BoneMet: An Open Large-Scale Multi-Modal Murine Dataset for Breast Cancer Bone Metastasis Diagnosis and Prognosis

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Overview

We introduce BoneMet: the first AI-ready, large-scale, high-resolution, open-source, and multi-modal murine medical dataset focusing on breast cancer bone metastasis (BCBM) foundation AI models.

- Spanning **5 years** (2019–2024).
- Compiling from **> 600** murine across **5-week longitudinal scans** over the span of breast cancer metastasis from early-stage to failure.
- Containing over **67 terabytes (TB)** of **spatial-temporal-aligned multi-modal** data:

A. Image modalities:

- *2D Rotation X-Ray (260 projections / mouse)*
- *4 3D CT volumes (Recon-CT, Seg-CT, Regist-CT, and RoI-CT)*

B. Text modalities:

- *Medical records (Pre-Op & Post-Op)*
- *Quantitative analysis*

- Supporting at least **6** breast cancer bone metastasis applications.
- Streamlining medical image data preprocessing with **3 open-source APIs** for segmentation, registration & RoI cropping.
- Releasing **first real-world paired radiograph/CT** resource—enables sparse-angle CT reconstruction.

Motivation & Challenges

Motivation

- Breast cancer **is the most common** non-skin cancers in women.
- Bone metastases **dramatically reduce 5-year survival** and cause severe pain, immobility and pathologic fractures.

Challenges

- Manual medical image preprocessing and analysis are *time-consuming*.
- Existing public X-ray/CT datasets are *low resolution, inadequate and noisy diagnosis labels, limited of dataset sizes,* and *lack of diverse modalities*.
- *No real-world paired* radiograph-CT dataset is available to enable sparse-angle CT reconstruction.

Ground Truth X-ray

Simulated X-ray

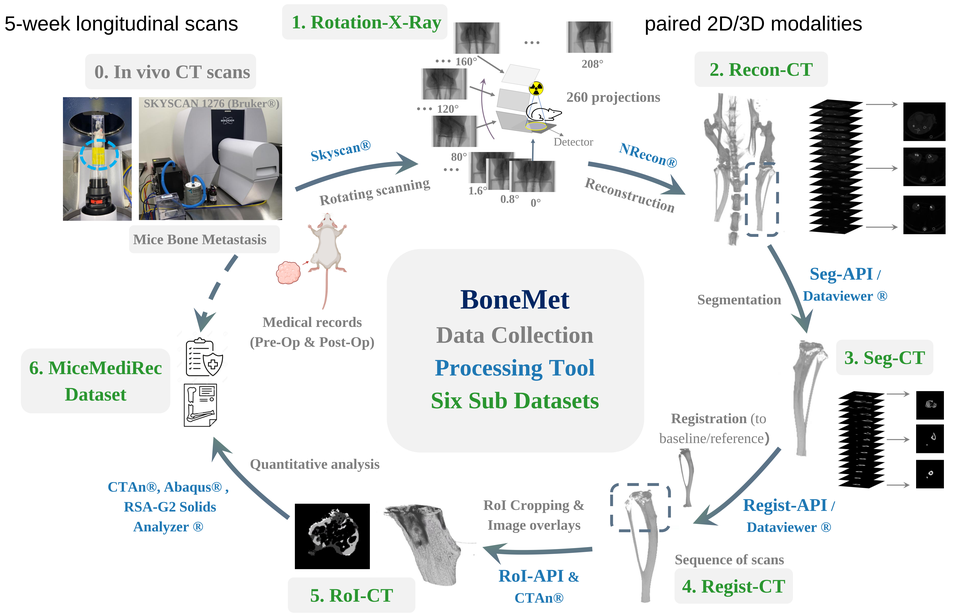
To date, existing paired X-ray/CT datasets are generated through simulation like digitally reconstructed radiographs (DRRs), rather than acquired from real, spatially aligned imaging.

DCMR Delaware Center for Musculoskeletal Research

NIH

Paper Code Dataset Contact

Dataset



Our dataset is compiled from over **600** murine across **5-week longitudinal scans** (just one week shown in the figure above), spanning **5 years** with diverse physiological characteristics. It contains **3 components: 1) 67 TB data-collection workflow**, **2) 3 APIs** as processing tools for **workflow automation** (e.g., tibiae segmentation, registration (alignment), and region of interest (RoI) cropping), **3) 6 sub datasets** with **paired 2D/3D modalities** : 1 of which is **2D X-ray** with **260 rotational projects** for each mice, **4** are **3D CT** composed by 2D cross-section slices, and **1 is compiled and annotated by human experts** serving as the **ground-truth labels** (e.g., cancer or non-cancer) and **biological records** (e.g., pre-op records including diagnosis (bone lesions), treatment (chemo, radiation therapy, and placebo control) and post-op quantitative analysis).

Experiments & Results

1. **Spatial** (260 projections)–**temporal** (5 weekly scans) **aligned (STA)** Rotation-X-Ray dataset for BCBM early diagnosis

Table 1:BCBM diagnosis on the Rotation-X-Ray dataset.

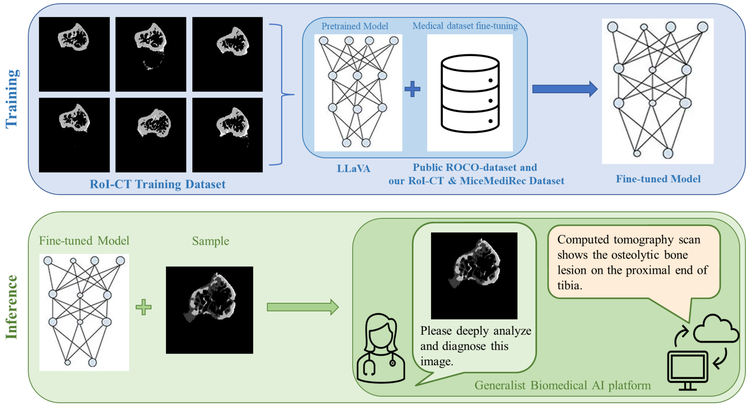
Methods	Training				Test			
	Precision	Recall	F1-Score	Accuracy	Precision	Recall	F1-Score	Accuracy
ViT (w/o STA)	99.6	99.7	99.7	99.5	92.3	80.5	86.0	79.1
ViT (w/ STA)	95.4	96.9	96.1	95.0	92.1	90.6	91.3	89.0

Observation:

- Dataset effectiveness has been validated through both self-supervised pretraining and supervised fine-tuning.
- Spatial-temporal alignment mitigates overfitting and enhances model generalizability.

Experiments & Results (continue)

2. Multi-modal Generative AI (GenAI) and Large Vision Models (LVM) for accurate diagnosis of BCBM



3. Sparse-angle CT reconstruction using our **real-world paired** 2D Rotation-X-ray & 3D Recon-CT dataset

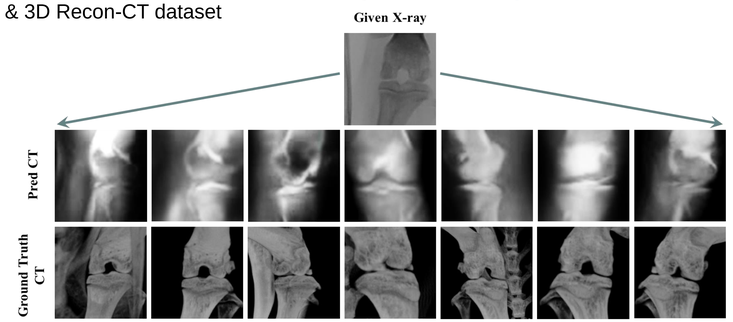


Table 2: Quantitative evaluations of sparse-angle CT reconstruction

Methods	PSNR (↑)	SSIM (↑)	FID (↓)	KID (↓)
PixelNeRF	20.2	0.740	155.2	0.128
MedNeRF	30.2	0.810	91.5	0.092

	Multi-projections with known angle	Ground Truth	High resolution
Exist paired X-ray/CT datasets	✗	Simulated	✗
Ours	✓	Real	✓

Clinical Relevance & Broad Impact

- *Mimics disease progression.* Murine model captures micro- to macro-scale metastatic evolution, filling the gap in human data of longitudinal imaging of cancer progress, and providing a testing benchmark for BCBM disease management.
- *Pre-clinical relevance.* Murine imaging data is validated as a surrogate for human metastasis, making our BoneMet dataset enabling sparse-angle reconstruction algorithms to convert a single human radiograph into CT for clinical applications.