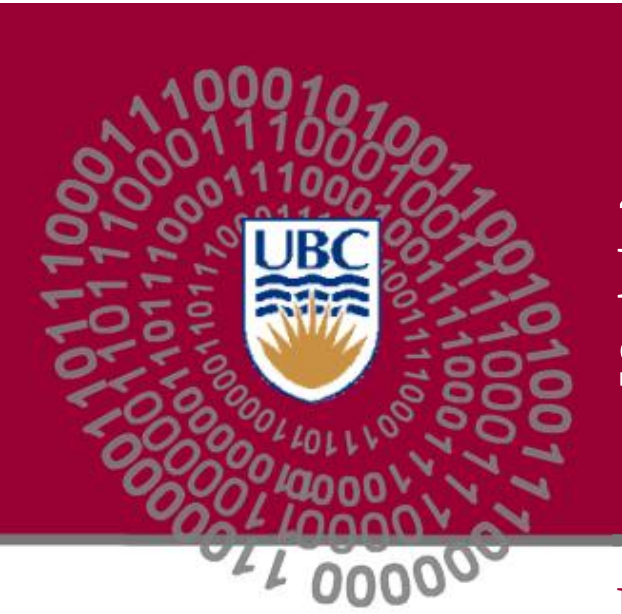

Zero-Shot Super-Resolution for Low-Dose CBCT Images Using Lightweight StereoMamba

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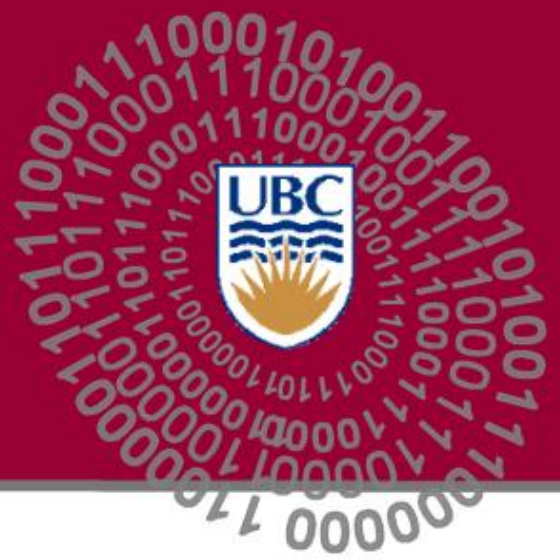
The University of British Columbia, Vancouver, BC, Canada

Date: May 20, 2025

Outline

1. Introduction
2. Challenge
3. Our Method
4. Results & Discussion
5. Conclusion

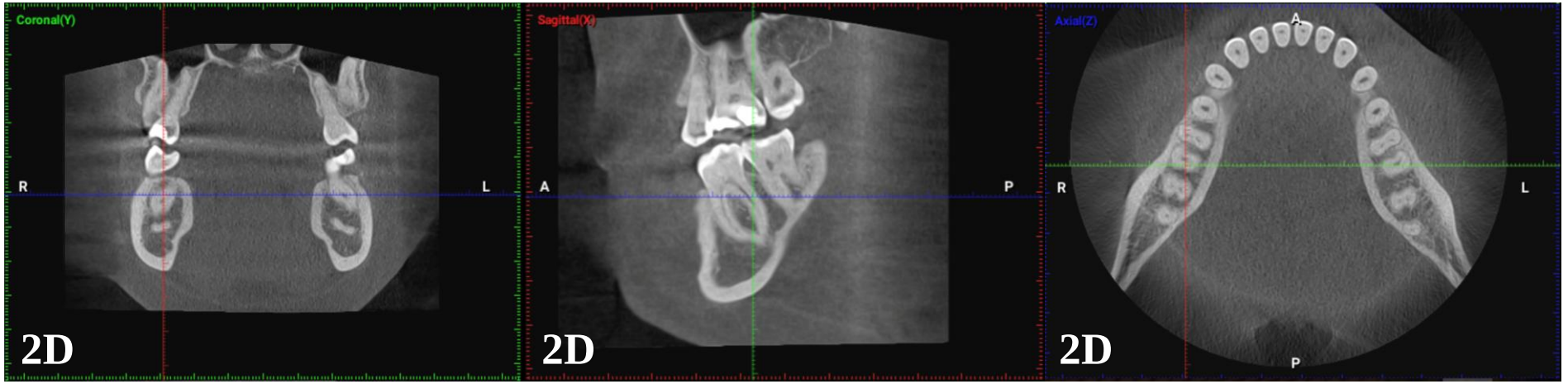


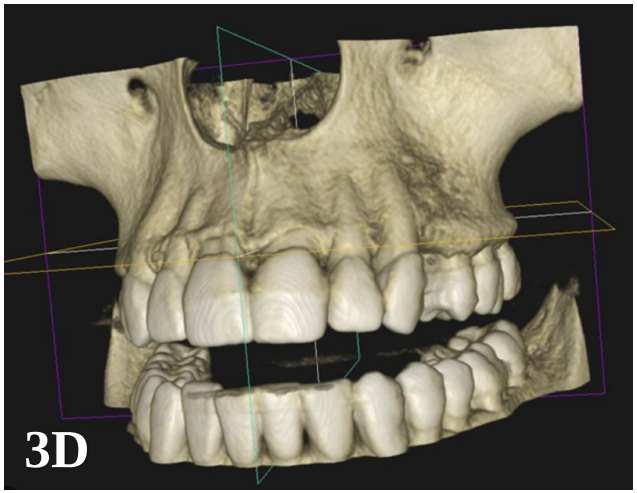
Introduction

Introduction to CBCT Technology

- An advanced imaging technique in dentistry

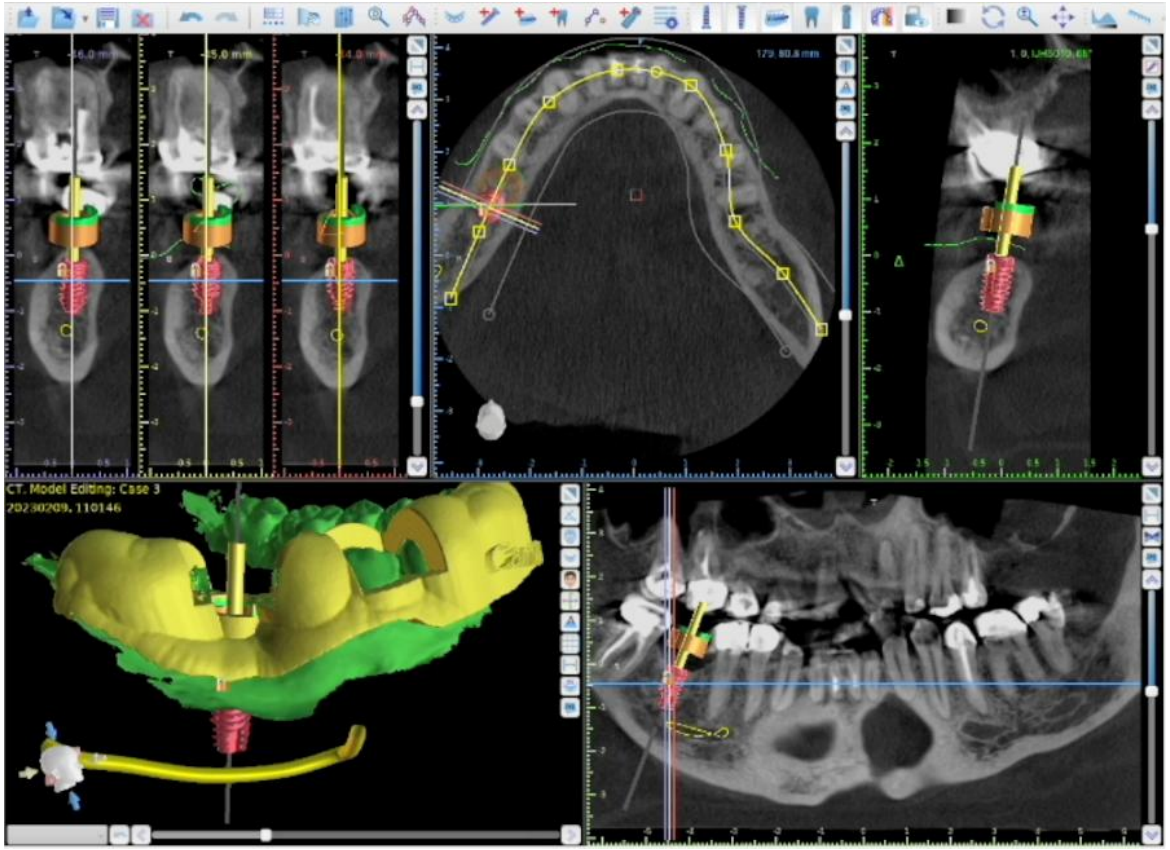
Introduction to CBCT Technology

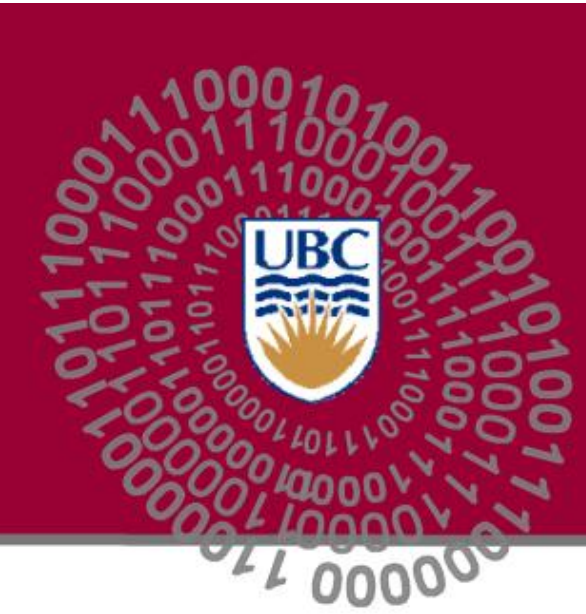




Introduction to CBCT Technology

- **Implant placement and surgery planning using CBCT images**





Challenge

Challenge

What is the main challenge?

High radiation exposure for high-quality images ⇒ **Higher risk of radiation-induced cancers**

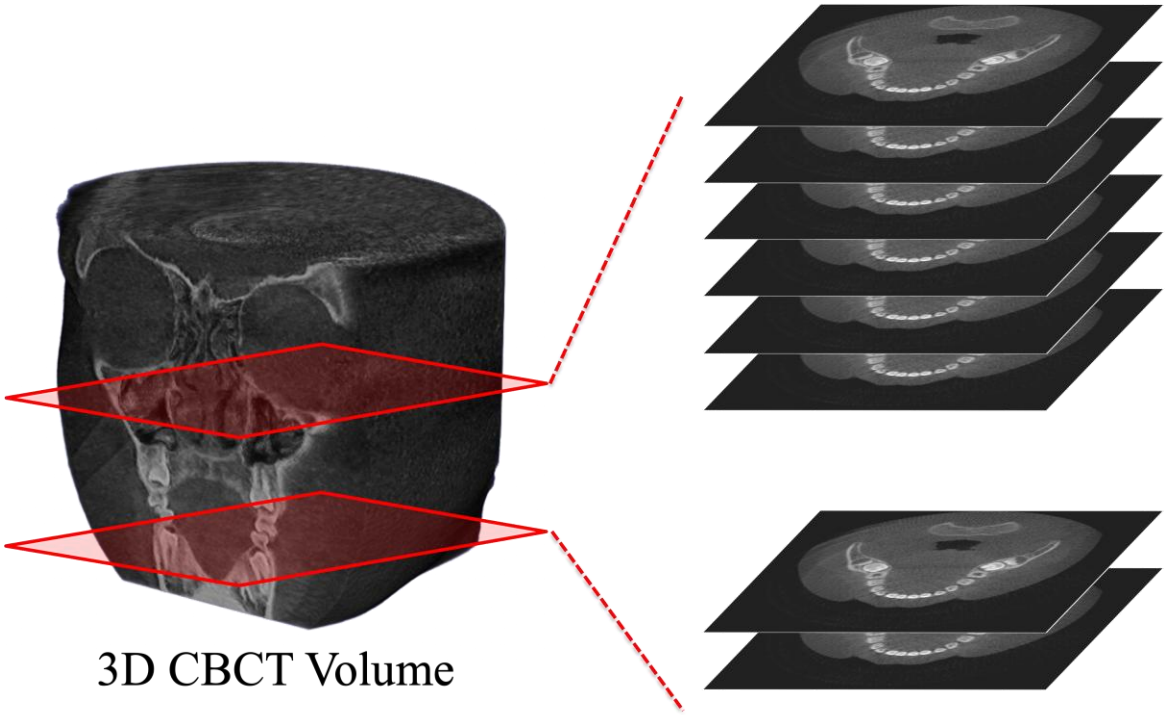
Industry Solution

Reduce radiation exposure for patient safety ⇒ **lower visual quality, and limited resolution** ⇒ ? **How can we enhance the spatial resolution of low-dose CBCT images?**

Challenge

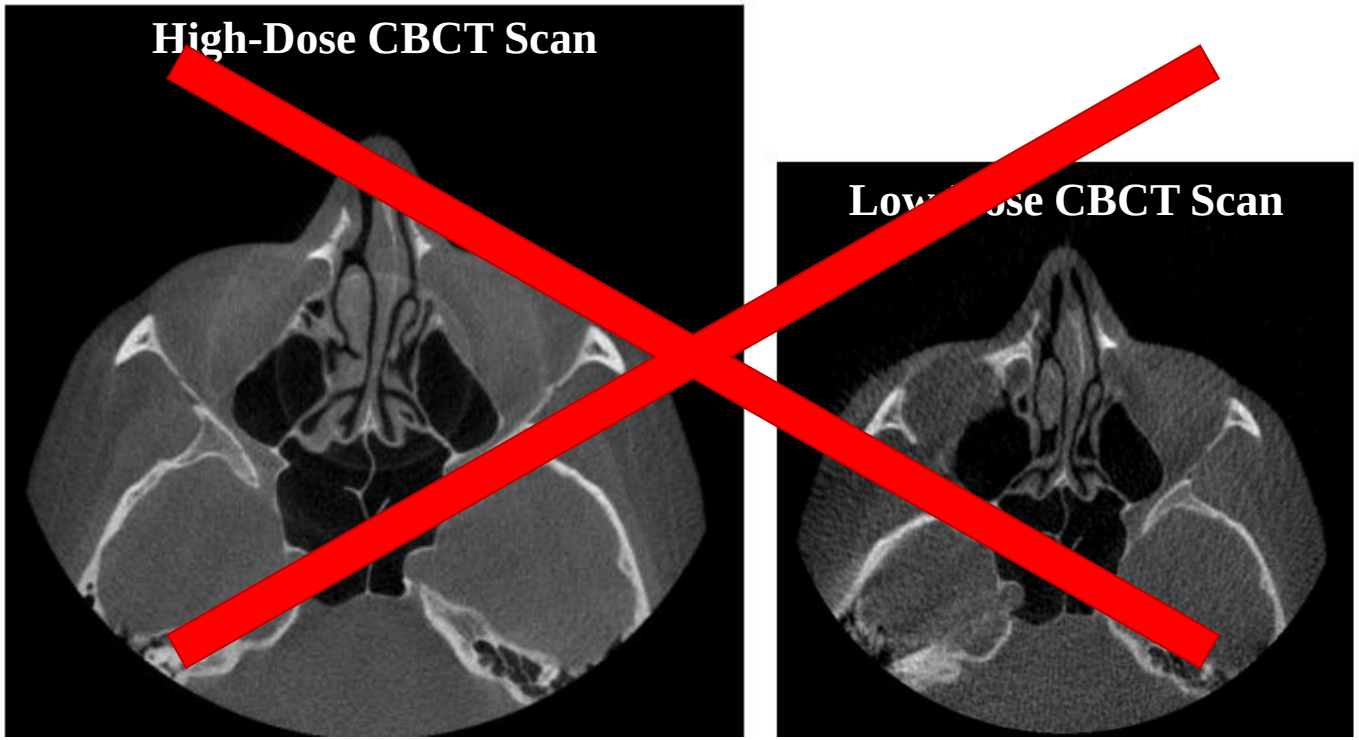
- ~~Single-image super-resolution methods~~ too simplistic
- Multi-image super-resolution methods ✓

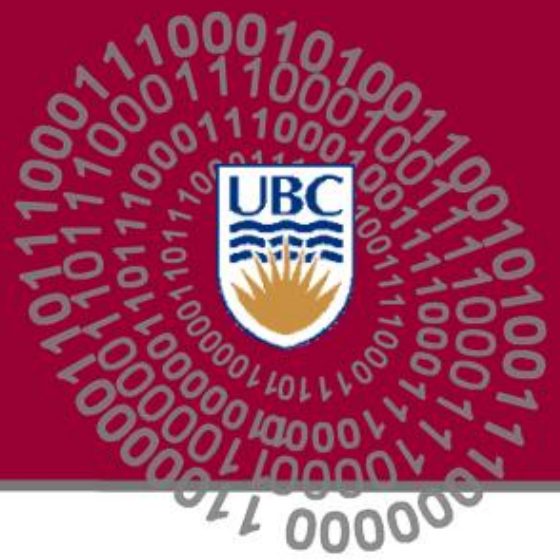
Inter-slice & intra-slice information



Challenge

- **No real-world paired CBCT dataset for training the neural networks**

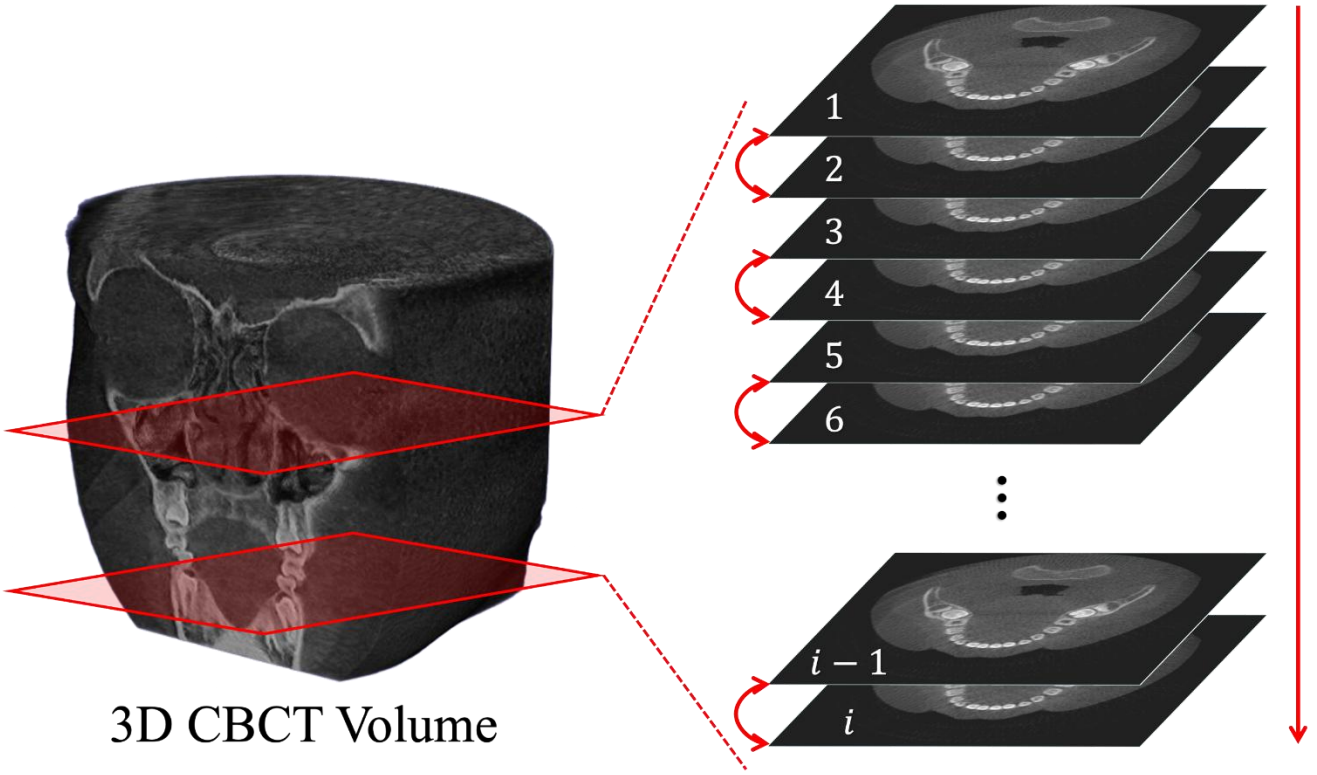




Our Method

Our Method

- **Leveraging both inter-slice and intra-slice information for resolution enhancement**



Our Method

Results of our comparative analysis of existing Single-Image Super-Resolution (SISR) & Stereo-Image Super-Resolution (SSR) methods

Zero-shot learning strategy applied to pretrained networks

	Method	#S	#Params	PSNR	SSIM
SISR	SwinIR	x2	11.28M	36.32	0.9849
SSR	NAFSSR-T	x2	0.45M	36.72	0.9865
	NAFSSR-S	x2	1.54M	36.65	0.9859
	NAFSSR-B	x2	6.77M	36.47	0.9857
	NAFSSR-L	x2	23.79M	36.08	0.9846
	StereoMamba	x2	7.55M	35.88	0.9840

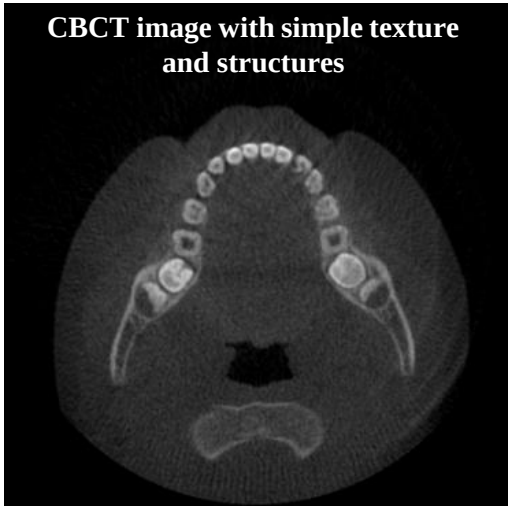
→ **The most promising architecture**
But worst generalizability

Our Method

Results of our comparative analysis of existing Single-Image Super-Resolution (SISR) & Stereo-Image Super-Resolution (SSR) methods

Zero-shot learning strategy applied to pretrained networks

Why does StereoMamba have the worst generalizability?

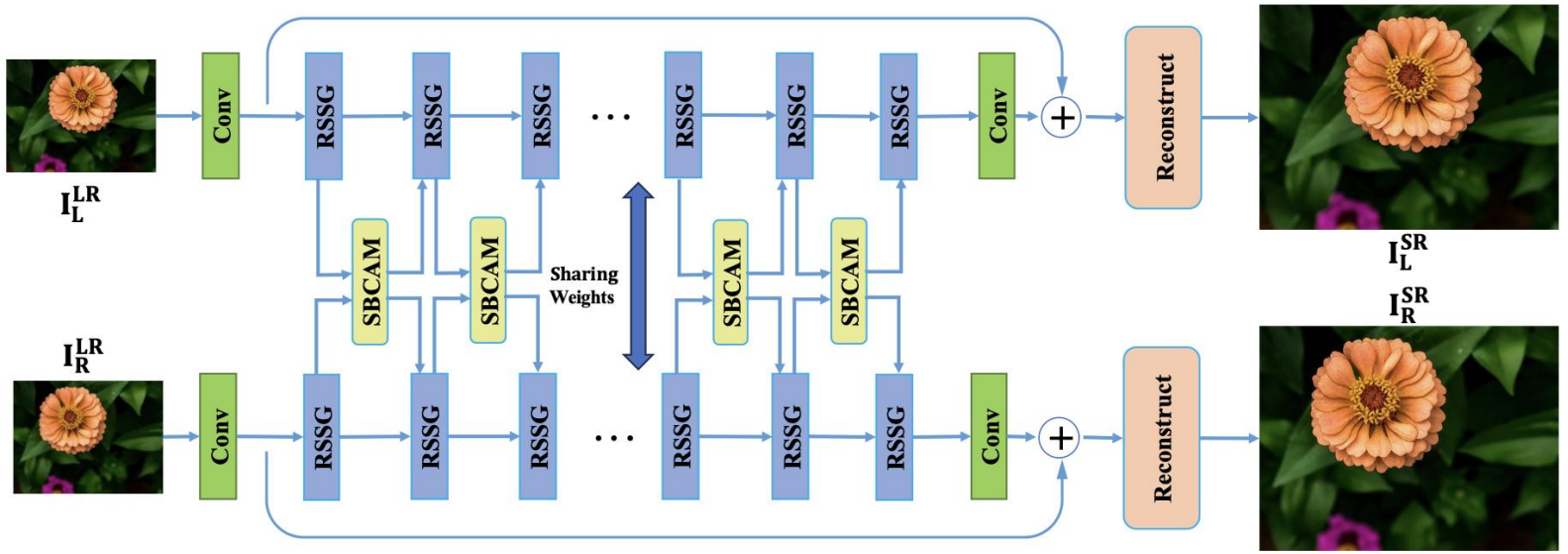


Forcing large, complex models to overfit to dataset-specific details and amplify noise

Our Method

Complexity reduction in StereoMamba → **A lightweight version without memorizing dataset-specific details** → **More robust feature extraction**

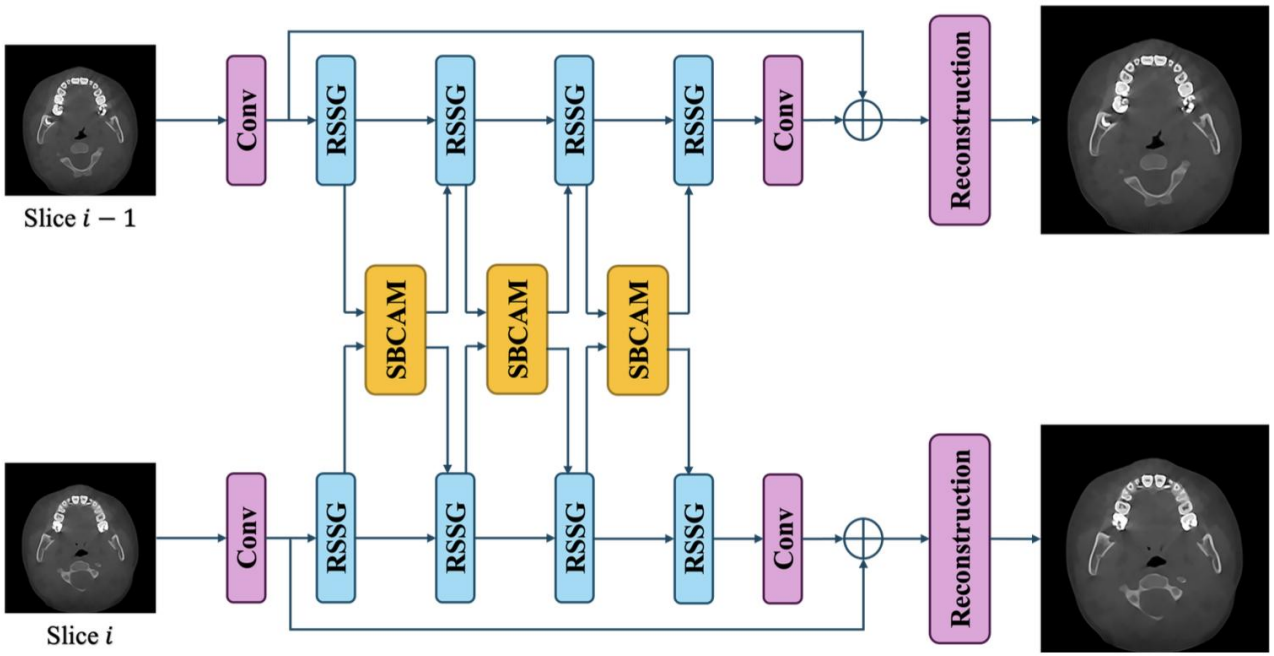
Original StereoMamba:

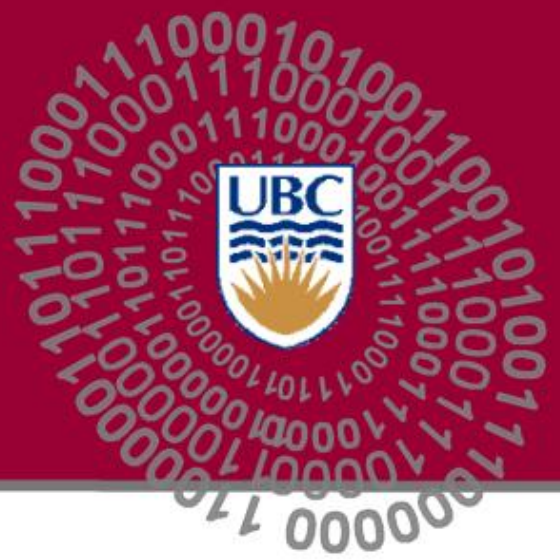


Our Method

Complexity reduction in StereoMamba → **A lightweight version without memorizing dataset-specific details** → **More robust feature extraction**

StereoMamba-Light:





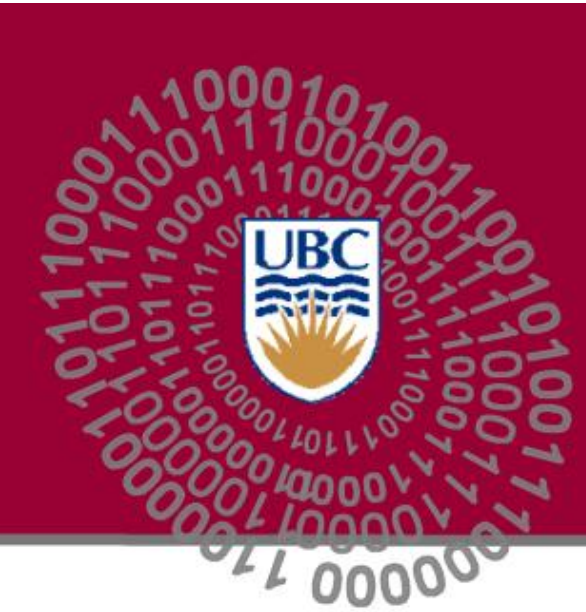
Results & Discussion

Results & Discussion

StereoMamba-Light outperforms all existing SISR and SSR methods.

- lighter models are more robust to domain shifts from RGB to grayscale CBCT images
- Avoid overfitting by focusing on fundamental spatial features rather than dataset-specific variations

	Method	#S	#Params	PSNR	SSIM
SISR	SwinIR	x2	11.28M	36.32	0.9849
SSR	NAFSSR-T	x2	0.45M	36.72	0.9865
	NAFSSR-S	x2	1.54M	36.65	0.9859
	NAFSSR-B	x2	6.77M	36.47	0.9857
	NAFSSR-L	x2	23.79M	36.08	0.9846
	StereoMamba	x2	7.55M	35.88	0.9840
	StereoMamba-Light	x2	**0.9M**	**38.03**	**0.9886**



Thank you for listening!