained either by selecting the color from the input with the larger chroma scale or by applying a weighted combination based on the chroma scale magnitude. In addition, gamma compensation is applied to the luminance channel of the U-Net output to enhance global contrast and improve the perceptual balance between bright and dark regions.

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III. TEST RESULTS

To evaluate the performance of the proposed image synthesis technique, Figure 3,4 illustrate comparisons with four models (Conventional MSR[2], DSIFT_EF[3],DEM[4],DBM[5]) using Figure 2 as input.

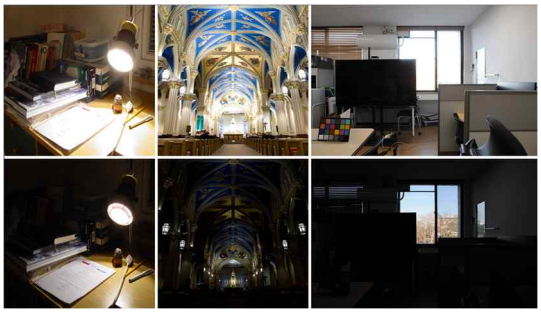
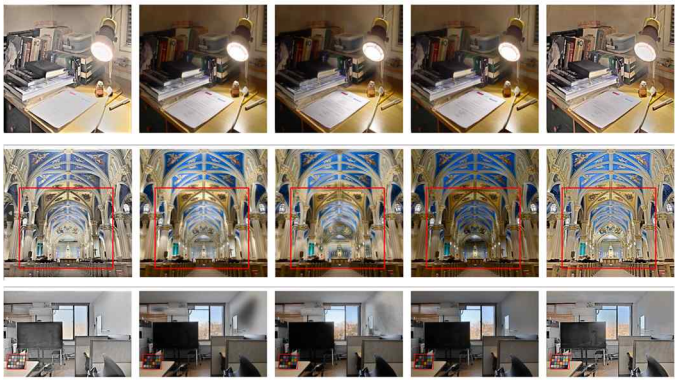
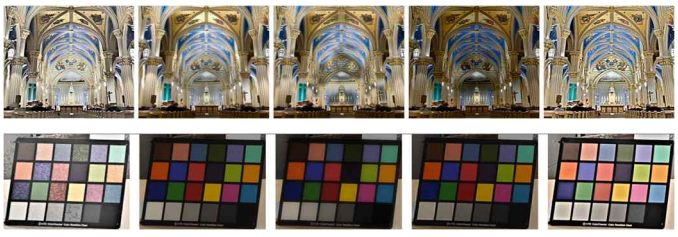


Fig. 2. Test input images : (top: high exposed, bottom: low exposed)



(a) (b) (c) (d) (e)

Fig. 3. Result images: (a) ConvMSR, (b) DSIFT_EF, (c) DEM, (d) DBM, (e) Proposed



(a) (b) (c) (d) (e)

Fig. 4. Region of interests in result images : (a) ConvMSR, (b) DSIFT_EF, (c) DEM, (d) DBM, (e) Proposed

IV. CONCLUSIONS

The proposed Chroma Based Mixture (CBM) significantly enhances local contrast and color reproduction in the output image by leveraging variance-difference-based U-Net training on two differently exposed inputs and incorporating the original image's geometric chroma distances. In future research, we aim to develop a device for filming and fusion of infrared band images and to develop a 3 Input MEF learning module by introducing multi exposure and multi band image fusion methods.

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