# High Dynamic Range Image Reconstruction via Deep Explicit Polynomial Curve Estimation


香港科技大學(廣州) THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY (GUANGZHOU)

Jiaqi Tang, Xiaogang Xu, Sixing Hu and Ying-Cong Chen*

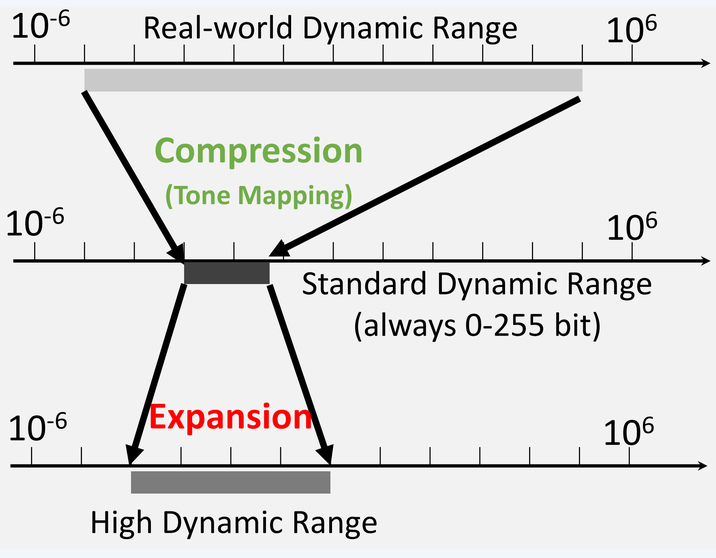
*Email: yingcongchen@ust.hk


Project Page | My LinkedIn

## Background

❑ HDR reconstruction

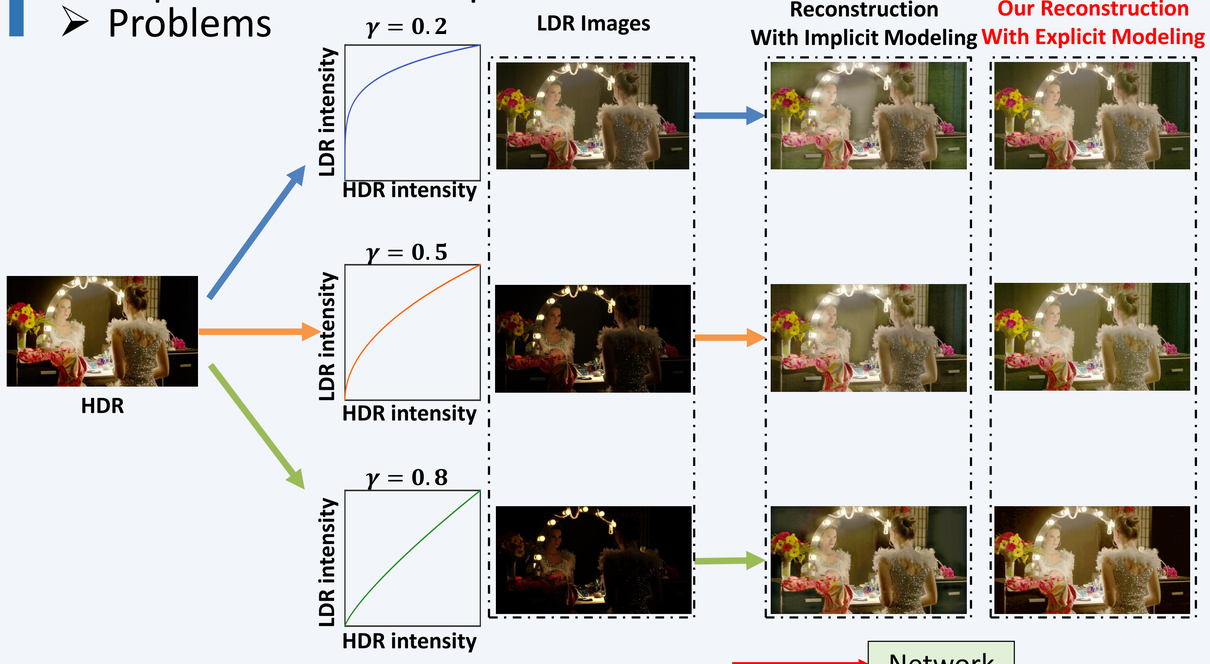
- ➢ To expend the dynamic range of image
- ➢ To reverse tone mapping function



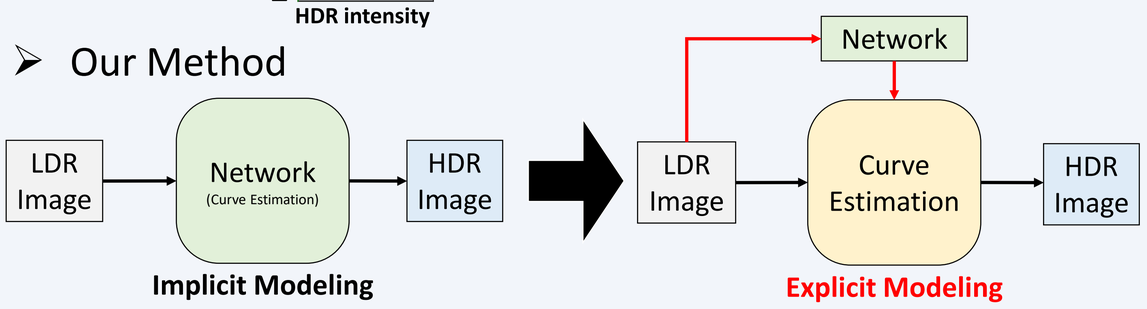

## Motivation

❑ Implicit Model vs. Explicit Model

➢ Problems




➢ Our Method




## Contribution

❑ We propose a new **framework** for explicitly modeling and estimating tone-mapping function parameters, which is capable of handling diverse tone-mapping functions, providing more accurate reconstructions in the process.

❑ We have constructed a new **dataset** specifically designed for this task, featuring a clear relationship between LDR images and their corresponding tone mapping functions.

❑ Our approach achieves **SOTA performance** in both synthesis and real dataset and clarifies a corresponding relationship between the tone-mapping function and the generated HDR image.

## Problem Formulation

❑ HDR-to-LDR conversion (Camera Pipeline):

$$L = \zeta(\tau(H))$$

LDR image | Other degradations | Tone mapping | HDR image

❑ Reversing HDR-to-LDR conversion:

$$H = \tau^{-1}(\zeta^{-1}(L))$$

❑ Two Goals:

- ➢ Reversing tone mapping function (Key)
- ➢ Removing other degradations

## Method

❑ Parameterizing the Tone-Mapping Function

What is structures of Tone mapping function?

❖ *Simple structure, monotonic or semi-monotonic curve.*

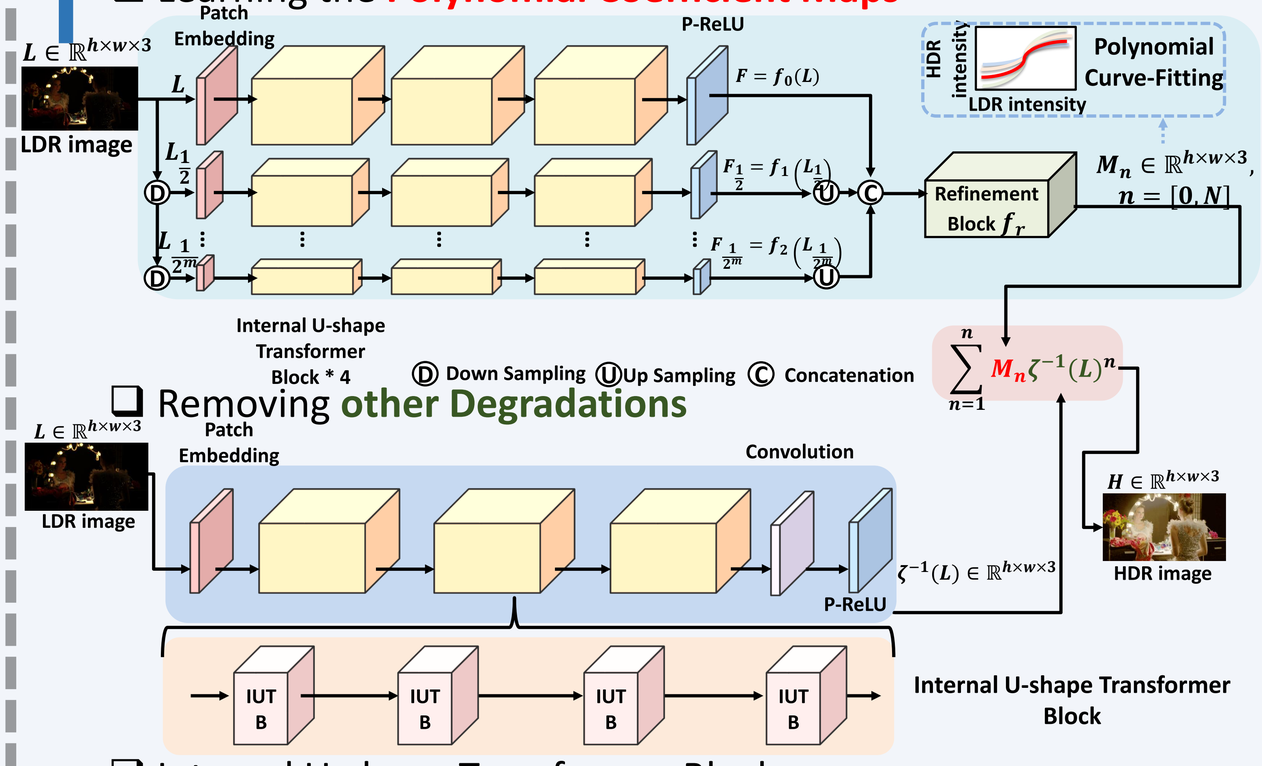
➢ To parameterizing it as a polynomial curve:

$$H = \tau^{-1}(\zeta^{-1}(L)) = \sum_{n=0}^{N} M_n \zeta^{-1}(L)^n$$

Polynomial Coefficient Maps (PCMs)

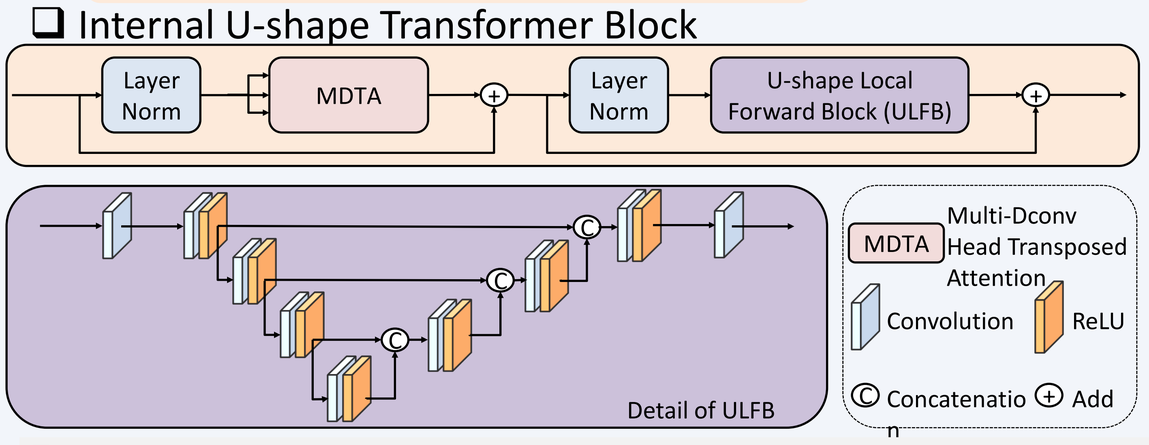
## Network Architecture

❑ Learning the **Polynomial Coefficient Maps**

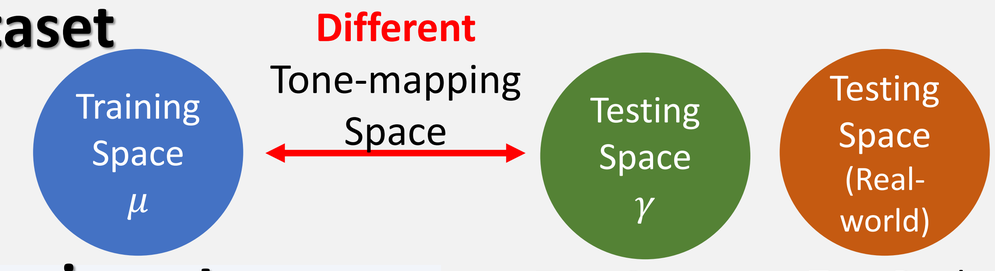



❑ Removing **other Degradations**

❑ Internal U-shape Transformer Block




## Dataset



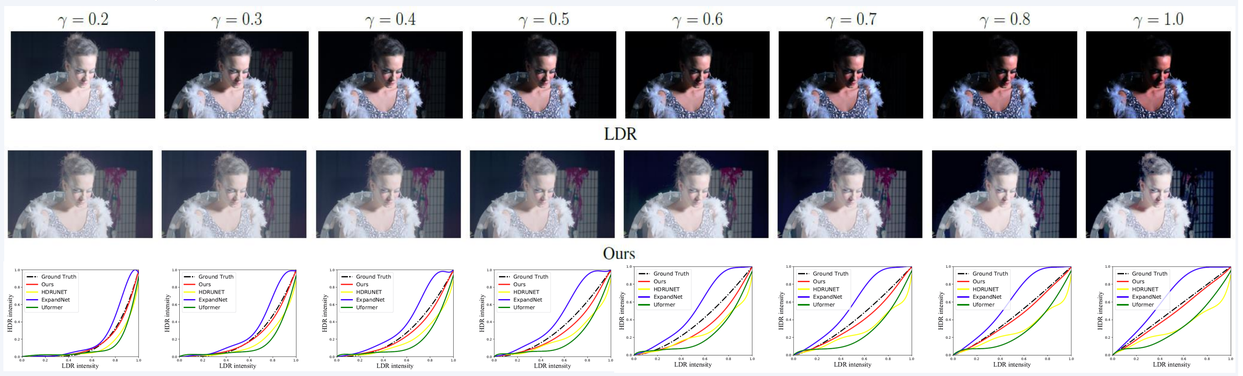

## Experiment

❑ Quantitative Comparison in Test-Real.

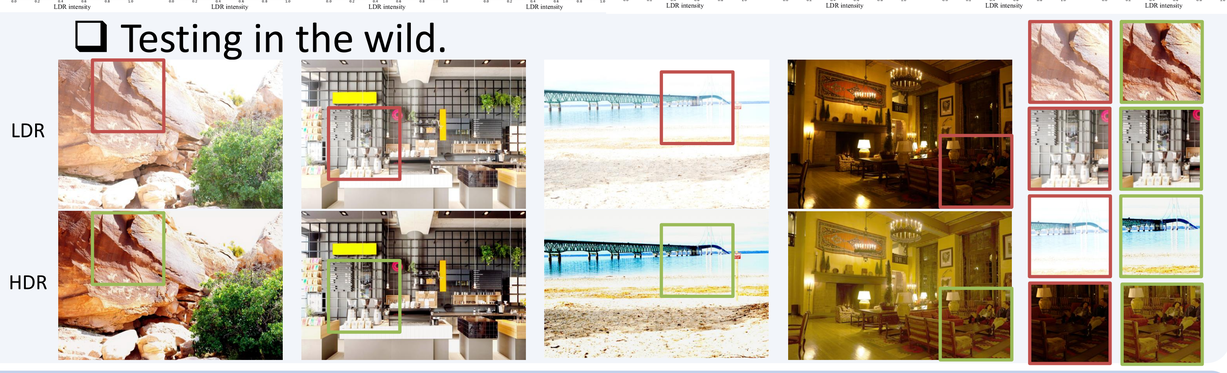
| | PSNR | $\mu$-PSNR | SSIM | $\mu$-SSIM | HDR-VDP-2.2 | AvgPSNR |
|---|---|---|---|---|---|---|
| ExpandNet [18] | 10.06 | 22.20 | 0.5203 | 0.6498 | 38.48 | 13.70 |
| HDRUNET [4] | 27.29 | 17.15 | 0.9337 | 0.6199 | 45.73 | 24.25 |
| Uformer [32] | 26.77 | 16.65 | 0.9109 | 0.6017 | 45.99 | 23.74 |
| Ours | 28.24 | 21.49 | 0.9406 | 0.6577 | 47.09 | 26.23 |

❑ Qualitative Comparison in Test-Real.


❑ Qualitative result and Curve Estimation in Test-Gamma.




❑ Testing in the wild.





**By Jiaqi Tang (HKUST(GZ) & HKUST)**

@ No.1 Du Xue Rd, Nansha District, Guangzhou

@ Clear Water Bay, Sai Kung, New Territories, Hong Kong



## Acknowledgement

This work is partially supported by National Natural Science Foundation of China (*No. 62206068*). Besides, part of this work belongs to Jiaqi Tang's undergraduate thesis at Northwestern Polytechnical University.