Optimal LED Spectral Multiplexing for NIR2RGB Translation (CVPR 2022)

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1 Brief Overview

The paper presents a novel approach for translating near-infrared (NIR) images into RGB images, focusing on night-time surveillance systems. The key contribution of the paper is the optimization of NIR LED multiplexing, which significantly improves the quality of NIR-to-RGB image conversion.

The authors propose a two-module framework: one for selecting the optimal LED spectral multiplexing (LSM) and another for translating NIR to RGB images using a GAN-based approach.

GitHub Repository: `https://github.com/dmitriharshit/IPR`

2 Dataset

Due to heavy computational requirements for IDH dataset. I have used CSS_ 13S2C ICVL dataset for training the model.

ICVL: A publicly available hyperspectral image dataset, primarily captured in outdoor environments. It is a public hyperspectral datasets. HSIs in ICVL are taken in sufficient light by using a Specim PS Kappa DX4 hyperspectral camera and a rotary stage for spatial scanning, and most of them are captured outdoors.

3 Testing

I used WSL for training the model on the CSS_13S2C dataset. When testing, the input NIR image is obtained under the selected LSM, and its corresponding RGB image will be obtained by feeding NIR one into the generator of translation module, which has already been trained in the former process.

The parameters of the RGB translation module are denoted by α. For the generator G in GANs, its objective has two parts: 1) L1 distance between the output of G and the ground truth; 2) MSE of the discriminator D's output with the correct judgment. Thus the objective $\mathcal{L}_t$ is written as:

$$\mathcal{L}_t(\alpha) = \frac{1}{T}\sum_{t=1}^{T} \|D(G_t(Y_t, \alpha)) - 1\|^2 + \lambda L_1(G_t(Y_t, \alpha), Z_t), \tag{1}$$

where G_t is the t-th output, Y_t is the corresponding selected NIR image from the LSM selection module. Z_t is the corresponding ground truth. λ is a predefined parameter.

The joint training of the entire network is by minimizing:

$$\mathcal{L} = \mathcal{L}_s(V) + \tau\mathcal{L}_t(\alpha), \tag{2}$$

where τ is a predefined hyperparameter. $\hat{Y}_t$ that corresponds to the selected optimal LSM has no need to be labeled in the joint training process, hence $\|\hat{Y}_t - Y_t\|^2$ can be ignored and we replace it with the largest value in V as the corresponding LSM. With this selection, the NIR image can be synthesized and be input to the translation module to obtain the RGB image.

4 Results

All the results and the checkpoints have been included in the result and checkpoints folder respectively. Results contain the NIR images, true RGB images and NIR to RGB model converted by model during testing.

In addition to that following are the optimal LSM ratio of ICVL using RVM technique. Values are all normalized and 0 denotes less than 10^{-4}.

LED	Wavelength (nm)													
	739	760	768	796	804	818	845	852	872	888	894	923	948	973
15SSC	0.24652361	0.3221459	0.28686695	0.057325322	0.02214592	0.01090129	0.0072103	0.00798283	0.00660944	0.00583691	0.00583691	0.00566524	0.00532189	0.00497854
13S2C	0.21955654	0.29454545	0.25281596	0.08201774	0.03771619	0.02170732	0.0127051	0.01405765	0.00977827	0.00891353	0.00891353	0.00953437	0.00993348	0.00953437
2113C	0.12352941	0.70588235	0.17058824	0	0	0	0	0	0	0	0	0	0	0

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