Spatial Mapping and Detection of Ductal Carcinoma In Situ and Invasive Breast Carcinoma on Faxitron Radiographs

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Introduction

- **Breast cancer** is a common and deadly disease.
- **One woman in eight** will develop invasive breast cancer over her lifetime.
- Resulting in an estimated 281,550 new cases and 43,600 deaths among women in the US in 2021.
- **Neoadjuvant chemotherapy** is used to treat breast cancers before surgical excision, which helps reduce
  - The risk for distant recurrence
  - The extent of surgery
  - Post-operative complications
- Presence and extent of residual invasive cancer is a strong prognostic factor for risk recurrence.
Introduction
Pathology Workflow

Patient Screening Mammography

Diagnostic MRI, biopsy, etc.

Treatment Cancer or High-risk Lesion
Chemotherapy and Surgery

Excised Tissue

Pathology Selection
Analysis

X-ray Imaging (Faxitron)

Stanford Pathology Workflow

Objective

• Integrate radiology and pathology information to streamline pathology workflow.

• Automatic identification of invasive and in situ carcinoma on faxitron radiographs of excised tissue using AI methods.

• Allows pathologists to select regions with high likelihood of invasive cancer for histologic evaluation more accurately and efficiently.

• Use pathology data to create accurate ground truth labels on faxitron radiographs for training the detection model.

• Register histology and faxitron data in order to map the labels (invasive and in situ carcinoma) from histopathology onto Faxitron images.
This study includes data of 100 women including Faxitron radiographs showing all gross sections of the excised tissue and partial or fully corresponding histopathology slides.
Step 1
Create accurate spatial ground truth labels of DCIS and IBC on Faxitron radiographs.

Data Preparation
Save raw data of all sections including faxitron and histopathology images.
Data Preparation
Faxitron Labeling and Segmentation
User Interface for Data Preparation

- Original Labels
- Original Borders
- Extracted Annotations
Step 1

Data Preparation
- Histopathology Images
- Faxitron Images

STEP 1

Preprocessing
- Fixed Image
- Moving Image

Registration
- Metric
- Interpolator
- Optimizer
- Transform Parameters

Transformed Image
- DCIS
- IBC

Labels
- DCIS
- IBC

Histopathology Mapped onto Faxitron

Labels
- DCIS
- IBC

Preprocessing

DCIS
IBC

Transform

Transform Parameters

Registracion
Step 1
Registration Preprocessing

Fixed Image

Moving Image

Rotate

User Interface
User Interface for Registration Preprocessing
Step 1
Registration Results

Performed 2D affine transformation between images of different modalities using the multi-resolution framework with a three-tier pyramid.

Preliminary registration results of Faxitron and histopathology images based on affine transforms. A) Fixed image, B) Moving image (preprocessed), C) Overlayed representation of registration result and corresponding landmark distance errors.
Step 1
Registration Challenges